TRAFFIC CONGESTION PROBLEMS IN NAIROBI: AN EXAMINATION OF UHURU HIGHWAY

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DECLARATION

This planning research project is my original work and has not been presented for a degree in any other University.

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This planning research project has been submitted for examination with my approval as the University supervisor

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DEDICATION

To my mum, Helené é as hard as it has been, both your love and prayers have done wonders in my academic life at the University. Thank you!

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I however remain responsible for any errors and omissions in this research project.

ABSTRACT

Infrastructure development has been taken as one of the critical foundations on which the Kenya vision 2030 is anchored. For this reason investment in the nationôs infrastructure has been given a high priority to ensure the main projects under the visionôs economic pillar are implemented.

Over the years, highways have been used as major transportation links between cities and different parts of the city, including the city of Nairobi. However, in the recent past, traffic congestion in Nairobi has overwhelmed the highways and Uhuru highway has not been spared.

The highway borders Nairobi CBD to the North and it starts at the Nyayo Stadium Roundabout to the East, ending at the Museum Hill Roundabout to the West. Due to limited time and financial resources the study has sought to cover just the section between Haile Selassie Roundabout and University Way Roundabout based on the fact that traffic congestion at this section directly affects traffic flow into and out of CBD.

The study seeks to examine the major factors contributing to traffic congestion along Uhuru highway. It does this by first of all investigating the existing traffic management system for Uhuru Highway with a view of establishing its effectiveness in facilitating traffic movement along the highway. It then goes ahead to find out the traffic challenges experienced along the highway, out of which traffic congestion is found to be the major challenge. It is at this point that the study sought to examine the factors behind this problem of traffic congestion along the highway. The last chapter comes up with proposals to help reduce this problem of traffic congestion not only along the highway but also in the city of Nairobi as a whole.

All the contents of the study have been organized systematically into six chapters, namely: introduction; methodology of the study; literature review; background to the study area; study findings; synthesis and recommendations. The study has been organized in six chapters starting from the introduction to the recommendations

The significance of the study has been captured in the urgent need to ease traffic congestion in the main streets of Nairobi city with the government being on the front line.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF MAPS

LIST OF CHARTS

LIST OF GRAPHS

LIST OF PLATES

LIST OF ACRONYMS

CBD	- Central Business District
CCN	- Nairobi City Council
GoK	- Government of Kenya
KRB	- Kenya Roads Boards
WUF	- World Urban Forum
UMR	- Urban Mobility Report
U.S.	- United States
OECD	- Organization for Economic Co-Operation and Development
MR	- Magadi Railways
KRC	- Kenya Railways Corporation
MR	-Magadi Railways
KUR	- Kenya Uganda Railway
NMC	- Nairobi Municipal Community
KBS	- Kenya Bus Service
NUTRANS	- Nairobi Urban Transport Study
LRT	- Light Rail Transit
BRT	- Bus Rapid Transit
UMR	- Mobility Report
NMMT	- Non-Motorized Means of Transport

CHAPTER 1: INTRODUCTION

1.1 Background to the Problem

Big cities across Africa suffer maddening traffic congestion, in most cases because they have failed to update road networks built decades ago to serve colonial administrations. There are no subways, elevated trains or bus lanes. The roads are generally two lanes ð although aggressive drivers often turn them into four lanes.

Kenya's capital, Nairobi, suffers from some of the worst traffic congestion in the world. Less than one-tenth of Nairobi's three million citizens own cars. Yet traffic is a serious problem. Every morning and evening, during peak commuter hours, the city comes to a standstill. This is not just a problem for commuters, but is also increasingly a major health risk. Millions of Kenyans are believed to be suffering from diseases related to pollution.

Nairobi's traffic problem is a difficulty shared by many cities in the developing world. It is the only problem we have in developing countries that does not get better as we get richer, it gets worse. If Kenya had three times the income per capita it had today it would have better education, health. But urban transport would be worse, it would be more cars, more traffic jams it would be more of a mess.

At this juncture, the government of Kenya, with support from development partners (JICA, ADB, WB, CHINA GOVERNMENT) is currently preparing to expand Uhuru Highway Thika road, Mombasa Road and Outer Ring roads. The government is also developing bypass roads on the fringes of the city to enable through-traffic and hence avoid the congested areas and other obstructions to traffic movement. These bypasses are Nairobi Southern, Northern and Eastern bypasses.

In addition, there is also a proposed link road between the Southern and Northern bypasses. Roads Department (RD) plans to do away with roundabouts on some major Nairobi roads, which have been the main reason for traffic snarl-ups in the city centre. Thika Road and Uhuru Highway are the first targets. The transport corridor pattern should also be modeled to include ring roads, radial and belt type transport corridors (Kingôori, 2007).

Expansion and reconstruction works on the 22km section of the Jomo Kenyatta International Airport (JKIA) - Uhuru Highway-Museum Hill to Gigiri road has already started. This rehabilitation includes the construction of an extra lane on both sides of the road to ease traffic flow and reduce traffic snarl-ups. Funding is being extended by China government through a Ksh5.9 billion development package.

The government of Kenya has long been exerting its effort to relieve Nairobi City from unfavorable traffic conditions. The traffic volume in the Central Business District of Nairobi has been increasing year after year, and the situation is becoming worse due to the industrial and commercial development in the sub-urban areas. According to AfricaDaily2 (Nov13-Kenya Traffic Congestion), traffic build-up in the streets of Nairobi is costing businesses millions of shillings in fuel consumption, car damage and time wasted on the road. The *Daily* notes that cars are increasing at a rate of about half a million per year in Nairobi. Omwenga (World Urban Forum, 2008), notes that the city of Nairobi alone accommodates about 30% of the car vehicle ownership in Kenya.

It is on this basis of urgent need for solving traffic congestion in Nairobi that the topic of the study is chosen. The study seeks to examine the factors contributing to traffic congestion along Uhuru highway. The highway borders Nairobi CBD to the North and it starts at the Nyayo Stadium Roundabout to the East, ending at the Museum Hill Roundabout to the West. Due to limited time and financial resources the study has sought to cover just the section between Haile Selassie Roundabout and University Way Roundabout based on the fact that traffic congestion at this section directly affects traffic flow into and out of CBD.

1.2 Problem Statement

Over the years, highways have been used as major transportation links between cities and different parts of the city, including the city of Nairobi. However, in the recent past, traffic congestion in Nairobi has overwhelmed the highways and Uhuru highway has not been spared. The dual role of the highway as a national and international road has resulted to conflict between through traffic and city centre traffic. This problem becomes worse during peak hours of each working day curbed with presence of pedestrian traffic that conflicts with vehicular traffic

The implementation of the proposed bypasses and ring roads has taken too long. The main objective of these bypasses i.e. to ease traffic congestion in the CBD by diverting through traffic from Uhuru Highway and Mombasa road, may not be easily realized since the suburbs, through which they were designed to pass, are already built up and their own traffic is building up.

Uhuru highway has therefore continued to face increasing levels of traffic congestion in the name of having to wait for implementation of these projects. This problem has of late manifested itself within the CBD and all the other roads intersecting the highway. Any attempt to solve this problem of traffic congestion at this stage demands a clear understanding of the inherent factors behind its occurrence as well as their interrelationship. The purpose of this study is therefore to examine the factors that contribute to rising levels of traffic congestion along Uhuru highway with an aim to coming up with appropriate measures to revert the trend.

1.3 Research Questions

The research questions of this study are as follows:-

i. What is the efficiency of the traffic management system along Uhuru highway?
ii. What are the major traffic challenges along Uhuru highway?
iii. What are the causes of traffic congestion along Uhuru highway?
iv. Which could be the possible solutions to traffic congestion along Uhuru highway?

1.4 Research Objectives

The research objectives of this study are as follows:-

i. To investigate the traffic management system for Uhuru highway.
ii. To find out the traffic challenges along Uhuru highway.
iii. To examine the causes of traffic congestion along Uhuru highway.
iv. To propose possible solutions to the problem of traffic congestion along Uhuru highway.

1.5 Assumptions of the Study

The following assumptions will be considered in the study:

1. That the population of Nairobi will grow exponentially as it has been doing in the previous years.
2. That a clear understanding of the causes of traffic congestion along the Uhuru highway will help in determining possible solutions the congestion problem.

1.6 Justification of the Study

Infrastructure development has been taken as one of the critical foundations on which the Kenya vision 2030 is anchored. For this reason investment in the nationôs infrastructure has been given the highest priority in ensuring the main projects under the visionôs economic pillar are implemented.

In April 2007, president Kibaki announced plans for a 2 billion Kenyan Shilling Chinese project to widen the Uhuru Highway and link it to the west of the city.

Traffic congestion along the highway inconveniences commuters in accessing the CBD, leading to wastage of time and money. A good road with smooth traffic flow reduces travel time and encourages investments. At the same time an effective transportation system helps to maximize the economic efficiency of the city, while an inferior system retards economic progress.

The study is significant in that it tries to identify the traffic problems experienced along the highway with a view of coming up with possible solutions to the problems. The overall output of the study can be used by the government as a good basis for formulating policies to decongest Uhuru highway and the city as a whole.

1.7 Scope of the Study

Uhuru highway has both national and international significance despite it having been designed as a primary arterial road meant to serve the city of Nairobi. The study was carried out along Uhuru highway due to its significance to traffic congestion in the CBD of Nairobi city. It has covered a section of about 1km in length starting from the Hailesellasie roundabout to the University Way roundabout. This also included Statehouse road and Hailesellasie Avenue both of which feed into the highway hence directly affected by traffic congestion along the highway.

1.8 Organization of the Study

This report is organized into six thematic chapters each of which is further subdivided into sub-chapters.

1.8.1 Chapter 1: Introduction

This chapter articulates the background of the problem from the point of view of manifestations of traffic problems experienced in big cities including Nairobi. It outlines the research objectives. It also gives out the assumptions of the study, justification, scope and finally the limitations.

1.8.2 Chapter 2: Research Methodology

This chapter elaborates the entire process under which the study is to be carried out. It entails description of the research design from the data collection stage up to the data synthesis and interpretation stage. Sample selection is also elaborated in this chapter.

1.8.3 Chapter 3: Literature Review

This chapter deals with the review of pertinent literature to the research. It introduces the place of transportation system in the urban setting and follows its evolution through time and space from the earliest times to the problems being experienced today. Within this context the chapter analyses the various components of the urban transport system - the road and the railway - as well as traffic movement within these systems, which include both goods and passenger traffic. This is not forgetting, of course, one of the critical components of the transport system in the urban setting ï parking - and how it interrelates with traffic congestion in the cities. The chapter also tries to come up with ideal criteria on which the urban transport system can be judged as well as inter-relating the problem of traffic congestion in urban areas with that of Nairobi.

1.8.4 Chapter 4: Study Area

This chapter analyses the study area which is Uhuru highway. It analyzes the characteristics of Uhuru highway with regards to traffic movement both at off-peak and at peak commuter periods. It also tries to identify the transportation role of Uhuru highway within Nairobi city and analyzes its physical characteristics.

1.8.5 Chapter 5: Study Findings

This chapter will analyze the study findings which are to be obtained from the field study. It will try to answer the research questions and also investigate the possible opportunities reducing traffic congestion along the highway.

1.8.6 Chapter 6: Synthesis, Conclusions, Recommendations

This chapter will synthesize the research findings gathered and summarize them in the form of emerging issues. It will try to give solution to the problems from previous chapter in the long, medium and short term proposals. It will also try to give possible areas that could be explored for further research.

1.9 Limitations of the Study

There were several limitations encountered due along the process of carrying out the study. First, limited resources especially on the financial side limited the collection of data in the study area. Limited time lead to selection of a small sample size compared to the target population. Secondly, the bureaucratic processes in collecting data from the Nairobi City Council slowed down the study process. Thirdly, lack of up to date information from these offices was a great limitation to the study. Finally, interviewing private motorists along the highway also proved difficult.

1.10 Definition of Key Terms

Congestion

The term congestion denotes any condition in which demand for a facility exceeds free-flow capacity at the maximum design speed (Altshuler, 1979).

Traffic congestion

This is a condition on transportation networks that occurs as use increases, and is characterized by slower speeds, longer trip times, and increased queuing. The most common example is the physical use of roads by vehicles. When traffic demand is great enough that the interaction between vehicles slows the speed of the traffic stream, congestion is incurred. As demand approaches the capacity of a road (or of the intersections along the road), extreme traffic congestion sets in. When vehicles are fully stopped for periods of time, this is colloquially known as a **traffic jam**.

Recurrent congestion

This refers to the consequence of factors that cause regular demand surges on the transportation system, such as commuting, shopping or weekend trips.

Non-recurrent congestion

This is congestion that is caused by random events such as accidents and unusual weather conditions (rain, snowstorms, etc.), which are unexpected and unplanned.

Highway

This is a main road intended for travel by the public between important destinations, such as cities and towns.

Carriageway

A carriageway is a part of a road referring to the part that will technically carry vehicle traffic

Dual carriageway

A dual carriageway or divided highway is a road or highway in which the two directions of traffic are separated by a central barrier or strip of land, known as a central reservation or median.

Road reserve

This means all of the area of land that is within the boundaries of a road

Road capacity

The maximum traffic flow obtainable on a given roadway using all available lanes; usually expressed in vehicles per hour or vehicles per day

By-pass road

A bypass is a road or highway that avoids or "bypasses" a built-up area, town, or village, to let through traffic flow without interference from local traffic, to reduce congestion in the built-up area, and to improve road safety.

Roundabout

This is a type of road junction at which traffic enters a one-way stream around a central island

Trip

This refers to a one way movement from one place to another with a purpose.

CHAPTER 2: RESEARCH METHODOLOGY

2.1 Introduction

This chapter outlines the steps that were followed in carrying out the study. It deals with the nature of data collected, units of observation and analysis, population sampling as well as the methods used to collect, analyze and represent data for the study.

2.2 Nature/Types of Data and Data Sources

Various types of data/variables will be needed in order to successfully carry out the study. There will be both units of observation and units of analysis.

2.2.1 Units of Observation

- Road users (Pedestrians, Motorists Cyclists, Motorcyclists, Handcart pullers)
- Traffic generators
- Road network
- Land use
- Traffic management system

2.2.2 Units of Analysis

- Traffic volume and road capacity
- Road network and traffic routes
- Means of transport and modal split
- Traffic flow/speed
- Traffic conflict points and accident points
- Road conditions, design and road network
- Pedestrian routes
- Transportation facilities
- Cost of travel and income levels
- Road user behaviour

Population Sampling

The population in the study area was stratified. This will required use of stratified random sampling in order to take into account data from all the population subgroups in the study area. The main subgroups included private vehicle owners, public vehicle operators and pedestrians. From each of the strata, fifteen (20) respondents were interviewed to give a population sample of fourty (60) respondents. The samples were selected based on periods and areas of high traffic congestion and traffic conflict on the premise that ample time is needed for the respondents to answer the questions, something that would be more difficult when the traffic is moving fast. This premise led to selection of the samples from the University Way, Kenyatta Avenue and Hailesellasie roundabouts as well as two terminals in the CBD (at Gill House and KenCom).

2.4 Data Collection

In the survey, both primary and secondary sources and methods of data collection were employed. The data collection consisted of both qualitative and quantitative techniques.

(a) Secondary data

Secondary data was obtained mainly through literature review of the existing work by various scholars and researchers on vehicular and pedestrian traffic challenges as well as transportation planning that is focused towards road traffic. Other sources of secondary information included previous plans of Nairobi with reference to the study area, aerial photographs, case studies, government publications, maps and other documents that could be obtained from relevant library, government offices, non-government offices, the media and the internet.

(b) Primary Data

Data was gathered directly from the field using the following techniques:

i) Observation

This involved the systematic selection, watching and recording of behavior and characteristic of subjects, objects or phenomena that are of relevance to the study. Variables to be observed included pedestrian, motorist and other road user behaviour, modes of traffic, traffic conflict points. It also included observing the challenges faced by road users while using the highway.

ii) Written Questionnaires

Written questionnaires were presented to respondents and answered in written form. There will be both structured and open ended questions to be answered in the questionnaires by the respondents.

iii) Interview

Oral interviews

Part of the data was collected through talking to the respondents, either individually or as a group.

This was a very useful method of complementing questionnaire technique especially where the sample characteristic did not understand the questionnaire. In such a case the whole questionnaire was be converted into a discussion between the respondent and the interviewer with the most convenient language to both parties.

The interview approach was also very important where questions were seeking opinion views, attitudes as well as experience of the respondents concerning traffic congestion along the highway.

Data collected included the problems faced by the respondents when using the highway as well as those problems faced elsewhere as a result of the operations of the highway. The respondents to be interviewed included both motorized and non-motorized vehicle operators, commuters and pedestrians who use the highway as well as traffic police involved in controlling traffic at along the highway. These were useful in giving out the true picture of the traffic problems at the ground.

