

**Challenges and Opportunities for Sustainable Urban Mobility
(Non-Motorized Transport): A Case Study of 'Nyamakima
Area', Nairobi County, Kenya.**

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DECLARATION

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

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DEDICATION

To God the Almighty who have given me opportunity to conduct this research, and to my dear Parents *Mrs. Norah Ayieko Angira* and *Mr. Musa Angira Angira* for their Love and soft words of the encouragement in facing real issue of life.

PROLOGUE

Sustainable City Transport *"Where it is pleasant and safe to walk to shops, parks and schools. Where streets are safe too cycle on, cross or even children to play on. Where work is not far away or is easily reached by bus. Where it is safe to take bicycle to the nearest rail station or bus interchange. Where buses move quickly in bus lanes and get priority at traffic lights. Where you don't need to go away for fresh air and do not have to shout over traffic noise. Where city is quiet but fully alive"* (SUSTRAN, 2000, p.4).



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ABSTRACT

The urban transport systems in Africa's cities and urban centres suffer from poor allocation of financial resources, lack of regulatory frameworks, institutional weaknesses, inefficient public transport systems, poor allocation of road space and inadequate traffic management systems. The today's urban mobility challenge in Kenya cities is to arrive at balanced provision of traffic infrastructure for both Motorized Transport (MT) traffic and Non-Motorized Transport (NMT) traffic. The road infrastructures within CBD of Nairobi City were majorly designed for MT giving little attention to NMT. The high proportion of all motor vehicles in the Nairobi city are personal private cars, where more than 70% only carry one passenger and the use of bicycles is very limited within the city. Drastic increases in the number of vehicles have strained urban road networks, resulting in congestion for most of the day. Most of these factors disproportionately affect the urban poor in terms of limited access to affordable transport services, ill-health from pollution, and road safety concerns. NMT passengers generate no air pollution, no greenhouse gases, and little noise and air pollution; they are efficient and environmentally sustainable means of making short trips within urban and city centres.

This study sought to investigate the current opportunities and challenges being experienced that affects the promotion of the NMT in providing a sustainable urban mobility within CBD in "Nyamakima Area" of Nairobi City. This study further seeks to examine the potential and sustainability for effective transportation planning for NMT and its effects in the reduction Motorized traffic congestion in the area.

The research methodology involved the review of literature, primary and secondary data collection, data analysis, interpretation and synthesis and subsequent recommendations to address urban mobility challenges and policy recommendations to promote NMT for urban areas. The study targeted a population of 120 road users and other Key informants within the transport and planning sectors. The primary data was sourced by administering questionnaire, interviewing key informants, focus group discussions, participatory transect walk, photography and GPS observations. Secondary data were collected from the review of published and unpublished materials, government reports, print media and the internet. The Microsoft Excel, AutoCAD Land Development and GIS software's (ArcGIS and ArcView) were the main computer packages used for data analysis.

The study found that there exist the high NMT and NMT traffic congestion, lack of NMT promotion programs and lack of NMT infrastructures which has led to unsustainable urban mobility and development within study area. The study recommended that NMT should be encouraged and promoted within the frame work of sustainable transport development due to its health, transportation, economic, quality of life and environmental benefits. From the study it can be concluded that logical integration of NMV and MT will enhance the modernization of sustainable urban transport. The policy makers, transport planners and engineers will require changes in transport investment patterns, infrastructure design standards, street space allocation, credit and financing systems, regulatory policy, public education, and marketing, depending to promote the NMT.

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ABBREVIATIONS AND ACRONYMS

| | |
|-----------------|--|
| ASIST | Advisory Support, Information Services, and Training |
| CBD | Central Business District |
| CBO | Community Based Organization |
| CO ₂ | Carbon dioxide |
| FHWA | Federal Highway Administration |
| GHG | Greenhouse gas |
| GDP | Gross Domestic Product |
| GoK | Government of Kenya |
| GPT | Graduated Personal Tax |
| Gurudumu tatu | Pedal-operated load carrying tricycles |
| IHE | International Institute for Infrastructural, Hydraulic and Environmental Engineering |
| IHS | Institute for Housing and Urban Development Studies |
| ILO | International Labor Office |
| IRAP | Integrated Rural Accessibility Planning |
| ITC | International Institute for Aerospace Survey and Earth Sciences |
| KBS | Kenya Bus Services |
| KUTIP | Kenya Urban Transport Infrastructure Program |
| LTMA | Land Transport Management Act |
| Matatu | Kenyan share taxis |
| MT | Motorized Transport |
| NCC | Nairobi City Council |
| NMVs | Non-Motorized Vehicles |
| NMR | Nairobi Metropolitan Region |
| NMT | Non-Motorized Transport |
| OECD | Organisation for Economic Co-operation and Development |
| SCP | Sustainable Cities Program |
| SIDA | Swedish International Development Cooperation Agency |
| SSA | Sub-Saharan Program |
| SSATP | Sub-Saharan Africa Transport Program |
| SUM | Sustainable Urban Mobility |
| SUT | Sustainable Urban Transport |
| TS | Transport systems |
| UMU | Urban Mobility Unit |
| UNECA | United Nations Economic Commission for Africa |
| WHO | World Health Organisation |

