SECURITY STRATEGIES APPLICABLE IN RESOLVING TRAFFIC CONGESTION IN CITIES, CASE OF JOGOO ROAD, NAIROBI CITY COUNTY, KENYA

BY

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REG. NO. C160/38915/2016

A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF AWARD OF THE DEGREE OF MASTER OF ARTS IN LEADERSHIP AND SECURITY MANAGEMENT IN THE DEPARTMENT OF SECURITY AND CORRECTION SCIENCE, SCHOOL OF DIPLOMACY, SECURITY AND PEACE STUDIES OF KENYATTA UNIVERSITY

NOVEMBER 2018

DECLARATION PAGE

This project is my original work and has not been presented for a degree in any other university or for any award.

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This project has been submitted to the graduate school for registration with my approval as University supervisor.

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DEDICATION

This research project is dedicated to my family and the Kenya National Police Service fraternity who provided the time and support for its completion.

ACKNOWLEDGEMENT

ABSTRACT

Road traffic congestion is a major issue of concern owing to its impact to the lives of people, the economy and the environment at large. Traffic congestion is a problem of the modern society that has come with urbanization. It has been predicted that the problem will get worse if mechanisms and best strategies are not put in place in time to manage it. In the City of Nairobi, Kenya, studies and mechanisms that have been undertaken have not solved the problem of road congestion whereby it has remained persistent. This research study therefore examined security strategies that could be applied to manage road traffic congestion in the city of Nairobi, Kenya. The site of Study was Jogoo Road which is one of the major roads in Nairobi city leading to the city centre and other crucial areas such as the industrial park. The study was guided by Transportation Engineers and Planners model of Cambridge systematics which focuses on three main perspectives of managing road supply, managing demand for vehicle use and improving the efficiency in the use of available network resource. The study employed mixed method design in which phenomenological and exploratory survey designs were undertaken. The study targeted stakeholders in the transport industry which included the study site road users and administrators. Sampling techniques used included cluster sampling, porposive stratified sampling as well as convenience sampling for the various groups who participated in the study. Questionnaires and interviews were the main tools that were used in data collection. The findings from both qualitative (interviews and quantitative (questionnaires) were triangulated to enhance the findings. Qualitative data was analyzed thematically guided by the objectives of the study. Quantitative data was analyzed using a descriptive statistics software, SPSS. Qualitative data was presented in quotes while quantitative data was presented in tables and graphs. The findings of the study showed that traffic congestion on Jogoo Road is a result of several contributory factors. These factors all lie within the boundaries of supply (network overload), demand and efficiency related factors. Accordingly, supply related contributors to congestion on Jogoo Road include road narrowness (19%), inadequate public service vehicles(17%), bumps (16%) and inadequate feeder roads (16%). Demand related contributors include large number of different road users(28%), pedestrians crossing the road (23%) and large number of vehicles during peak (25%). Efficiency related contributors included poor urban planning ((21%), inadequate enforcement (29%), poor incident management (20%), poor attitude (indiscipline) (21%) and defective traffic lights (19.4%). These deficiencies posed security issues as road users flouted traffic rules making it difficult for traffic police to enforce the laws. The strategies applicable in resolving congestion on Jogoo road according to the study findings included Road network supply strategies ; construction of lanes for use by other road users such as hand cart pullers and bicyclists (16%), Construction of more footbridges (15%), redesigning road junctions to allow for smooth entry and exit (15%), construction of lanes for heavy commercial vehicles (15%), enhancing the use of HOVs and railway system (13%), introduction of advanced road designs that need less space such as overhead roads (13%) and increase parking spaces and bus stop points on the road (13%). Road Travel demand management strategies entailed reducing cost of alternative transport means (24%), introduction of toll charges (22%), and introduction of charges targeting private car owners during peak hours (20%), increase charges on fuel levy ((18%)and increasing the cost and charges of private cars importation (16%). Operating existing road capacity more efficiently according to the study findings will be achieved by enhancing the use of mass media in providing real time information about roads status (21.6%), enhancement of the use of ICT in traffic matters (21.1%), enhanced use of smart phone apps (20.7%), improvement of traffic flow control by both Traffic officers and traffic lights (20%), strengthen enforcement and introduce laws that alter traveler's behavior(16.8%). The study recommends the use of the three prong approach of supply, demand and efficiency management in resolving congestion, advanced techniques in road construction such as overhead roads, stakeholder involelement in finding best strategies, sound legislation to control number of vehicles and behavior, and lastly enhancing the use of ICT to manage road traffic matters.

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DEFINTION OF TERMS

Bottleneck :   A narrow section of road or a junction that impedes traffic flow.

Efficiency improvement: It involves putting in place mechanisms and measures that are going to

enhance performance of existing road networks. It is usually cheaper

and faster than developing new networks altogether.

Interchange :   A road junction designed on several levels so that traffic streams do not

intersect.

Intersection :   A point at which two or more roads intersect, especially road.

Network supply: Supply involves increasing the number and sizes of roads and highways and

expanding transit and freight rail service.

Resolve :   Settle or find a solution to a problem, dispute, or contentious matter.

Security: This is freedom from, or resilience against, potential harm or other unwanted

external forces.

Strategy: A plan of action or policy designed to achieve a major or overall aim.

Traffic congestion :   Traffic congestion is a temporal condition on road networks that occurs as

utility and demand increases. It is characterized by slower speeds, longer

trip times, and increased queuing.

Transit time: The time necessary to travel a given distance

Vehicle demand: The urge and willingness of using vehicles in transportation

ABBREVIATIONS AND ACRONYMS

CBD: Central Business District

CFI: Continuous Flow Intersection

ECMT: European Conference of Ministers of Transport

FGD: Focus Group Discussion

IC3 :   Integrated Command and Communication Centre

ITS: Intelligent Transportation System

KENHA: Kenya National Highways Authority

KIPPRA: Kenya Institute for Public Policy Research and Analysis

KNPS: Kenya National Police Service

NTSA: National Transport and Safety Authority

NACOSTI: National Commission of Science, Technology and Innovation

OECD: Organization for Economic Cooperation and Development

PSV: Public Service vehicle

RU: Road User

TDM: Travel Demand Management

TMC: Transportation Management Center

TSM&O: Transportation System Management and Operations

TUDA: Transport and Urban Decongestion Authority

UK :   United Kingdom

VTPI: Victoria Transport Policy Institute

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Transportation is an activity of life that provides access to various services, goods and activities that satisfy mobility needs of mankind (Arasan, 2012). Among the many forms of Transport road transport is most common (UK Road Use Statistics, 2016). However, a major hiccup of road transport today in many cities and urban areas is congestion. Traffic congestion is a problem in cities of both developed and developing countries the world over yet it is predicted that it will get worse in the future (Godavarthy and Russell, 2015). This may be due to upsurge in world population and developmental growth. According to Meyer (1997) traffic congestion can be viewed from two main opposing perspectives. First it can be considered as an indicator of economic growth and as long as we live in urban areas we are prone to experience this problem. In the second perspective it can be considered as a poor planning problem. However, whichever perspective, road traffic congestion has become a major challenge to many cities both developed and developing, globally today.

In many developing economies the problem of traffic congestion was uncommon. Today it is no longer a rush hour problem but has become an all day and weeklong problem. At least the developed countries have put in place mitigation mechanisms for dealing with congestion (Arnot and Timann, 2005). This is unlike underdeveloped and developing countries which are still grappling with the problem. In developing countries, most cities often suffer from chronic

highway congestion, echoed by poor mobility and accessibility, significant economic waste, adverse environmental impact and safety problems (Litman, 2005).

According to Organization for Economic Co-operation and Development (OECD), (2007) report there is no universally accepted definition of road traffic congestion. This is so due to the fact that congestion is both a physical and a relative phenomenon. As a physical phenomenon traffic congestion can be defined as situation where demand for available road space exceeds supply. This consequently results to slower speed, longer trip times and increased motor vehicular queuing. The slower speed or longer trip times affects people and the entire society in different ways. For example, the longer the people stay on the roads the fewer hours they spend on productive and constructive work. This impacts the economy negatively. Similarly in case of an emergency it is unlikely that rescue exercises will be achieved in time due to delays on the road. The slow pace at which vehicles move has thus negative effect on the society at large. On the flip side, as relative phenomenon, traffic congestion is seen as the difference between road performance and road user's expectations and desires (Thomson, 2010). This could imply that people usually buy vehicles or use vehicles as a faster means of transport. However due to traffic congestion they incur delays that they neither expected nor desired. This interferes with people's plans in various ways making it difficult for them to achieve their daily individual, family or societal goals. Traffic congestion is a condition on road networks that comes about when use of roads increases. Research cannot fully predict under which conditions traffic congestion (as opposed to heavy, but smoothly flowing traffic) may suddenly occur. Nevertheless, it has been found that individual incidents such as accidents or even a single car braking heavily in a previously smooth flow may cause ripple effects which may then spread out and create a sustained "traffic jam" when, otherwise, normal flow might have continued smoothly. (Beaty, 1998).Within

the Great Britain the inevitability of congestion in some urban road networks was officially recognized when the Department for Transport set down policies based on the report "Traffic in Town" (Eddington, 2006). The report noted that even when everything that could possibly be done like building of new roads and expanding public transport, there would still be, in the absence of deliberate limitation, more cars trying to move into, or within our cities than could possibly be accommodated by the road network. The Department for Transport sees growing congestion as one of the main transport predicament facing the United Kingdom (UK).

Rod Eddington, a transport researcher, published on 1st December 2006, a UK government-sponsored report into the future of Britain's transport infrastructure. The Eddington Transport Study set out the case for action to improve road and rail networks, as a "crucial enabler of sustained productivity and competitiveness". Eddington pointed out that congestion is expensive and estimated that congestion may cost the economy of England £22 billion a year in lost time by 2025.

The continent of Africa has not been spared either. Many African urban cities are also facing the same problem of road traffic congestion. For instance, Nigeria's major cities of Lagos, Abuja, Kaduna and Calabar are all experiencing traffic congestion which has tended to defy various remedial measures adopted by different government regimes over the years such as road network expansion (Ukpata and Etikaa, 2012). Journey times from one point to another within urban areas have remained unreliable inconveniencing residents and travelers. These are accompanied by other vices such as noise, air pollution and the high costs that result from fuel wastage (Ukpata and Etikaa, 2012). Strategies of resolving the congestion problem are therefore imperative in most African cities.

Within East Africa, in Tanzania traffic congestion is one of the key urban challenge in Dar es Salaam city where it becomes worse during the peak hours of the mornings and evenings (Mfinang and Fungo, 2013). In Tanzania, it is a relatively new phenomenon although it has become worse on the yearly basis due to increase in Dar er Salaam population and due to increased social and economic activities in the city. This has led to the rise of the number of motor vehicles in the city. The Government and City authorities are attempting to mitigate the problem by increasing road capacity and improving public transport operations. It appears that this approach has not fully delivered the desired results. It is claimed that one of the contributing factors for poor performance of this approach is none implementation of strategies for controlling traffic congestion proposed in physical plans. (Kiunsi, 2013). Besides, limited research has been conducted to identify the best strategies that can be used to ease the congestion.

In Kenya, the Mwai Kibaki Presidency and Grand Coalition Government had as its legacy the massive investment in infrastructure, particularly roads, with the Thika Superhighway being their signature project (Mugwe, 2013). Whereas good, wide roads play an important role in the management of traffic, it must be stated that alone cannot end traffic gridlock in a city that is growing in population of people and vehicles at an alarming rate (Downs, 2005). Subsequently, a combination of strategies ought to be applied. One of the commonly applied strategies in managing congestion has been the widening and increasing the number of roads by governments. However, one of the least understood aspects of peak-hour traffic congestion is the principle of triple convergence. This phenomenon was discussed and detailed in the first version of 'Stuck in Traffic' (Downs, 2000). This phenomenon occurs because traffic-flow in a region's overall

transportation networks form almost automatically self-adjusting relationships among different roads, times, and modes (Dunphy and Fisher, 1992). For example, a major commuting expressway might be so heavily congested each morning that traffic literally crawls. If that expressway's capacity were doubled, traffic would flow rapidly because the same number of drivers would have twice as much road space. As word spreads that this particular highway was not congested, drivers who had once used that road and opted for alternative routes due to congestion would shift back during the peak period. Within no time, there would be a triple convergence onto the expanded road during peak hours making the road as congested as it was before its expansion (Deakin, 2011). This is what perhaps became of Thika Super Highway which is today congested during peak almost as it was before its expansion.

Several techniques have been applied to mitigate against congestion in Nairobi City County. For instance, a committee, Transport and Urban Decongestion Authority (TUDA), was appointed by the Nairobi County Governor in 2014 to come up with solutions of reducing congestion in the city. The Committee released an interim report by the end of the month of June, 2014. It acknowledged the two approaches of improving traffic flow: Increasing road network capacity (supply) or reducing number of vehicles on the road (demand). However, traffic congestion has persisted in the City.

According to Gachanja (2015) traffic control in the Nairobi Metro has been wanting, and it is now believed that some of the traffic interventions such as use of traffic lights or traffic marshals/police officers have been a contributor to congestion when they don't function well.
Other measures which have been undertaken including revamping the traffic department have not

produced best results despite enormous resources being used. Intervention by traffic officers have often led to even more confusion and more congestion (Gachanja, 2015)

Many research studies on traffic congestion have been carried out to come up with ways of mitigating on this problem. For instance, Kibunja (2005) did a study on traffic congestion along Uhuru highway, Nairobi City County, where he focused on parking space and removal of roundabouts. When these techniques were tried there was a slight improvement then but today traffic congestion still persists. Nzau (2013) researched on traffic situation in Nairobi city where he looked into road net work expansion, improving traffic operations and emphasis on the use of public transport. Both studies recommended general conventional methods of reducing congestion by increasing road network capacity and venturing into ways of reducing the use of private cars as opposed to public vehicles. All these strategies

notwithstanding, there has been limited information on what are the causes of congestion and what can work best to reduce traffic congestion in Nairobi as the problem is still persistent on many roads including Jogoo Road which is the focus of this study.

Jogoo Road is a major and important corridor to the economy of the city of Nairobi and Kenya at large. It is used daily by the highest population of city dwellers and workers who reside on the Eastern side of the City. The dwellers reside in large estates like Embakasi, Kayole, Umoja, Dandora, Ruai, Buruburu, Kariobangi, Jericho, Maringo, Jerusalem, Hamsa and Makongeni. Jogoo Road begins at Donholm Round about and ends at the City Stadium roundabout where it joins Landhies Road together with Lusaka Road towards the City center. The ripple effect has it that when this road is congested, other roads within the city will also have traffic snarl ups.

New strategies of tackling road congestion are therefore urgent as traffic congestion affect all members of the society. It is on this basis of urgent need that this research study looked into other novel applicable strategies of solving traffic congestion problems in the City with specific focus on Jogoo Road.

1.2 Statement of the Problem

Traffic congestion has stubbornly persisted on Jogoo Road in Nairobi City despite several strategies that have been put in place such as increasing road capacity, installation of traffic lights, use of traffic police officers and County Government traffic Marshalls. It is a problem that affects all members of the society such as school children, workers in different sectors of the economy and the general public subsequently affecting the overall development of the society. However, few studies have been conducted to establish effective strategies that can be employed to ease congestion by applying the stakeholder approach particularly on Jogoo Road.

The studies on traffic congestion in Nairobi city that have been carried focus on isolated strategies. For instance Kibunja (2005) focused on expansion of the road network and removal of roundabouts while Nzau (2013) researched on traffic situation in Nairobi city where he looked into the improvement of parking management, traffic operations and emphasis on the use of public transport. These are conventional methods that have not effectively worked bearing in mind that each city and road is unique. Although some of the recommendations have been implemented, the problem of traffic congestion still persists.

This study therefore sought to find out the best strategies or mix of strategies applicable in resolving traffic congestion in the city of Nairobi, a case of Jogoo Road through an all inclusive approach in which stakeholders participated and consensus built.

1.3 The purpose of the study

The purpose of this study was to establish best combination or "mix" of security strategies applicable in reducing traffic congestion on Nairobi city County's Jogoo Road grounded on the views of stakeholders.

1.4 Study Objectives

The objectives of this study were to:

1. Ascertain the factors that contribute to traffic congestion on Jogoo Road, Nairobi City County, Kenya.

2. Assess the extent of road network supply strategies applications in reducing traffic congestion on Jogoo Road, Nairobi City County, Kenya.

3. Determine vehicle demand management strategies that can be applied to reduce traffic congestion on Jogoo Road, Nairobi city County, Kenya.

4. Explore road operations efficiency management strategies that can be applied to reduce traffic congestion on Jogoo Road, Nairobi City County, Kenya.

1.5 Research questions

1. What are the factors that contribute to traffic congestion on Jogoo Road, Nairobi City County?

2. To what extent can network supply be applied to reduce traffic congestion on jogoo Road, Nairobi City County?

3. How can vehicle demand management be used to reduce traffic congestion on Jogoo road, Nairobi City County?

4. How can road operations efficiency management be applied to reduce traffic congestion on Jogoo Road, Nairobi City County?

1.6 Justification of the study

This study was informed by the need to address and mitigate traffic congestion in Nairobi city County, Kenya. The problem has inflicted suffering to motorists and commuters alike who have to endure long hours on the roads owing to congestion. Transit time unreliability is so high and one cannot predict how long it will take to travel from one part of the city to the other. Transit time between one side of the city to the other during the day has become unbelievably long and unpredictable to the extent that one has to depart extremely early to catch up with an appointment. The study would therefore assist in improving transit time reliability and improve on predictability in the city of Nairobi, Kenya.