Due to the nature of the subject of the study, at times the interviewer was required to board commuter vehicles that use the highway and interview the conductor/driver and commuters along the way, both at peak and off-peak commuter periods. This was to ensure convenience in terms of time for the drivers as well as the interviewer getting the real experience of the problems experienced by the motorists along the highway.

Another approach to oral interview was for the interviewer to question the vehicle operators at their destination points in the Central Business District of Nairobi city. Ample time for interview was available at these points as the operators wait for passengers to board their vehicles.

Written Interview schedules

Interview schedules were prepared for the relevant stakeholders in traffic management in the CBD. These will include the NCC (transportation section), Ministry of Roads, Ministry of Transport and Traffic police personnel. Data collected from the above sources included planning data on traffic patterns and management as well as the challenges and prospects of highway traffic.

iv) Mapping and Photography

Existing maps were used to map out the spatial traffic scenarios within the study area. Photographs will enhanced the analysis of the existing traffic situation along the highway.

2.5 Data Analysis and Presentation

The data collected was then analyzed using computer based analysis. This was done using programs such as SPSS to help in understanding how the existing situation affects the traffic volume situation on the road under study. It was not possible to do traffic count due to limited time and finance hence literature review on previous traffic census was done followed by ground truthing at the field. Qualitative data analysis was also be used. Data was presented in the form of graphs, tables, charts, diagrams and maps.

2.5 Data Synthesis

The analyzed data whose output was in the form of graphs, charts, tables, maps and diagrams was interpreted so as to aid in answering the research questions and either support the hypothesis or not. The data also aided to formulate formidable and implementable proposals that may be used planning for reduction of congestion along the highway.

CHAPTER 3: LITERATURE REVIEW

3.1Introduction

This chapter reviews the main traffic challenges within urban areas. It starts with reviewing urbanization and its effect on transportation. The section has also discussed in detail the urban transport system. It goes ahead to review the causes of traffic congestion before finally discussing a possible way towards congestion free transportation system.

3.2 Urbanization

The city has been depicted by many urban analysts as a kind of dynamic interface machine of movement(transport), channels of communication including information links, serving activities accommodated by the settlements, (Dimitriou, 1992). Such needs provide for the needs of industrialization and commerce, encourage further economic and urban growth, and generally increase the pace of modernization.

Urbanization refers to the process of transition from a rural to a more urban society. Statistically, urbanization reflects an increasing proportion of the population living in settlements defined as urban, primarily through net rural to urban migration (Rodrigue: *Transportation and Urban Form*). The level of urbanization is the percentage of the total population living in towns and cities while the rate of urbanization is the rate at which it grows (UNFPA, 2007).

In the year 2000, world population was about 6.1 billion and growing at a rate of 1.2 % or 77 million people per month. B y this period, 47 % of this world population was urbanized and it was estimated that more than half of the world population will be living in urban areas by the end of the year 2008. By the year 2030, it is expected that 60 % of the world population will be living in urban areas. This is due to two main demographic trends:

- **Natural increase**. It is simply the outcome of more births than deaths in urban areas, a direct function of the fertility rate as well as the quality of healthcare systems (lower mortality rates, particularly for infants).
- **Rural to urban migrations**. This has been a strong factor of urbanization, particularly in the developing world where migration accounted between 40 and 60% of the urban

growth. Such a process has endured since the beginning of the industrial revolution in the 19th century but has become prevalent in the developing world. The reasons for urban migration are numerous and may involve the expectation to find employment, improved agricultural productivity which frees rural labor or even political and environmental problems where populations are constrained to leave the countryside.

Together, these growth phenomena have created a lethal combination of interrelated and self-generating urban problems of enormous proportions. Problems of urban transport associated with the rapid growth in vehicles, are but one integral component of the wider urban development situation the third world cities.

Such rapid growth phenomena has also made the management of the third world city complex, difficult and expensive, as the demand for additional urban space for new activities(and the traffic they generate) introduces severe competition for the use of land. As Dimitriou (1992) notes, typically such cities have a total land area of below 10%, and rarely above 15%, allocated to roads. By comparison, in cities in industrialized countries, land allocated to roads is generally 15-25% of total land areas.

3.2.1 Transportation and Urban Structure

Rapid and expanded urbanization occurring around the world involves an increased number of trips in urban areas. Cities have traditionally responded to growth in mobility by expanding the transportation supply, by building new highways and/or transit lines. In the developed world, that has mainly meant building more roads to accommodate an ever-growing number of vehicles, therefore creating new urban structures. Several urban spatial structures have accordingly emerged, with the reliance on the automobile being the most important discriminatory factor. Four major types can be identified at the metropolitan scale [Thomson, 1977]:

- **Type I - Completely Motorized Network**: Representing an automobile-dependent city with a limited centrality.
- **Type II - Weak Center:** Representing the spatial structure of many American cities where many activities are located in the periphery.

- **Type III - Strong Center:** Representing high density urban centers with well developed public transit systems, particularly in Europe and Asia.
- **Type IV - Traffic Limitation:** Representing urban areas that have implemented traffic control and modal preference in their spatial structure. Commonly, the central area is dominated by public transit.

Facing the expansion of urban areas, congestion problems and the increasing importance of inter-urban movements, several ring roads have been built around major cities. They became an important attribute of the spatial structures of cities, notably in North America. Highway interchanges in suburban areas are notable examples of new clusters of urban development. The extension (and the over-extension) of urban areas have created what may be called peri-urban areas. They are located well outside the urban core and the suburbs, but are within reasonable commuting distances.

3.2.2 Elements of Urban Movements

The consideration of urban movements involves their generation, the modes and routes used and their destination:

- **Trip generation**. On average, an urban resident undertakes between 3 and 4 trips per day. Moving in an urban area is usually done to satisfy a purpose such as employment, leisure or access to goods and services. Each time a purpose is satisfied, a trip is generated. Important temporal variations of the number of trips by purpose are observed.
- **Modal split.** Implies which transportation mode is used for urban trips and is the outcome of a modal choice. **Modal choice** depends on a number of factors such as technology, availability, preference, travel time and income.
- **Trip assignment.** Involves which routes will be used for journeys within the city. For instance, a commuter driving a car has most of the time a fixed route. This route may be modified if there is congestion or if another activity (such as shopping) is linked with that trip; often known as **trip chaining**. Several factors influence trip assignment, the two most important being transport **costs** and **availability**.

- **Trip destination**. Changes in the spatial distribution of economic activities in urban areas have caused important modifications to the destination of movements, notably those related to work. The **central city** used to be a major destination for movements, but its share has substantially declined in most areas and **suburbs** now account for the bulk of urban movements.

3.3 The Urban Transport System

In any urban transport system different modes often complement and compete with each other. They have different associated costs and benefits for the user and non-user, and are normally associated with a variety of operators. The complementary characteristics are those which facilitate the interchange of modes so that combination of transport means provides coverage of a given area and accommodates the needs of different markets. Competition exhibits the contest between modes for patronage of the same routes and geographical area.

Many big cities contain a rich mixture of traditional and modern modes of transport. In some places they share the same different market segment of the public. Dimitriou (1992) argues that the wider the range of transport modes offered, and the greater the spectrum of income brackets accommodated, the more effective the transport system. He equates diversity with the response to changing transport demands of different urban areas and groups.

However, many third world countries, as Dimitriou (1990) observes, do not consider diversity an asset. Instead, given a cityôs limited capacity to accommodate growing motorized traffic volumes, traditional and informal transport modes are often considered obstacles to the modernization of the transport system.

In an increasing number of cities such as Mexico City Cairo and Hong Kong, the range of transport systems has been enhanced relatively by the construction of metro schemes to relieve the traffic pressure on city road systems. Solutions of this kind are however, far beyond the available resources of many other urban areas of the third world.

The significance of urban transport systems lies in the following (Dimitriou, 1992):

i. Their provision of linkages between points of residence and employment
ii. Their contribution to the economies of scale and specialization of urban based activities ï industrial and commercial activities.
iii. The employment opportunities they offer to the inhabitants of settlements, and
iv. Their impact on geographical growth and urban form

The evolution of urban transport systems can be said to respond to, as well as adapt to, changing basics needs and aspirations of urban activities as they attempt to maximize their accessibility to other dependent activities. Dimitriou (1992) identifies the influential factors detrimental to the efficiency of urban transport systems as follows:

i. The rapid geographical spread of urban areas which encourages both longer trip-making and the generation of additional demands for ill affordable peripheral transport facilities.
ii. Inadequate traffic restraint and management efforts pursued by governments which fail to contain trends of the increased indiscriminate use of motorized transport in urban areas
iii. The employment of ineffective development control measures and urban transport planning efforts by municipal agencies which allow major traffic generators and land-use developments to take place at locations which are developments to take place at locations which are incompatible with transport facility provision

An argument has been pushed by Thomson (1977) that before judging the effectiveness or adequacy of a transport system one should first look deeper than the amount of congestion on the roads or the punctuality of the railways. This can be arrived by asking the following questions:

(i) To what extent can people engage in the activities they want? Are they prevented or deterred by travel difficulties or costs from obtaining the work they want, going to the school of their choice, shopping where they wish and indulging in the social, cultural and sporting activities that they like? Are people able to reach, not the places, but the activities they want.
(ii) To what extent can people live in the area they prefer, subject to what they can afford? Some people may accept a less satisfactory home in order to be within easy reach, by the

available transport, of the community activities they want, while others may choose an inaccessible place in order to obtain a better home at a price they can afford.

(iii) How easy, cheap, pleasant and quick (in time, not in speed) are the journeys involved by community activities, especially business journeys and journeys to work, to school, shops and to the city centre.

(iv) How costly is the distribution of goods within the city? This is largely a multiple of the speed of goods movement and the distances involved. It is relatively easy to achieve high speeds in low-density cities and in the outskirts of cities, but the distances to be travelled in such places are apt to be relatively long.

(v) How many accidents, and of what severity, occur on the transport system?

(vi) How does the transport system impinge upon the environment in which people live, work, shop and spend their leisure?

It is this kind of transport- activity analysis that is really needed to enable one to assess the performance of the transport system and to judge where it needs improvements. The analysis of transport system has however been invariably based on engineering concepts which attach importance only to motorized journeys and which take as given the activities at the end of the journeys. A rather effective approach to analysis of cities should be the one designed to discover how well the cities meet human needs rather than how well they function as machines.

The spatial imprint of urban transportation system

The amount of urban land allocated to transportation is often correlated with the level of mobility. In the pre-automobile era, about 10% of the urban land was devoted to transportation which were simply roads for a traffic that was dominantly pedestrian. As the mobility of people and freight increased, a growing share of urban areas is allocated to transport and the infrastructures supporting it. The major components of the spatial imprint of urban transportation are:

- **Pedestrian areas**-Refer to the amount of space devoted to walking. This space is often shared with roads as sidewalks may use between 10% and 20% of a road's right of way. In central areas, pedestrian areas tend to use a greater share of the right of way and in some instances; whole areas are reserved for pedestrians. However, in a motorized

context, most of pedestrian areas are for servicing people's access to transport modes such as parked automobiles.

- **Roads and parking areas**-Refer to the amount of space devoted to road transportation, which has two states of activity; moving or parked. In a motorized city, on average 30% of the surface is devoted to roads while another 20% is required for off-street parking. This implies for each car about 2 off-street and 2 on-street parking spaces. In North American cities, roads and parking lots account between 30 to 60% of the total surface.
- **Cycling areas**-In a disorganized form, cycling simply shares access to pedestrian and road space. However, many attempts have been made to create spaces specifically for bicycles in urban areas, with reserved lanes and parking facilities.
- **Transit systems**-Many transit systems, such as buses and tramways, share road space with automobiles, which often impairs their respective efficiency. Attempts to mitigate congestion have resulted in the creation of road lanes reserved to buses either on a permanent or temporary (during rush hour) basis. Other transport systems such as subways and rail have their own infrastructures and, consequently, their own rights of way.
- **Transport terminals**- Refer to the amount of space devoted to terminal facilities such as ports, airports, transit stations, rail yards and distribution centers. Globalization has increased the mobility of people and freight, both in relative and absolute terms, and consequently the amount of urban space required to support those activities. Many major terminals are located in the peripheral areas of cities, which are the only locations where sufficient amounts of land are available.

3.3.1 Road Transport

Roads are the primary communication links to all sectors of the economy and the population. It is widely recognized that an efficient road infrastructure is a prerequisite for economic and social development.

Modern roads tend to follow the structure established by previous roads, as it was the case for the modern European road network, which follows the structure established by the Roman road network centuries before (Rodrigue and Brian: *Road Transportation*).

3.3.1.1 Road Network Classification

Roads have two basic, but possibly conflicting functions: to move traffic smoothly without interruption, and to provide access. The provision of access will often necessitate interruption to traffic flow and hence the conflict. In order to balance and define the dominant function, the concept of hierarchy has been developed. The classification of a roadôs function within the hierarchy has an effect on its design standards.

National Roads are the main highways of the classified road network comprising Class A, B, C roads and are managed by the Roads Department of the Ministry of Roads and Public Works.

These roads provide mobility in a national context and the traffic on these roads is usually associated with longer travel distances. Hence design provisions for these roads allow for relatively higher speeds and minimal interference with through traffic i.e. restricted access. Further classification of roads is based on the functionality of different elements as defined below:

Class A - these are international trunk roads linking international boundaries or terminating at international ports e.g. Malaba-Nairobi-Mombasa Road. all trunk roads should be designed with limited access where possible.

Class B - these are national trunk roads linking provincial headquarters and centers of national importance

Class C - these are primary roads linking district headquarters to each other or to higher class roads.

District Roads

They comprise Class D, E and other unclassified rural roads (excluding urban roads) and are managed by the District Roads Committees (DRCs).

These roads primarily serve local traffic. The design speeds are usually lower while access control is more relaxed than for the Trunk roads. Further classification of roads is based on the functionality of different elements as defined below:

Class D - Secondary roads linking locally important centers to each other or to higher class roads

Class E - Minor roads linking minor centers

Class F ï special purpose roads including those for tourists, township, agriculture and strategic purposes.

With regard to Urban Roads the following classification is proposed (Kenya Urban Transport Infrastructure Project):-

Table 1: Urban road classification

TYPE OF ROAD	URBAN CLASSIFICATION
International trunk roads óAô	Urban Arterial Roads
National trunk roads óBô	
Primary distributors	Urban Collector Roads
District Distributors	
Minor Distributors	Local Roads
Local Streets	
Stand Access	

Source: Ministry of Local Government: Kenya Urban Transport Infrastructure Project, 2001

Urban arterial roads

The prime function of arterial roads is the movement of traffic, and these roads should primarily cater for long distance movements in the urban system ó throughô traffic. The arterial roads carry most of the trips entering or leaving the conurbation. In the urban areas, these roads provide continuity from major rural arterials that intercept the urban boundary. Access to abutting land is subordinate to the free movement of traffic.

However, the design standards recommended for the urban collector roads may be too high for the smaller towns and those recommended for the urban collector roads may be suitable.

- **International Trunk Roads**

These have a high proportion of international traffic travelling through the urban area. It carries a large number of heavy vehicles on international haulage routes. Access should be limited to national trunk roads and urban collector roads with probably grade-separated intersections. There should be no direct access to adjacent properties; no street parking and the number of crossing and turning movements should be limited to the maximum extent practicable.

- **National Trunk Roads**

These roads have a high proportion of traffic travelling through the urban area and traffic travelling from outside to the urban area. There should be limited access at controlled intersections, which should be grade separations or roundabouts. There should be no street parking or direct access to adjacent properties

Urban Collector Roads

The function of the collector roads is to carry traffic from the local roads and streets to the arterial network. They should function both to serve the movement of traffic, and provide access to local roads and adjacent properties. Although they may link adjoining districts they are not intended for long cross-town journeys for which the arterial network should provide a more attractive alternative. Their primary function is to facilitate the safe and unhindered movement of traffic in the districts they serve. These roads place more emphasis on land access than arterial roads and offer lower mobility.

- **Primary Distributors**

These roads serve the town as a whole and channel traffic between suburbs including the city.

- **District Distributors**

These serve specific suburbs, the same way the primary distributors serve the town as a whole.

Local Roads

- **Minor Distributors**

They collect traffic from local streets and feed the urban collector roads and provide access to stands. Unlike the urban collector roads, the minor distributors do not carry any major through

traffic, but as feeder roads between residential areas and the urban collector road network. Such roads may carry bus routes.

- **Local Streets**

These are primarily for access to stands and feed minor distributors. Through traffic is discouraged.

- **Residential Stand Access**

These serve residential stands including cul-de-sacs, where there is no through traffic.