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE RESEARCH PROBLEM

The rapid population growth and spatial expansion has led to a sharp increase in demand for proper urban transport facilities and social services in many cities all over the world. However, the provision of social services in African and Asian Cities have been hindered due to high of spatial expansion with little or no development planning, while in some cases the failure of the instruments of governance has resulted in a significant wastage of resources or substandard quality of social infrastructure. The huge capital costs, institutional weaknesses and time required to develop high capacity transport systems have prevented the timely implementation on transport sector in urban areas. This has led to a situation where many cities only rely on road-based transport systems, which have serious capacity constraints, negative environmental consequences and other limitations. Consequently, many cities in the region are facing serious urban transport problems, including significant levels of traffic congestion, air pollution, high rates of traffic accidents and inadequate access to transport facilities by poor and vulnerable groups, such as people with disabilities. The “liveability” and productivity of many cities are threatened by deteriorating urban environment and poor planning on Non-Motorized transport. In some of the major capitals in Asian and Africa, such as Manila, New Delhi, Lagos and Nairobi the situation is getting out of hand this will affect urban economy, health and welfare of the people living in the city (Steg et al, 2005).

In 1990’s the Federal Highway Administration (FHWA) of the US government described bicycling and walking as “the forgotten modes” of transportation in urban centers as stated in FHWA (1997). This led many Federal, State, and local agencies to neglect the non-motorized options for years, even as others acknowledged their importance. Sources of funding for NMT projects were

limited, with only \$6 million in federal funds spent on pedestrian and bicycle projects in 1990 compared to what was spend in 1980,s. Several studies amongst the Highway statistics commissioned by FHWA of 2008 have confirmed that bicycle and pedestrian crashes accounts for more than 15 percent of traffic fatalities (4 and 11 percent, respectively). Recognizing the decline in walking and bicycling, and the rise in fatalities, the US Department of Transportation (USDOT) adopted the first national transportation policy to "increase use of bicycling, and encourage planners and engineers to accommodate bicycle and pedestrian needs in designing transportation facilities for urban and suburban areas, and increase pedestrian safety through public information and improved crosswalk design, signaling, school crossings, and sidewalks." These priorities represented a significant shift in the attention given to bicycling and walking to cover short journey (FHWA, 2012b).

The variety of modal mixes of non-motorized vehicles (NMVs) which include bicycles, cycle-rickshaws, and carts now plays a vital role in urban transport in Asian Cities. Linda Baker in 2009 stated that the NMVs used in Asian account between 25 and 80 percent of vehicle trips, this is more than anywhere else in the world. However, the growing motorization, loss of street space for safe NMV use, lack of adequate funding of Non-Motorized Transport (NMT) projects and perception associated by NMT prompted by motorization have threatened the future of NMVs in Asian. The NMT Strategies are to be developed and adopted to slow or reverse this trend.

A sustainable urban transport requires more efficient, equitable and environmentally sensitive transport system which makes it sensitive to political, economic, social and environmental constraints. In 2003, Litman affirmed that for sustainability of the transport system to be achieved the transport infrastructure design and evaluation of the solution to transport problems must be looked into, to ensure it meets the present and without compromising future

generation's needs. Sustainability has significant implications for rural and urban transportation planning, since transport activities tend to be highly resource intensive, have numerous external costs, and frequently distribute impacts inequitably. Sustainable transportation network requires using each mode of transport for what it does best which typically means greater reliance on non-motorized for local travel, increased use of public transit in urban areas, a reduction of personal automobile. NMVs offer low cost private transport, emit no pollution, use renewable energy, emphasize use of labor rather than capital for mobility, and are well suited for short trips in most cities regardless of income, offering an alternative to motorized transport for many short trips. Thus, they are appropriate elements in strategies dealing with poverty alleviation, air pollution, management of traffic problems and motorization, and the social and economic dimensions of structural adjustment. NMVs have a most important role to play as a complementary mode to public transportation (Wilmink, 2001).