The study would be beneficial to city planners who have tried many methods of reducing congestion. Congestion management is essential as it is envisaged to have a positive impact on the economy, environment, climate andwell being of city dwellers and commuters in terms of health. The study would also enrich the available literature on the subject.

1.7 Scope of the study

This research study explored the causes of traffic congestion on Jogoo road, Nairobi city with the aim of generating the best strategies of resolving the problem using stakeholder involvement and participation approach. The study made use of Government officials in the transport industry engaged on Jogoo Road as well as the general public and motorists who ply this road on daily basis as respondents.

The variables under study were 'strategies applicable' which was the independent variable and 'traffic congestion' which was the dependent variable. Intervening variables were traffic rules enforcement and drivers competency and attitudes. The study was conducted between the month of August 2018 and November 2018.

Respondents of the study were Traffic Police officers deployed along Jogoo Road, Nairobi City County Transport officials, Ministry of Transport and infrastructure and National transport Safety Authority Personnel(NTSA), motorists and motorbike riders who used the road consistently. They were selected as they were considered to be key stakeholders and as such the information they provided was considered valid.

1.8. Study Limitations

The study faced lack of co-operation and unwillingness to answer the questionnaire by some respondents due to suspicion. However, this limitation was overcome by explaining to the potential respondents the confidentiality in place and the importance of the study. Majority thereafter cooperated and were enlisted in the study. Besides, the introduction letters to the heads of concerned Departments and permission seeking went a long way in getting the corporation of the concerned

respondents. Jogoo Road was assumed to be a replica of other major city roads in as far as the problem of congestion is concerned. However, Jogoo road specifically may not present the same challenges as presented by other Nairobi City Roads owing to location, population size, population social status, length of the road and number of intersections. Therefore the strategies appropriate for resolving congestion on Jogoo Road may not be the best applicable on other city roads

1.9 Assumptions of the Study

This study assumed that recurrent traffic congestion was caused by factors which can be controlled and mitigated upon to reduce it. It was assumed that road net work supply strategies could offer a solution to road congestion but only specific supply strategies could apply to a given road. The study also assumed that vehicle demand management could reduce traffic congestion but each road had its unique applicable demand strategies.It was also assumed that road operation efficiency strategies can reduce traffic congestion but again they cannot be generalized on all roads for attainment of best result. Lastly the research assumed that there are many strategies applicable in resolving traffic congestion. Each road or city has its best strategies for resolving the problem owing to factors such as population, geographical location, intersections, land use, policies and legislations in place. The best strategy would therefore be provided through inclusion of the views of all the stakeholders. This is so mainly because there are many undertakings by Authorities in the past or on going aimed at managing congestion but the problem has persisted

CHAPTER TWO

LITERATURE REVIEW

This chapter entailed review of literature with regard to causes of road traffic congestion and effectiveness of various strategies for resolving congestion problems with the gaps to be filled. The chapter ended with a summary of a conceptual framework.

2.1 Theoritical Framework

This research project is based on the Transportation Engineers and Planners Model (Cambridge Systematics Inc, 2005) where by causes and strategies of dealing with congestion are grouped into three general categories:

1. Increasing road capacity

2. Road Travel demand management and

3. Operating existing road capacity more efficiently.

The model highlights three different categories of strategies that can be applied to combat traffic congestion in cities. Increasing road capacity has to do with enlarging the road net work. Road travel demand management means controlling the demand for car use to reduce the number of vehicles on the road. Lastly operating existing road capacity efficiently means proper use of existing road network for optimum performance. Each category has a number of different strategies that can be applied to manage road traffic congestion.

Figure 2. 1 and 2.2 below provides a schematic representations of the above named model used in dealing with the problem of road congestion.

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                          ┌─────────────────────────────────────────┐
                          │ Alternate hours of travel               │
              ┌──────────┐│ Alternative work schedules              │
              │  Travel  ││ Telecommuting                           │
              │Alternatives├ Pedestrian/bicycle facilities          │
              └──────────┘│ Alternative fare strategies             │
                          │ Public education campaign on driving     │
                          └─────────────────────────────────────────┘
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Demand Management

Travel Alternatives
- Alternate hours of travel
- Alternative work schedules
- Telecommuting
- Pedestrian/bicycle facilities
- Alternative fare strategies
- Public education campaign on driving

Land Use
- "Smart Growth" policies
- Pedestrian/bicycle connections
- Transit stop/station design
- Transit-oriented design
- Parking strategies

Pricing
- High occupancy toll lanes (HOT)
- Time-of-day pricing
- Activity center pricing
- Parking pricing

HOV
- Rideshare matching
- Transportation Management Associations (TMAs)
- Vanpools
- Priority parking for HOVs
- Parking cashout
- Guaranteed ride home program
- Instant ridesharing

Transit
- Subsidized fares
- Transit-oriented design
- Enhanced transit stops/stations
- Trip itinerary planning
- Transportation Management Associations (TMAs)
- Transit security systems

Freight
- Truck only toll lanes (TOT)
- Lane restrictions
- Delivery restrictions

Figure 2.1 Schematic representation of road traffic demand management by Engineers and

Planners Model (Source: Cambridge systematic Inc. 2005)

```
Operational
Improvements ─┬─ Highway ─┬─ Arterial ─── Road weather information systems
              │           │              Geometric improvements
              │           │              Intersection improvements
              │           │              One-way streets
              │           │              Access management
              │           │              Advanced signal systems
              │           │              Signal retiming/optimization
              │           │              Changeable lane assignments
              │           │              HOV ramp bypass
              │           │              Incident management
              │           │              Event management
              │           │              Real-time traveler information
              │           │              Parking restrictions
              │           │
              │           └─ Freeway ──── Transportation Management
              │                              Center operations
              │                           Incident management
              │                           Event management
              │                           Ramp metering
              │                           Lane controls
              │                           Managed lanes
              │                           Realtime traveler information
              │                           Electronic toll collection
              │                           Work zone management
              │                           Road weather information systems
              │                           Variable speed limits
              │                           Ramp closures
              │                           Bottleneck removal
              │
              ├─ Transit ──── Vehicle tracking (AVL)
              │               Advanced scheduling/run cutting
              │               Signal priority for buses
              │               Bus ramp bypass
              │               Real-time transit information
              │               Express bus service
              │               Demand responsive bus service
              │               Fare strategies
              │
              └─ Freight ──── Vehicle tracking (AVL)
                              Real-time freight information
                              Roadside electronic screening/clearance programs


Additional
Capacity ─┬─ Highway ──── New freeways/arterials
          │               Widen freeways/arterials
          │               Street connectivity
          │               New toll roads
          │               Grade separations
          │               HOV/managed lanes
          │               Multimodal corridors
          │
          ├─ Transit ──── New rail lines
          │               New bus routes
          │               New busways/BRT
          │               Additional service on existing lines/routes
          │               Neighborhood/activity center circulator routes
          │               Park/ride lots
          │
          └─ Freight ──── Truck only lanes
                          Rail improvements
```
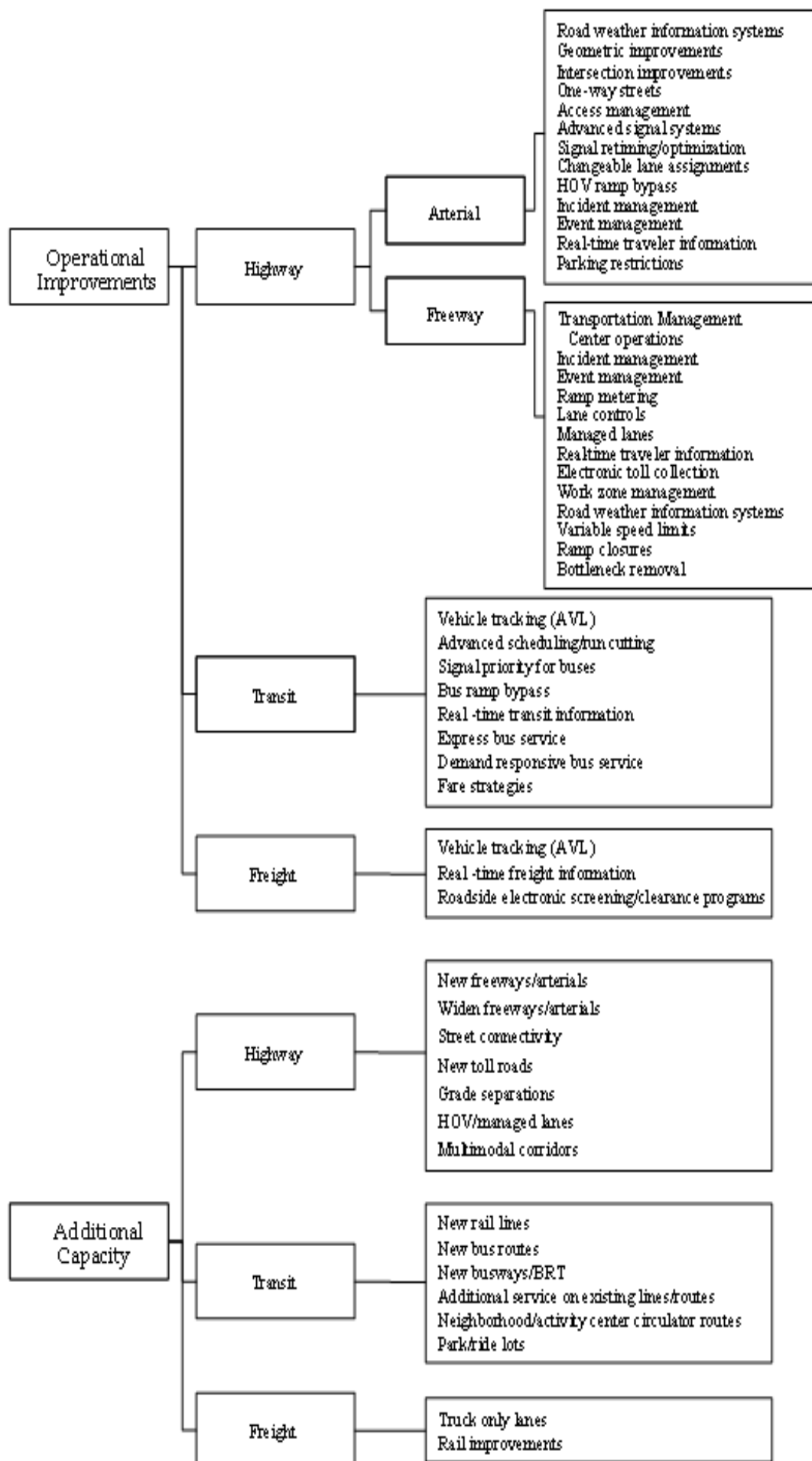
Figure 2.2 Schematic representation of road traffic operation efficiency improvement and supply management strategies by Engineers and Planners Model (Source: Cambridge systematic Inc. 2005)

2.2 Traffic Congestion and its Contributory Factors

An effective and efficient transportation system plays a significant role in sustaining economic growth in contemporary economies as it provides linkages between different parts of the country and the world (Eddington, 2006). An efficient and effective urban transport system fulfils the demand for accessibility within cities (Okoko, 2006). Congestion, however, is one of the major operational attributes and hiccups that assess and evaluates overall highway performance. Congestion reflects slowness caused by traffic crowding and accumulation on the roads. Traffic congestion is a temporal condition on road networks that occurs as utility and demand increases. It is characterized by slower speeds, longer trip times, and increased queuing (Downie, 2010). When the number of vehicles on the road is high and so heterogeneous that the interaction between vehicles slows down the rate of traffic flow, traffic congestion results. It is reflected by slowness caused by traffic crowding and accumulation. The moment demand approaches the capacity of a road, traffic congestion begins. When vehicles stop for a period of time due to congestion it is colloquially referred to as a traffic jam (Downie, 2010).

According to the Institute of Transport Engineers of UK (2010), traffic congestion is a situation where "there are more users attempting to use a transportation facility during a specific period of time than the facility can handle with what is considered to be acceptable levels of delay or inconvenience" (Meyer 1997). This implies that traffic congestion is inevitable on our urban areas only that there are acceptable levels of inconvenience.

Some authors argue that traffic congestion is a result of a phenomenon referred to as traffic waves. A traffic wave "occurs when cars slow down, and the slowing trend continues backward over a stretch." The higher the demand for a particular road the bigger the traffic wave (Garling and Schutema, 2007). Traffic waves however, in themselves are not the cause of traffic congestion but other physical factors which bring about vehicle's deceleration and pile-up and eventual traffic waves.

It has also been argued that traffic congestion is not primarily a problem, but rather the solution to our basic mobility problem, which is that many people move at the same times each day. This is so because efficient operation of both the economy, industries and school systems requires that people work, go to school, and even run errands almost at the same hours so that they can interact with each other. That paramount need of interaction cannot be altered without crippling our economy and societal operatives (Downie, 2010). The problem exists in most urban areas of the world especially the developing ones like the city of Nairobi, Kenya. The interdependency and interaction among people cannot be stopped without having adverse effects. However, the congestion that ensues as a result of the need for one another brings with it negative externalities which need urgent strategies to manage.

Factors which contribute to road traffic congestion can be divided into two: Traffic Disturbances (Non Recurrent causes) and Network Overload (recurrent causes) (Garling and Schutema, 2007). Traffic disturbances occur temporarily and only impact traffic the moment they happen. They include accidents, harsh weather conditions, stalled defective vehicles and road constructions or repair. An accident can cause obstruction or slow down traffic flow as motorists try to have a glance of what has happenned. Similarly, harsh weather conditions such as foggy or rainy weather can cause drivers to slow down as they worry for their safety (US Department of Transportation, 2005). Road construction or repairs on the other hand can cause reduction of lanes thereby forcing

drivers to crowd the passable lanes. This can be worse if the road is a two way and not a dual carriage. These factors can exacerbate congestion. Due to their randomness in occurrence, not much can be done to prevent such unpredictable incidents save for a planned construction or repair of a road section (Berisha, 2016). While this classification broadly holds, other causes could include poor vehicle driving methods caused by incompetence or poor attitudes and weak law enforcement or weak justice systems. Poor attitudes may cause some motorists to drive recklessly without taking cognizance of other road users. Since traffic disturbances are unpredictable and temporary in nature, this study focused on network Overloads (recurrent causes). Network Overload consists of cases where road congestion is caused either by inadequate road capacity or elevated demand for road transportation (Hon, 2005). That is to say, congestion network overloads can be categorized into supply factors and demand factors.

Starting with supply or physical factors, the biggest contributor in this category are bottlenecks (Garling and Schutema, 2007). Bottlenecks are narrowed roads that lead to increased congestion when demand for road network is higher than supply. Based on road structure, there are different types of bottlenecks. Firstly,the high volume merge bottleneck occurs when another lane is merged to the existing road; secondly lane reduction bottleneck occurs when the number of lanes is reduced causing two or more lanes to merge into one;

Thirdly short weave bottleneckoccurs when one lane is added to the road while another one goes out (Falconcchio and Levinson, 2015). Bottlenecks are common in Nairobi city. A good example is when Jogoo road gets merged with Lusaka road as both roads join Landhies Road towards the city. Both roads have two lanes making a total of four but then this is reduced to two lanes. Another example is Thika Super Highway which consists of six lanes towards the city but as it nears the city it reduces to three lanes at Pangani Area. As shown in Figure 2.1, the below described bottlenecks lead to vehicle pile up and delays, thus resulting to traffic congestion.
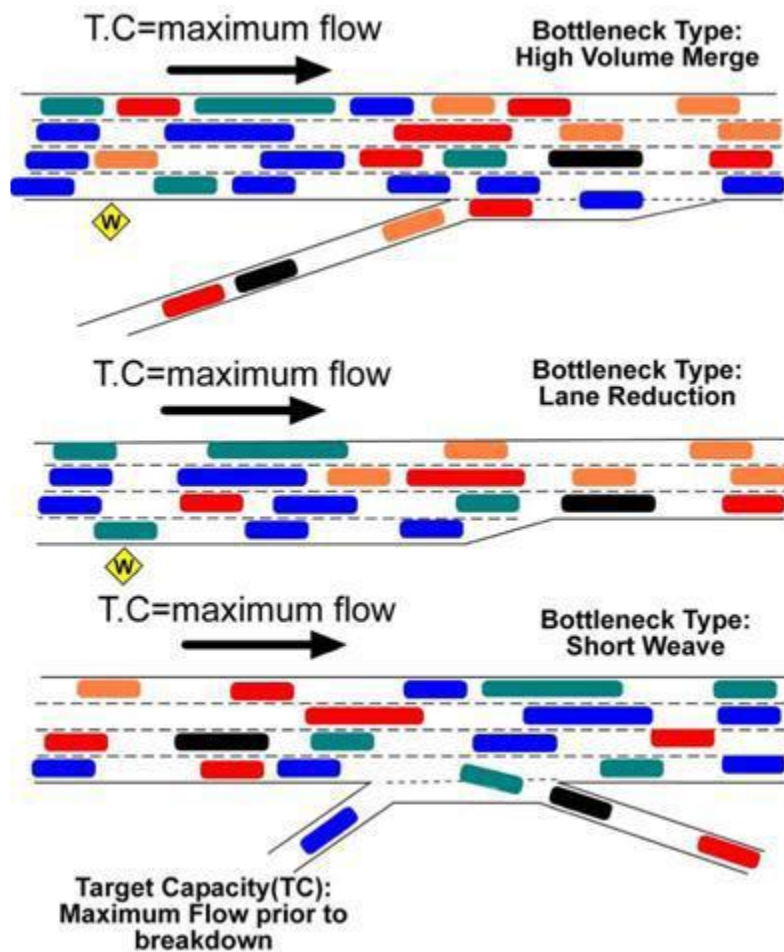
Figure 2.3 Types of road Bottlenecks. (Source: Garling and Schutema, 2007)

The second supply or physical factor that cause traffic congestion is road intersections. According to Atomode (2013), urban road intersections can easily result to the worst traffic snarl-up. This is informed by the fact that at intersections, vehicles are driven from several different directions making either left-turn, through and right-turn movements competing for the same physical space at the same time. In the city of Nairobi along Jogoo road in particular, most intersections have roundabouts except where there are T- junctions and they are both sources of congestion.