- **Commercial and Industrial Stand Access**

They serve commercial and industrial stands, where there is little through traffic.

- **Shopping Streets**

These serve shopping streets of varying importance.

The functions and characteristics of urban road classes in Kenya are outlined in Table 3.2 below.

Table 2: Functions and characteristics of urban road classes

FUNCTION	LOCAL	COLLECTORS	ARTERIALS
Traffic movement	Secondary to access	Equal to access	Primary
Flow Conditions	Interrupted flow	Interrupted flow	Uninterrupted flow except at intersections
Design Speed km/h	30-40	50-70	70-90
Running speed km/h	20-40	30-70	40-90
Road reserve width	9-15m	20-70m	80-90m
Carriageway width	5-7m	7-7.5m	7.5m
Property access	Primary	Equal to traffic movement	Preferably excluded
Connections	Collectors and Locals	Arterials, collectors and locals	Arterials and collectors
Parking	Accepted	Accepted/restricted	Excluded

Source: Ministry of Local Government: Kenya Urban Transport Infrastructure Project, 2001

Jean-Paul Rodrigue (1998-2009) outlines the various advantages of road transport over other modes of transport as follows:

i) The capital cost of vehicles is relatively small. This produces several key characteristics of road transport. Low vehicle costs make it comparatively easy for new users to gain entry, which helps ensure that the trucking industry, for example, is highly competitive. Low capital costs also ensure that innovations and new technologies can diffuse quickly through the industry.

ii) Another advantage of road transport is the high relative speed of vehicles, the major constraint being government-imposed speed limits.

iii) One of its most important attributes is the flexibility of route choice, once a network of roads is provided. Road transport has the unique opportunity of providing door to door service for both passengers and freight.

These multiple advantages have made cars and trucks the modes of choice for a great number of trip purposes, and have led to their market dominance for short distance trips.

3.3.3 Railway Transport

Rail transport is the second most important mode of transport in Kenya, after road transport, for both freight and passenger services. It is suitable for transporting bulky and heavy commodities over long distances. Kenya Railways Corporation (KRC) and Magadi Railways (MR) offer rail transport operations in Kenya. MR operates the line between Konza and Magadi (150 km) on behalf of the Magadi Soda Company, which leases locomotives from KRC, for transport of Soda Ash.

3.3.3.1 Urban rail transit

Urban rail transit is an all-encompassing term for various types of local rail systems serving urban or older suburban areas. The vast majority of modern urban rail vehicles run on electricity. The set of urban rail systems can be roughly subdivided into four categories, which sometimes overlap, causing some systems or lines to have aspects of each.

3.3.3.2 Types Urban rail Transit

Trams - are systems that run mainly or completely along streets, with low capacity and frequent stops. Passengers usually board at street- or curb-level (but low-floor trams and level boarding platforms may be used). These can be called *trams*, *streetcars*, or *trolleys*, while the longer-distance lines which have now mostly vanished were called *interurban* or *radial railways*.

Light Rail - Light rail is a relatively new term, as an outgrowth of trams/streetcars. Speeds are usually higher, and articulated vehicles may be used to increase capacity. Note that some systems called *light rail* have most or all of the characteristics of *rapid transit* (see below) and may be better placed in that category, while others are essentially trams referred to as light rail for political reasons.

Funiculars - are inclined railways that carry passengers up and down steep slopes.

Regional rail or commuter rail - runs on track age often shared with intercity rail and freight trains, typically serving newer suburbs and rural areas. Commuter rail trains are typically built to higher standards, as they run at higher speeds are at risk of more severe crashes. This distinguishes commuter rail from interurban, which use light-rail vehicles on tracks through lower density

Monorail - is a metro or railroad with a track consisting of a single rail (actually a beam), as opposed to the traditional track with two parallel rails. Monorail vehicles are wider than the beam they run on.

Rapid Transit - A rapid transit, underground, subway, tube, elevated, or metro(politan) system is a railwayð usually in an urban areað with a high capacity and frequency of service, and grade separation from other traffic. In most parts of the world these systems are known as a "metro", in London, England the system is called the "underground", while in most of North America and in Glasgow, Scotland it is a "subway".

3.3.4 Parking

Parking is the act of stopping a vehicle and leaving it unoccupied for more than a brief time. Parking on one or both sides of a road is commonly permitted, though often with restrictions.

Parking facilities are constructed in combination with most buildings, to facilitate the coming and going of the buildingôs user (Bacon: Parking, People and Cities)

The asymmetry between streets and parking makes congestion worse and undermines one of densityôs great benefitsð vibrant street life. This is what Bacon (1998) says concerning the disregard of parking by most people in urban areas:

> *The parking lot is where we stop thinking about the car, because parking means we have reached our destination; it is where the driver becomes a pedestrian. For the car, however, the parking lot is the destination, and the parked car takes up more room than the person walking away from it.*

Parking, as Bacon (1998) notes, is entirely a product of the car culture. Most streets are publicly owned, while most off-street parking is privately owned but publicly required. Most important, the supply of streets is relatively fixed, particularly in built-out areas, and in such areas street space increases only marginally even as population rises or land is redeveloped ï a dynamic that contributes mightily to traffic congestion.

Because of the distance needed between vehicles when they are moving in traffic, cars take up more space when they are being driven than when they are parked. But a car in motion also occupies a given amount of space for only a short time, while a car that is parked takes up slightly less room for a much longer period. For this reason the cumulative space and time consumed by an average vehicle trip is much smaller than the space and time consumed by most parking durations.

The space that parking requires can be problematic in any part of a city, but it poses particular problems in central business districts. A CBD thrives on high density because its prime advantage over other parts of a metropolitan area is proximity ï the immediate availability of a wide variety of activities. The clustering of museums, theaters, restaurants, and offices is the commodity a downtown can offer that other areas cannot.

Parking lots make walking more hazardous and less enjoyable, because they force pedestrians to dodge cars that slide out of underground structures, or to cross featureless terrains where buildings are set far back from the street. All this serves to alienate pedestrians and sterilize street life. The more a downtown gets broken up and interspersed with parking lots, ñthe duller

and deader it becomes. And there is nothing more repellent than a dead downtown.ò [Jane Jacobs, as quoted by Bacon (1998)]

Parking and the Central Business District

In order to thrive, a CBD must receive a critical mass of people every day but do so without clogging itself to the point of paralysis (Manville and Shoup, 1998). According to Manville, one way to do this is to require off-street parking spaces. Off-street parking can reduce the cruising for parking that often strangles the streets of CBDs, but parking requirements have high costs. Because land is most expensive in the CBD, off-street parking is also most expensive there, and constructing it uses up capital that could otherwise be invested more productively. More important, if off-street parking is required, as it is in many cities, then it becomes rational for firms to locate in places where land is less expensive, meaning it becomes rational to locate outside the CBD. A parking requirement applied uniformly across a city implicitly discriminates against development in the CBD, because the burden of complying with the requirement is greater in the CBD than almost anywhere else.

Lewis Mumford (1961) argues that the right to access every building in the city by private motorcar, in an age when everyone owns such a vehicle, is actually the right to destroy the city. Mumford meant not physical destruction, of course, but loss of the cohesion that can make a CBD more than the sum of its parts.

Modes of parking

For most motorized vehicles, there are four basic modes of parking, based on the arrangement of vehicles - parallel parking, perpendicular parking, angle parking, and Anderson parking. These are self-park configurations where the vehicle driver is able to access the parking independently.

3.4 Urban Traffic

3.4.1 Composition of Traffic

Vehicles of different size and mass have different operating characteristics that must be taken into consideration in the design. Besides being heavier, lorries are generally slower and occupy more road space and consequently impose greater effect than passenger vehicles. At important intersections, percentages of Lorries during both the morning and evening peaks should be determined. Variations in truck movements at intersections may be substantial and will influence the geometry of the layout. It is important to count heavy vehicles for several peak hours that are

considered representative of the design hour and an average that appears representative determined.

3.4.2 Passenger traffic

77% of the population in developing countries lives in urban areas. Higher incomes, more leisure time, ageing of the population, more access to cars by women and declining household size have all contributed to extending car usage for commuter trips as well as for social, leisure and shopping activities. Private vehicles offer considerable advantages over other modes of transport in terms of comfort, flexibility and availability, characteristic highly valued by users, even in urban areas with an efficient system of public transport. Therefore, the number of passenger vehicles in use is increasing by around 3% per year, and trip lengths are becoming longer.
Given the limited space available in urban areas, this trend has led to severe competition between various means of passenger transport and goods transport. Integration between passenger and goods transport is often difficult, since urban goods transport operate within integrated supply chain management whereas passenger transport serve individual needs. Ruled by the ñgoods do not vote, passengers doò principle, passenger transport has received attention and priority in policy making when competing for limited funds.

In many countries, passengers and parcels are transported together in public transport systems in rural areas. However, a substantial integration of passenger and goods transport in urban areas remains a challenge, due to the intolerance of passengers in waiting during loading/unloading of goods.

In many countries, still, people make use of passenger vehicles to get goods to their homes. For example, in the Netherlands, an articulated truck carrying goods for C&A fashion stores containing 5000 pieces of clothing is considered to carry the same amount of goods as normally carried by 2000 passenger vehicle moves (customers). In countries with large shopping facilities, such as supermarkets, shopping malls and factory outlets on the outskirts of towns, passenger vehicles are often the only efficient means of transportation.

Therefore, urban goods transport policies need to take into consideration the interactions between passenger and goods traffic.

3.4.3 Goods Traffic

This is the delivery of consumer goods (not by retail, but also by other sectors such as manufacturing) in city and suburban areas, including the reverse flow of used goods in terms of clean waste. The operations of urban goods transport are complex and therefore difficult to take account in public policy. The various aspects of urban goods transport operations (OECD, 2003) are as follows:

i. The number of vehicles/trips to premises in urban areas
ii. Number of goods vehicle trips at each premise
iii. Organization of supply chain
iv. Time/day of service goods operations
v. Traffic disruptions caused by goods and service vehicles
vi. Impact of urban freight operations
vii. Number of services and other commercial trips to/from premises
viii. Size of goods vehicles in urban areas and dwell time of vehicles while loading/unloading
ix. Distance travelled by each vehicle in urban AREA.

Trends in Freight Transport

Freight transport is a fundamental component of urban life. Every day, citizens consume and use goods produced by people throughout the world. Urban goods transport enables these citizens to have access to these products whenever and wherever they require. Continuing globalization of economic activities, changes in consumer behaviour and developments in advanced technologies have led to many developments in freight logistics (Asian Development Bank: 2006).

In the United Kingdom, freight traffic in urban areas is regulated in many different ways, including:

- Pedestrianisation schemes with access time restrictions
- Loading time restrictions
- Planning restrictions (conditions in planning permissions) or noise abatement orders restricting delivery times
- Vehicle size and weight restrictions.

3.4.4 Traffic Problems

Cities are locations having a high level of accumulation and concentration of economic activities and are complex spatial structures that are supported by transport systems. The most important transport problems are often related to urban areas, when transport systems, for a variety of reasons, cannot satisfy the numerous requirements of urban mobility (Rodrigue, 1998-2009).

Urban transport problems can be classified into root problems and manifestation problems (Dimitriou, 1992). The main root problems in urban traffic include the following:

i) Rapid traffic growth

Rapid traffic growth (especially of motorized movement) is concentrated primarily in the larger cities (Dimitriou, 1992). It has been largely stimulated both by increased incomes and an overall expansion in related urban economic activities. Additional transport demand has in some cities been further created by improved transport infrastructure and service provision.

ii) Shortage of Adequately Maintained Transport Facilities

The traffic growth has taken place at a pace far in excess of the rate of investment in suitably constructed and maintained urban transport infrustructure. This in turn has contributed to both widespread and location-specific congestion problems. Circumstances of this kind are typically a result of insufficient funds allocated to the urban transport sector and the absence of appropriate fund-raising mechanisms by which public authorities are able to raise adequate finance from those who benefit most from the transport facilities.

iii) Transport Systems Efficiency and Settlement Structures

The efficiency of an urban transport system is greatly influenced by its management, its capacity, and the conditions under which the system operates and the demand made upon it, the geographical location, its population size, and urban form.

As Dimitriou (1992) observes, the predominance of a single high-density central area in most third world cities and lack of well developed secondary centers with adequate transport networks, not only encourages longer average trip-making but ñpresents grave circulation problemsò both from the central area in question and its immediate environs.

iv) Urban Transport Technology Mix and Misuse

The mix of old and new transport technologies highlighted by fast-moving motorized vehicles with slow-moving human-powered vehicles typifies many street scenes in most cities of the third world countries. This results traffic conflict and road safety problems. In addition, there is evidence of widespread technological abuse of transport modes.

v) Ineffective Traffic Management and Enforcement

In addition to the rapid growth rates of urban traffic and problems caused by such factors as widespread poor driver behaviour and inadequately maintained vehicles and infrastructure, the lack of regard for traffic regulations, the common absence of adequate road signs and markings, and a growth of uncontrolled hawker activities, traffic enforcement also contributes to the problem. For instance, some traffic institutions have been pressurized to use sophisticated measures and traffic control technologies for which they have been inadequately prepared. Sometimes the traffic police personnel are known to regularly override the computerized system on more occasions than necessary, thereby defeating the very purpose of the installation of the traffic control system.

Other root problems as noted by Dimitriou (1992) include increased urban expansion and inadequate land use control.

The main manifestation problems include traffic congestion and parking difficulties; environmental impacts and energy consumption, public transport inadequacy; freight distribution problem; land consumption; loss of public space and increased inaccessibility of the underprivileged. These are as discussed below:

i) Traffic Congestion and Parking Difficulties

Congestion is one of the most prevalent transport problems in large urban agglomerations. It is particularly linked with motorization and the diffusion of the automobile, which has increased the demand for transport infrastructures. However, the supply of infrastructures has often not been able to keep up with the growth of mobility. Since vehicles spend the majority of the time parked, motorization has expanded the demand for parking space, which has created space consumption a problem particularly in central areas. This problem is elaborated more on its own in the preceding section as it forms the basis of this study.

ii) Environmental Impacts and Energy Consumption

Pollution, including noise, generated by circulation has become a serious impediment to the quality of life and even the health of urban populations. Further, energy consumption by urban transportation has dramatically increased and so the dependency on petroleum.

iii) Accidents and Safety Issues

Growing traffic in urban areas is linked with a growing number of accidents and fatalities, especially in developing countries. Accidents account for a significant share of recurring delays. As traffic increases, people feel less safe to use the streets.

iv) Increased Inaccessibility of the Underprivileged

This mostly affects the urban low-income groups. Transport-related problems among the urban low-income groups are exacerbated by rising transport costs and the subsequent growing need for the poor to travel longer distances in search of employment (Dimitriou, 1990). Difficulties for pedestrians, as Rodrigue (1998-2009) observes, are either the outcome of intense traffic, where the mobility of pedestrians and vehicles are impaired, but also because of a blatant lack of consideration for pedestrians in the physical design of facilities. Dimitriou (1992), further, goes ahead to identify four principal kinds of access problems for the urban poor, which require a policy and management response. These are:

- Physical proximity to transport facilities
- Ease of access to public transport vehicles
- Affordability of public transport services, and
- City-wide access provided by the transport systems

v) Loss of Public Space.

The majority of roads are publicly owned and free of access. Increased traffic has adverse impacts on public activities which once crowded the streets such as markets, agoras, parades and processions, games, and community interactions. These have gradually disappeared to be replaced by automobiles. In many cases, these activities have shifted to shopping malls while in other cases, they have been abandoned altogether. Traffic flows influence the life and interactions of residents and their usage of street space. More traffic impedes social interactions

and street activities. People tend to walk and cycle less when traffic is high (Rodrigue, 1998-2009).

vi) Land Consumption

The territorial imprint of transportation is significant, particularly for the automobile. According to Rodrigue (1998-2009), between 30 and 60% of a metropolitan area may be devoted to transportation, an outcome of the over-reliance on some forms of urban transportation.

vii) Freight Distribution Problem.

Globalization and the materialization of the economy have resulted in growing quantities of freight moving within cities. As freight traffic commonly shares infrastructures with the circulation of passengers, the mobility of freight in urban areas has become increasingly problematic. City logistics strategies can be established to mitigate the variety of challenges faced by urban freight distribution.

viii) Public transport inadequacy

Many public transit systems, or parts of them, are either over or under used. During peak hours, crowdedness creates discomfort for users. Low ridership makes many services financially unsustainable, particularly in suburban areas. In spite of strong subsidies almost every public transit systems cannot generate sufficient income to cover its operating and capital costs.

Many dimensions to the above urban traffic problems are linked with the dominance of the automobile.

The problem of traffic congestion, as the basis of this study, is elaborated more clearly on the preceding section.