Plate 1. A section of Cross road (source: Author Jan, 2013)

According to Langen et al (2001) cycling provides a highly improved mobility to its users, 50% more trips and longer trip distance than non-cyclists, at a unit cost. Most cycling is on mixed traffic roads (NMT and NT) with average motor vehicle speeds of 50 Km/hr. with relatively simple and low cost measures. He further stated that in Nairobi as well as in Dar-es Salaam, traffic conditions are generally so unsafe for cyclists and pedestrians due to poor road design and lack

of proper strategy. The improved safety on the number of collector roads through speeds humps and raised pedestrian crossing seems to play a positive role in encouraging more people to cycle and walk within the urban centers.

Langen et al (2001) further noted that the effective instruments to improve bicycle mobility and pedestrian safety exists in Africa but lacks proper planning and funds to be achieved. The most immediately applicable interventions are of a small scale, of a spot intervention nature, and do not require large sum of money. Their application is straight forward, and their benefits/cost ration is high, since their primary function is to repair serious deficiencies in the existing urban roads networks. The second is a large scale interventions that can significantly improve the mobility of most urban inhabitants and the same time reduce their transport cost burden is the large scale provision of basic bicycle access infrastructure and coherent of pedestrians and bicycle routes.

1.2 THE PROBLEM STATEMENT

A balanced provision of infrastructure starts with a balanced perception of what urban traffic is and should aim to achieve. The World Bank paper of 2006 on a sustainable urban transport suggested that one of the reasons that it has been so difficult to achieve such balance is that many people automatically think of traffic as Motorized transport (MT) traffic and never realize that NMT traffic is there just as well, in most African cities NMT trips outnumber MT trips. The balanced and sustainable urban mobility is a problem in African cities including Lagos, Kampala, Nairobi, Mombasa and Kisumu amongst others. A sustainable transportation systems should be seen as an economic production and market system that requires efficiency, hence the need for reduction of the direct and indirect cost of transport and time spend during the journey. The challenge is to arrive at balanced provision of traffic infrastructure for both MT traffic and NMT traffic within the cities.

The Nairobi Metro (2030) states that the Nairobi Metropolitan Region (NMR) contributes approximately 60% of the National Domestic Produce and is home to over 60% of the urban population. Nairobi city host most of the International Conferences in Africa and therefore receives the highest number both foreign and domestic visitors. The Nairobi Metropolitan area is experiencing the highest level of immigration resulting into very high pressure on existing physical and social Infrastructure. The most prominent manifestation of this scenario is the persistence traffic congestion being experienced in the Central Business District (CBD) both during peak hours and anytime of the day and in all the directions. For the last 20 years traffic management measures have been discussed but with little implementation. In fact the large public service vehicles (PSV) have greatly lost to small private vehicles destined in the city.

From field observations, the CBD with special reference to Nyamakima area is actually stalling due to unorganized NMT and MT traffic, and high rate of transport and business activity in the area. The capacity of the CBD road carriage ways are over-stretched and needs be designed to ensure the urban mobility is effective, affordable and sustainable to meet the mobility needs of all road users.



Plate2: *Cyclist and pedestrian using the River road carriage way (Source: field Photo, May 2011)*

From the Nairobi City Council Engineers department, the road design records confirms that road infrastructures within the Nyamakima area of Nairobi City are

majorly designed for motorized transport giving little attention to NMT. From the observations it was noted that the Nyamakima area is very compact and supports mixed small and medium businesses with high traffic both MT and NM traffics. This seems to contribute high traffic jams within these busy business and transport area, and leads to more time is taken for a short trip along River road from Ronald Ngala junction to Tom Mboya roundabout. The NMT challenges and promotion potentials within the study area are real, they must be addressed to ensure that our urban centres are developing in the right direction.

Where NMT is the main transport mode for the work journeys of the poor, it is also critical for the economic functioning of the city and the country as a whole. Despite these obvious merits, NMT have tended to be ignored by economic and spatial planners, road engineers and policymakers in the formulation of infrastructure policy and positively discouraged as a service provider. The purpose of this study is to highlight the characteristics, challenges, opportunities, role, and benefits for NMTs and, to suggest a framework within which NMT's potential may be better exploited, to enhance the urban mobility within the Nyamakima area of Nairobi CBD, Kenya.