In addition to vehicular flows, there could be pedestrians crossing the roads thereby exacerbating the situation. When pedestrians are crossing the road at the designated parts motorists are expected

to stop. This becomes a source of vehicle pileup. According to Kenya National Highways Authority (KENHA) report (2016) on the need for more pedestrian foot bridges, sections of major roads such as Jogoo Road and Thika Super Highway have bumps and rumble strips aimed at slowing down traffic to allow pedestrians to cross. The report indicates that some of these crossing spots have become notorious for snarl-ups during morning and evening rush hours. It is also common in Nairobi city to find pedestrians who prefer crossing major roads while avoiding the use of foot bridges that are just nearby. This is an issue that needs to be addressed urgently because as it slows vehicles down it can result to accidents which again cause obstruction. According to a study carried out by Manjanja (2013) regarding non-usage of pedestrian footbridges in Kenya there are many causes and effects. Effects includes accidents and traffic pile-up among others. This calls for strategies to address the issue.

The third supply or physical factor of traffic congestion can be considered as the presence of heavy commercial vehicles and the lack of their designated lanes. For example owing to the number of stops that buses have to make throughout their daily routine, and the fact that the majority of the time there are no designated lanes for buses, they end up unintentionally delaying vehicles behind them, thereby adding to traffic congestion (Doçi and Bajraktari 2011). On express ways, however this may not occur. In addition drivers may intentionally aggravate the problem by stopping right in the middle of the road at disallowed points either to pick or drop passengers. The problem then shifts from the lack of designated lane to disobedience to traffic rules.

On the other, hand not all traffic congestions are caused by physical restrictions or inadequate supply; there are situations whereby the demand for a road is higher than the capacity of that specific road (Thompson, 1998). These factors are called demand factors. Increase in population of people living in urban areas as well as the number of vehicles lead to increase in the demand

for roads (Meyer, *1997*). Due to lack of or inappropriate public transportation controls, people will tend to use their cars

thus escalating the demand for roads. Moreover, increase in job opportunities, inadequate or poor urban planning, economic growth and other economic factors contribute to increase in demand for road usage (Kiunsi, 2013). This may occur as a result of the population increasing disproportionately with infrastructural development. Strategies of resolving congestion can best be traced from the causal point of view. Just like in medical field, to completely manage a health condition, it can best be done after the cause or trigger has been identified. This will require proper diagnosis. On Jogoo Road, this study will seek to identify the causes of congestion which will play a part in informing the best strategies applicable in resolving it considering the stakeholders point of view.

Managing traffic congestion does not promise a complete elimination of the problem;

however, minimizing congestion to a bearable satisfactory level is achievable (ECMT, 2007).

Approaches that have been suggested by models and many literature on the subject include:

1. Dealing with the demand side by reducing the number of vehicles demanding road use.

2. Dealing with supply side, by increasing the road network capacity.

3.Making use of the existing facilities more efficiently

(Downs, 2005 and Hons, 2005)

2.3 Approaches for Resolving Road Traffic Congestion

As stated earlier, this research project is based on Engineers and Planners Model (Cambridge Systematics Inc. 2015) where strategies of dealing with congestion have been grouped into three categories; Increasing road capacity, road travel demand management and operating existing road network more efficiently. These strategies will now be dealt with indepth.

2.3.1 Supply Management Measures–Increasing Road Capacity

Supply management involves increasing the number and sizes of roads and highways and expanding

transit and freight rail service. Lane addition to existing roads and constructing new roads have been the obvious and traditional response to congestion mitigation (Handy and Lee, 2018). In other urban areas, however, it has become difficult to undertake major highway expansions due to several constraints including funding constraints, lack of space, and opposition from local and national groups (Handy and Lee 2018). This calls for other strategies of resolving road traffic congestion. While expansion of road network has worked, it depends so much on availability of space. As much as governments would wish to enlarge or increase roads, lack of space can be a hindrance. An example is the land use features along Jogoo Road in which there is no sufficient space available for surface road expansion. This therefore calls for a concerted effort to come up with alternative applicable ways of mitigating road congestion such as construction of overhead roads.

Increasing physical capacity for highways, transit, and railroads is known to be an important strategy for alleviating congestion. In many cities, it is the lack of sufficient physical capacity that has contributed the most to congestion. In such cities, the addition of new capacity is essential if space is available. Other strategies of resolving congestion therefore may be considered (Berisha, 2016). This means that highway designers must be open to new designs that accommodate all stakeholders' including motorists, commuters and other road users' concerns (Levinson and Lomax, 2007). The involvement of stakeholders is essential in coming up with the best strategies. One essential requirement however is that the stakeholders must be knowledgeable and conversant with the dynamics of congestion for them to give valid ideas.

The worst highway bottlenecks have been found to occur at Highway interchanges (ECMT, 2007). As a result hi-tech designs that spread out turning movements and remove traffic volumes from main merge areas may be considered. While techniques of exploiting geographical landscape to develop

traffic flowing interchanges may work, its efficacy is dependent on other factors such as geographical features of the surrounding area which enhance visibility such as flatness . The use of traffic lights in some interchanges have worked very well (Talukdar, 2017). For traffic lights to function well it is required that motorists obey them calling for better enforcement strategies and enhanced discipline of motorists. Proper synchronization of the lights at various junctions is also essential.

Developing more freeways or more lanes to existing ones will definitely increase capacity of a road network. However there are other aspects of transportation that can be enhanced to alleviate congestion, albeit in a localized area. For instance, combining widening of arterial roads, increasing street connectivity, providing grade separations at congestion prone intersections and providing lanes for high-occupancy vehicles (HOV) will ultimately mitigate on congestion (ECMT, 2007).

Arterial roads are roads joining highways and have usually smaller widths. If the widths are enlarged then congestion on these roads may reduce but there could be a problem where they join the highway. Increasing street connectivity is also a strategy of mitigation as motorists will have alternative roads to use. The HOVs on the other hand are able to transport many people at ago thus reducing the number of vehicles on the road. These are supply management measures. Moreover , increasing capacity of the transit system, whether it is the bus system, urban rail

system or commuter rail system has proven to be of assistance in relieving congestion on urban roads. Last but not least, enhancing capacity of the intercity rail system can be a strategy to reduce the use of highways by trucks (Hon, 2007).

Basically all these are strategies that can mitigate on traffic congestion. However, governments or authorities must undertake keen selection of the best strategies and also conduct cost-benefit analysis before implementation to enhance proper utilization of resources.

Continuous Flow Intersection (CFI) is another innovation that reduces congestion by getting rid of conflicting turns at intersections by placing the turning movements several meters before the main intersection" (Lee, 2013). This design has been applied in several towns of the developed countries like Louisiana in the USA. It allows for smooth and continuous non-stop entry into a free way at a junction. The design allows turns and mainlines through movements to happen simultaneously and as a result reducing traffic pile-up on intersections. As this design eliminates the left turns, less accidents which were common on intersections have reduced (Berisha, 2016).

The impact to which this design could have on reducing congestion has not been tested fully in Kenya. It is an area that can be exploited if tests prove that it can work on Kenyan Roads and especially on Jogoo Road considering space availability.

Figure 2.4: Continuous Flow Intersection   (Source: Lee, 2013)

Baton Rouge is one of the cities that have made huge improvements in reducing traffic

congestion. It is said to be the first city to implement Continuous Flow Intersection (CFI) design

at road intersections (Lee, 2013).

2.3.2 Demand Management Measures

Demand congestion management techniques are alternative measures for mitigating road traffic

congestion. These measures are aimed at reducing the demand for vehicle use (Barisha, 2016).

Here there are three related demand reducing factors which include access management, parking

management and pricing policies which are all useful in managing vehicle demand (ECMT,

2007). Pricing policy factors are disincentives which discourage the use of private vehicles

through introduction of charges. Further, access and parking management can be categorized as

regulatory measures whereas pricing can be considered as an economic measure. Economic

because it involves certain charges or fees which must be paid for a motorist to pass through or

be allowed to use a certain road. The funds generated can be redirected to infrastructural development.

A good example of this kind of initiative is the implementation in London in 2003 where congestion charge idea was introduced to manage traffic congestion in the city. Nonresident motorists with private vehicles were charged £5 (Ksh. 600) to drive their cars in the city center between 7:00 am and 6:30 pm. Public service vehicles and taxis were exempted from paying the fee ("Congestion Charge," 2015).

To enforce the policy, security cameras were mounted at strategic positions throughout the city. These security cameras can capture the number plates and verify if the driver had paid the fee or not. Violators' vehicles were impounded and they were fined £80 (Ksh 9600) (Apostol, 2005).

In Kenya, congestion charges have never been tried as a mitigation strategy and perhaps it is high time the strategy is tested to manage congestion.

The demand-side management strategies can also be categorized as ; economic, regulatory and land use (Hon, 2005). The three are explained below:

a) **EconomicMeasures**

These are measures intended to influence human behavior by discouraging acquisition and use of vehicles to minimize congestion. They include; taxation (Disincentives) and subsidies (Incentives).

Disincentives include road tolls, cordon charges, taxes or congestion pricing, area licensing scheme and electronic road pricing system (Dimitrakopoulos, Destichas and Koutra, 2012). Cordon charges are imposed on motorists accessing a certain location. Pricing systems and Road toll are charged whenever a motorists opt to use certain earmarked roads. The charge has two functions of either discouraging the use of cars or raise funds for maintenance. On the other hand

Congestion charges are imposed at certain peak hours to control congestion. (Leape, 2006). However, these kind of mitigants may not be implimented without proper legislation and stakeholder engagement in a democratic state like Kenya where public participation is mandatory.

To restrain increase in traffic, financial disincentives such as taxation measures can be introduced. These taxes are usually imposed on ownership of vehicles, including car purchase tax, annual or biannual registration tax, and charges imposed on vehicle use such as fuel tax and parking fees (Potter et al., 2003). Imposing such taxes will raise government revenue and also discourage citizens from purchasing or using their private vehicles (Handy and Lee, 2018).

Increasing charges/levies such as fuel tax, congestion charge or road use toll charges may reduce the demand for using private vehicles but not on all private vehicle users. Other strategies need to be combined with these particular ones for better results. For example the Nairobi City County Government raised the parking fee from Ksh. 140 (about $1.5) to Ksh. 300 (about $3) in 2014 in trying to discourage motorist from using private vehicles and eventually reduce demand for parking space and congestion. This strategy has not reduced the number of vehicles in the Nairobi CBD as getting parking space after 08:00AM is usually hectic. Today motorists searching for parking space cause obstruction to others who are passing through. Subsequently this results in vehicle pile-up and congestion will ensue.

On the other hand, subsidies, which are financial incentives, are also used. Subsidies are discounts or tax reductions aimed at encouraging the use of'green' or environmental friendly transport modes, such as walking or cycling. (Button, 1992). Subsidies could be imposed on bicycles and tricycles to promote and encourage their purchase and use by the city dwellers.

Subsidies will reduce bicycle costs but again this is not an obvious attraction because different people have different preferences. In Nairobi bicycles are often used by low earning members of the society or for leisure by youth (Nairobi Non Motorized Transport, 2015). In other cities such

as Amsterdam Bicycles are a preferred mode of transport because they are environment friendly and cycling is a form of physical exercise (Kwirikiza, 2004). Congestion pricing, also referred to as road pricing is another economic measure for reducing congestion. It is a road infrastructural tax imposed on motorists and it can directly discourage the use of roads. It includes road tolls (also called development levies) and congestion pricing (also called congestion tax) (Hon, 2005).

One advantage of congestion pricing is that the revenues that accrue provide funds for further infrastructure investments. This happens when the revenue is channeled into transport infrastructure improvements (ECMT, 2007).

A good example in this regard is Singapore which adopted a form of congestion pricing in 1975 where it is referred to as Area Licensing Scheme (ALS). Other cities, such as Oslo, Bergen and Trondheim too docontrol their traffic with peak-period entry charges or permits (Richards, 1990). Their experiences have proven that congestion charge or is capable of reducing travel demand and at the same time raising government revenues (Hon, 2005).

While introducing charges may reduce the demand for motor vehicles use, it is not known to what extent the charges can be imposed so that the levies can discourage motorists from using their vehicles. This has been envisaged when parking fee was raised by the County Government of Nairobi as mentioned earlier. The increase in the fee did not have a big impact in reducing congestion within the CBD. This then calls for a meticulous study on preferences and on how to manage general populace.

Nevertheless, Congestion charge has been considered a success in many cities including London. Six months after implementation of the charge congestion dropped by 30% in 2003. Revenue collection from fines rosefrom $138 million to $172 million annually. This funds have been harnessed inimproving the transportation system in the city (Apostol, 2005). Besides, this policy

has positively impacted the environment by decreasing the release of greenhouse gases by 20% annually (Apostol, 2005).

b) **Regulatory strategies**

Regulatory strategies refer to policies, regulations, administrative measures, or even legislations that alter many travelers' behaviors (Hons, 2005). They include parking control, restrictions, access management, prohibitions on the use of certain vehicles, traffic calming and flexible or alternated working hours. Regulatory strategies are intended to put constraints to the public by minimizing individual choices and are often termed as rigid to human freedom.

They may not be applicable to every society and also they may end up adversely affecting the economic well-being of a people by altering traffic flows (Hon, 2005). In Kenya, the democratic space is opening up and the Constitution of Kenya holds that before Government undertakes any measures to deal with an issue that affect the public stakeholders involvement is a must. Regulatory measures can sometimes be met with a lot of resistance owing to their disruption of the norms. A good example is when the Nairobi county Government in 2015 decided to close roundabouts in trying to reduce intersections in managing congestion. This measure was met with a lot of resistance and protests for as the measure was beneficial to motorist coming from one direction, others from a different direction were negatively affected.

This then implies that regulatory measures however attractive may not always work and be acceptable. A different approach then needs to be used in selecting the best and acceptable policies for implementation. This study is therefore going to apply stakeholder involvement approach to ensure that the stakeholders views are taken into account.

c) **Land use policies**

Transport and land use policies are interconnected. Land uses results into travel styles which have an influence on travel modes, patterns and methods. It is therefore a necessity to co-ordinate long

term land use and transport planning. Studies on a number of countries, regions and cities have shown that well coordinated transport and land use policies allowed for better management of urban travel demand. Eventually this reduced road incidences and severity of traffic congestion (ECMT, 2007).

To mitigate on traffic congestion problems in the long term, land use policies that address the imbalance should be put in place. Through proper forecasting and planning, land uses should be implemented in such a way that the need, time and the amount of travel is minimized (Hon, 2005). These conditions will apply very well to upcoming urban areas undergoing planning. For established urban areas like Nairobi whose land use pattern has been established, making changes may pose serious challenges of displacements. An example within the city of Nairobi is when residential houses were demolished in Muthurwa Estate to pave way for the construction of the Muthurwa bus terminus.

Therefore as a strategy, land use policies, good as they may be, may not apply to a larger extent in cities that are established unless major changes are made including demolitions. For developing cities the congestion reducing land policies are applicable and may be handy in reducing traffic congestion in future. Land use measures that would ensure the majority of the population can access key areas within the city easily by simply walking will reduce congestion.

2.3.3 Operating Existing Capacity More Efficiently

Enhancing the reliability and efficiency of the road, street, highway, fright and transit systems is an aspect of the transport that is most often accomplishable in shorter period (Talukdar, 2013). That is to say, putting in place mechanisms and measures that are going to enhance efficiency on existing networks is cheaper and faster than developing new ones altogether. This is expected to happen at a lower cost with public support than some other strategies because the infrastructural

facilities are already established. The magnitude of the benefits from any single project may by far out do a new freeway lane or rail transit line. Also the cost and implementation time will be less (Cambridge Systematics, 2005). The benefits of existing operational projects is that they would enhance the returns on investment in the infrastructure projects within a short time. Operating existing capacity more efficiently means making an optimization of the available infrastructural resources. Currently, transportation engineers and planners are increasingly embracing strategies that deal with the efficient use and operation of existing infrastructure than building new ones (Meyer, 1997) .