3.5 Traffic Congestion

The term congestion denotes any condition in which demand for a facility exceeds free-flow capacity at the maximum design speed (Altshuler, 1979). In principle, it is applicable to all transportation modes. Under such circumstances, each vehicle impairs the mobility of others.

The problem of traffic congestion may be attributed to the break-down and /or the inadequacy of the management machinery, the break-down of the vehicles themselves, careless driving and inadequate road carrying capacity (Korir, 1986).

Congestion does not happen as an end, rather it is a process. It is the experience that one goes through in the process of congestion that is most important in defining congestion. In his book, *"Great Cities and Their Traffic"*, Thomson comes up with three stages of congestion that are normally experienced, each stage with its respective experience over which traffic congestion is experienced; they are as follows:

(i) The initial stage of congestion. This is the time when he driver cannot maintain speed at or near the maximum specified due to the volume of traffic on the road.

(ii) The second stage is when the brakes have to be applied constantly due to t he nature of traffic flow. This is a very costly stage of congestion in terms of energy that has to be expended. This is also the stage when one starts to get frustrated due to the attitudes of the other road users who may be pulling in and out of lanes in an attempt to get through congestion faster. This in turn makes one to concentrate more on the road out of nervousness.

(iii) The third stage is that of maximum congestion or peak point of congestion, at which time the traffic flow comes to a complete stop. This is also a very costly stage of congestion in terms of energy wastage due to the idling of engines.

According to Altshuler (1979), the degree to which any particular level of congestion is perceived as problem requiring public action is largely a function of public expectations and of the perceived costs of remedial measures. Inability to overcome congestion and to remove obstacles to mobility threatens to make the big city an economic liability rather than an asset.

Congestion itself has come to be viewed as only one among numerous problems associated with the urban transportation system, but congestion relief remains, almost everywhere, one of the professed priority objectives of urban transportation

The greatest transportation difficulties are experienced while commuting between home and work. This movement is frequently accomplished with the most antiquated facilities and under the most frustrating conditions. The trip to work often cancels the gain from shorter hours on the job and the daily battle with congestion is in sharp contrast to other improvements in modern working conditions.

As congestion and blight have multiplied the difficulties and frustrations of urban life, there have been growing indications that in many places urban growth has passed the point of diminishing returns. The spatial convergence of traffic causes a surcharge on transport infrastructures up to the point where congestion can lead to the total immobilization of traffic. Not only does the massive use of the automobile have an impact on traffic circulation and congestion, but it also leads to the decline in public transit efficiency when both are sharing the same roads.

Commenting on the extent of congestion in big cities, Altshuler, in his book, *The Urban Transport System (1992),* says the following:

> *"The threat of greater congestion would raise the question of whether a nation born of farms is destined to die of cities"*

Urban traffic congestion mainly concerns two domains of circulation, often sharing the same infrastructures:

- **Passengers** - In many regions of the world incomes have significantly increased to the point that one automobile per household or more is common. Access to an automobile conveys flexibility in terms of the choice of origin, destination and travel time. The automobile is favored at the expense of other modes for most trips, including commuting. For instance, automobiles account for the bulk of commuting trips in the United States.
- **Freight** - Several industries have shifted their transport needs to trucking, thereby increasing the usage of road infrastructure. Since cities are the main destinations for freight flows (either for consumption or for transfer to other locations) trucking adds to further congestion in urban areas. The "last mile" problem remains particularly prevalent for freight distribution in urban areas. Congestion is commonly linked with a drop in the frequency of deliveries tying additional capacity to insure a similar level of service.

Daily trips can be either ñmandatoryò (workplace-home) or ñvoluntaryò (shopping, leisure, visits). The former is often performed within fixed schedules while the latter comply with variable and discretionary schedules. Correspondingly, congestion comes in two major forms:

- **Recurrent congestion** ï The consequence of factors that cause regular demand surges on the transportation system, such as commuting, shopping or weekend trips. However, even recurrent congestion can have unforeseen impacts in terms of its duration and severity. Mandatory trips are mainly responsible for the peaks in circulation flows, implying that about half the congestion in urban areas are recurring at specific times of the day and on specific segments of the transport system.
- **Non-recurrent congestion** ï The other half of congestion is caused by random events such as accidents and unusual weather conditions (rain, snowstorms, etc.), which are unexpected and unplanned. Non-recurrent congestion is linked to the presence and effectiveness of incident response strategies. As far as accidents are concerned, their randomness is influenced by the level of traffic as the higher the traffic on specific road segments the higher the probability of accidents.

3.5.1 Causes of Traffic Congestion

The causes of both recurrent and re-current congestion can be summarized as follows:

Recurrent

Insufficient capacity
Unrestrained demand
Ineffective management of capacity (e.g. poor signal timing)

Non-Recurrent

Incidents
Work zones
Weather events
Special events
Emergencies (e.g. hurricanes)

In some areas, the automobile is the only mode for which infrastructures which is provided. This implies less capacity for using alternative modes such as transit, walking and cycling. At some levels of density, no public infrastructure investment can be justified in terms of economic returns. Longer commuting trips in terms of average travel time, the result of fragmented land

uses and congestion levels are a significant trend. Convergence of traffic at major highways that serve vast low density areas with high levels of automobile ownership and low levels of automobile occupancy is also much evident. The result is energy (fuel) wasted during congestion (additional time) and supplementary commuting distances.

The Urban Transit Challenge

As cities continue to become more dispersed, the cost of building and operating public transportation systems increases. Dispersed residential patterns characteristic of automobile dependent cities makes public transportation systems less convenient to support urban mobility. In many cities additional investments in public transit did not result in significant additional ridership. Unplanned and uncoordinated land development has led to rapid expansion of the urban periphery. Residents, by selecting housing in outlying areas, restrict their potential access to public transportation. Over-investment (when investments do not appear to imply significant benefits) and under-investment (when there is a substantial unmet demand) in public transit are both complex challenges.

Urban transit is often perceived as the most efficient transportation mode for urban areas, notably large cities. However, surveys reveal stagnation or a decline of public transit systems, especially in North America. The economic relevance of public transit is being questioned. Most urban transit developments had little, if any impacts to alleviate congestion [Cox, 1998] in spite of mounting costs and heavy subsidies. This paradox is partially explained by the spatial structure of contemporary cities which are oriented along servicing the needs of the individual, not necessarily the needs of the collectivity. Thus, the automobile remains the preferred mode of urban transportation. In addition, public transit is publicly owned, implying that it is a politically motivated service that provides limited economic returns. Even in transit-oriented cities such as in Europe, transit systems depend massively on government subsidies. Little or no competition is permitted as wages and fares regulated, undermining any price adjustments to changes in ridership. Thus, public transit often serves the purpose of a social function (ñpublic serviceò) as it provides accessibility and social equity, but with limited relationships with economic activities. Among the most difficult challenges facing urban transit are:

- **Decentralization** - Public transit systems are not designed to service low density and scattered urban areas that are increasingly dominating the landscape. The greater the decentralization of urban activities, the more difficult and expensive it becomes to serve urban areas with public transit. Additionally, decentralization promotes long distance trips on transit systems.
- **Fixity** - The infrastructures of several public transit systems, notably rail and subway systems are fixed, while cities are dynamical entities, even if the pace of change can take decades. This implies that travel patterns tend to change and that a transit system built for servicing a specific pattern may eventually face "spatial obsolescence".
- **Connectivity**. Public transit systems are often independent from other modes and terminals. It is consequently difficult to transfer passengers from one system to the other.
- **Competition** - In view of cheap and ubiquitous road transport systems, public transit faced strong competition and loss ridership in relative terms and in some cases in absolute terms. The higher the level of automobile dependency, the more inappropriate the public transit level of service. The public service being offered is simply outpaced by the convenience of the automobile. However, changes in energy prices are likely to impose a new equilibrium in this relationship.
- **Financing and fare structures** - Most public transit systems have abandoned a fare structure to a simpler flat fare system. This had the unintended consequence of discouraging short trips for which most transit systems are well suited for, and encouraging longer trips. Information systems offer the possibility for transit systems to move back to a more equitable distance based fare structure.

3.5.2 Towards a Congestion Free Transport System

Just as congestion has a number of potential causes, there are several ways to address the problem. Generally, the approaches can be grouped under four main strategiesð adding capacity, increasing the efficiency of the existing system, better management of construction and maintenance projects, and managing the demand. The benefits associated with these improvements include ***reduced delay, and more predictable and lower trip times***. Emissions may be reduced due to the reduction in demand or congestion, improved efficiencies and the

change in the way travelers use the system. The locations of congestion may also move over time due to the new development that occurs or is encouraged by the new transportation facilities.

i) More Travel Options

While not a specific improvement, providing more options for how a trip is made, the time of travel and the way that transportation service is paid for may be a useful mobility improvement framework for urban areas. For many trips and in many cities, the alternatives for a peak period trip are to travel earlier or later, avoid the trip or travel in congestion. Given the range of choices that citizens enjoy in many other aspects of daily life, these are relatively few and not entirely satisfying options.

The Internet has facilitated **electronic "trips."** There are a variety of time-shift methods that involve relationships between communication and transportation. Using a computer or phone to work at home for a day, or just one or two hours, can reduce the peak system demand levels without dramatically altering lifestyles

Using information and pricing options can improve the usefulness of road space as well as offering a service that some residents find very valuable. People who are late for a meeting, a family gathering or other important event could use a priced lane to show that importance on a few or many occasionsð a choice that does not exist for most trips.

The diversity of transportation needs is not matched by the number of travel alternatives. The private auto offers flexibility in time of travel, route and comfort level. Transit can offer some advantages in avoiding congestion or unreliable travel conditions. But many of the mobility improvements below can be part of creating a broader set of options.

ii) Adding Capacity

Adding capacity is the best known, and probably most frequently used, improvement option.

Pursuing an ñadd capacityò strategy can mean more traffic lanes, additional buses or new bus routes, new roadways or improved design components as well as a number of other options.

Grade separations and better roadway intersection design, along with managed lanes and dedicated bus and carpool priority lanes, can also contribute to moving more traffic through a given spot in the same or less time. The addition of, or improvements to heavy rail, commuter rail, bus system, and improvement in the freight rail system all can assist in adding capacity to

varying degrees. In growing areas, adding capacity of all types is essential to handle the growing demand and avoid rapidly rising congestion.

iii) Managing the Demand

Demand management strategies include a variety of methods to ***move trips away from the peak travel periods***. These are either a function of making it easier to combine trips via ridesharing or transit use, or providing methods to reduce vehicle trips via tele-travel or different development designs.

The fact is, transportation system demand and land use patterns are linked and influence each other. There is a variety of strategies that can be implemented to either change the way that travelers affect the system or the approaches used to plan and design the shops, offices, homes, schools, medical facilities and other land uses.

Relatively few neighborhoods, office parks, etc. will be developed for auto-free characteristicsð that is not the goal of most of these treatments. The idea is that some characteristics can be incorporated into new developments so that new economic development does not generate the same amount of traffic volume as existing developments. Among the tools that can be employed include better management of arterial street access, incorporating bicycle and pedestrian elements, better parking strategies, assessing transportation impact before a development is approved for construction, and encouraging more diverse development patterns. These changes are not a congestion panacea, but they are part of a package of techniques that have and are being used to address ñquality-of-lifeò concernsð congestion being only one of many.

iv) Increasing Efficiency of the System

Sometimes, the more traditional approach of simply adding more capacity is not possible or not desirable. However, improvements can still be made by increasing the efficiency of the existing system. These treatments are particularly effective in three ways. They are relatively low cost and high benefit which is efficient from a funding perspective. They can usually be implemented quickly and can be tailored to individual situations making them more useful because they are flexible. They are usually a distinct, visible change; it is obvious that the operating agencies are reacting to the situation and attempting improvements.

In many cases, the operations improvements also represent a ñstretchingò of the system to the point where the margin of error is relatively low. It is important to capitalize on the potential

efficiencies ï no one wants to sit through more traffic signal cycles or behind a disabled vehicle if it is not necessary ï but the efficiency improvements also have limits. The basic transportation systemð the roads, transit vehicles and facilities, sidewalks and moreð is designed to accommodate a certain amount of use. Some locations, however, present bottlenecks, or constraints, to smooth flow. At other times, high volume congests the entire system, so strategies to improve system efficiency by improving peak hour mobility are in order. ***The community and travelers can benefit from reduced congestion and reduced emissions, as well as more efficiently utilizing the infrastructure already in place.***

Among the strategies that fall into this category are tools that make improvements in intersections, traffic signals, freeway entrance ramps, special event management (e.g., managing traffic before and after large sporting or entertainment events) and incident management. In addition such strategies as one-way streets, electronic toll collection systems, and changeable lane assignments are often helpful.

Freeway entrance ramp metering (i.e., traffic signals that regulate the traffic flow entering the freeway) and incident management (i.e., finding and removing stalled or crashed vehicles) are two operations treatments that are very useful. When properly implemented, monitored and aggressively managed, they can decrease the average travel time and significantly improve the predictability of transportation service. Both can decrease vehicle crashes by smoothing traffic flow and reducing unexpected stop-and-go conditions. Both treatments can also enhance conditions for both private vehicles and transit.

v) Managing Construction and Maintenance Projects

When construction takes place to provide more lanes, new roadways, or improved intersections, or during maintenance of the existing road system, the effort to improve mobility can itself cause congestion. Better techniques in managing construction and maintenance programs can make a difference. Some of the strategies involve methods to improve the construction phase by shortening duration of construction, or moving the construction to periods where traffic volume is relatively low. Among the strategies that might be considered include ***providing contractor incentives for completing work ahead of schedule or penalties for missed construction milestones; adjustments in the contract working day; using design-build strategies; or maintenance of traffic strategies during construction to minimize delays.***

vi) The Role of Pricing

Urban travelers pay for congestion by sitting in traffic or on crowded transit vehicles. This is the price that citizens are willing to pay for the benefits that they derive from the land development and activity arrangements that cause the congestion. But for most citizens (urban dwellers) there is no mechanism that allows them to show that they place a higher value on certain trips. Finding a way to incorporate a pricing mechanism into some travel corridors could provide an important option for urban residents and freight shippers.

In some America, for instance, a fee has been charged on some transportation projects for a long time. Toll highways and transit routes are two familiar examples. An extension of this concept would treat transportation services like most other aspects of society. There would be a direct charge for using more important system elements. Price is used to regulate the use and demand patterns of telephones, movie seats, electricity, food and many other elements of the economy. In addition to direct charges, transportation facilities and operations are typically paid for by per-gallon fees, sales taxes or property taxes. One could also include the extra time spent in congestion as another way to pay for transportation.

Electronic tolling methods provide a way for travelers to pay for their travel without being penalized by stopping to pay a fee. Electronics can also be used to reduce the fee for travelers in certain social programs (e.g., welfare to work) or to vary the fee by time of day or congestion level. Implementing these special lanes as an addition to roads (rather than converting existing lanes) has been the most common method of instituting pricing options in a corridor. This offers a choice of a premium service for a fee, or lower speed, less reliable travel with no additional fee.

In automobile dependent cities, a few measures are used alleviate congestion to some extent (TTI: 2003).

- **Ramp metering**. Controlling the access to a congested highway by letting automobiles in one lane at a time instead of in groups. The outcome is a lower disruption on highway traffic flows.
- **Traffic signal synchronization**. Tuning the traffic signals to the time and direction of traffic flows.

- **Incident management** - Making sure those vehicles involved in accidents or mechanical failures are removed as quickly as possible from the road.
- **HOV lanes** - High Occupancy Vehicle lanes ensure that vehicles with two or more passengers (buses, vans, carpool, etc.) have exclusive access to a less congested lane.
- **Congestion pricing** - A variety of measures aimed at imposing charges on specific segments or regions of the transport system, mainly as a toll. The charges can also change during the day to reflect congestion levels so that drivers are incited to consider other time periods or other modes.
- **Public transit** - Offering alternatives to driving that can significantly improve efficiency, notably if it circulates on its own infrastructure (subway, light rail, buses on reserved lanes, etc.).

All these measures only partially address the issue of congestion, as they alleviate, but do not solve the problem. Fundamentally, congestion remains a failure at reconciling mobility demands and acute supply constraints.

CHAPTER 4: STUDY AREA

4.1 Introduction

This chapter gives a description of the actual location of the study area. It puts the study area into the national regional and local context with an aim of showing the physical relationship between Uhuru Highway and the wider Nairobi. To do this it is important to highlight the historical development of the study area both in time and space as well as the physical and environmental characteristics of the same.