1.3 RESEARCH QUESTIONS

The research questions that the study seeks to address include:-

- i. What is the current level of NMT (cycling and walking) within the Nairobi Nyamakima area compared other modes of transport?
- ii. What are the challenges and potentials of promotion of NMT within the Nairobi Nyamakima area to enhance business activities and mobility?
- iii. What kind of policy alternatives with specific reference to physical infrastructural interventions that can promote sustainable NMT within the Nairobi Nyamakima area?

1.4 Purpose of Study

The overall aim of this study is to highlight the existing situation of the urban mobility challenges and opportunities within the Nyamakima area of Nairobi, Kenya. The study have underlined characteristics, role, and benefits for NMTs and, to suggest a framework within which NMT's potential may be better exploited, to enhance the urban mobility within the study area.

1.4.1 Specific Objectives

The specific objectives of this study are:-

- i. To determine current levels of NMT (cycling and walking) within the Nairobi Nyamakima area compared other modes of transport.
- ii. To examine the existing NMT challenges that can be addressed by exploring the effective transportation planning and road design mechanisms.
- iii. To propose policy alternatives with specific reference to physical infrastructural intervention that can be introduced to promote the sustainable NMT within the Nairobi Nyamakima area.



Plate3: Cart puller and pedestrian using the vehicle carriage way. (Source: field Photo, Dec 2012)

1.5. RESEARCH HYPOTHESIS

The research working hypothesis can be modeled as promotion for NMT (cycling and walking) within the Nairobi Nyamakima area will promote sustainable urban mobility in the area. To achieve this the policy makers need to provide pedestrians and bicyclists with a system of facilities, incentives, and services, that fully support trip-making connections between residential areas, employment centers, shopping, recreational facilities, schools, public transit and other public services. The city comprehensive plan must Support trip-making by developing an integrated Citywide sidewalk/pathway plan including on and off-road trails to establish safe bicycle and pedestrian circulation.

1.6 JUSTIFICATION AND SIGNIFICANCE OF THE STUDY

In Nairobi, the control of road transport sector is split between the public sector and the private sector. The public sector supplies the transport infrastructure, through the Ministry of Roads and Public Works and the Nairobi City Council. The private sector supplies the bulk of the transport services through passenger vehicles provided by private bus operators, and mini-buses, known locally as matatus.

Most urban road infrastructure constructions in Nairobi county focus on motor vehicle traffic and car traffic in particular, with little attention given to the NMT. The study highlights the current danger in the promotion of MT and neglecting the NMT in the urban central business centres specifically in African cities. The promotion of use of public (boda-boda) and private bicycle transport and walking are largely seen as an environmentally friendly, cheap, efficient and effective mode of transport within busy urban streets. Non-Motorized Transport (NMT), including walking and cycling, remains a viable option in meeting a sustainable approach to urban transport. Bicycles, walking and the minimized private vehicle traffic results to the greening of urban transport sector. The major issues for NMT includes firstly, many junction designs and roadway designs are not optimal

for pedestrian and cyclist safety; secondly, a network of protected or separated bicycle lanes and pedestrian tracks has not been developed on existing transport systems; thirdly, bicycle parking facilities at key locations such as bus stations, shopping centers, and public facilities are insufficient (Asian Development Bank, 2009).



Plate4: Pedestrians walking on road carriage way along River road, Nairobi (Source: field Photo, May 2011)

This study will offer the opportunity to identify the challenges and potentials for sustainable transportation planning for NMT (cycling and walking) within the Nairobi Nyamakima area and its effects in the reduction traffic congestion and air pollution. It will also present the current use level of cycling and walking within the Nairobi Nyamakima area compared other modes of transport.

1.7 THE SCOPE AND LIMITATION OF THE STUDY

The study will cover the area between River Road, Kumasi Road, Kirinyaga road, Race Course road and Ronald Ngala within the CBD of Nairobi City known as the Nyamakima area. In this case the Nyamakima area is hereby by treated as traffic analysis zone. The case study area was chosen because it is compact, ever congested (both with NMT and MT), high number of public transport, and high concentration of small and medium business activity. It is also chosen since it experience high level of traffic jam both during peak and off peak period in weekdays and weekend.

CHAPTER TWO

REVIEW OF LITERATURE

2.0 INTRODUCTION

This chapter covers the NMT mobility, transport planning and urban growth models, and their significant in sustainability of urban transport. It explores the sustainable urban transport and how it influences the development of the green urban centres. This chapter also covers the impact of urbanization of transport in both third, developing and developed countries on the sustainable transportation. The conceptual framework for the study that will guide the NMT mobility in this study is also illustrated.