As an example, the philosophy behind Transportation System Management and Operations (TSM&O) is to mitigate the effects of roadway happenings and also to control short-term demand for an existing roadway network. TSM&O consists of the application of advanced technologies in using real-time information about highway conditions to have control measures (Meyer, 1997). This is generally referred to as Intelligent Transportation Systems (ITS). It is areal-time control of highway operations that is managed at a transportation management center (TMC). It has today become a major activity undertaken by most transportation agencies. ITS control strategies take many forms including; dynamic retiming of traffic signals, metering flow onto freeways, providing travelers with pertinent information, providing alternative routes and modes of travel and managing traffic incidents . ITS has

also been used to improve freight and transit services. Apart from ITS, other TSM&O strategies that are intended to improve the efficiency of the existing capacity includes movable median barriers that add capacity during peak periods, restricting turns at intersections and reversible commuter lanes.

The National Police Service (NPS) has developed an information center called the Integrated Command and Communication Center (IC3) within the City Centre. Although the center's main objective is to check the run away crime in the City slowly by slowly it is being used to check on traffic matters. Officers manning the center are able to see happenings in major city streets real time and then communicate with officers on the ground for appropriate action. One area that has not been exploited is that of public awareness and participation in the project in one way or another to curb society problems such as congestion.

2.5 Conceptual framework

Independent Variables   **Intervening Variables**   **Dependent variable**

```
┌─────────────────────────┐
│ Supply management       │
│ e.g. Increasing no. of  │
│ roads, increasing lanes,│
│ improve transit systems,│
│ railways, apply CFI,    │                ┌──────────────────┐
│ remove bottlenecks,     │                │ Traffic laws     │
│ improve interchange     │                │ enforcement      │
│ systems.                │                └──────────────────┘
└─────────────────────────┘

┌─────────────────────────┐                                        ┌──────────────────────────────┐
│ Demand management       │                                        │ Reduced  Road  Traffic congestion│
│ e.g. -Economic          │                                        │                              │
│ measures-taxes, road    │                                        │ -Improved travel reliability and│
│ charges subsequently    │                                        │ economy,                     │
│ -Regulatory Measures-   │                ┌──────────────────┐    │ -Less pollution,             │
│ Parking , restrictions, │                │ Driver training and│   │  -Less stress and diseases,  │
│                         │                │ Behaviour change of│   │ -Better  climatic conditions.│
│ -Land use measures  and │                │ motorists        │    └──────────────────────────────┘
│ policies – Controlled   │                └──────────────────┘
└─────────────────────────┘

┌─────────────────────────┐
│ Efficiency improvement  │
│                         │
│ e.g. use of TSMO, ITS,  │
│ and Vision oriented     │
│ planning                │
└─────────────────────────┘
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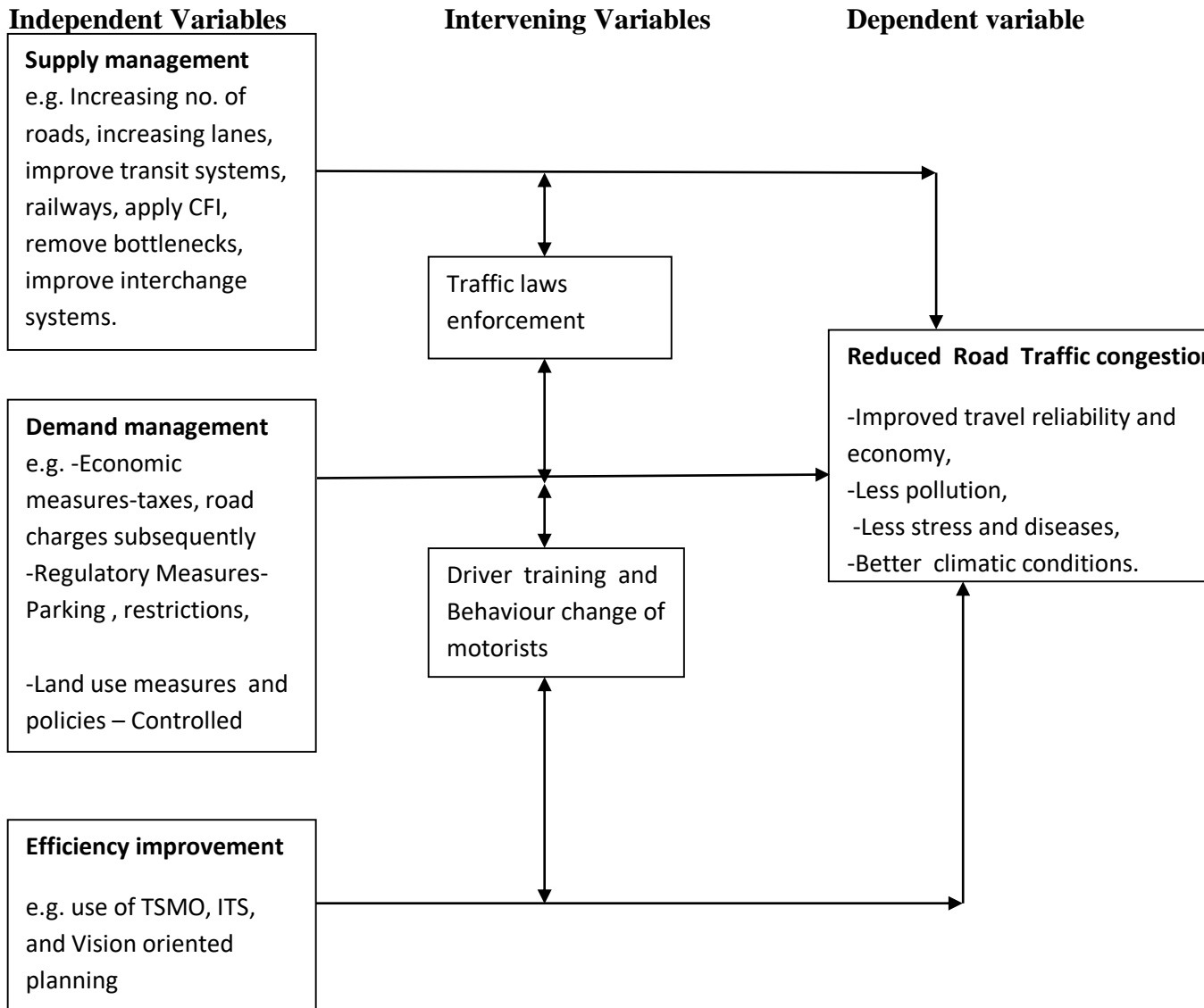
Figure 2.5 : Conceptual Framework on Strategies for Resolving Congestion

 (Source: Author, 2018

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the steps that were followed in carrying out the study on strategies of resolving traffic congestion in cities, a case of Jogoo Road in Nairobi. It presnts the nature of research design, study variables, site of study, target population, sampling techniques and sample size, research instruments, secondary data, validity and reliability, data collection procedures, data analysis and presentation and finally issues to do with data management and ethical considerations.

3.2 Research Design

Basically research design is the plan that guide data collection and analysis in a research study. This research employed a **mixed design** in which phenomenological and exploratory survey designs were applied. **Phenomenological design** involves seeking to understand the essence of a phenomenon by examining the views and experiences of people to get experiences and views of stakeholders in transport on causes of traffic congestion on Jogoo road and what should be done to resolve the problem. The **Exploratory survey research** aspect require the researcher to investigate different observable research items, and opinions about the phenomenon under study. In this research there was need to explore factors that contribute to congestion and solutions there of. Both quantitative and qualitative data were collected and triangulated to increase validity of evaluation and research findings.

3.3 Study variables

This study had two variables, independent and dependent. The dependent variable is road traffic congestion whereas independent variables are the strategies applicable in resolving it. Traffic congestion would vary depending on the strategies put in place.

3.4 Study Site

The research study was conducted along Jogoo Road, Nairobi city County. Jogoo Road is a major and important corridor to the economy of the city of Nairobi and Kenya at large. It covers a stretch of about 3 miles (5km) and is used daily by the highest population of city dwellers and workers who reside on the Eastern side of the City. The dwellers reside in large estates like Embakasi, Kayole, Umoja, Dandora, Ruai, Buruburu, Kariobangi, Jericho, Maringo, Jerusalem, Hamsa and Makongeni. In between these estates there are other informal settlements which aggravate the problem of congestion when its residents sell wares along the road. Jogoo Road begins at Donholm and ends at the City Stadium roundabout where it merges with Lusaka Road towards the City center.

3.5 Target population

This research study targeted stakeholders in the transport sector in the City of Nairobi on Jogoo Road. The stakeholders consisted of road users and administrators. Road users included private car motorists, PSV operators, passengers, motor bike riders and taxi drivers. Administrators included Nairobi County government transport officials, Ministry of Transport personnel, National Transport and Safety Authority (NTSA) and Traffic police personnel.

The sample consisting road users was clustered into the five categories with regard to the means of transport as named above. These respondents were sought at three points; Donholm Area, Makadara Area and City stadium Area. At each point five respondents were targeted. A total of 100 respondents were expected to be interviewed including those in focused group discussions.

3.6 Sampling Techniques and Sample Size

A multistage approach was used in sampling participants using different techniques. Sampling

technique used in the study population was stratified and purposive. The stratified sample consisted of traffic Police officers who are of different ranks. Police officers of the rank of constable and non

commissioned officers formed one starta. The second strata comprised of members of inspectorate and

gazetted officers. A total of 25 Police officers were targeted to respond to questionnaires.

The rest of the population sample consisting road users and other Government officials i.e. NTSA, County Government and Ministry of Transport officials, were purposively selected according to their mode of transport and their departments respectively. This was done on the premise that some subjects were more suitable than others for the research study. The population consisting road users was sampled purposively whereby the researcher engaged transportation stakeholders willing to participate. This included private car motorist, public transport vehicle operators, motor cyclists and taxi drivers.

The process was repeated at three distinct locations along the road of study to get a wider perspective. The locations were Donholm intersection, Makadara area and City Stadium roundabout all along the road. The respondents were engaged during periods of high traffic congestion. That is Morning peak hours of 6:30AM and 8:30 AM and evening peak hours of 4:30PM to 6:30 PM to get their views during rush hours. A total of 25 traffic police officers, 25 NTSA officers, 25 city County Governmnet traffic marshalls and 25 Ministry of Transport personnel were targeted to to respond to questionnaires. On the other hand 100 road users including private car motorists, public transport vehicle operators, motor cyclists and taxi drivers were targeted to respond to interviews and focus group discussions. A total of 200 participants were sampled to take part in the study.

Table 3.1: Sample size

	Targeted Sample
Government Officials (Questionnaires)	100
Road Users (Interviews, FGD)	100
Total	200

Source: Author (2018)

3.7 Research Instruments

3.7.1 Primary Data

Primary data was collected directly from the field using the following techniques:

i)   Observation

Observation as a systematic data collection approach entailed the use of eye and ear senses to examine people's behaviour and vehicle interaction in a natural settings or naturally occurring situations. The researcher sought to establish causes of congestion with regard to demand, supply and efficiency management. The researcher did this by looking at how vehicles interacted on straight sections, on bends, and at intersections. Snap shots were taken for record. Observation involved prolonged engagement in a traffic setting situation along Jogoo Road**,** methodical and tactical observation in order to develop a full understanding of   what causes congestion and recording of one's observations

(Appendix E)

ii) Questionnaires

Questionnaires were presented to Government official respondents for them to answer in writing. There was both closed and open ended questions to be answered in the questionnaires by the respondents. Closed   ended questions were expected to   produce data that was analyzed

quantitatively. Here the agenda was entirely predetermined by the evaluator and there was little flexibility for respondents to qualify their answers. On the other hand open ended questions allowed respondents to answer in their own words where they had greater qualification opportunity of their responses. At total of 100 questionnaires were administered through section heads to Traffic police officers, NTSA officials, County Government Transport officials, Ministry of Transport and Roads Personnel (Appendix D)

iii) **Interviews and Focus Group Discussions**

Part of the data was collected through interviewing of respondents, either individually or as Groups (Focused groups discussion). Interviews were conducted on road users, i.e. private car motorists, PSV operators and motorbike riders. The researcher steered the discourse within the limits of causes and strategies of resolving traffic congestion on Jogoo Road. 100 respondents were targeted and a total of 73 were interviewed including four focus group discussions along the study road. Data from interviews and focus group discussions were recorded as discussions proceeded by writing down respondents' views.

3.8 Validity and Reliability

Validity of the tool was achieved by ensuring that all the domains of interest as articulated in the objectives and research questions were captured. This was ensured through adequate coverage as guided by research objectives. Construct validity was achieved by the accurate operationalization of key variables. The dependent variable is traffic congestion in which with it comes poor travel time reliability, pollution, stress, diseases and climatic changes. The independent variable are strategies of resolving traffic congestion which were categorized as supply management, demand management and traffic operations efficiency enhancement.

Reliability was tested by ensuring that response from respondents is consistent and produced same answers under similar conditions. This is the internal reliability. The questionnaire was

given to different people from the target population before the actual data collection to test reliability. Test –retest reliability was achieved by re- administering the questionnaire after a short time with the aim of getting similar answers. This was aimed at enhancing accuracy. Reliability was necessary for determining the overall validity of the scientific research and enhancing the strength of the results that emanated.

3.9 Pilot Study

The **pilot study** is the small scale preliminary study that is conducted in order to evaluate feasibility, time, cost, adverse events, and effect size (statistical variability) in an attempt to predict an appropriate sample size. The aim was to improve upon the study validity and reliability of the tools prior to performance of the full-scale research project. In this research study a pilot study was carried out along Kiambu Road and at Kiambu Police Division in Kiambu County, Kenya to refine and check on any inconsistencies of the tools of data collection. Inaccuracies and inconsistencies were corrected upon detection.

In each strata and cluster as indicated in the sampling and sample size two respondents were engaged.

3.9 Data Collection Procedures

Data in this research was collected through administration of questionnaires to Police officers engaged in Traffic and Road safety along the site road, NTSA officers, Ministry of Transport personnel and Nairobi City County Government transport personnel. Among traffic police officers questionnaires were distributed to the two identified strata. The officers in-charge facilitated the distribution of questionnaires. The questionnaires were expected back within a period of about one week as was agreed with the officer in-charge. Both qualitative and quantitative data were collected.

Observations were made by the researcher to find out the likely causes of traffic congestion on the study road with the objective of finding probable corrections through looking at the way vehicles interact and how drivers behave. Pictures of what was observed were taken. Another procedure for data collection was by conducting interviews and holding focus group discussions. Short interviews were carried out on public transport operators, passengers,private vehicle motorists, taxi drivers and Motor bike riders. This was done through volunteering and willingness of the respondents to participate in the research. Within the five clusters, five willing respondents were approached randomly for the interviews. Responses were recorded briefly on paper and also using an audio recorder.

The interviews approach was vital where questions soughtstakeholderopinions, views, attitudes as well as experience of the respondents concerning traffic congestion along Jogoo Road.

Due to the nature of public transport vehicles, the interviewer had to board commuter vehicles that use the highway and interview the conductor and driver and along the way, during peak periods. This enhanced convenience in terms of time for the drivers as well as the interviewer getting the real experience of the problems experienced by the operators along the highway.