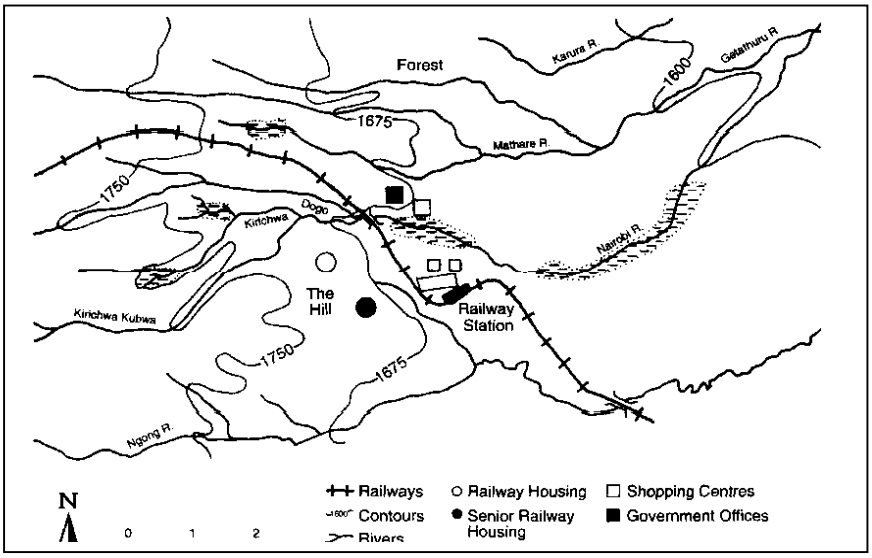
4.2 Historical Background of Nairobi

The site of Nairobi was chosen by the Kenya Uganda Railway (KUR) authorities because it offered a suitable stopping place between Mombasa and Kisumu; adequate water supply from the nearby Nairobi and Mbagathi rivers; ample level land for railway tracks and sidings; elevated cooler ground to the west suitable for residential purposes; and apparently deserted land offering freedom for land appropriation. Another primary consideration for the selection of the site was that the place was free from tropical diseases, especially malaria. The new settlement was named after the Maasai name *Enkare Nairobi,* which means "a place of cold waters," although there was no permanent African settlement since the place was grazing land and a livestock watering point. In 1896, a small transport depot was established at the site to keep provisions for oxen and mules (White et al., 1948, p. 10). The railhead reached the site in June 1899 and by July it had become the KUR headquarters (Boedecker, 1936; White et al., 1948; Foran, 1950, p. 220; Hallman, 1967, pp. 1428; Hake, 1977, p. 20; Obudho and Aduwo, 1992). By the end of 1899 the Government of Kenya (GOK) had selected a site on the high ground on the northern side of the Nairobi River and away from the railway station to be the administrative headquarters (Morgan, 1968;). In 1900, the Nairobi Municipal Community (NMC) regulations were published by the GOK and these defined the urban centre as "the area within a radius of one and a half miles from the offices of the sub-commissioner of the Ukambani Province" (Morgan, 1976, p. 100; see fig. 9.1). A small number of settlers had begun settling in the urban centre by then and, with the construction of the KUR on the move, it became essential to designate a mid-way site where a well-equipped maintenance depot could be built. The then Engineer stated that:

Nairobi has with great judgment, been selected as the site for the principal workshops. It is about 5,500 m above the sea level, which ensures a comparatively salubrious climate; there is ample space of level ground for all sorts of requirements, and excellent sites for the quarters of officers and subordinates. On the higher ground there is a fairly good supply of water but reservoirs and tanks will have to be constructed. (Walmsey, 1957, p. 18)

Once the KUR authorities had made the decision to locate a depot in Nairobi, spatial patterns around it and the railway station emerged. Europeans established their homes on the hill to the west, away from Asians and Africans soon leading to exclusive European residential settlements. Meanwhile, Asian employees who had been discharged from KUR employment established shops not far from the railway station, an area that came to be known as the Indian Bazaar. The Asian buildings were used both for business and as living quarters by a few Africans who worked for the KUR, while others lived in employee housing and shanty villages to the east (White et al., 1948). By 1906 the original KUR depot and camp had grown into an urban centre of over 10,000 people and definite land-use zones had appeared, though these had not been planned, with the Europeans mainly occupying the cooler Westlands, the Indians in the north, and the African workers mainly concentrated on the periphery. With the completion of the KUR and the influx of more non-African settlers, the settlement expanded rapidly. By 1909 much of its internal structure, especially the road network in the CBD, was already established.

Map 1: Nairobi circa 1900



(Source: White, 1948, p. 11)

In 1919, the Nairobi Municipal Community was replaced by Nairobi City Council (NCC). At the same time the boundary was extended to include pert-urban settlements (Croix, 1950, pp. 23-24). The boundary was again extended in 1927 to cover 30 square miles (White et al., 1948). From 1928 to the time of independence of Kenya in 1963, this boundary remained the same, with only minor additions and excisions taking place. By 1950, permanent residential zones had already been demarcated, very much along the lines first established in the early years of the century. In 1963, the boundary of Nairobi was further extended and remains the same today. Expansion was expected to take place within this area, mainly on the 20 square miles of black cotton soil and ranching land to the east of the early settlement.

Map 1.1 shows the extent of Nairobi around 1906. By 1909 much of the internal structure especially the road network was developed. The boundary of Nairobi was extended in 1927 to cover 30 square miles (77 km2) as a result mainly of the rapid growth of the urban centre both in terms of population and infrastructure.

Map 2: Nairobi and Suburbs: Current Road Network

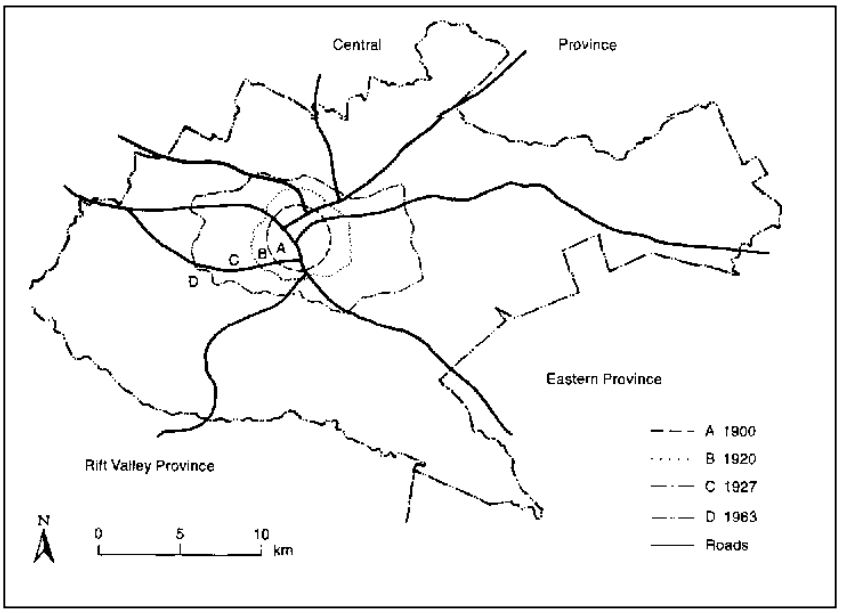
Source: HassConsult, Real Estate

From 1928 to 1963, this boundary remained the same with only minor additions and excisions taking place. In 1963, the boundary of Nairobi was extended to cover an area of approximately 266 square miles (686 km2). There have not been any boundary changes since then. From this

early growth, the cityôs functions have developed and expanded such that today it has achieved an overwhelming dominance in the political, social, cultural and economic life of the people of Kenya and the whole of the Eastern Africa region. The Nairobi Municipal Committee Regulations of 1960 defined the initial boundaries for the then Nairobi town as:

"The area within a radius of one and a half miles [about 2.25 km] from the offices of the sub-commissioner of the then Ukambani Province" (Morgan, 1967:102 in Obudho and Aduwo, 1992: 51).

Map 3: Nairobi: Boundary Changes, 1900-1963



(Source: Obudho and Aduwo, 1992, p. 53)

4.3 Transportation

One of the earliest problems that Nairobi faced during this period was that of traffic. It has been argued that in 1928 Nairobi was in fact the most motor-ridden urban centre in the world in proportion to its non-African population (Aduwo, 1990). Parking and speeding became major problems that were often discussed by the authorities. From 1929 a programme to tarmac all roads in the CBD was carried out. The relatively large numbers of cars contributed to the thinning out of the western side of Nairobi, which by 1962 had a population density as low as 6.1 people per acre, compared with the African residential zone in the east with 125.9 people per acre during the same period (Hake, 1977, p. 24). Meanwhile, a public bus service was inaugurated following an agreement with United Transport International (Aduwo, 1990). The

result of this agreement was the establishment of the Kenya Bus Service (KBS), which was given the exclusive franchise of carrying fare-paying passengers in and around Nairobi. During this time the demand for public transport was low, consisting mainly of European and Asian expatriates and a growing number of African workers.

Today transport in Nairobi can be split into five components: private vehicles, buses, *matatus,* commuter trains, and taxis. Private vehicles are almost exclusively reserved for the middle- and upper-income groups because of the high cost of purchase and maintenance. The KBS, which has over 300 buses, operates commuter transportation mainly oriented towards the eastern part of Nairobi where low-income people live. Although the fares are quite low they are still high for the majority of residents. It was hoped that the Nyayo Bus Services launched by the GOK in 1986 would ease the commuter problem in the city, but 90 per cent of its buses are not functioning owing to gross mismanagement and lack of spare parts. The *matatu* is an African invention. Originally private taxis, they offer regular services with better frequencies than the bus service, thus providing a relatively quick means of transportation to the CBD and increasing the accessibility of many of the outlying areas (Aduwo, 1990; Obudho, 1993b, pp. 91-109). Recently, commuter trains were introduced by the Kenya Railway to help ease transportation to the suburbs and this service has been well received despite the high fares (Aduwo, 1990; Obudho 1993b, pp. 91-109). Taxis have little impact on the mass transportation systems in Nairobi, because they have primarily geared themselves to tourists (Ndegea, 1995). Despite all these urban transportation systems, the majority of trips are still undertaken using non-motorized forms of transport, even over long distances.

The inherited transport patterns, together with the additional travel generated mainly by an increased population, exerted demands on the urban form and its infrastructure that they were ill equipped to meet. A major problem here has been the centralization of the civil service, commerce, and other service activities in the CBD and industrial area, where it is estimated that over 75 per cent of commuters are employed. Much of the employment in wholesale and retail trade, restaurants and hotels, transport and communications, finance, insurance, real estate, and business services is located within the CBD. The CBD has for a long time been subjected to numerous traffic problems, which are exacerbated by a lack of space in its vicinity. Since 1970,

the city has expanded tremendously and a new population distribution pattern has emerged. Even more important is the fact that a large percentage of low-income users of public transport now live further away from the CBD. Expansion of the city to the east, south, and north has not been matched by an expansion in transport facilities and services. The annual rate of growth of daily passenger journeys is currently estimated to be almost 6 per cent. A clear manifestation of the unmet demand for public transport services are the daily stampede and jostling at most of the city's transport terminals, especially during the rush hours, and the overflowing number of passengers transported by the existing modes of public transport. Nairobi's transportation problems are due to neglect of maintenance, inadequate investment, poor management of traffic systems, breakdown of road discipline, and failure to develop an adequate policy and planning framework.

Table 3: Nairobi: Public Transport Demand, 1985, 1990, and 2000

Year	Passenger journeys per day ('000)	Growth rate per annum (%)
1985	676	
1990	873	5.82
2000[a]	1,393	5.95

Source: Obudho (1993b), p. 97.

4.4 The Physical City

Nairobi lies at the southern end of Kenyaôs agricultural heartland, 1.19 degrees south of the Equator and 36.59 degrees east of meridian. At 1,661 metres (5,449 ft) above sea level, Nairobi enjoys a fairly moderate climate. The altitude makes for some chilly evenings, especially in the June/July season when the temperature can drop to 10 °C (50 °F). The sunniest and warmest parts of the year are from December to March, when temperatures average the mid-twenties during the day. The mean maximum temperature for this period is 24 °C (75 °F).

There are two rainy seasons but rainfall can be moderate. The cloudiest part of the year is just after the first rainy season, when, until September, conditions are usually overcast with drizzle. As Nairobi is situated close to the equator, the differences between the seasons are minimal. The

seasons are referred to as the wet season and dry season. The timing of sunrise and sunset does not vary tremendously throughout the year, due to Nairobiôs close proximity to the equator.

The table below shows the current weather averages for Nairobi:-

Table 4: Weather averages for Nairobi city

Weather Averages for Nairobi

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average high °C (°F)	24.5 (76)	25.6 (78)	25.6 (78)	24.1 (75)	22.6 (73)	21.5 (71)	20.6 (69)	21.4 (71)	23.7 (75)	24.7 (76)	23.1 (74)	23.4 (74)
Average low °C (°F)	11.5 (53)	11.6 (53)	13.1 (56)	14.0 (57)	13.2 (56)	11.0 (52)	10.1 (50)	10.2 (50)	10.5 (51)	12.5 (55)	13.1 (56)	12.6 (55)
Precipitation mm (inches)	64.1 (2.52)	56.5 (2.22)	92.8 (3.65)	219.4 (8.64)	176.6 (6.95)	35.0 (1.38)	17.5 (0.69)	23.5 (0.93)	28.3 (1.11)	55.3 (2.18)	154.2 (6.07)	101.0 (3.98)

Source: WorldWeather.org–2008

Road making in Kenya began in 1905 with the construction of feeder paths to the railway (White et al., 1948, p. 53). Motor vehicles and bicycles shifted emphasis to goods transport as far as the railway was concerned.

The main roads were the road from Mombasa, the road from Fort Hall, the road from Uganda, the road from Ngong and Karen. Uhuru highway formed part of the East African trunk Roads, connecting the coast port of Mombasa, and with adjoining territories to the South, West and North. If this main road was to bypass Nairobi (White et al., 1948, p. 68), there would have to be a branch road from it into the city, and the great majority of traffic would turn into this branch road to visit Nairobi and then return along it to rejoin the trunk road. The Nairobi Master Plan for a Colonial Capital (1948) therefore recommended, for convenience and economic reasons, to

coincide this trunk road with the major parkways in Nairobi, and that the parkway to be widened to take the additional traffic

Mixed use of the road was initially accepted as inevitable and the By-Law Road was invented to step the avalanche of traffic descending on the roads in the nineteenth century and the twentieth (Ibid). The road turned out to be too wide and expensive for mere access and not wide enough and too frequently intersected, for through traffic (Ibid).

Currently, Uhuru highway plays the transportation role of a primary distributor to the city of Nairobi as well as an international road for various countries such as Uganda. It has a total length of 3.7m stretching from the Nyayo stadium roundabout in the East (where it joins Mombasa road) to the Museum Hill roundabout in the West (where it is joined by Waiyaki Way). The total road reserve is for the highway 50m with two right-of-ways, each measuring 12m wide. Pedestrian walkways are provided on both sides of the highway.

The highway is joined by various secondary roads leading into the city centre of Nairobi to other commercial and residential areas outside the city.

The highway is highly intersected by numerous roundabouts that are very close to one another totaling up to six roundabouts in a distance of less than 4km as shown in the diagram below.

4.5 Ongoing projects

In April 2007, president Kibaki announced plans for a 2 billion Kenyan Shilling Chinese project to widen the Uhuru Highway and link it to the west of the city. The project had not commenced at the time of the study.

Currently the highway is undergoing rehabilitation under the Ministry of Roads

The potential economic benefits of rehabilitating and upgrading the highway were derived from:

- Savings in vehicle operating cost
- Savings in maintenance expenditures
- Time savings to passengers and freight
- Reduction in the number and severity of accidents
- Residual value of the road structure at the end of the evaluation period

- Induced economic development, such as industrial, agricultural or tourist activities that were previously constrained by poor access.
- Social benefits arising from the increased mobility of the population and improved accessibility to health, education and other services.

4.6 Locational context of the Study area

Figure 4.1 below shows the locational context of the study area at the national, regional and local level.

Map 4: Location of roundabouts along Uhuru highway

Source: Google Earth, 2008

1. MUSEUM HILL ROUNDABOUT
2. UNIVERSITY WAY ROUNDABOUT
3. KENYATA AVENUE ROUNDABOUT
4. HAILESELASIE AVENUE ROUNDABOUT
5. BUNYALA ROAD/AERODROME ROUNDABOUT
6. NYAYO STADIUM / LUSAKA ROAD ROUNDABOUT

CHAPTER 5: STUDY FINDINGS

5.1 Introduction

This section analyzes the findings of the study in the form of graphs, charts and photographs. The findings are also analyzed to come up with recommendations and conclusions, which are further discussed in the final chapter.