2.1 SUSTAINABLE TRANSPORT

Yuri (2002) argues that a sustainable transport system must meet the mobility and accessibility needs of people by providing safe and environmentally friendly modes of transportation. Sustainability in transport sector is a complex and difficult task in the mega-cities of developing countries because the needs of people belonging to various income groups are not only different, but also often conflicting in nature. For example, if a large section of the population cannot afford to use motorized transport – private vehicles or public buses – they have to either walk to their place of work or use bicycles. Providing a safe infrastructure for cyclists and pedestrians means either physically segregating road space for cyclists and pedestrians from motorized traffic, or, if that is not possible, reducing the speed of motorized traffic. Both measures imply restricting the mobility of car users to by promoting the mobility of pedestrians and bicycle users amongst others to achieve the aim.

Since the 1970s, many statements have been made asserting that the world would be unable to sustain any growth without a possible socioeconomic and/or *environmental breakdown*. This context was well underlined by the **Brundtland**

Commission in 1987 which defined **sustainable development** as "Development which meets the needs of the present without compromising the ability of future generations to meet their own needs". Sustainable developments are those which fulfill present and future needs (WECD, 1987) while [only] using and not harming renewable resources and unique human-environmental systems of a site: [air], water, land, energy, and human ecology and/or those of other [off-site] sustainable systems.

According to Andrew Macbeth in 2003 and 2004 stated that Centre for Sustainable Transportation (CST) in Canada defined the sustainable transportation system as "that which allows the basic access of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations. It must also be affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy. More so it also limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise."

The economic, the environmental and the socio-cultural determinants are key pillars to sustainable development that interact to produce the complexity of weighing costs and beneficiaries. The sustainable development interacts between the three objectives as illustrated in Fig. 2.1.

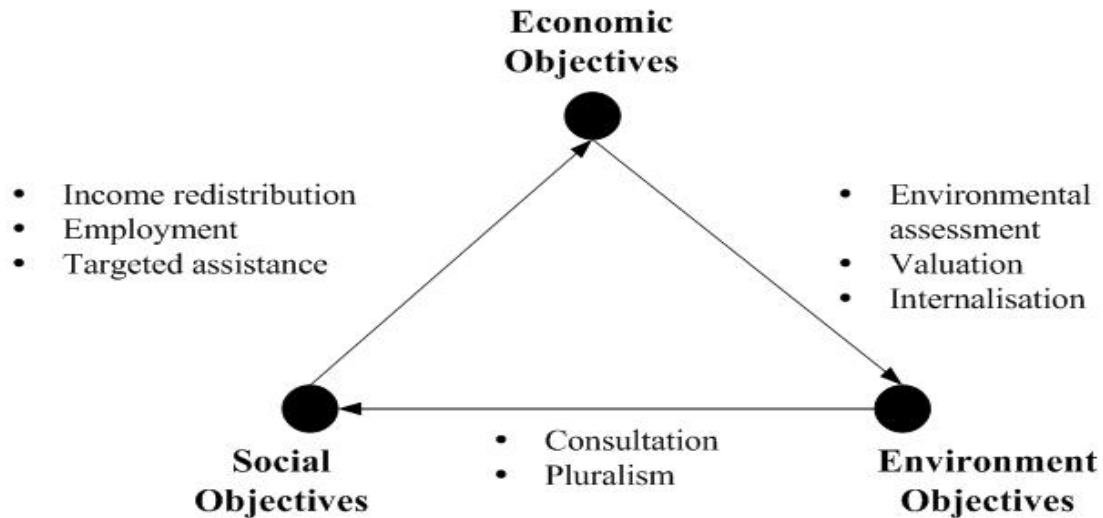


Figure 2.1 Pillars of Sustainable Development (Source: Hung, C.C.2002))

Todd (2003) acknowledged that accessibility is not just the ability to overcome space but the ease with which one reaches destination merit for its own sake. Whilst many journeys are necessary and many of them are too far for walking or cycling, they need to be made with mechanical transport. So very often, in defining the function of transport, the view that transport exists to serve the people’s needs must be sustainable.

2.2 TRANSPORT PLANNING

Transport policies have changed over time, in response to the increasing vehicle performance and ownership levels, increasing congestion and increasing awareness of environmental issues. Likewise, transport planning strategies and objectives have changed from fully satisfying demand for transport to a more objective oriented. Furthermore, with improved knowledge on travel behavior of people in cities, the decision-makers, urban planners and transport engineers are able to change policy directions into management of road space.