Another approach of conducting interviews was for the interviewer interacting with the vehicle operators at their passenger collection terminus. Ample time for interview was available at these points as the operators waited for passengers to board their vehicles. Secondary data was collected from the named Government websites in form of policies, research papers, expert recommendations and relevant future city infrastructural plans sought for relating and comparing with other suggested strategies by respondents.

3.11 Data Analysis and Presentation

Quantitative data collected was analyzed using descriptive statistical techniques. A computer software, statistical package for social sciences (SPSS) was used. Data collected was first entered

into columns and rows. It was cleaned before proceeding with the analysis. Qualitative data collected by conducting of interviews and focus group discussions was recorded and analyzed thematically. Qualitative data collected by observation was analyzed at the reviewing of the data through mental processing for themes or patterns that exhibit themselves. The qualitative data analysis results were triangulated with the quantitative results to get rid of biases and for confirmation. Data was presented in the form of graphs, histogram, charts and diagrams.

3.12 Data Management and Ethical Considerations

Before proceeding for data collection, authority to do so was requested from Kenyatta University and Kenya National Commission for Science, Technology and Innovation (NACOSTI). Authority to conduct the research was granted. In addition, to the various organizations visited such as Traffic Police Headquarters, NTSA and Ministry of Transport, permission was sought in writing before commencement of data collection. The respondents were also requested to participate voluntarily having been shown the consent letters for carrying out the research. The identity of the respondents is held in confidentiality and the information provided was used in this research study only and nowhere else.

CHAPTER FOUR:

RESEARCH FINDINGS AND DISCUSSION

4.1 Introduction

This chapter presents data analysis and discussion of the findings. The main purpose of this study was to find out the strategies applicable in resolving congestion in cities, a case of Jogoo Road Nairobi City County. The chapter provides results from the study according to information from the respondents through questionnaires, interview guide and observation guide. It is organized around the specific objectives that guided this study. The discussion and interpretation of data in this chapter is presented through the use of qualitative and quantitative forms in averages, percentages, frequency tables, bar graphs and pie charts. The specific objectives of the study were to:

1. Ascertain the factors that contribute to traffic congestion on Jogoo Road, Nairobi City County, Kenya.

2. Assess the extent of road network supply strategies application on reducing traffic congestion on Jogoo Road, Nairobi City County, Kenya.

3. Determine vehicle demand management strategies that can be applied to reduce traffic congestion on Jogoo Road, Nairobi city County, Kenya.

4. Explore road operations efficiency management strategies that can be applied to reduce traffic congestion on Jogoo Road, Nairobi City, Kenya.

The chapter begins by presenting the demographic features of the participants followed by the findings of the main study**.**

4.2   Response Rate

Table 4.1: Response Rate

	Targeted	Responded	% Response Rate
Government Officials (questionnaires)	100	79	79
Members of public(interviews, FGD)	100	73	73
Total	200	152	76

Source: Author (2018)

The study targeted 200 respondents for participation. 100 of them were to respond to questionnaires in which 79 returned their questionnaires. The other 100 targeted respondents were to be interviewed where 73 interviewees responded including those in focus groups. Four focus group discussions (FGD) were held. FGD occurred whenever I introduced myself to groups of PSV operators, Taxi drivers and private motor bike riders who happen to wait for their clients at designated points along or near the study road. The four focused groups consisted of twelve, fourteen, nine and fifteen people each.

This gave a total of 152 respondents out of the targeted 200 which is equivalent to 76% of the total. This response rate was considered adequate for the study in line with Mugenda and Mugenda (2003) and Gall et al. (2007) who affirmed that a response rate of between 10 and 30% of the targeted population is a good representation of the target population.

Table 4.2: Distribution of target population by Department of Government officials

Governement Department	Frequency	Percent
County Government Traffic Marshalls	21	26.6
NTSA personnel	20	25.3
Ministry of Transport personnel	15	19.0
Traffic Police Department Officers	23	29.1
Total	79	100

Source : Field Data

From Table 4.2 above, it can be seen that responses from targeted Government officials ranged between 60 percent and 92 percent out of the total number of 25 questionnaires issued per department. This could be attributed to the fact that consent was sought from head of sections concerned. They took it upon themselves and assisted in distributing questionnaires to their officers. One way of increasing response rate and minimizing refusal among other ways is sending advance letters (Curtin, 2007). It has also been discovered that surveys in which questionnaires are distributed internally (i.e. to employees) generally have much higher response rate (usually 30% and above on average) than those distributed to external audiences or customers (Fryrear, 2015)

Table 4.3 Distribution of target population by mode of Transportation

Mode of Transport of Correspondents	Frequency	Percent
PSV operators	18	24.7
Taxi drivers	12	16.4
Private vehicle drivers	13	17.8
Commercial vehicle/truck drivers	11	15.1
Motor bike riders	19	26.0
Total	73	100

Source : Field Data(2018)

The response rate by mode of transportation ranged between 55 percent and 95 percent as 20 respondents were targeted in each category. Again this response could be rated as high. This could be attributed to the fact that the study was touching on an issue that directly affect the respondents in terms of time wastage, journey time unreliability, traveling cost and health.

4.3   Demographic Information

The researcher examined the gender, age and education level for both Government officials and members of the public. The findings are as tabulated below.

4.3.1 Gender of the Respondents

Table 4.4: Distribution by Gender

Gender	Government Officials		Members of public	
	Frequency	Percent	Frequency	Percent
Male	45	57	51	70
Female	34	43	22	30
Total	79	100	73	100

Source : Field Data(2018)

Concerning the gender of the respondents, among the Government officials 57% were male while 43% female. This implies that there were more men than women among the targeted Government departments' respondents. Similar findings were observed among members of the public with 70% (51) male and 30% (22) female. This means that there are more men than women in the work places. A study on disparities in the Kenyan labour market revealed that female labour force partcipation in the modern sectors has remained below 30% (Suda, 2002). These findings relate closely to a survey carried out in the US where it was found that only a third of men and women say their work place is balanced in terms of gender. Two thirds of the respondents cited men being more than women (Parker, 2017). These findings are in congruence with the findings by Prenzler and Sinclair (2013) who in a survey of English-language police departments internationally (in England and Wales, Scotland, Northern Ireland, Eire, the United States, Canada, Australia (eight departments), New Zealand, South Africa, Ghana, Nigeria, India, Pakistan, Hong Kong, Papua New Guinea, and Fiji), found that the proportion of female officers was lower than that of male officers.

4.3.2 Distribution by Age

The study found that most of the respondents were between 41-45 years of age at 30.38% followed by 20-25 years at 21.39%. The least age interval was 26-30 at 10.13% followed by 46 years and above at 11.3%. This shows that most of the respondents were of mature age and could reason logically. These findings resonate with the 'Index Mundi' records which show that majority of the working population in Nairobi Kenya is aged between 15 and 54 years. (Nyakango, 2016)
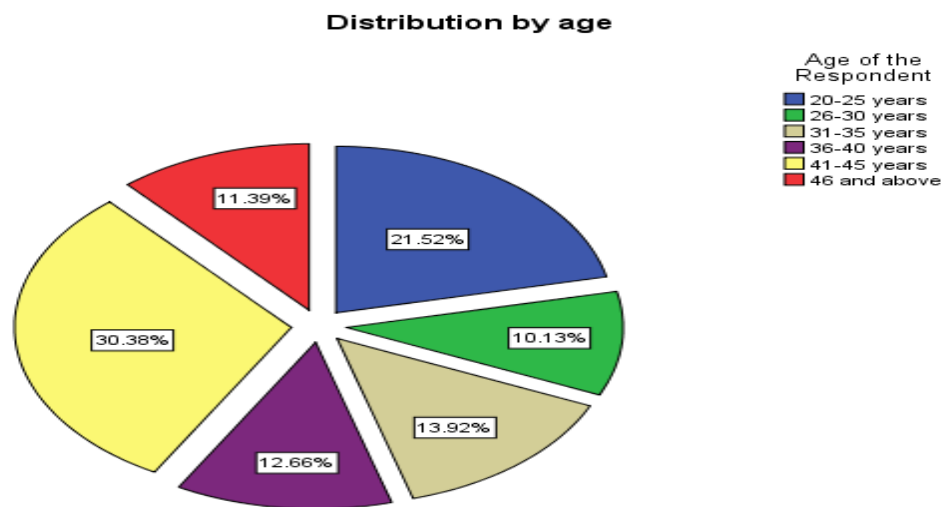
Figure 4.1 : Field Data (2018)

4.3.3   Highest Level of Education

Regarding the education level, 38% of Government officers had a diploma while 22% had a bachelor's degree. Those with secondary level education were 19% of the total while primary level 11%. Lastly, those with post graduate level of education were 10% of the total number of government officials who participated. This indicates that majority of the Government officers have tertiary education. As for the road users who participated 38% had secondary level education, 23% diploma, 19% primary, 16% bachelors' degree and 3% post graduate degree. This is in agreement with a survey conducted by the Kenya National bureau of Statics (Mukhwana, 2016) which revealed that Nairobi City as well as Kisumu city have the highest numbers of people who have ever attended school at 97.5%. The indication that majority of respondents in the study were literate was an important factor as it positively affected the respondents' understanding of the questionnaires and interview questions. This would subsequently result in giving of informed responses for enhanced reliability of the findings.

Table 4.5: Distribution by Level of Education

| Highest level of education | Government Officials | | Road Users | |
	Frequency	Percent	Frequency	Percent
Post graduate	8	10	2	3
Bachelor's degree	17	22	12	16
Diploma	30	38	17	23
Secondary level	15	19	28	38
Primary level	9	11	14	19
Total	79	100	73	100

Source Field Data (2018)

Findings of study objectives

It will be recalled that the purpose of this study was to find strategies of resolving traffic congestion in cities, a case of Jogoo road Nairobi City County. The findings of the objectives focus in responding to the concerns of the study. The first objective was focusing on factors contributing congestion. This is discussed below:

4.4 Factors Contributing to Congestion on Jogoo road

It will be recalled from the introduction that the study sought to find out interventions that could be put in place to ease congestion on Jogoo road. To be able to address the main concern of this study, it was important to understand the factors that contribute to congestion so as to develop effective mechanisms to be put in place to address the problem. According to Eliasson (2014) evidence based approach provides for efficient ways of addressing a social problem. Therefore understanding the factors that contribute to road congestion on Jogoo road was deemed important in informing this study on what needs to be addressed. To study the factors that contribute to congestion in the study, a three pronged approach was used. Informed by some of the best practices the questionnaire was structured to understand the supply factors, demand factors as well as operation efficiency factors. This was expected to provide a holistic understanding of the drivers or causes of road congestion that would then need to be addressed in the intervention mechanisms. The results are presented according to each cluster of factors below:

4.4.1 Supply related contributors

Table 4.6 Supply related contributors

S/No	What are the Road traffic Congestion Supply related contributors on Jogoo road?	Percentage frequency					Mean	%
		Highly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Highly Disagree(1)	Mean	%
1	Inadequate large public service vehicles (HOVs)	11.4	57	11.4	17.7	2.5	3.6	17
2	Lack of lanes for heavy transport vehicles	31.6	29.1	31.6	7.6	0	3.8	16
3	Bumps and rubble strips	7.6	53.2	6.3	30.4	2.5	3.4	16
4	Inadequate feeder roads	11.4	49.4	15.2	24.1	0	3.5	16
5	Road junctions	22.9	25.3	25.3	15.2	11.4	3.3	15
6	Narrow roads or sections of the road	34.2	53.2	5.1	7.6	0	4.1	19

Source: Field Data (2018)

From figure 4.2 below, it can be deduced that narrow roads or narrow sections of the road

(19%), lack of lanes for heavy transport vehicles (17%) and inadequate public service vehicles

(17%) are the major supply or physical causes of congestion on Jogoo Road. These findings

corroborate with themes emanating from interviews and focused group discussions as follows

(verbatim):

This road is narrow and cannot accommodate the big number of vehicles during morning and
evening rush hours.(RU 1)
The number of public service vehicles are inadequate in capacity to ferry majority of
commuters and have to do many trips to and from town.(RU 2)

These findings agree with the findings of a study conducted by Garling and Schutema (2007)

citing bottlenecks as one of the main contributors to congestion in this category. Bottlenecks or

narrowed sections of the road result in congestion when vehicles moving parallel to each other from a wide area come to a constricted area. Two other supply factors; inadequate arterial roads bumps and rubble strips were found to contribute at equal levels (16%). Road junctions least contribute to congestion at 15% on the study road. Inadequate arterial roads will force motorist wishing to divert from the main road to travel long distances before doing so causing pileups. Similar results were found from interviews with themes such as (verbatim):

Bumps and rubble strips cause vehicles to slow down causing pile-ups behind.(RU 3)
Junctions on Jogoo Road are not properly designed to have sufficient acceleration and deceleration lanes interms of the length(RU 1)

Bumps and rubble strips cause motorist to slow down hence resulting in congestion. Insufficient lanes for acceleration when joining the main road or decelaration lane when turning away from the main road may cause congestion due to a bigger difference in the speeds of the vehicles on the main road and the vehicles joining the main road.

These findings are in agreement with a study conducted in Kampala regarding causes and effects of congestion where it was found that inadequate infrastructure was a major cause of congestion (Kwikiriza, 2016) According to Thomson (1998) adding new transport infrastructural capacity including extra lanes, new roads, expressways and railways are strategies that could reduce traffic congestion. Narrow roads make vehicles coming from different directions to scramble for the available two lanes towards the city and as a result cause vehicle pile up. Lack of lanes for heavy commercial vehicles which normally move at a slower pace brings about snarl ups and build upof traffic congestion behind them. On the other hand, inadequate large public service vehicles may result in people using their personal vehicles to go to work. Cumulatively this may result to many vehicles on the road at the same time.

Supply related contributors of congestion

- inadequate large public service vehicles 17%
- lack of lanes for heavy transport vehicles 17%
- Bumbs and rubble strips 16%
- Iadequate feeder roads 16%
- Road junctions 15%
- Narrow roads or sections of the road 19%
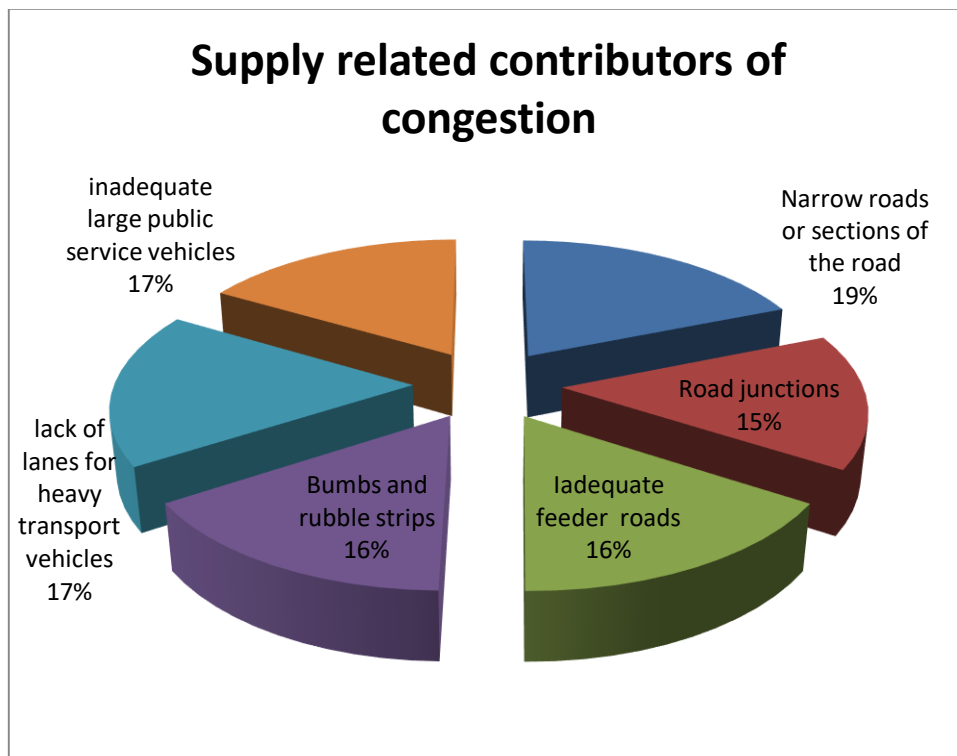
Figure 4.2 : Source Author (2018)

4.4.2 Demand related contributors to congestion

Table 4.7 Demand related contributors to congestion

S/No	What are the Road traffic Congestion Demand related contributors on Jogoo road?	Percentage frequency						
		Highly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Highly Disagree(1)	Mean	%
1	Large number of vehicles during peak	30.4	29.1	19	11.4	10.1	3.6	25
2	High demand for private car use	21.5	40.5	3.8	25.3	8.9	3.4	24
3	Large number of different road users at a time	55.7	21.5	2.5	15.2	5.1	4.1	28
4	Pedestrians crossing the road	21.5	34.2	13.9	21.5	8.9	3.4	23