5.2 Traffic Management System along Uhuru Highway

The success of any transport system is highly influenced by the conditions of the existing traffic management system at any particular time. The components of traffic management system along a highway include: traffic lights; pedestrian facilities (crossing levels, walkways, overpasses); cycling lanes; curbs and road markings; acceleration and deceleration lanes and bus stops. Traffic police personnel are also considered as part of the traffic management system based on their tendency for manual control of traffic. Roundabouts also qualify to be part of the management system based on their capacity to effectively distribute traffic at junctions.

Currently, traffic management along Uhuru highway is under the Ministry of Roads.

5.2.1 Traffic lights

There are traffic lights for controlling traffic in all the six roundabouts of the highway. Since the Ministry of Roads took over the management of the highway from the Nairobi City Council, preparations have been made to replace all the existing traffic lights along the highway with those from the Ministry.

The traffic lights automatically control the off peak traffic passing at the roundabouts. During peak hours they are used in conjunction with manual hand control by the traffic police personnel.

However, the T-junctions along the highway have no provision of traffic lights. These are Uhuru Highway/City Hall Way Junction and Uhuru Highway/ Harambee Avenue Junction

All the motorists expressed dissatisfaction with the lack of traffic lights at these two junctions.

Plate 1: Traffic lights

No traffic lights at pedestrian crossing points

Existing traffic lights for motorists

Source: Field survey, 2009

5.2.2 Bus stops

There is one designated bus stop along Uhuru highway that is used to pick and drop passengers along the way. This is located between Hailesellasie roundabout and Bunyala road Junction. However, matatus are using the exit of the petrol station at the Hailesellasie roundabout as a terminal to pick passengers, thus inconveniencing traffic flow along the highway.

Further, the location of the bus stop at the University way interrupts traffic flow along the highway as it is located vey close to the roundabout.

Matatus are however picking and dropping passengers at prohibited points of the highway and even at the middle of the road. Such illegal bus stops include one along the university way (towards the roundabout) and another one along Uhuru highway, near the Main Campus tunnel. The illegal stopping of matatus and buses also interrupts traffic flow along the Uhuru highway and thus contributes to congestion

Plate 2: Illegal stopping by matatus

Pickling passengers along the road

Failure to use properly the existing terminals

Source: Field Survey, 2009

5.2.3 Kerbs and Road Markings

Kerbs have been provided along the whole of Uhuru highway and all its adjoining roads. These are necessary for segregating pedestrians from motorists along the highway to avoid conflicts. There are no road markings along the whole of the highway. Road markings are necessary for indicating different lanes along the highways. They help motorists to keep or change lanes correctly without conflicting with other motorists. This is especially useful at junctions and roundabouts.

Plate 3: Kerbs and road markings

Lack of road markings

Provision of kerbs

Source: Field Survey, 2009

5.2.4 Pedestrian Facilities

Pedestrian Walkways

These are provided in most sections of the highway. Their surface conditions were found to be poor but they are currently being replaced with more aesthetic ones under the rehabilitation project being undertaken by the Ministry of Roads.

Plate 4: Pedestrian walkways

Before rehabilitation

After rehabilitation

Source: Field Survey, 2009

However, some of the newly installed street lights are at the middle of the walkways they not only reduce the capacity of the walkways but also obstruct pedestrians walking along these walkways.

Plate 5.5: Inadequacy of sidewalks

Conflict arises between pedestrians and motorists

Insufficiency of NMT

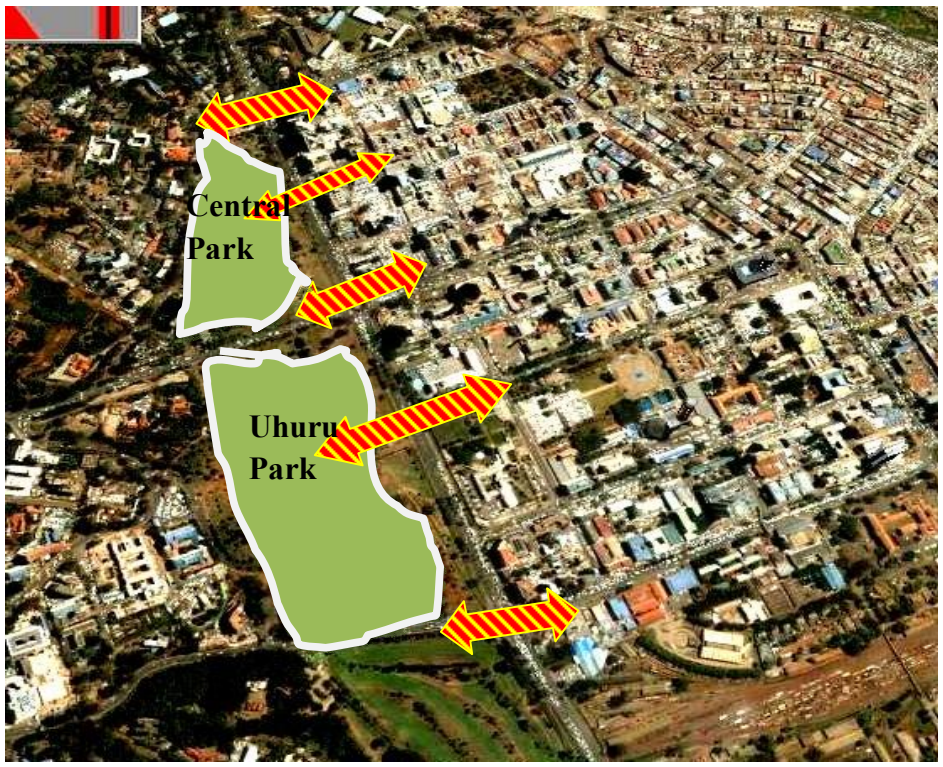
Source: Field Survey, 2009

There is complete **lack of zebra crossings** along the whole of Uhuru highway, particularly at the major crossing points. These are important in helping pedestrians to cross the road safely without conflict with motorists. Pedestrians have been used to crossing the highway at any point that is closest to their respective destinations.

There is **lack of signboards** to alert motorists of crossing pedestrians.

Plate 5: lack of pedestrian crossing

Figure 1: Major pedestrian crossing points



Roundabouts are the mostly used points for pedestrian crossing

Source: Field survey by Author, 2009

5.2.5 Cycle Lanes

There is complete lack of cycle lanes along the highway. These are important for the safety of cyclists using the highway and its adjoining roads. Cyclists along the highway use the same lane with motorists. This not only interferes with the traffic flow but galso exposes the cyclists to dangers of being hit by the motorists.

Plate 6: lack of cycle lanes

Source: Field Survey, 2009

5.2.6 Advertizing Billboards

Advertizing companies have been using roundabouts and road junctions for strategic location of bill boards to capture attention of the public. The study observed a lot of these in most of the roundabouts along the highway (See Plate 5.14). The huge sizes of these bill boards were found to distract motorists and were identified as having high potential for causing serious road accidents along the highway. The NCC had initially put a by-law prohibiting bill boards along Uhuru highway but there seemed to be no enforcement of the same yet they still collect advertisement fee from these advertisements. The Ministry of roads too, since taking over the management of traffic along the highway, seemed to have done nothing towards these billboards.

5.2.7 Roundabouts and Road Junctions

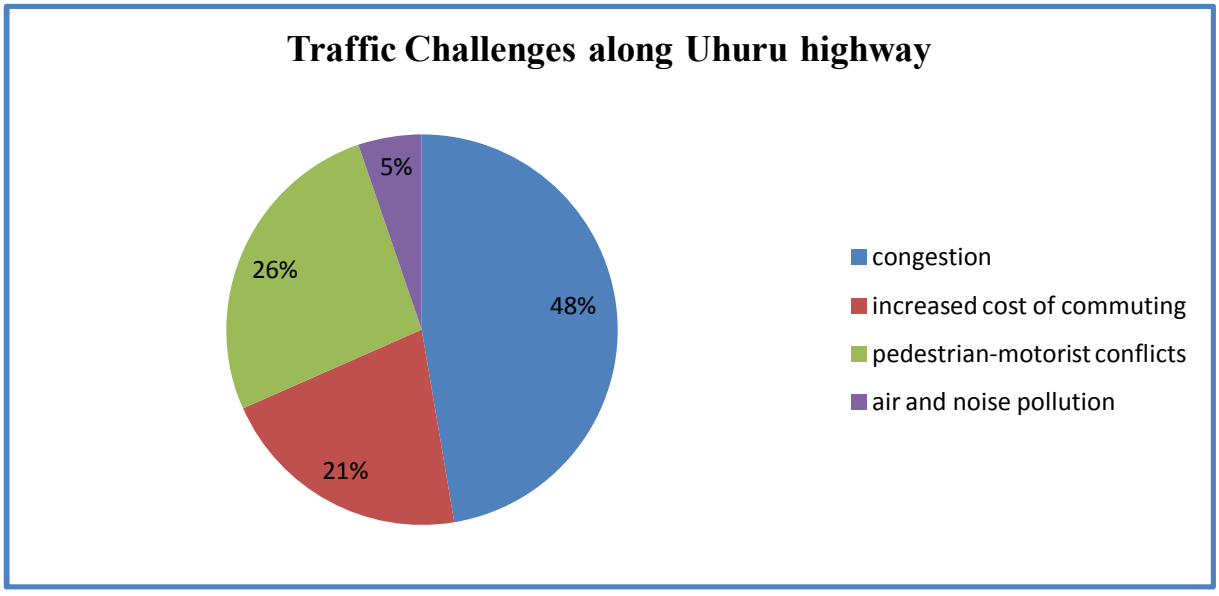
There are a total of six roundabouts along Uhuru highway at which secondary distributor roads intersect the highway. The secondary distributor roads are as shown in the map below. The roundabouts are located at an interval distance of approximately 0.5 Km. Roundabouts are important tools for distributing traffic at major junctions of the city but they become inefficient with very heavy traffic, especially when this is a mix of ćthroughô and ćcityô traffic. The closeness of the roundabouts does not favour ćthroughô traffic due to the frequent stops required at each of the roundabouts (peak time).

The highway has three more junctions namely: Uhuru Highway/City Hall Way Junction; Uhuru Highway/Harambee Avenue Junction and; Uhuru highway/Slip Road junction. The Slip road provides a quicker route for motorists using University to enter city centre.

5.3 Traffic Challenges along Uhuru Highway

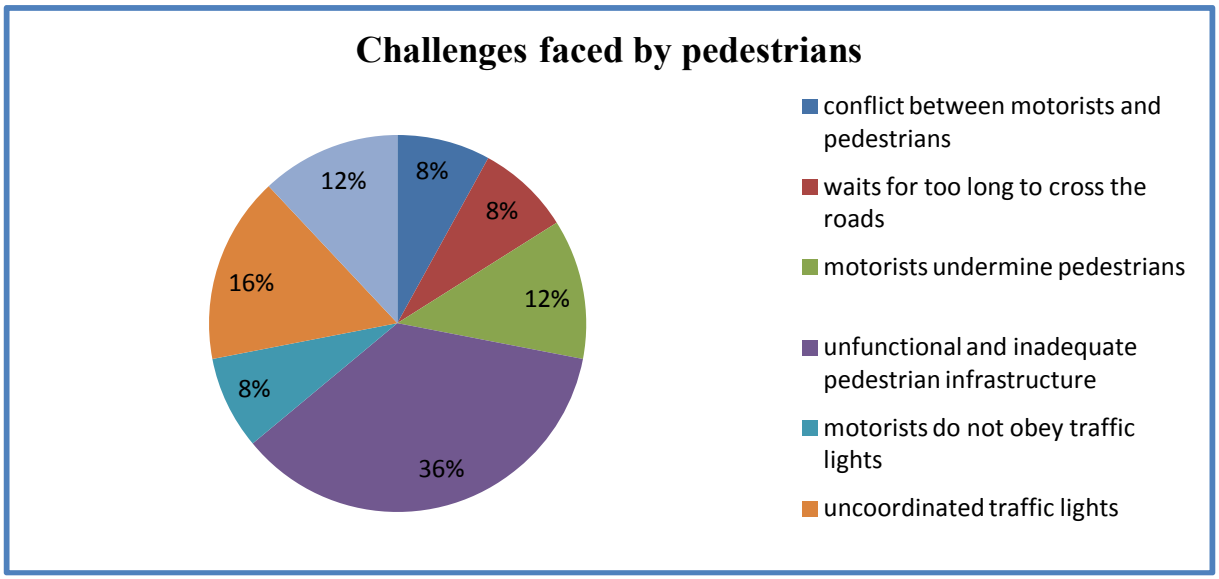
The study identified several traffic challenges along Uhuru highway that which included traffic congestion, increased cost of commuting, increased travel time, pedestrian-motorist conflicts as well as air and noise pollution. These problems are hereby elaborated further.

Chart 1: Traffic Challenges



Source: Field Survey, 2009

Chart 2: Pedestrian Challenges



Source: Field Survey, 2009

5.3.1 Traffic congestion

Traffic congestion was found to be the major traffic challenge experienced along Uhuru highway with 45% response. The average congestion degree in the Nairobi Metropolitan Area was estimated to be 0.57 in 2004 (NUTRANS: 2004). Without intervention, this is estimated to reach a level of 0.90 in 2005.

Plate 7: Aerial View of traffic flow along Uhuru Highway

Kenyatta Avenue - Roundabouts act as bottlenecks during peak periods-

Traffic flow during the morning peak

Source: Google Earth, 2007

Plate 8: Traffic Congestion along Uhuru Highway

Congestion in the evening of a weekday

Source: Field Survey, 2009

Plate 9: The spread of congestion

Congestion along Haile Selassie Avenue

Insufficient system capacity at roundabouts

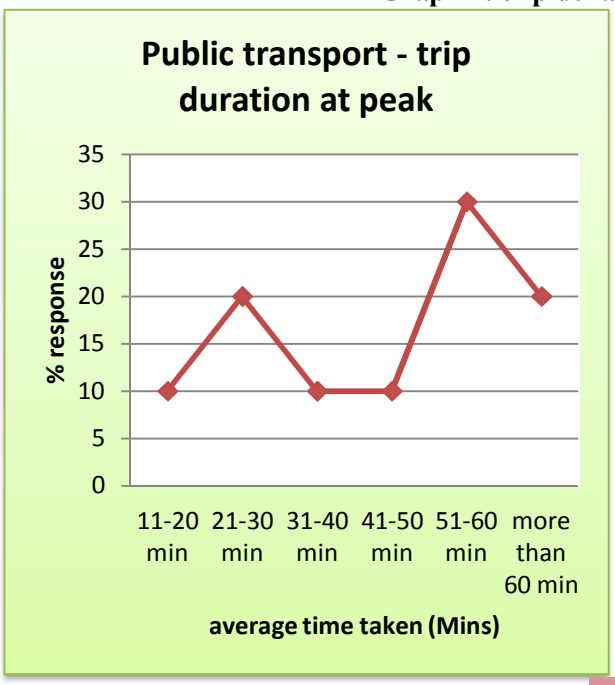
Source: Field Survey, 2009

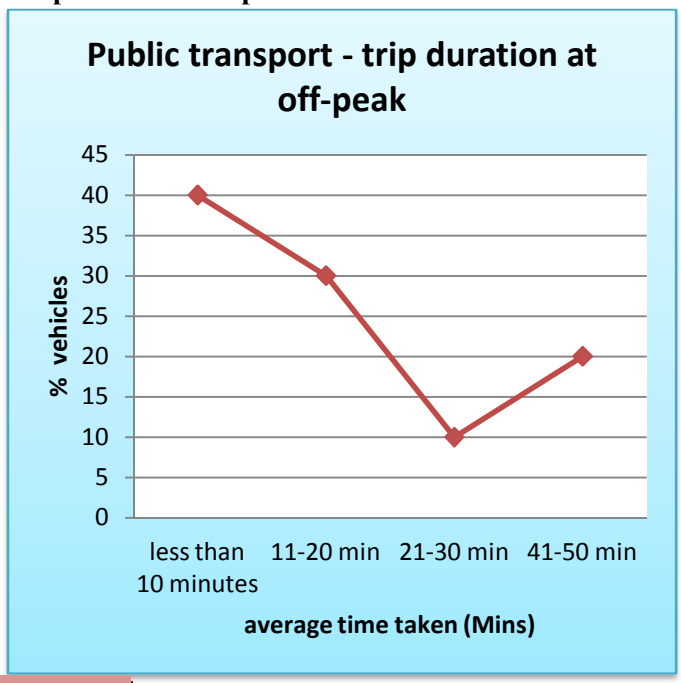
5.3.2 Increased trip duration and high traffic cost

For each of the modes, the study compared trip duration at peak with trip duration at off-peak, and the difference was taken as the time lost per trip due to the ópeak problemô. For public vehicles, the difference ranged between 10 minutes and one hour per trip, where 35 % of the public vehicles interviewed lost between 31 and 50 minutes for each trip made at peak period.