Manheim (1979) explains that the transport system may shape societal and economic processes in the area. In return the societal and economic processes

indirectly affect the shape of the transport systems. In a systems approach three basic variables can be distinguished in the transport system; the *activity system*; and *traffic* and *transport flows*. First, the traffic and transport flows derive from the equilibration of transport system supply and the activity patterns that generate a travel demand. This is typically a short to medium term relationship. Second, the traffic and transport flows might on the longer-term change activity patterns (shifts in modal choice and trip frequency choice) and eventually land-use patterns. Third, traffic and transport flows might necessitate changes in the transport system itself, through actions of traffic managers and transport planners. Urban transport planning is concerned with this interaction, which is the equilibration of travel demand, i.e. derived demand from the activity system, and infrastructure supply, i.e. the characteristics of the transport system. It intends to steer the process of allocation of traffic generators and the provision of transport facilities.

On further premise, it can be interpreted that urban transport planning can therefore control the equilibrium flow in Manheim's systems approach, through the collection and monitoring of basic current and expected future traffic and transport related data as well as the analysis of these data, the transport problems at hand are derived in relation to (future) political, social and economic developments. In addition, quantitative techniques are to be applied to model, analyse and forecast alternative interventions, and (future) scenarios. Several plans must be evaluated on the basis of several indicators such as cost-benefit analysis, environmental impact assessment and the best selected for implementation in Nairobi city amongst others in Kenya.

2.3 MEANING AND MODES OF NON – MOTORIZED TRANSPORT (NMT)

Mobility and accessibility in a safe and environmentally friendly mode of transportation is what sustainable transport system is aiming at. In the particular context of transport, modal split is heavily weighted towards walking and other

non – motorized vehicles. In Imran (2002) research indicated that Non-Motorised transport usually refers to walking and cycling suggested that 'walking' should be considered as a mode of transport and is complementary to motorised trips, it also consider cycle rickshaws and tricycles as a form of non-motorized transport. Replogle (2009) on his publication on bicycle and public transportation noted that NMT system is a form of pedicab operations commonly found in town, cities and regions. It is a multipurpose tool that can be used for the door-door transport of persons and goods with improved travel time and route option.

The NMT is the most sustainable transport mode being non-polluting modes, most vulnerable to large scale road building programmes. It can be regarded as a means of subsistence for groups of people for whom there is quite *literally no current alternative*. *The definition of NMT according to Replogle (2009) includes any form of transportation that provides personal or goods mobility by methods other than the combustion motor engine*. The World Bank report (2002) on urban transport strategy highlights that other common form of NMT include bicycles/tricycles; human portage; handcarts/wheelbarrows; animal drawn carts; and other human powered vehicles. Walking is the most familiar form of NMT.

The two major modes of NMT are walking and various forms of cycling, which can be personal or public transport. Transport experts are quick to point out that pedestrian and cyclist's traffic had always been excluded from the main discussion of transport and traffic activities. Currently experts are now recommending in their studies that NMT should be considered in all road projects, transport and traffic management. The Asian Development bank (2009) acknowledged that the NMT public transport sector, which is particularly important in South Asia, comprises many load-carrying variants. Particularly in higher-income countries, many people also walk or bicycle for exercise and pleasure. NMT accounts for between 40 and 60 percent of all trips in several

major cities in Asia. According Gwilliam in 2003 on transport in developing in the poorer cities in Africa (like Nairobi, Abuja and Kampala), that proportion is even higher.

2.3.1 Walking

For very short trips, walking is the main mode of transport in most societies, rich or poor since every must walk in one way or the other. According to Langen (2001) indicated that most trips in all countries involve some walking as access and egress to the main mode. The modal share of walking can be very high compared to other modes of transport. Recent studies show that between 25 and 50 percent of trips in the major Indian cities, and around 50 percent of all trips in major African cities, are entirely on foot, and that trips undertaken primarily by public transport also involve significant walking distances. In medium and smaller cities, the share of all-walking trips increases to 60 to 70 percent. Further research by Marius de Langen and Rustica Tembele (2001) confirms that walking dominates for shorter trips, but even in terms of distances traveled, walking accounts for over 50 percent of all trips in Morogoro, Tanzania and Nairobi, Kenya. The political, engineering and planning attitude toward pedestrians is often neglectful as the pedestrian space is continually being neglected and ignored. Major roads in Africa cities Nairobi included have no cycle tracks and sidewalks, and those that exist are frequently occupied by street vendors, encroached upon by shop premises, or blocked by parked cars, motorcycles, and bicycles.