Source: Field Data (2018)

The figure 4.3 shows that high demand for road use by motorists, motor bike riders, hand cart pullers and bicycle riders are the main demand contributors of traffic congestion on Jogoo Road. During morning and evening peak hours there is usually high competition for this road. These findings corroborate with findings in interviews and observation where the following theme emanated from interviews (verbatim):

The population density of the Eastern part of the city has rapidly increased causing a scramble for the road by different users (FGD 1).

The real estate industry has so much advanced in this side of the city thus attracting many people yet this is the only shortest road to the city (RU2).

Most of the people who buy houses or plots to construct houses have cars and this has made the number of cars to rise drastically (FGD 2).

This findings are not unique to Jogoo road alone. A study conducted in Dar er Salaam by Kiunsi found that increase in job opportunities and economic growth in major towns increased demand in road use resulting in congestion (Kiunsi, 2013). The observed findings can partly be attributed to rapid population growth especially within the Eastern part of Nairobi City. As in the city of Perth in Australia, rapid population growth has resulted in more cars on the road as provided by Office of the auditor general report (2015). In another study conducted in Oyo city of Nigeria, it was found that high population of road users caused a rise in road space demand (Raheem et al, 2015)

It was also observed that vehicles from different directions scramble for space as they join Jogoo road. The situation is usually worsened when non motorized vehicles such as carts are on the road making overtaking difficult (Appendix- H). This is because during morning rush hour many people are going to their work places and in the evening rush hour, they travel back home. Also the Kenyan economy works in such away that majority of people are required to report at their work places at 8:00 Am and break for home at 5:00 PM.

Demand related contributors to congestion

- Large no. of vehicles during peak 25%
- High demand for private car use 24%
- Large number of different road users 28%
- pedestrians crossing 23%
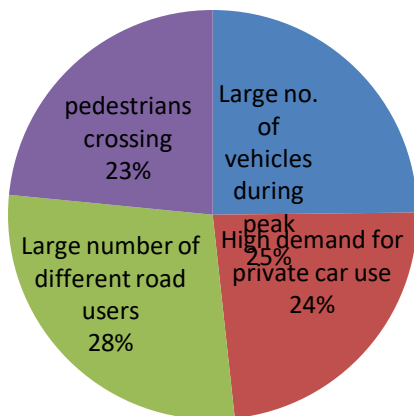
Figure 4.3 : Demand Related Contributors to Congestion. Source Author (2018)

4.4.3 Efficiency related contributing factors

Table 4.8 Efficiency related contributing factors

| S/No | What are the Road traffic Congestion efficiency related contributors on Jogoo Road? | Percentage frequency | | | | | | |
		Highly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Highly Disagree (1)	Mean	%
1	Poor urban planning	50.6	38	6.3	5.1	0	4.3	21
2	Inadequate traffic laws enforcement	45.6	24.1	8.9	17.7	3.8	3.9	19
3	Poor incident management	41.8	39.2	7.6	5.1	6.3	4.1	20
4	Poor attitude and arrogance of drivers	62.0	24.1	2.5	2.5	8.9	4.3	21
5	Defectively functioning traffic lights	50.6	16.5	21.5	5.1	6.3	4.0	19.4

Source : Field Data (2018)

Among the major efficiency traffic congestion contributors as indicated above were found to be poor urban planning (4.3) and poor attitude of road users (4.3), poor incident management (4.1) defective traffic lights(mean 4.0) and inadequate enforcement (3.9) in that order. Majority of correspondents blamed poor urban planning and poor attitude and arrogance (or indiscipline) of drivers as one of the main efficiency traffic congestion contributors on Jogoo Road. A point to note is that the mean for all the named efficiency factors were between 3.9 and 4.3. These findings are in congruence with findings of a study conducted in Los Angeles where it was found that the one of the major cause of road traffic congestion is inefficient operations (Chen et al, 2001). Poor urban planning on the other hand contributes to traffic congestion where by shopping centers and high rise buildings along the road heap more vehicles on it when people stop to do shopping or

seek to join the road after shopping. This is corroborated by findings in interviews and focused group discussions with themes as below (Verbatim):

Buildings along Jogoo Road were constructed near the road leaving no space for road expansion and parking causing commuter vehicles to stop right on the road to collect or drop passengers(RU4).

The distance between a passenger collection/dropping stages to another is very long prompting drivers of public service vehicles to stop on the road (RU 5).

Lack of parking space cause passengers to board passenger service vehicles or disembark at non designated points. This causes vehicle build-up behind leading to congestion(RU 6).

These statements elucidate poor planning in infrastructure and development which later bring about road traffic congestion. As can be seen from the quotes, poor planning contributes to congestion in different ways. Lack of space as depicted in the first quote leaves no space for road expansion. This has the implication that when the population increases there might be no way of increasing the size of the road. It is important to take cognizant that Jogoo road was constructed in the 1950s when the population in the Eastern side of Nairobi was not as high as it is today. With no space for expansion, the road users have to content with the road size that was probably meant for fewer road users than the present population. Arguably there are more vehicles on Jogoo road than there was 10 years ago hence congestion. Zhang (2011) observed that the growth of vehicles is a gradual contribution to road congestion.

Poor attitude and indiscipline result in drivers flouting traffic rules by overlapping or driving their vehicles recklessly.This creates unnecessary competition as well obstructions that make people stay long at certain areas. This sometimes compels the police to go to the scene to help in addressing the obstructions. Further, flouting of traffic rules could lead to accidents that not only cause delays but also cause injuries or fatalities to road users. According to Kersieck (2016), better driving habits could significantly reduce crippling traffic congestion.

Another factor associated with poor planning as seen in the quotes is lack of space for parking. Without designated places to park, drivers are likely to park anywhere along the road. This leads to blocking of the roads. According to Mahumud,Cope and Chowdhury (2012), the problem of parking disorderly not only brings inconvenience to the city residents' daily travel but also influences the life quality of residents. Accordingly, road side packing makes movement of road users difficult and can be a major cause of accidents besides causing congestion. Therefore it is not surprising that the road users perceive lack of parking spaces as a key factor that contributes to road congestion

Regarding incident management and functioning of traffic lights , this iswhat the road users said Verbatim:

Sometimes you will find all the lights on green. Impatient motorists from different directions will then tend to move at the same time only to meet at the centre of the junction resulting into a mishap but again police officers take too long to attend to the mishaps (RU 7).

It is common to find that non of the lights are functioning. If a police officer is not near, there will be heavy traffic congestion and pandemonium(RU 3).

These traffic lights are non functional and misleading. I think they are not properly programmed (FGD 3).

The statements above point at the inefficiency and inconvenience that is a result of dysfunctional traffic lights and the slowness in taking action by Traffic Police officers. When traffic lights give wrong signals or are not working then there will be confusion and eventualy traffic snarl ups. On the other hand when traffic officers delay in handling road mishaps, the number of available lanes are reduced or the road may become completely obstructed causing congestion.

From the findings above, it is clear that road congestion is not a result of one single factor. There are many factors that contribute to raod congestion that are couched in the framework road supply which could mean availability of road space , demand which is about the number and

types of vehicles on the road and efficiency which is about planning and regulating road use. This has the implication that to ease congestion on Jogoo road, these aspects must be addressed. The three factors were thus considered to determine strategies applicable in mitigating congestion by the road users and regulators of road use .
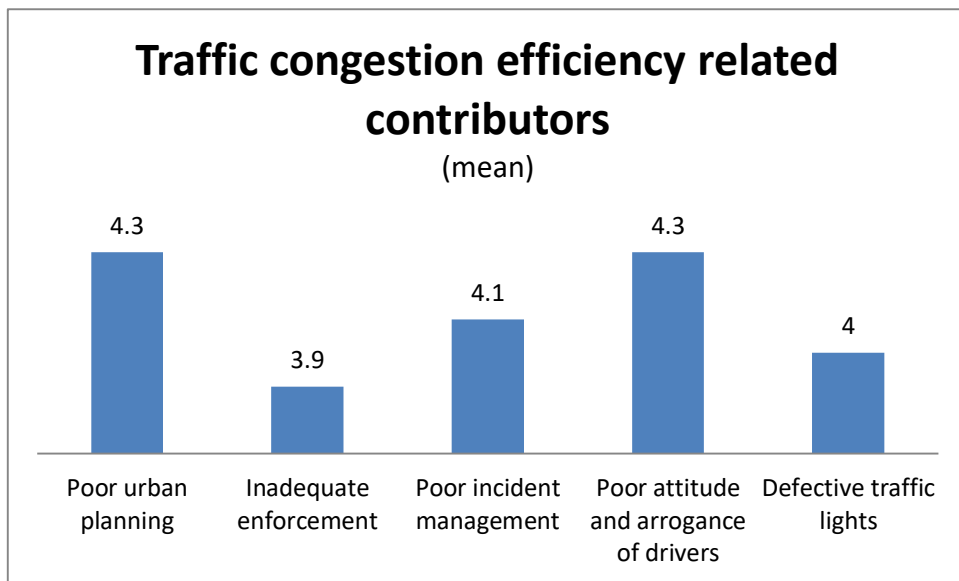
Figure 4.4 : Traffic congestion efficiency related contributors. Source : Field Data (2018)

4.5 The extent of network supply strategies applications in reducing traffic congestion on Jogoo Road, Nairobi City County.

To find out the supply strategies that could be applicable in reducing traffic congestion on jogoo road a five likert scale was developed in line with some of the best practices in the world. The scale was administered to the road users and transport managers where the results are as shown in the table 4.5 below:

Table 4.9 : Average scores of network supply strategies findings

S/No	What are the Supply Congestion Management Strategies applicable on Jogoo Road	Percentage frequency						
		Highly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Highly Disagree(1)	Mean	%
1	Increase No. of lanes	55.7	36.7	5.1	2.5	0	4.5	15
2	Introduce advanced road design	45.6	31.6	2.5	20.3	0	4.0	13
3	Improve services of railway system and HOVs	38.0	38.0	13.9	10.1	0	4.0	13
4	Improve road junctions design	68.4	27.8	0	3.8	0	4.6	15
5	Introduce lanes for other road users	72.2	25.3	2.5	0	0	4.7	16
6	Increase the number of pedestrian foot bridges	65.8	3.4	3.8	0	0	4.6	15
7	Increase parking space	35.4	48.1	0	10.1	6.3	3.9	13

Source : Field Data (2018)

To resolve congestion menace on Jogoo Road using Road network supply measures, introduction of lanes for other road users such as cart pullers and bikers, increasing number of foot bridges, improvement of road junction designs and increasing number of lanes featured more prominently with mean values of 4.7, 4.6, 4.6 and 4.5 respectively. All in all the physical supply measures were proffered so strongly by both focused group discussions and interviewees with themes as follows(verbatim):

This is a very old road which was constructed before many of the Estates on this side of the city came up and when the population was not as it is today. It should be widened (RU 8).

The number of vehicles has tremendously increased necessitating road enlargement (R U 9).

Vehicles from different directions join Jogoo road at the same time and begin to squeeze as they compete for space   blocking each other and causing huge traffic 'jam'(FGD 3).

The statements above point at the need to enlarge the road and create more lanes.

These findings concur with a study conducted by a researcher, Levinson (2016) who found that the most obvious solution to traffic congestion is to expand capacity and increase connectivity. Enlarged roads ease the flow of vehicles making them to move faster. Another study conducted in Hangzou City, China by Zhang (2011) found that supply side approach of managing congestion required improvement of public transport system which could provide people with wider choices of travelling including high occupancy vehicles, bicycles and railway system. In the city of Nairobi people have fewer choices of travel that major on the use of roads.

To reduce congestion more lanes are needed to accommodate the different categories of road users. There is also an urgent need for more foot bridges especially at *Hamsa* and   *Makongeni* areas along the road. Lack of sufficient foot bridges result in pedestrians crossing the road dangerously at non-designated points making vehicles to slow down and eventually to pile up. Insufficient footbridges had a mean score of 4.6 in the study. This is corroborated by a statement that produced the theme below (verbatim):

> *People crossing Jogoo Road sometimes bring about congestion when vehicles have to slow down or stop for them to cross. More foot bridges are required(RU 1).*

This finding resonate with a study in China where it was found that the use of pedestrian foot bridges not only relieve traffic congestion but also increase the comfortable level of walking (Jiang & Zeng 2012). Another study by Pritchard (1992) on flyover-bridges found that one way of reducing congestion at grade intersection is by the construction of flyover bridges.This has the implicationthat insufficient footbridges cause traffic congestion when people have to cross roads in competition with vehicles. This results into traffic congestion andsometimes in the unfortunate

event, accidents. The findings and statements are in agreement with Hon (2007) who found that increasing the physical capacity of highways is one of the important strategies of alleviating congestion. This includes constructing more lanes, foot bridges, well designed junctions and overhead connections.
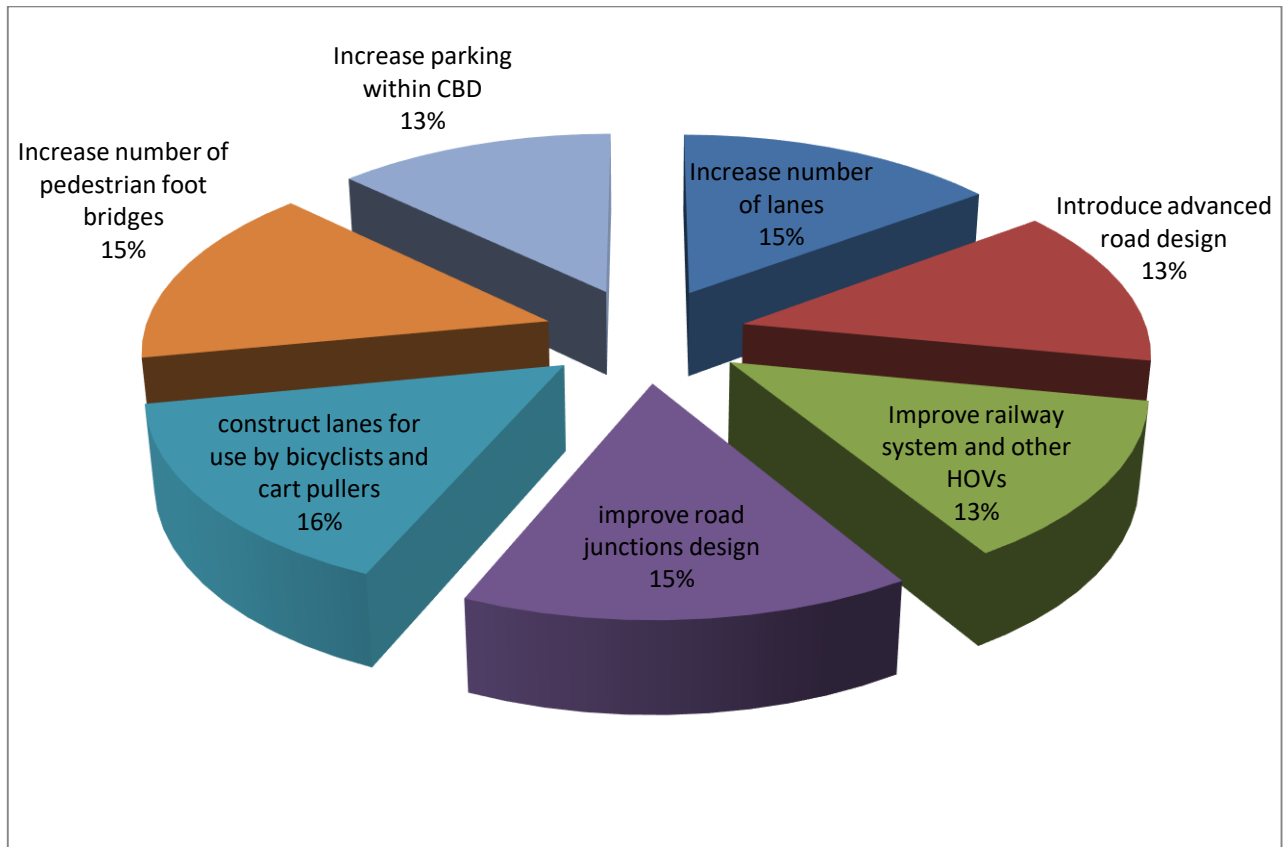
Figure 4.5 : Percentages of network supply strategies. Source : **Author** (2018)

4.6 **Vehicle demand management strategies that can be applied to reduce traffic congestion on Jogoo Road, Nairobi city County**

The third objective of the study was to determine motor vehicle demand management strategies that are applicable in resolving traffic congestion on Jogoo Road, Nairobi city. It can be recalled that demand strategies for managing congestion comprise strategies that aim at minimizing the

use of private car use. The table 4.6 below provides the respondents' percentage frequencies for demand management stategies:

Table 4.10 : Average scores of demand management strategies

S/No	What are the Congestion demand Management Strategies applicable on Jogoo road	Percentage frequency						
		Highly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Highly Disagree(1)	Mean	%
1	Increase charges on vehicle importation cost	16.5	8.9	19.0	21.5	34.2	2.5	16
2	Introduce road use charges (Toll)	10.1	35.4	26.6	25.3	2.5	3.3	22
3	Introduce congestion charges on the road	8.9	36.7	20.3	15.2	19.0	3.0	20
4	Increase charges on fuel levy	0	8.7	15.2	54.4	21.5	2.7	18
5	Reduce cost of alternative transport means	31.6	15.2	44.3	5.1	3.8	3.7	24

Source: Field Data (2018)

From table 4.6 and figure 4.6, it can be seen that to manage the demand for vehicle use as a strategy for reducing congestion, reduction of the cost of alternative transport means came highest with a mean value of 3.7. It was followed by introduction of laws that alter travelers behavior at a mean of 3.5 then followed by introduction of congestion charges at a mean of 3.3. All these measures are usually aimed at reducing the demand for vehicle use as found out by Berisha in his study "Alleviating Traffic Congestion in Prishtina" (Barisha, 2016). They are generally disincentives which discourage the use of private vehicles. Demand management measures if put in place will discourage people from using their private vehicles and instead board public vehicles. When applied, these measures will enhance the reduction of vehicles on the road.

This is also in agreement with Masanobu and Hanaoka (2003) who found that private car dependence is the largest factor causing congestion and pollutant missions. Also the quantitative

data was found to corroborate with the qualitative data when a theme of the number of vehicles being so much on the road came out (verbatim):

> *Whether you use your car or board a public service vehicle the cost of transport is almost the same. The cost of public service during peak should be checked to make it attractive(RU 10).*