As a result of traffic congestion along the highway, public vehicles in all the routes took longer trip duration in peak than in off-peak (see the figure below), hence took fewer trips.

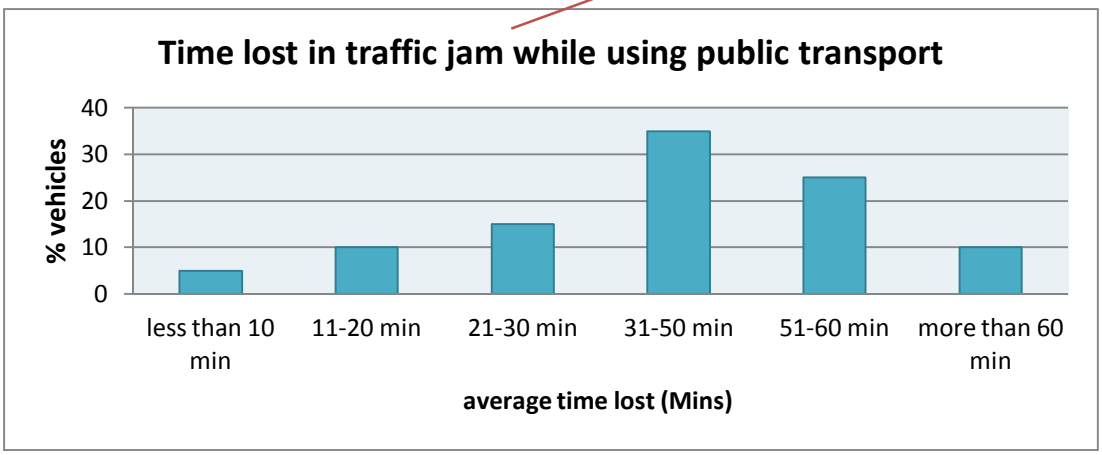
Graph 1: trip duration at peak and at of-peak





The difference

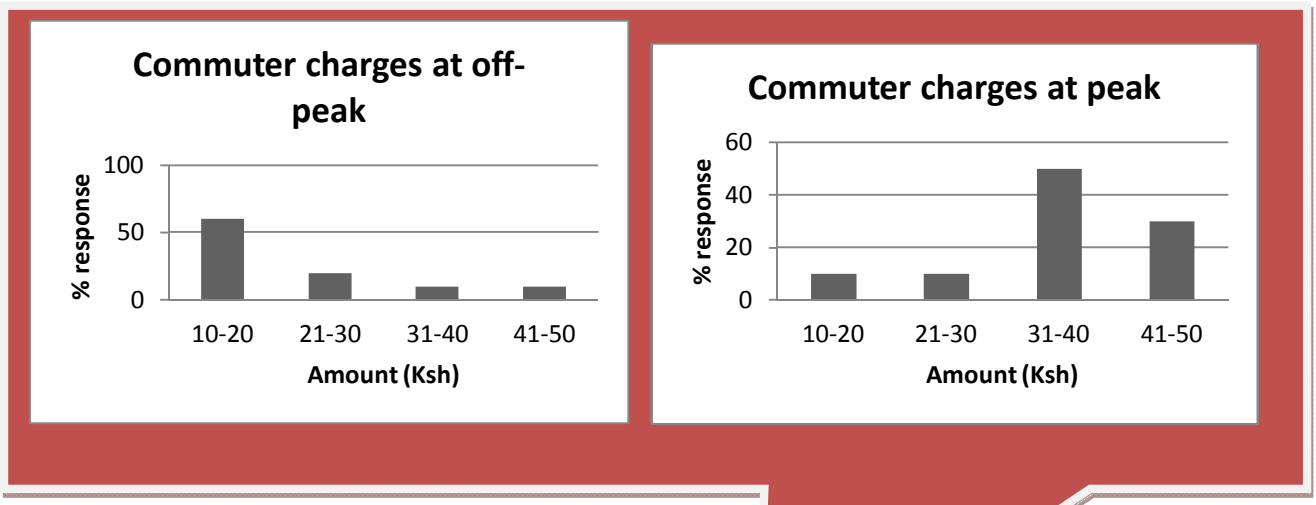
Graph 2: Time lost at peak



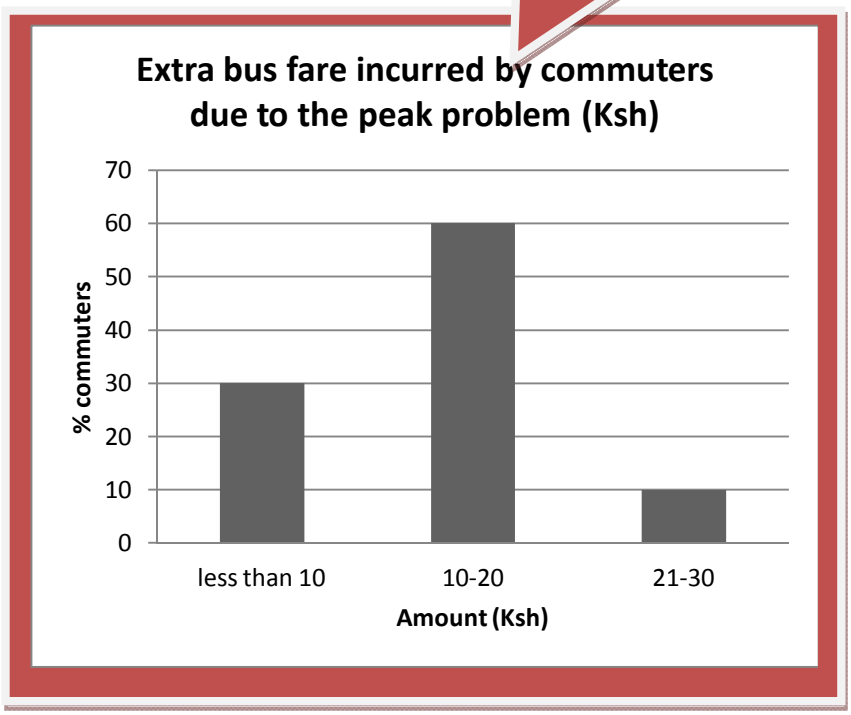
Source: Field Survey, 2009

Public transport operators hiked their rate of charging during peak time in order to cover for the trips lost in traffic jam. The difference in the amount of charge between the two periods was taken as the average time lost by commuters of public transport due to traffic congestion.

Graph 3: Commuter charges at peak and off-peak



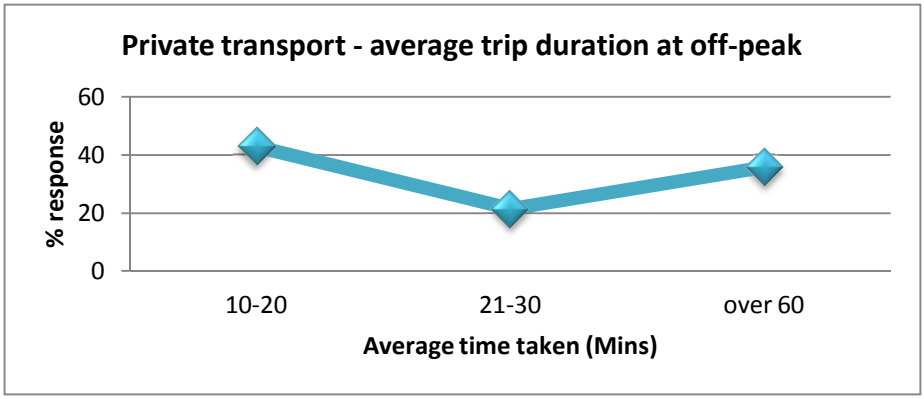
Graph 4: Extra bus fare incurred from congestion

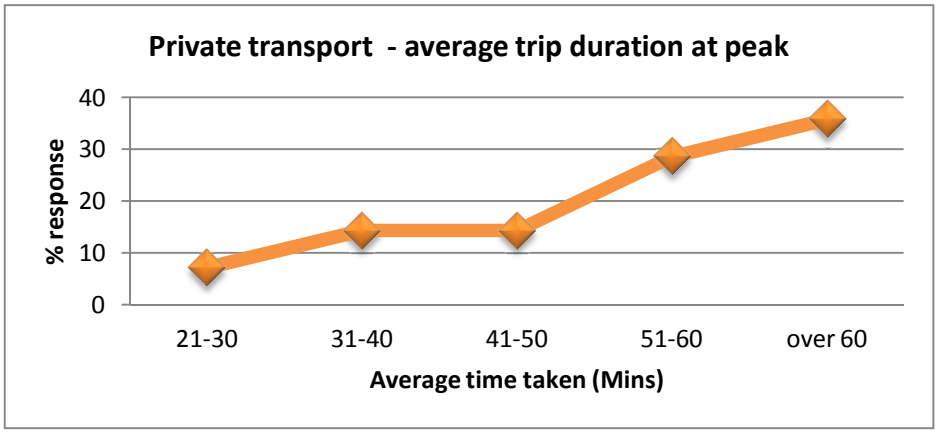


Source: Field Survey, 2009

For private vehicles, the difference ranged between 20 minutes and 2 hours per trip, where 40 % of the private vehicles interviewed took between 51-60 minutes longer for a trip made at peak period.

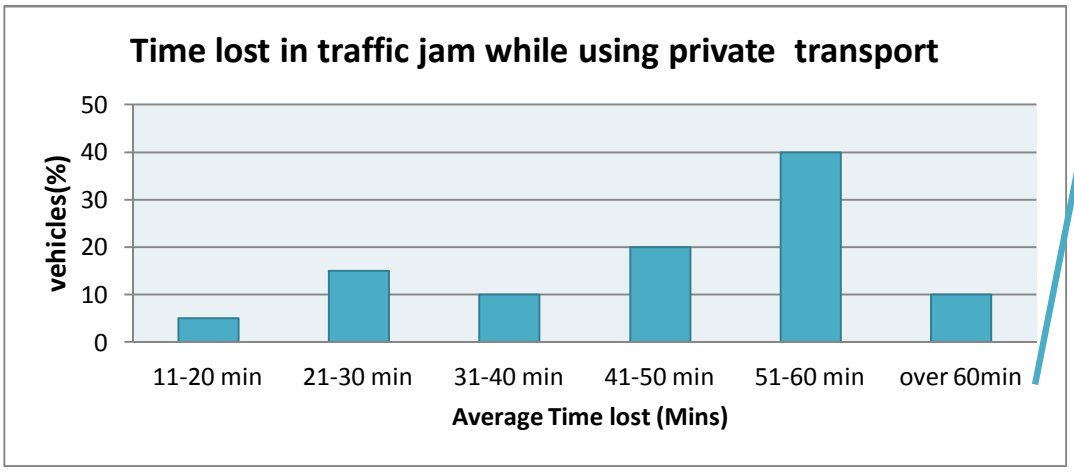
Graph 5: Average trip duration and time lost for private transport mode





The difference

The difference in the amount of charge between the two periods was taken as the average time lost by users of private transport due to traffic congestion. This explains the rise in travel cost due to the extra fuel spent on delays caused by congestion as illustrated in the graph below.



Source: Field Survey, 2009

5.3.3 Conflict between Motorized and Non-motorized traffic

There were frequent cases of conflict between vehicular, pedestrian and bicycle traffic along the highway. This was partly due to poor road user behaviour among road users and partly due to inadequacy of NMT infrastructure such as zebra crossing levels and cycle lanes, and road markings as illustrated in the previous sections of this chapter. Pedestrians are used to cross at any pint along the highway even when there is approaching motorists. This not only results to a slow down of vehicular traffic but also endangers the safety of pedestrians and cyclists.

Plate 10: Conflict between pedestrian and motorists

Conflict at university way roundabout

A good example of Conflict free section of Hailesellasie Avenue

Source: Field Survey, 2009

5.3.4 Air Pollution

Emission of diesel and petrol fumes along the highway has increased with the increase in traffic volume. If uncontrolled, this will have adverse effects on both the human and environmental health. However, under the NUTRANS Master Plan, the daily air pollutants (NOx & CO) in Nairobi Metropolitan Area are expected to reduce by 1.1 ton in 2010, and 2.4 ton in 2025

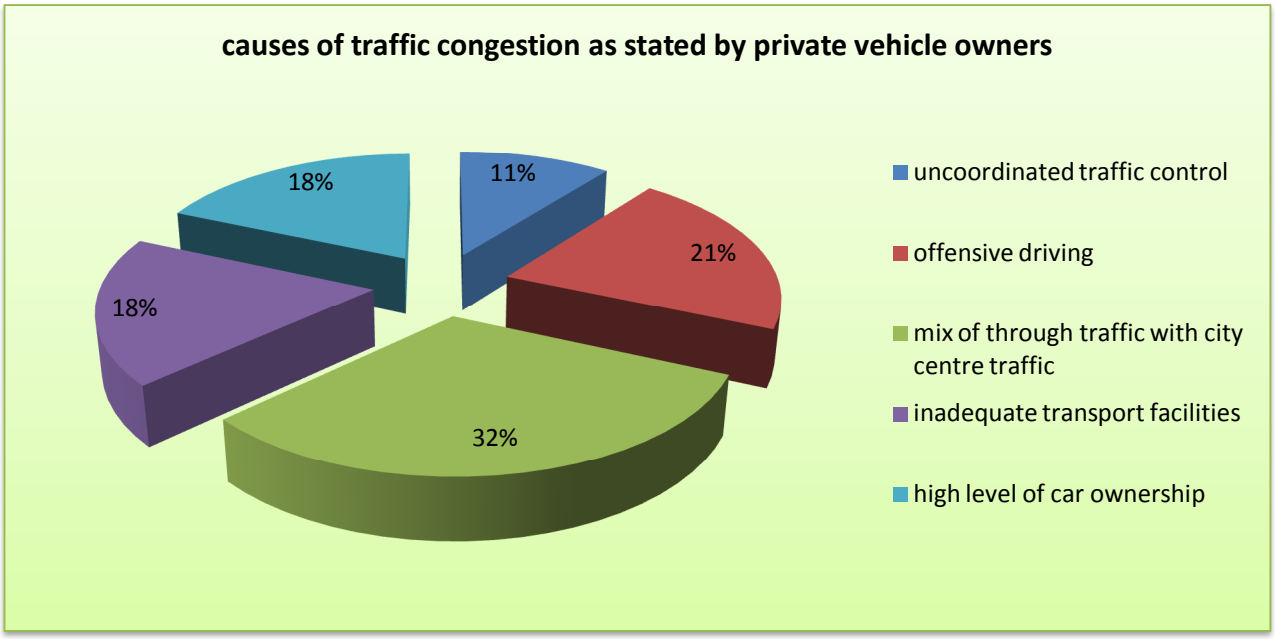
5.4 Causes of Traffic Congestion along Uhuru Highway

The following were identified as the main causes of traffic congestion along Uhuru highway. These are based on what was observed on the study area, views of respondents and information from the Nairobi city council and Traffic Police.

5.4.1 Uncoordinated traffic control at the roundabouts

The act of combining both automatic traffic lights and police manual hand in controlling traffic was found to cause confusion among different road users. This is always prone errors that results to severe traffic jams particularly at peak periods

Chart 3: Causes of traffic congestion



Source: Field Survey, 2009

5.4.2 Lack of proper coordination of traffic management between the Nairobi city council and the Ministry of Roads

Traffic management along Uhuru highway is done by the Ministry of Roads in isolation with traffic management in the CBD by the Nairobi City Council. Traffic flow along the highway is directly affected by the efficiency of traffic management in the CBD. The rate of traffic flow out of the CBD at the evening peak hours determines the traffic volume entering CBD at the same time.

5.4.3 Poor road user behaviour

Most of the road users do not observe traffic lights at the roundabouts unless there are traffic police personnel in sight. This is especially so during off peak hours and weekends when traffic lights are left to control traffic automatically. This leads to conflict among motorists and other road users with a resultant reduction in overall traffic speed along the highway.

Illegal change of lanes by matatus at peak time and the illegal picking and dropping of passengers causes confusion and reduction in traffic speed and eventually leads to traffic congestion. As one of the cyclists interviewed along the highway commented:

Matatu drivers think the other lane is always moving faster. Whenever traffic builds up, and without traffic police in sight, they keep changing from the 'slower lane' to the 'faster lane'

5.4.4 Poor traffic management in the city centre

Lack of proper management of the parking system in the CBD leads to traffic clogging on the major streets curbed with the high volume of pedestrian traffic. This directly impacts on the rate at which vehicles are entering or leaving the city hence and affects the traffic volume held up along the highway; waiting to get in. Corruption between city council askaris and some prominent public transport operators of was blamed for this situation in conjunction with the operations of illegal bus management groups.