2.3.2 Walking On Wheels (Bicycles)

The publication by Wilmink (2001) confirmed that bicycles are a desirable mode of transport in many cities, but it is important to analyze who is using them, what the prevailing social and political attitudes are to the use of the mode, and whether there are particular obstacles to their use by women. The bicycle represents a trade-up from walking.

2.4 THE CHALLENGES AND OPPORTUNITIES OF NON-MOTORIZED TRANSPORT

It is assumed that Non-motorized transport is the main mode of transport for the poor and in some a significant source of income for them. Where NMT is the main transport mode for the work journeys of the poor, it is also critical for the economic functioning of the city that must be used by all social classes in a society. Despite these obvious merits, NMT have tended to be ignored by policymakers in the formulation of infrastructure policy and positively discouraged as a service provider (Asian Development Bank, 2009). The use of NMT to transport goods is also economically significant as an important part of the supply chain in many cities. The reasoning behind this new support for bicycling and walking should be based on the numerous benefits associated with them which includes the environmental, economic, health, and transportation goals.

2.4.1 Opportunities of Non-Motorized Transport

Improving the efficiency of non-motorized travel is economically vital. Virtually every trip begins and ends with walking or cycling trip.

2.4.1.1 Health Benefits

The health benefits of regular physical activity due to the use of NMT are far-reaching:- reduced risk of coronary heart disease, stroke, diabetes, and other chronic diseases; it also lower health care costs; and improved quality of life for people of all ages. Even small increases in light to moderate activity, such as daily bike rides or 30-minute walks, can produce measurable benefits among those who are least active (Langen et al, 2001).

2.4.1.2 Transportation Benefits

Many trips daily are less than three miles in length, yet 72 percent of these short trips are made in vehicles. According to Jeroen (2009) who stated that bicyclists

and walkers can often bypass congestion and gridlock traffic, and in some instances may even arrive at their destinations faster than if they had driven a car. Accommodating bicyclists and pedestrians also ensures that individuals have transportation choices aside from driving a car or being driven.

2.4.1.3 Economic Benefits

According to UK, department of transport (2008) report found out that the cost of owning and operating a car, currently estimated at \$9,055 per year, can account for almost 18 percent of a typical household's income. To compare this with the \$120 yearly operating cost of owning a bicycle, or essentially free travel by foot and it is clear that walking and bicycling can provide options for those who would like to save money. In Kenya the economic benefits of NMT can also be achieved as persons needs to be encouraged to cycle and or walk to work as the cost of bicycle is cheaper than MVs. The increasing of the modal share of bicycling and walking can reduce a country's dependence on import oil for MVs. Many developing countries are going deep into debt to continue subsidizing oil, which is overwhelmingly used by higher income motorists.

The promotion of a safe bicycling and walking improves the accessibility of the poor and the rich in cities, municipalities and rural areas. In Africans cities not limited to Nairobi city, reaching centers of employment from low income settlements is an arduous journey consuming over one quarter of a family's disposable income and more than 4 hours each day.

2.4.1.4 Quality of Life Benefits

Numerous intangible benefits are associated with bicycling and walking, the benefits are not limited to providing more travel options can increase a sense of independence in old persons, school students and pupils, and others who cannot or choose not to drive. The Canada, Ontario Ministry of Transportation, (2005) indicated that the increased levels of bicycling and walking can have a great

impact on an area's sense of livability by creating safe and friendly places for people to live and work. Undoubtedly, programs developed to support bicycling at the provincial and municipal levels have successfully increased levels of winter bicycling. In Kenya the benefits are real and can be achieved very easily with right programs and enforcements administered by the relevant authorities.

2.4.1.5 Environmental/Energy

Roughly 85% of worldwide commercial energy use is derived from fossil fuels (Harris and Goodwin, 2003). While fossil fuel reserves can meet projected needs for at least two more decades, world oil production is expected to peak between 2010 and 2030 (Campbell et al, 1998; MacKenzie 1996). The major contributor to global warming is the burning of fossil fuels, and the largest single use for fossil fuels is in transportation. Fossil fuel emissions-induced global warming – or “climate change” as it is now commonly referred – will lead to reduced crop yields, increased instances of extreme weather events, decreased water availability in water-scarce regions, increased flooding in other regions, increased spread of diseases, and inundation of low-lying areas (Harris et al, 2003). It is important to promote initiatives to reduce usage of personal automobiles and successfully meet Kyoto's goals.

2.4. 2 Constraints of NMT

Despite widespread popularity of bicycles in sustainable transportation strategies across Europe, Asia and Africa several negative factors – some real, others imagined – have prevented most Kenyans from considering the bicycle a serious transportation mode. The safety, comfort and efficiency cover the wide spectrum of bicycling issues.