> *The number of private vehicles on Jogoo road is so high calling for drastic measures by the government to reduce them(RU 11).*

According to this findings, the number of private vehicles is much more than that of public vehicles yet the number of people they convey is much less. Subsequently the road becomes congested.

A remarkable finding to note is that the mean values of demand management strategies were lower than those of network supply strategies. This shows that people generally detest measures that affect their preferences or freedom of choice, vis-à-vis the use of private vehicle. The general public prefers having the liberty to use their preferred mode of transport regardless of road conditions which could sometimes be adverse. These findings were reinforced by the qualitative data with themes as below (Verbatim):

> *Private cars are more than public service vehicles and are the ones bringing about congestion. If you peep into them during rush hour you will find that in them there is only the driver or a driver and one passenger.*

> *A law should be legislated to ban private cars from entering the city center (RU 12).*

These statements concur with the findings that private car use is one of the contributors to congestion and to manage the problem the cars should be reduced. Generally, The statements also corroborate with observations made when it was found from a general out view that private cars were more than public service vehicles. See pictures in the appendix F. It is the hope of majority of the citizens to own a car. People generally prefer using their vehicles due to several factors

including comfort, flexibility in travelling, cost, speed, reliability and so on. All these factors must be considered for private vehicle users to shift into public transport. The findings agree with a study in Malaysia by Kamba (2007) who found that the most important variable likely to encourage the use of public transport were reduced travel time and subsidized fares.
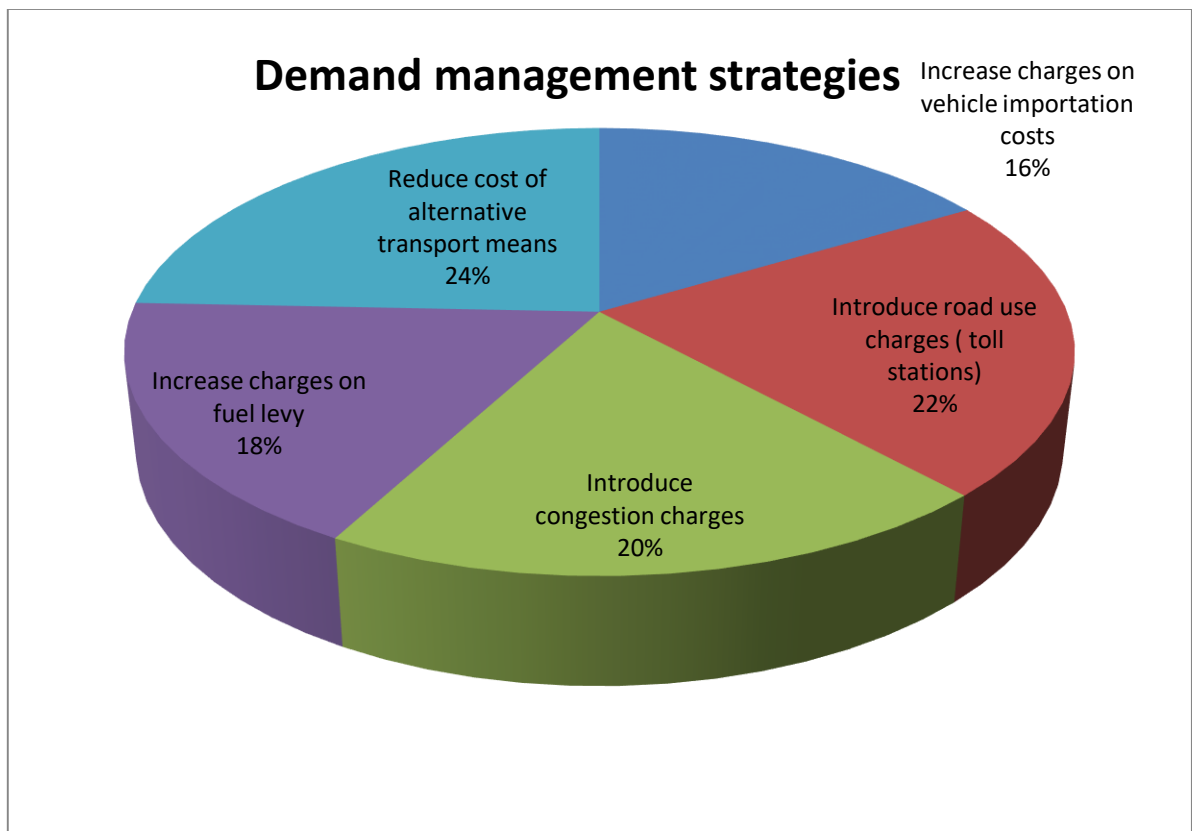
Figure 4.6 : Percentages of demand management strategies. Source : Author (2018)

4.7 Road operations efficiency management strategies that can be applied to reduce traffic congestion on Jogoo Road, Nairobi City County.

Among the objectives of the study, applicable operation efficiency strategies is the fourth objective. The study sought to findout which efficiency mechanisms could be applied to reduce congestion on Jogoo Road. Efficiency management strategies entail factors that can be put in

place to enhance road operations without increasing the size or number of roads or reducing number of vehicles.

Table 4.11 : Averages of operation efficiency management

S/No	What are the Congestion efficiency Management Strategies Applicable on Jogoo Road		Percentage frequency					
		Highly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Highly Disagree (1)	Mean	%
1	Enhance use of Mass media	55.4	21.5	24.1	0	0	4.5	21.6
2	Enhance use of ICT	55.7	32.9	11.4	0	0	4.4	21.1
3	Use of mobile phone apps as a source of traffic information	53.2	24.1	17.7	5.1	0	4.3	20.7
4	Enhance enforcement by traffic officers	35.4	44.3	12.7	5.1	2.5	4.1	20
5	Introduce laws that alter travelers behaviour	22.8	38	6.3	29.1	3.8	3.5	16.8

Source : Field Data (2018)

From table 4.11 and figure 4.7 above the use of mass media was the most preffered efficiency management method of mitigating road traffic congestion with a mean of 4.5. This was followed by the use of ICT at 4.4, mobile phone applications at 4.3 , enfocement at a mean of 4.1 and introduction of laws that alter travellers behaviour at 3.5 in that order. In most developed countries such as theU.S.A. where technology is highly applied, TSM&O has been used to manage congestion (Meyer, 1997). It is also through mass media that most motorists and road users get information regarding the condition of roads including congestion. This has been strengthened by a theme in qualitative data with statements as below (Verbatim):

Majority of the public can easily be informed about high levels of congestion through mass media, some people may decide to leave their vehicles at home and board public service vehicles (RU 13).

The mass media can provide a good platform for communication between the government and its citizens. Through it people can be informed and educated about the dangers associated with

congestion and the startegies in place to decongest the city. Eventually they may support the Governement (RU 14).

Majority of the population get information through the mass media and in it are a lot of teachings regarding different issues that affect the populace including traffic congestion. People can easily get information on what they can do as citizens to reduce congestion (RU 15)

Governemnt policies are also easily transmitted and diseminated to the citizens through mass

media (FGD 4)

The simple explanation is that majority of citizens can easily access information through mass media such as radio and television. Subsequently whennever there are issues of interest on our roads, they are communicated via electronic mass media. Mass media is an important tool in passing information such as major public events on certain roads by providing dates and time the activities will take place. For example when the Nairobi Standard Chartered Marathon is to be held, the roads, date and time of the event is usually circulated in the media.

As a matter of fact some congestion demand management strategies can hardly be implemented without technologies such as ICT. For instance the congestion charge in most developed countries makes use of ICT to check compliance (Dimitrakopoulas, Destichas and Koutra, 2012) . Also in the use of ICT, portable, variable messege signs installed at startegic locations, either on posts or on trailers, can direct drivers to an event location, available parking or back to main thoroughfares. These signs have the advantage of being able to be programmed remotely whereby the operator sits in an office monotoring the activities on a screen then sending corrective measures electronically. The development of ICT technologies has expanded the development of wireless and mobile devices. Today applications such as 'Traffic on the palm' are useful in providing real time information regarding traffic matters and further providing advice on the peferable roads to use. It enable users to find the current location using GPS and display locations on the screen. A study on social media and road traffic congestion in Kenya found that conventional road traffic

congestion control methods are non responsive to emergent situations on the road (Kiratu and Nzuki, 2015). Social media is one way of positively influencing road traffic management.

The findings on efficiency improvement strategy agreed with the findings in a study conducted by Ivan and Kojic (2015) who found that traffic and transport have spatial relation where they cannot be managed efficiently without adequate infrastructure and database GIS (Geographical Information System) character. GIS is vital in providing geospartial information i.e. information about location/position and time. Another theme from interviews and focus group discussions that corroborates the quantitative data findings was the efficient use of ICT. The quotes below help to explain the views of road users:

ICT should be used other than relying on physical presence of traffic police officers and traffic marshalls. This will enhance synchronization of the traffic lights in the city and also offenders can easily be apprehended (RU 4)

When motorists and especially public service vehicles realize that they are being monitored by road cameras and that if they break traffic rules they will be apprehended, they will behave well (FGD 4).

The above statements confirm that with ICT, effiency will be enhanced as non or minimum number of Police officers or Traffic Marshalls may be required on the roads. This will apply when the traffic lights are well programmed and closed circuit cameras (CCTV) are in place. This is because vehicles flow control will be done effectively and any traffic offenders will simply be captured by cameras, identified and nabbed. This will in effect deter would be traffic offenders as the system proves to be an efficient, foolproof and better method of enforcement.

Legislation of laws that alter travellers behaviour had the lowest mean value of 3.5. This could be pegged to the fact that people dslike being controlled and patronised. They prefer having freedom of choice in their modes and timings of travel.
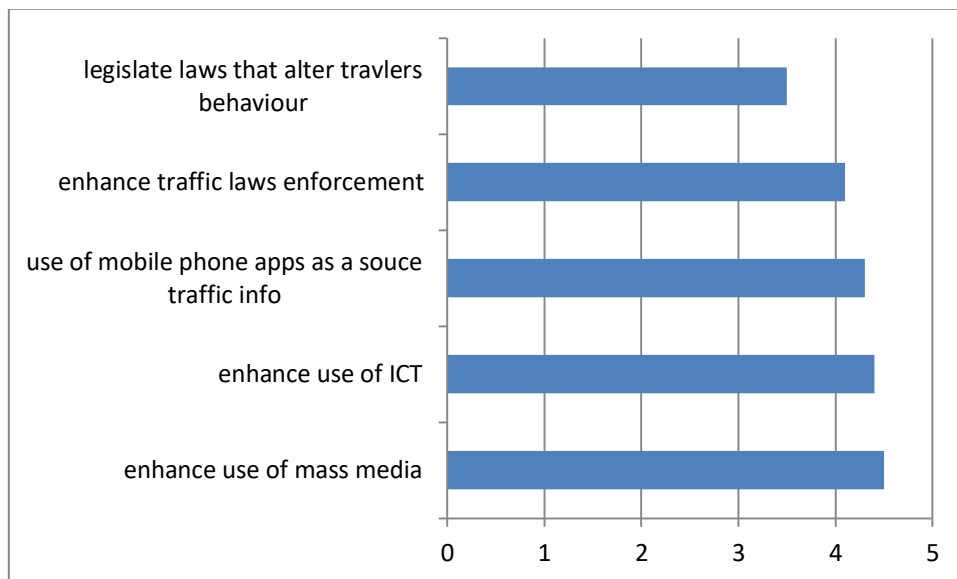
Figure 4.7: Operation efficiency management strategies. Source: (Author)

In summary, the strategies of congestion management on Jogoo Road from each category starting with the most proffered are as follows :

Supply management strategies include; Introducing lanes for other road users such as pedestrians, bikers and cart pullers, Increase number of pedestrian footbridges, Improvement of road junction design to allow for smooth joining and detouring, Increasing the number of lanes on the road, Improve services rendered by railway system and introduce HOVs, Introduce advanced road designs such as overhead roads, Increase parking space and passenger collection points

Demand management strategies include; Reduction of cost of alternative transport means, introducing road use charge i.e. toll stations, Introducing congestion charges, Increase charges on fuel levy andIncreasing charges on vehicle importation cost. Efficiency management strategies include; Enhance the use of mass media, Introduce the use of ICT in managing traffic, Enhance the use of mobile phone apps, Strengthening enforcement of traffic rules in terms of effectiveness and efficiency and Introduction of laws that alter travelers behaviou

CHAPTER FIVE

SUMMARY OF THE FINDINGS, CONCLUSION AND RECOMMENDATION

5.1 Introduction

In this chapter, an assessment of the findings in chapter four will be discussed looking at the consequences and implications of these findings and how they relate to our problem statement, research objectives and research questions. Thereafter a conclusion, recommendations and suggestion for further research will be proffered.

5.2 Summary of Findings

The main objective of this study was to find the best security strategies applicable in resolving traffic congestion on Jogoo Road, Nairobi City. To resolve congestion it was imperative to find out the factors that contribute to it. Subsequently, the first objective of the study was to investigate the factors that contribute to traffic congestion on the study road.

5.2.1 Factors Contributing to Congestion on Jogoo Road, Nairobi City County

The study found that traffic congestion on Jogoo Road is a result of several contributory factors. These factors all lie within the boundaries of supply (network overload), demand and efficiency related factors.

Accordingly, supply related contributors to congestion on Jogoo Road include road narrowness, inadequate public service vehicles, bumps and inadequate feeder roads. Demand related contributors include large number of different road users, pedestrians crossing the road and large number of vehicles during peak.

Efficiency related contributors include poor urban planning, inadequate enforcement, poor incident management, poor attitude and defective traffic lights.

The strategies applicable in resolving congestion on Jogoo road according to the study are as follows:

5.2.2 Network supply Strategies for Resolving Congestion on Jogoo Road

Road network supply strategies accoding to the study include construction of lanes for use by other road users such as hand cart pullers and bicyclists, Construction of more footbridges , redesigning road junctions to allow for smooth entry and exit, construction lanes for heavy commercial vehicles, enhance the use of HOVs and railway system, introduction of advanced road designs that need less space such as overhead roads and increasing parking spaces and bus stop points on the road.

5.2.3. Road Travel Demand Management Strategies

Road Travel demand management strategies according to the study entail; reducing cost of alternative transport means, introduction of toll charges, introduction of charges targeting private car owners during peak, increase charges on fuel levy and increasing the cost and charges of private cars importation.

5.2.4 Increasing Efficiency in the Existing Road Network Operation

Efficient use of available road network is an aspect of congestion management that came out strongly. Operating existing road capacity efficiently means making an optimum utilization of available infrastructural resources. These strategies have been embraced by road engineers and planners because they emphasize on efficient use and opertion of existing infrastructure than building new ones. This have an advantage of eventually cheaper and quicker to commission.

Operating existing road capacity more efficiently as per the study findings will be achieved by enhancing the use of mass media in providing real time information about roads status, enhancement of the use of ICT in traffic matters, enhanced use of smart phone apps, improvement of traffic flow control by both Traffic officers and traffic lights, strengthen enforcement and introduce laws that alter travellers behavior.

5.3 Conclusion

Congestion on Jogoo Road is a result of several factors which can be categorized as either supply, demand or operation efficiency related. This implies that factors contributing to congestion and congestion mitigation strategies are related. This study found that to effectively manage or mitigate on road traffic congestion menace on the study road, a conglomeration of strategies and not a single one ought to be applied as was earlier aluded in the literature review. All stakeholders opinions need to be taken into account to generate an all round solution.

The strategies were found to lie within the limits of supply strategies, demand control strategies and efficiency improvement strategies.

This could involve increasing physical capacity for highways, transit, and railroads as an important strategy for alleviating congestion. Accordingly increasing the number of lanes, increasing the number of pedestrian foot bridges, improving the design of road junctions, improving the railway system, construction of more bus stop points, introduction of advanced road designs and increasing parking space would reduce road congestion on Jogoo Road. Other startegies that would ease congestion on Jogoo Road include demand management strategies which are measures aimed at reducing the demand for vehicle use. They include reducing cost of

alternative transport means such as bus transport, introduce road use charges, introduce congestion charge, increase charges on fuel levy and increase vehicle importation cost.

Finally, efficient use of available road network is an aspect of congestion management that came out strongly. Operating existing capacity more efficiently means making an optimization of the available infrastructural resources. From this study, to mitigate on traffic congestion using efficiency management strategies the use of mass media, enhanced use of ICT in traffic management, introduction of laws that alter travelers' behavior, use of mobile apps enhancement of traffic laws enforcement and legislate laws that alternate travelers behavior were proffered in that order.

5.4 Recommendations

It will be recalled that congestion on Jogoo Road is a product of many factors, some are related to policy and others to practice. Therefore based on the findings, the following recommendations have been made from the study:

1. Policy makers involved in road transport matters such as congestion ought to consider the views of all stakeholders and apply the three prong approach of supply, demand and efficiency in finding the causes of traffic congestion menace.

2. Policy makers must take cognizance of the fact that different roads are unique in nature due to factors such as population, geographical features, proximity to the city, land use policies and development. These factors should be considered when generating strategies for reolving road congestion. In addition a study should be carried out to come up with the best strategies for resolving congestion on a particular road before the project is undertaken. Road designers should also embrace advanced technology of road construction and not rely on conventional road

construction methods alone to maximize on the use of available road reserves to enhance efficiency. Other techniques such as increasing the number of footbridges and reducing the number of bumps and rubble strips ought to be considered.

3. Legislatures in both national and county Governments should be bold enough to legislate laws and by-laws that may look unacceptable but whose impact will be far reaching in resolving the congestion menace. This includes laws aimed at alternating travellers'behaviours, laws aimed at reducing private cars in the city but also creating palatable alternatives etc.

4. To enhance efficiency and to cut costs of mitigating congestion, The use and enhancement of ICT by both traffic regulators and administrators should be given fore priority. Motor vehicle driver trainers should consider ways of enhancing drivers' attitude and discipline besides the driving skills because this as was found in the research is key in curbing congestion. This will be reinforced by proper legislation and enforcement.

5.5 Suggestion For Further Studies.

a)　Considering the methodology and findngs of this study, similar research study and methodology may be conducted on other roads within the city of Nairobi to find out if there will be any commonalities or relationships in the findings.

b)　A similar study should be conducted on the same road after a certain period of time, say two years, then compare the findings.

c)　A study may also be conducted to find out why Nairobi City motorists prefer using their private cars under the difficult conditions of traffic congestion, high fuel prices and parking fees and not public service vehicles.

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APPENDICES

Appendix A: Map of Jogoo Road and surrounding Areas
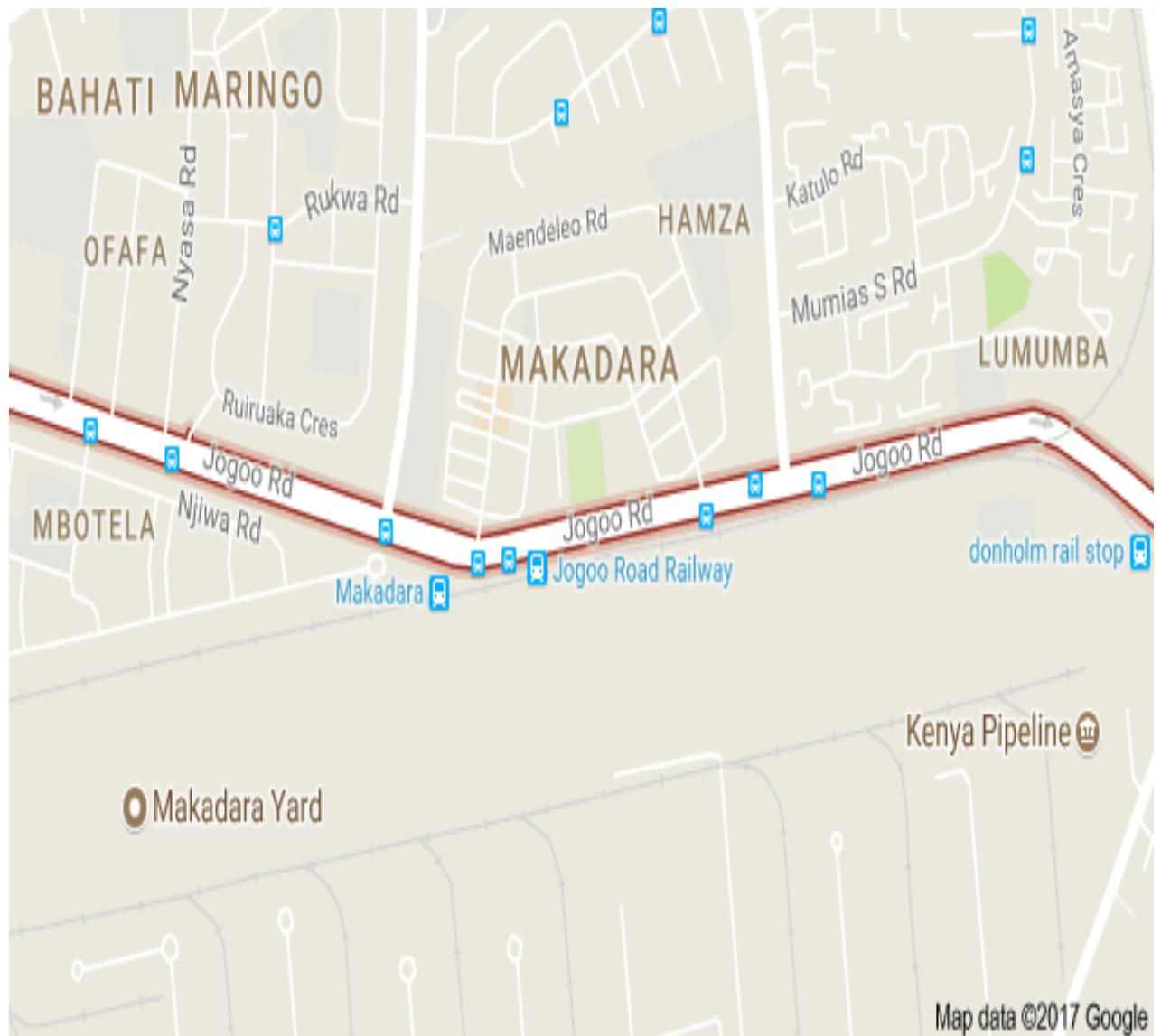
Appendix B: The plan for intervention by the Executive Task Force on Nairobi Decongestion
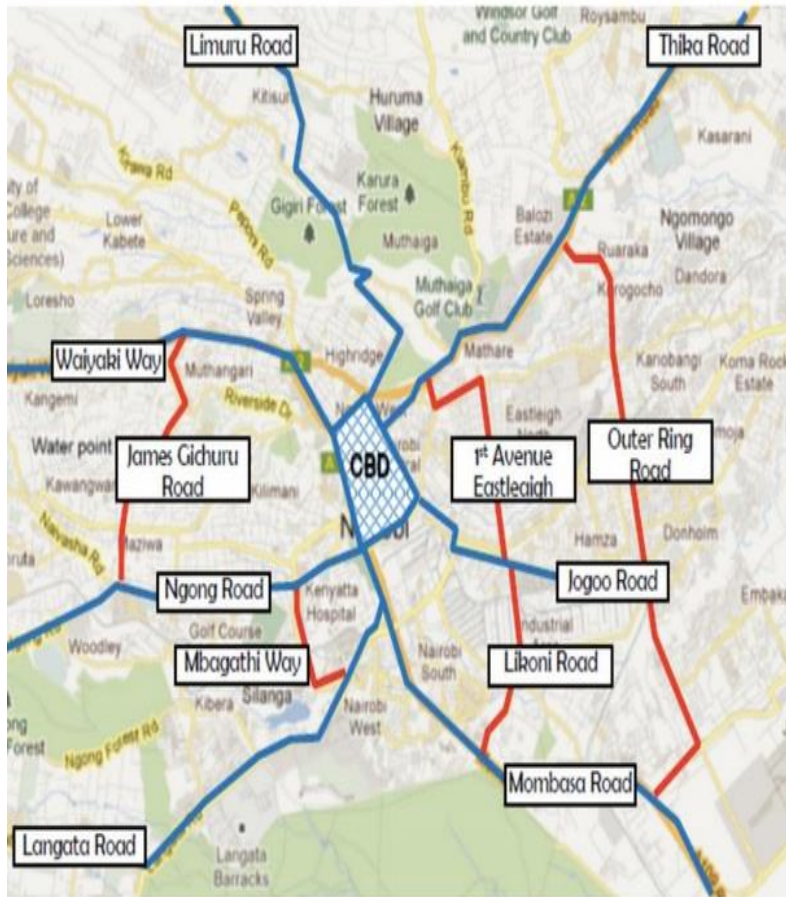
Arterial Roads – By priority

1. A104 Waiyaki way / Mombasa Road
2. Langata Road
3. Ngong Road
4. A2 Thika Road
5. Jogoo Road
6. Juja Road
7. Limuru Road

CBD - By priority

1. Uhuru Highway
2. Tom Mboya
3. Moi Avenue
4. Haile Selassie
5. Ronald Ngala / Racecourse Road

Appendix C: Letter of Introduction

Date …………………………   Questionnaire ID………………………….

Emmanuel M. Ogao

Kenyatta University
P.O Box 43844-00100
Nairobi.
Cell phone 0721236417
Dear participant

I am the above named master's student pursuing a course in Leadership and Security Management at Kenyatta University, Kenya Police Staff College Loresho Campus. Iam undertaking an academic research study that aims at **Looking at Strategies Applicable in Resolving Traffic Congestion on Jogoo Road, Nairobi city.** You have been carefully selected to participate in this study because I believe you have information that will greatly enrich the outcome of the research. All responses will be treated with strict confidence and will not be used for purpose(s) other than what is stated.

It is expected that the study findings will be helpful to the various stakeholders in coming up with the best strategies for resolving the problem of traffic congestion in the city of Nairobi. All information obtained will be treated with utmost confidentiality and results of the study will be available on request at no cost. Kindly complete on or before 10th November, 2017. Feel free to communicate to me via my mobile phone.

Thank You.

E.M. Ogao

<u>**Appendix D: QUESTIONNAIRE**</u>

This questionnaire is designed to collect data from police officers to inform recommendations that are aimed at generating best strategies for resolving traffic congestion in Nairobi city specifically, Jogoo road.

SECTION A: BACKGROUND INFORMATION

1. Respondent age group
   [1.] 20-25 yrs   [2.] 26-30 yrs [3] 31-35 yrs
   [4.] 36-40 yrs   [5] 41-45 yrs [6.] 46- 50 yrs
2. Sex: male [1.] female [2.]
3. What is your rank in the National Police Service?
   [1.] constable
   [2.] corporal
   [3.] sergeant
   [4.] any other (specify)
   ....
   ....
   ..

4. Your work station
   …………………………………………………………………………………………
   …………………………………………………………………………………………
   ……
5. What are your duties (specify)
   …………………………………………………………………………………………
   …………………………………………………………………………………………
   …………………………………………………………………………………………
   ……...
6. How long have you served in the Traffic Department, Kenya police service.
   [1.] Less than one year
   [2.] 1-3 yrs
   [3.] 3-5 yrs
   [4.] 5-7 yrs
   [5.] 7-9 yrs
   [6.] More than 9 yrs (specify) ………………………………………….
7. What is your level of education
   [1.] Primary
   [2.] Secondary

[3.] Diploma

[4.] Degree

8. Have you undergone any training on traffic management? Yes ☐ No ☐

If yes what was the length of the course(s) cumulatively?

[1.] 1 months

[2.] 3 months

[3.] 6 months and more

SECTION B: CAUSES OF TRAFFIC CONGESTION ALONG JOGOO ROAD

This section requires you to provide information on what you think are the causes of traffic congestion along Jogoo Road.

9. Do you agree or disagree that traffic congestion is problem or a concern on Jogoo road? Tick

    A. Agree ☐

    B. Disagree ☐

10. How would you rate the level of traffic congestion on Jogoo Road during peak hours ? Tick

a) Very High ☐ b) High ☐ c)Medium ☐ d)Low ☐ c) Very low ☐

11. How would you rate the level of traffic congestion in Nairobi City? Tick

a) Very High ☐ b) High ☐ c)Medium ☐ d)Low ☐ c) Very low ☐

12. In the list of Causes of traffic congestion on jogoo Road below please tick where appropriate in the boxes to indicate the level of agreeing or disagreeing

Likert Scale: Highly agree=5; Agree=4;Neutral=3; Disagree=2; Highly Disagree=1

S/No.		Level of agreement or disagreement				
	What is your level of agreement as to the causes of congestion on Jogoo Road?	Highly Agree	Agree	Neutral	Disagree	Highly Disagree
1	Narrow roads or narrow sections of the road					
2	Road junctions					
3	Inadequate roads					

4	Bumps and rubble strips on the road					
5	Lack of lanes for heavy transport vehicles					
6	Poor attitude and arrogance of drivers					
7	Large No. of vehicles plying the road at the same time					
8	High demand for private car use					
9	High population of different road users i.e. pedestrians, cyclists, cart pullers, motorists etc					
10	Pedestrians Crossing at designated points					
11	Inadequate large public service vehicles (HOV)					
12	Inadequate quality Public service vehicles					
13	Poor urban planning					
14	Inadequate enforcement					

13. Is there any other cause(s) of road congestion on Jogoo Road according to you ?

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14. SECTION C: STRATEGIES OF RESOLVING TRAFFIC CONGESTION

Please indicate by ticking in the appropriate box on how you agree or disagree with the strategies of resolving congestion on Jogoo Road.

Scale : Highly agree=5; Agree=4; Neutral=3; Disagree=2; HihglyDisagree

S/No.	What is your level of agreement as to the suitability of Congestion	Level of agreement or disagreement				
		Highly Agree	Agree	Neutral	Disagree	Highly Disagree

	Management Strategies below on Jogoo road					
1	Increase number of lanes on the road					
2	Introduce advanced road design such as flyover roads					
3	Improve the services of railway system					
4	Improve road junctions design to allow for smooth continuous entry					
5	Construct lanes for use by bicyclists, tricyclists and pedestrians					
6	Increase number of pedestrian foot bridges					
7	Increase parking spaces within the Central Business District(CBD)					
8	Increase charges on vehicle importation cost					
9	Introduce road use charges (toll station) along Jogoo Road					
10	Introduce charges targeting private car owners during rush hours (congestion Charge)					
11	Increase charges on fuel levy					
12	Reduce prices of alternative transportation means					

13	Introduce laws that regulate or alter travelers behaviours					
14	Enhance the use of mass media in providing real time information on status of roads					
15	Introduce use of Information and Communication Technology to manage Traffic					
16	Use of Mobile phone apps to get information about conditions of roads					

15) Can you think of any other strategy applicable in resolving congestion on Jogoo Road?…………………………………………………………………………………………..

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Appendix E: Interview schedule

My name is Emmanuel M. Ogao. I am a student at Kenyatta undertaking a Masters Course in Leadership and Security Management. As part of the Course fulfillment Im required to Undertake a research study. My study is on Security Strategies of Resolving Traffic Congestion in Cities, a case of Jogoo road Nairobi. By virtue of being a stakeholder in matters of transport in this city I hope your response and suggestions/recommendations will be useful in this research study. Kindly allow me to ask you a few questions in regard to the subject.

      a) Where do you work?
      b) For how long have you been working there?

c) Do you agree or disagree that jogoo road is usually congested during peak hours?
d) Have how would you rate congestion level on Jogoo Road?
e) How would you rate congestion level in the city of Nairobi?
f) Having agreed that congestion exists on Jogoo Road, what do you think are the causes?
g) What do you think should be done to resolve the congestion problem on Jogoo Road?

Thank you for giving me the opportunity to interview you. Your response will be useful in finding lasting solutions to the problem of congestion on this road and in the city of Nairobi. Thank you. Please have my contacts …. 0721236417. You can contact me regarding our interview and the research study progress any time.

Appendix F: Pictorials from obseravation

The population of private vehicles seems to outnumber that of PSVs

Two roads with two lanes from Manyanja and Lungalunga each joining Jogoo road's two lanes is a form of bottlenecking

Lack of sufficient passanger collection points cause PSVs to collect passangers on the road

APPENDIX G : Letter to the Traffic Commandant, other Governement departmental heads and Consent form

No. 231017

           Emmanuel MakokhaOgao

D.C.I. Headquarters,

P.O.Box 30036-00100,

Nairobi.

<u>15/11/2017</u>

OC Traffic Nairobi Area

Kenya Police Traffic Unit

P.O.Box 46782

Nairobi.

Dear sir,

RESEARCH STUDYFOR MASTERS PROGRAMME AT KENYATTA UNIVERSITY

I am the above namedstudent ofKenyatta University undertaking a Mastersdegree course in Leadership and Security Management at Kenya Police Staff College Loresho Campus. I am undertaking a research study as part of the Masters degree course.

My research study is focusing on Security Strategies for resolving Traffic Congestion in Nairobi City, Case of Jogoo Road. Traffic Congestion is a major problem in our Cites today and has brought with it many negative externalities. Our city of Nairobi is not an exception. It is with that in mind that I have chosen this topic with the aim of engaging stakeholders for purposes of generating the best strategies for mitigating this problem on Jogoo Road.

The focus area of the study was selected on the premise that Jogoo Road is one of the mostly affected roads in the city by traffic Congestion and it is a very important road to the Country. This road is used by a very big percentage of Nairobi City dwellers who reside in the Eastern side of the City. Most of this city dwellers make-up the middle and low class members of the society who contribute highly to the labour force of the City's economy Commercially and also Industrially.

Kindly accord me the permission to engage traffic officers by administering questionnaires to them to get their views about the problem in search for solutions.

Your assistance will have a huge impact on the validity and reliability of the data collected which will lead to well informed conclusions with regards to generating the best strategies of resolving traffic

congestion in our city.Thanking you in anticipation of your positive response.

Emmanuel M. Ogao

1.	I have read and understood the information about the research, as provided in the Information Sheet.	
2.	I have been given the opportunity to ask questions about the research and my participation.	
3.	I voluntarily agree to participate in the research.	
4.	I understand I can withdraw at any time without giving reasons and that I will not be penalized for withdrawing nor will I be questioned on why I have withdrawn.	
5.	The procedures regarding confidentiality have been clearly explained (e.g. use of names, pseudonyms, anonymity of data, etc.) to me.	
6..	The use of the data in research, publications, sharing and archiving has been explained to me.	
7.	I understand that other researchers will have access to this data only if they agree to preserve the confidentiality of the data and if they agree to the terms I have specified in this form.	
8.	Select only **one** of the following: • I would like my name used and understand what I have said or written as part of this study will be used in reports, publications and other research outputs so that anything I have contributed to this project can be recognised. • I do not want my name used in this project.	
9.	I, along with the Researcher, agree to sign and date this informed consent form.	

Informed Consent form for respondents. Please tick on the RHS boxes

I, the undersigned, confirm that (please tick box as appropriate):

Participant:

_____ _____ _____

Name of Participant   Signature   Date

Researcher:

_____ _____ _____

Name of Researcher   Signature   Date

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

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When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

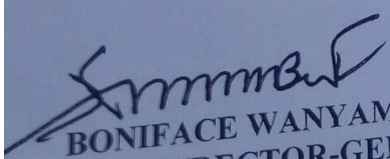Ref: No. **NACOSTI/P/18/79006/25124**   Date: **2nd October, 2018**

Emmanuel Makokha Ogao
Kenyatta University
P.O. Box 43844-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on *"Security strategies applicable in resolving traffic congestion in cities, case of Jogoo Road, Nairobi City"* I am pleased to inform you that you have been authorized to undertake research in **Nairobi County** for the period ending **2nd October, 2019.**

You are advised to report to **the County Commissioner and the County Director of Education, Nairobi County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

BONIFACE WANYAMA
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Nairobi County.

The County Director of Education

THIS IS TO CERTIFY THAT:
MR. EMMANUEL MAKOKHA OGAO
of KENYATTA UNIVERSITY, 30036-100
G.P.O,has been permitted to conduct
research in Nairobi County

Permit No : NACOSTI/P/18/79006/25124
Date Of Issue : 2nd October,2018
Fee Recieved :Ksh 1000

on the topic: SECURITY STRATEGIES
APPLICABLE IN RESOLVING TRAFFIC
CONGESTION IN CITIES, CASE OF JOGOO
ROAD, NAIROBI CITY.

for the period ending:
2nd October,2019

....
Applicant's
Signature

....
Director General
National Commission for Scie
Technology & Innovation