5.4.5 The mixing of through traffic with city centre traffic

Lack of an alternative link for through traffic makes it inevitable for it to use the same road with the traffic destined for the city centre. The numerous intersections of the highway interferes with smooth flow of through traffic as they have to be stopped at very close intervals to give way for city center traffic. Furthermore, most of the through traffic includes the large slow moving trucks that take time to accelerate after stopping.

In this regard, the Ministry of Roads intends to open all the Nairobi bypasses and link roads. The objective of reserving the road corridors for the Nairobi Bypasses was to develop roads on the fringes of Nairobi City to enable through-traffic to avoid the congested areas of the City and other obstructions to traffic movement thus solving the problem of traffic congestion in the main streets of Nairobi (White et al, 1948).

However, with the expiry of the Nairobi Master Plan (1948), in which the bypasses were proposed, the above objective might not be achievable since the targeted urban fringes (e.g. Kahawa West and Ngong) are already built up, their own traffic building up. The bypasses might only shift the problem to somewhere else instead of solving it.

5.4.6 Inadequacy of traffic management system for the highway

Lack of cycling infrastructure has made the cyclists and handcart pullers to be using the same lane with motorists. The slow movement of these modes of transport greatly reduces the speed of motorists and causes conflicts as the motorists try to overtake them.

With the lack of zebra crossing levels and overpasses, the ever- high number of pedestrians tends to cross at any part of the highway, and the oncoming motorists are forced to slow down unexpectedly. This contributes to reduction of overall traffic speed and the outcome is congestion

Lack of road markings at the junctions and roundabouts leads to confusion of most motorists as they approach the roundabouts. Motorists fail to keep to the correct lanes or opt to do it too late and the resultant conflict contributes to traffic congestion along the highway.

5.4.7 The Tendency of the City Centre to have Uniform Peak Periods

Majority of the urban population in Nairobi undertake ómandatoryô daily trips (workplace-home) that make them commute at the same time of the day. Mandatory trips are mainly responsible for the peaks in circulation flow implying that about significant congestion in the city centre is recurring at specific times of the day and on specific segments of the roads.

5.4.8 Rapid Rise in Car Ownership Levels with Inadequate Infrastructure.

The car ownership rate per household in the Nairobi Metropolitan Area has been rising rapidly with the increase in income levels. It was projected to increase from 23% in 2004 to 31% in 2010, and 49% in 2025 with an average annual growth rate of 3.6% [Nairobi Urban Transport Study (NUTRANS): 2004]. This means more and more traffic is pouring into the highway each day. This is happening without correspondent increase in the existing transport infrastructure, considering that the highway is still the same width it was at the start of the city.

5.4.9 Roundabouts Located Too Close to One Another

The frequent interruption of traffic flow at every roundabout has resulted to overall reduction of the highway efficiency in traffic movement. This problem mainly affects through traffic which has nothing to do with the city centre. Of greater deal is the increasing number of large trucks that often switch of engine at every of these stops such that at the release of traffic they take time to accelerate thus leading to slowing of the traffic.

5.4.10 Non-recurrent Factors

These do no not occur on daily basis but when they do they cause even more severe congestion than that caused by the aforementioned recurrent factors. They include the following:-

i) Special events such as national and international sports and celebrations in Nyayo Stadium, overwhelming the already insufficient capacity of the highway

ii) Traffic incidents such as crashes, disabled vehicles; causing delay within the whole system (See Plate:

Adverse weather events (rain, fog)- reduces visibility hence lowering the speed of traffic

iii) Occasional construction/rehabilitation works ;reduces the number of lanes at particular sections of the highway creating a bottleneck effect hence adding to the congestion problem

Plate 11: Large trucks reduce traffic speed

Truck movement has a slowing effect on traffic speed

Huge advertising boards Haile Selassie Avenue roundabout

Source: Field Survey, 2009

Plate 12: traffic congestion in the City Centre affects traffic flow along Uhuru highway

Congestion approaching Globe Cinema roundabout

Congestion on Moi Avenue

Source: Field Survey, 2009

Plate 13: Non-recurrent factors of congestion

Disabled vehicles contribute to congestion

Source: Field Survey, 2009

Plate 14: Environmental problems

Air pollution along Uhuru highway

Source: Field Survey, 2009

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter seeks to advice on the possible solutions to the traffic challenges identified in the previous chapter, particularly the problem of traffic congestion. The limitations will form part of the section for further research. This will enforce the capacity of research to solve the day to day problems in totality.

6.2 Conclusions

With the foregoing, it is clear that traffic congestion experienced along Uhuru highway on daily basis. A solution to this problem is only possible through clear understanding of the factors contributing to it. This has been done in the previous chapter of this study where some of the factors were found to relate to the traffic management system both along the highway and in the city centre. Though not possible to eliminate traffic congestion completely, the study has explored and recommended various ways through which traffic congestion along the highway can be minimized to ensure smooth and efficient traffic flow along the highway. Some of the recommendations are short term while others are long term.

6.3 Recommendations

The study has identified some of the possible solutions to the problem of traffic congestion along Uhuru highway as outlined in the table below:-

Table 5: Recommendations

PROBLEMS	RECOMMENDATIONS
Ineffective and Inefficient Management of the Existing Road Capacity	
Uncoordinated traffic control within the roundabouts (poor signal timing)	• Use technology to better manage traffic • Advanced signal control • Ramp metering (traffic signals that regulate the traffic flow entering the highway)
The mixing of through traffic with city centre traffic	• Introduce measures to separate through traffic from the city centre traffic • Divert through traffic to the northern bypass upon completion
Inadequacy of traffic management system for the highway (lack of signboards, road markings,)	• Improve on the existing traffic management system along Uhuru highway- put sign boards and road markings where they are missing.

	• Changeable lane assignments to increase the efficiency of the highway.
Poor road user behaviour	• Promote public awareness on the existing traffic rules and importance of following them. • Strengthen enforcement of traffic rules along the highway • Increase highway patrols by traffic police along Uhuru highway • Install surveillance camera system to monitor traffic along Uhuru highway
Institutional irregularities (lack of proper coordination in traffic management between the Nairobi city council and the ministry of roads)	• Strengthen institutional framework for traffic management along the highway • The NCC and the Ministry of Roads should integrate traffic management along the highway and the city centre instead of isolating the two.
Parking mismanagement in the CBD	• Curb corruption among parking agents

	• Involve genuine bus management companies in the management of parking for public vehicles in the CBD
Inadequate non-motorized transport infrastructure	• Provide adequate non-motorized transport infrustructure along the highway for pedestrians, cyclists and hand cart pullers- over-passes and foot bridges at the main pedestrian crossing points
Unrestrained Demand	
The Tendency of the city centre to have uniform peak periods	• Manage travel demand • Introduce measures to move most of the trips away from the peak travel periods • Use of Electronic ñtrips.ò-Promote usage of a computer or phone to work at home for a day, or just one or two hours, this will reduce the peak system demand levels without dramatically altering lifestyles.
Poor management and unhealthy competition in public transport Sector	• Ensure proper management of public transport in the city

	• Issuance of operational licenses to be based on passenger traffic survey • Short term solutions to the urban public transportation system problem would be to introduce LRT expansion of the trunk roads and introduction of Bus Rapid Transit (BRT). BRT can be in form of express buses, limited busways, or rapid busways • Long-term solution will be to construct urban rail transport along the radial trunk roads. Railway construction and environmental concerns should be considered part of road development in a broad sense, and road funds should be utilized for these purposes. The construction of such a railway system will greatly change the modal share in Nairobi culminating in decongestion. Railway transport would gain more prominence over other transportation modes due to its punctuality and reasonable fare characteristics.

Rapid rise in car ownership levels and use	• Ban private cars from the C.B.D., either with pedestrianized streets or by stopping them from coming into the city centre at all (e.g. on certain days). Also Charging car drivers when they enter the city centre • Introduce Park and Ride strategy- where one parks your car on the edge of the built up area and then ride bus or train into the C.B.D. *A complete solution to traffic congestion needs people to be able and willing to travel on public transport more* • Establish road pricing for the highway to incorporate a pricing mechanism e.g. charging fee on some during peak time so as to improve the usefulness of road space along the highway.
A) Insufficient Capacity	
Inadequate road capacity	• Build additional highway capacity • Widen the highway to be a superhighway with additional and managed lanes. • Faster implementation of the proposed ring roads and by-

	passes to provide alternative routes for through traffic • Improve on the management of the existing railway system to attract most of the travelers and relive the highway of the increasing congestion • Establish rapid railway transit system in the city to cater for the increasing deficit in supply of transportation system
Roundabouts located too close to one another ï creates bottleneck effects	• Remove bottlenecks (redesign to increase capacity)
B) Non-recurrent Factors	
Traffic incidents(crashes, disabled vehicles)	• Traffic Incident Management • Real-time transportation (traveler) information • Establish Response and Clearance Procedures and Policies- finding and removing stalled or crashed vehicles • Institutionalize traffic incident management

Adverse weather events (rain, fog)- reduces visibility hence lowering the speed of traffic	• Develop and apply traffic management for adverse weather conditions • Develop and apply accurate, real-time road weather information • Develop and apply operator control strategies to minimize weather impacts
Occasional construction/rehabilitation works ;blocking some lanes	• Manage construction and maintenance projects • Move the construction to periods where traffic volume • is relatively low • Maintain traffic strategies during construction to minimize delays.
Special events such as national and international sports and celebrations in Nyayo stadium overwhelming the already insufficient capacity	• Ensure management of traffic before and after large sporting or holiday events in Nyayo Stadium

Source: Author, 2009

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APPENDICES

UNIVERSITY OF NAIROBI

DEPARTMENT OF URBAN AND REGIONAL PLANNING

B.A. IV PLANNING RESEARCH PROJECT

TRAFFIC CONGESTION PROBLEMS IN NAIROBI

Declaration: **This is a research exercise which is part of training offered in B.A (Planning). The information obtained is purely confidential and will be used for academic purposes only.**

QUESTIONNAIRE FOR PUBLIC VEHICLE OPERATOR

Name of interviewer: Njoroge Joseph Kibunja

Questionnaire Noé é é é é é Dateé é é é é é é é é é

Localityé ..

Section I: Background Information

1. Name (Optional)é é é é é é é é é é é é é é é ......é é é é é é é

2. Ageé é é é é é é ..

Section II: Trip Details

Type of Vehicle	Trip origin	Trip destination	No. of trips per day	Route	Distance (Km)	Avg.Time (off peak)	Avg. Time (peak)	Charges (off peak)	Charges (Peak)

4. (a) Apart from Uhuru highway do you have alternative route to your destination?

   1. Yes (specify)é é é é é é é é é é é 2. No

   (b) If yes, why do you avoid it?

   é

5. In your own view what do you think causes traffic congestion along Uhuru highway? (Tick)

1. Uncoordinated traffic control
2. Offensive driving
3. Mix of through traffic with city traffic
5. Inadequacy of transportation facilities (traffic lights, zebra crossings, bus stops, etc)
5. Others (specify)

6. Does the following road users affect your easy movement along Uhuru highway?

Road user	**In what way?**
Other public vehicles	
Private vehicles (including heavy commercial)	
Motorcyclists	
Pedestrians	
Hand cart pullers	
Any other (Specify)	

7. What would you recommend to reduce traffic congestion along Uhuru highway?

(a).....

(b).....

(c).....

Thank you!

UNIVERSITY OF NAIROBI

DEPARTMENT OF URBAN AND REGIONAL PLANNING

B.A. IV PLANNING RESEARCH PROJECT

TRAFFIC CONGESTION PROBLEMS IN NAIROBI

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QUESTIONNAIRE FOR PRIVATE VEHICLE OPERATOR

Name of interviewer: Njoroge Joseph Kibunja

Questionnaire Noé é é é é é Dateé é é é é é é é é é

Localityé ..

Section I: Background Information

1. Name (Optional)é é é é é é é é é é é é é é .....é é é é é é

2. Ageé é é é é é ..

3. Gender

    1. Male
    2. Female

4. Occupationé ..

Section II: Trip Details

5. Where are you coming from?

Type of vehicle	Trip origin	Trip destination	Distance covered (km)	Avg. time (off peak)	Avg. time (peak)

6. What is the purpose of your trip?

    1. Work
    2. Shopping
    3. Leisure/social
    4. Any other (specify)

13. (a) Apart from Uhuru highway do you have an alternative route to your destination?

    1. Yes (specify)é é é é é é é é é é é é é . 2. No

(b) If yes, why do you avoid it?

é é
é é é é é é é é é é é é é

15. Does the following road users affect your easy movement along Uhuru highway?

Road user	**In what way?**
Other private vehicles(including commercial)	
public vehicles	
bicyclists and motorcyclists	
Pedestrians	
Hand cart pullers	
Any other (Specify)	

14. In your own view what do you think causes traffic congestion along Uhuru highway?(Tick)

1. Uncoordinated traffic control
2. Offensive driving
3. Mix of through traffic with city traffic
5. Inadequacy of transportation facilities (traffic lights, pedestrian crossings)
5. Others (specify)

16. What would you recommend to reduce traffic congestion problems along Uhuru highway?

(a).é é

(b)é é

(c)é é

Thank you!

UNIVERSITY OF NAIROBI

DEPARTMENT OF URBAN AND REGIONAL PLANNING

B.A. IV PLANNING RESEARCH PROJECT

TRAFFIC CONGESTION PROBLEMS IN NAIROBI

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PEDESTRIAN QUESTIONNAIRE

Name of interviewer: Njoroge Joseph Kibunja

Questionnaire Noé é é é é é Dateé é é é é é é é é é

Localityé ..

Section I: Background Information

1. Name (Optional)é é é é é é é é é é é é é é é .....é é é é é é é
2. Ageé é é é é é é ..
3. Gender
    1. Male
    2. Female
4. Occupationé ..

Section II: Trip Details

5. Where are you coming from?é é
6. Where are you going?é é
7. What is your main reason for travel?
    1. Work 3. School
    2. Leisure/social 4. Shopping
8. (a) Do you always feel comfortable while you are crossing Uhuru highway?
    1. Yes 2. No.

(b) If yes, give reason(s)

é é
é ..é é
é ..

(c) If no, give reason(s)

é é
é é
é é
é é
é é é é é é é é é é é é

9. In your own view what do you think causes of traffic congestion along Uhuru highway? (Please tick)

1. Uncoordinated traffic control
2. Offensive driving
3. Mix of through traffic with city traffic
5. Inadequacy of transportation facilities (traffic lights, pedestrian crossings)
5. Others (specify)

10. What would you recommend to reduce traffic congestion problems along Uhuru highway?

(a).é é
é é é é é é é é é é é é é ..

(b)é é
é é é é é é é é é é é é é é

(c)é é
é é é é é é é é é é é é é ..

Thank you!

UNIVERSITY OF NAIROBI

DEPARTMENT OF URBAN AND REGIONAL PLANNING

B.A. IV PLANNING RESEARCH PROJECT

TRAFFIC CONGESTION PROBLEMS IN NAIROBI: AN EXAMINATION OF UHURU HIGHWAY

Declaration: The information obtained is purely confidential and will be used for academic purposes only.

INTERVIEW SCHEDULE – CITY COUNCIL OF NAIROBI

Name of interviewer: Njoroge Joseph Kibunja

Dateé é é é é é é é é

- How do manage vehicular traffic along Uhuru highway?
- Problems encountered in enforcing the rules and regulations under the above measure.
- Factors contributing to traffic congestion along Uhuru highway
- Method for carrying out traffic census, if any.
- Is road capacity adequate to meet the current traffic along Uhuru highway?
- Who should be the key player(s) in reducing traffic problems along Uhuru highway?
- What could be done to reduce traffic congestion problems along Uhuru highway?

Njoroge Joseph
University of Nairobi
Department of Urban and Regional Planning
8th January 2009

Human Resource Director
City Council of Nairobi
P.O Box 375
Nairobi

Dear Sir/Madam

RE: AUTHORIZATION TO COLLECT DATA FOR PLANNING RESEARCH STUDY

I am an undergraduate student pursuing the Bachelors degree in Urban Planning at the University of Nairobi, Department of Urban and Regional Planning. I am currently undertaking a research study on traffic congestion problems in Nairobi with respect to Uhuru highway as part of my course requirement for the fulfillment of the degree.

It is with the assistance of the Nairobi City Council that I can obtain useful information concerning traffic management along Uhuru highway, maps and plans showing the location of the highway, ongoing or proposed projects, traffic problems as well as challenges faced by the City Council in managing traffic along the highway.

I am therefore requesting for your authorization to collect, from the appropriate department of the City Council, relevant information on traffic management for my study. I will appreciate your assistance. Thank you in advance.

Yours faithfully,

Joseph Kibunja Njoroge