2.4.2.1 Road Safety

The current perceptions and statistics relating to road accidents / fatalities arguably present the greatest obstacle for the successful implementation of NMT

in the City as a good percentage of all road fatalities in Asia and Africa involve pedestrians and cyclists. Most pedestrian accidents happen when pedestrians cross a road while others occur when they walk in the road, and also when they walk on the verge. Cycling in Kenya especially Nairobi and Kisumu is a relatively dangerous activity as cyclists are not very visible and are generally not considered equals by motorists in terms of access to road space. From Aligula et al (2005) states that the Kenya police records indicate that "Cyclists make up about 5% of all fatalities on Kenya roads". Without tangible proof that current trends are drastically improving or significant capital investment is made in dedicated cycle lanes this will mitigate against any of the objectives and targets of a NMT strategy for the City.

2.4.2 .2 Lack of Security

The World Bank (2002) report indicates that the African cities including Nairobi, the street environments are not fully equipped in terms of lighting, NMT storage facilities, CCTV and direct sight lines. This presents an environment which is unsafe for pedestrians and a haven for criminals especially in hours of darkness. From the observations the vast majority of workplaces and bus terminus in Nairobi City do not presently make provision for cycle storage facilities. This is also the case in the majority of destination points (libraries, retail centres, shops, eateries and banks amongst others). Without secure and monitored storage facilities, it is likely that cycling patterns will remain "circular" and recreational in nature (i.e. start / end point the same, not based on convenience).

2.4.2.4 Efficiency

The efficiency of NMT encompasses the primary purpose of this study – to find ways to shorten bicycle trip distance and time. This goal is achieved by optimizing the systems and environmental aspects affecting bicycle journeys – in essence, maximizing efficiency.

2.4.2.3 Lack of Comfort

Cycling generally lacks comfort or feeling of pleasurable ease, well-being, and contentment especially in highly terrain and during the rainy seasons. The provision of attractive routes to public transport interchanges for NMUs [non-motorised users], and pleasant waiting facilities, can all contribute towards offering an appealing alternative to the car. Wilmink, (2001) indicated that the provision of safe and convenient bicycle parking is an important infrastructure consideration that can decrease negative perceptions of bicycling by providing cyclists with a sense of security and safety, thus, making bicycling easier and more comfortable mode of transport.

2.4.2.5 Distance and Topography

The convenience based trips to destination points need to be short distances and with limited gradients for cyclists. It is recognized that for many African countries, the walking is the only available mode of transport for all in all terrain. Whilst international standards recognize distances of 500m – 1km to represent a fair walking distance, the actual daily walking distances for many poor commuters is much greater depending on so many factors. The Planning Framework for Non-Motorised Transportation -Infrastructure Improvements, as compiled by Tao, et al, (2002) indicates that most walking trips are less than 2km and most bicycling trips, less than 5km in length. It also highlights that reasonable trip distances and times would be 30mins to jobs/school and 10-15mins to shops and services by walking or cycling.

2.4.2..5 Supporting Infrastructure and Facilities

In African Cities unlike in the Asian the provision for cycle storage, cycle tracks, lockers or shower facilities do not exist according to De langen, et al (2001). These facilities will be especially important if weekday commuters are to be persuaded to switch from the convenience of using a private vehicle. There is also almost no provision at present for designated cycle lanes and NMT modes

remain unprioritised in the streetscape in Kenya especially Nairobi City. Whilst pedestrian footpaths of varying quality are prevalent in some areas, these are often not continuous and fail to link areas and reflect pedestrian desire lines. Inadequate footpaths and a lack of cycling facilities have the potential to limit the integration and ultimately use of planned public transport infrastructure. De Langen, et al, (2001) further noted that the provision of safe and convenient bicycle parking is an important infrastructure consideration that can decrease negative perceptions of bicycling by providing cyclists with a sense of security and safety, thus, making bicycling easier and more friendly.

2.4.2.6. Status and Convenience

Non-Motorized transport especially, the cycling and walking are generally associated with activities for recreation or with poverty. The GTZ (2002) report on urban transport and poverty in developing countries indicates that the connotations of NMT are as a low-tech affordable means of transport, not innovative and sometimes unpleasant.

2.5 URBAN GROWTH MODELS

According to the Training manual prepared by Mr. Z. Maleche in 1993, a lecturer at the University of Nairobi, the urban trends and the performance of a city depend on its productive, the inclusiveness, the organization and its sustainability. The inclusive city can be measured by the extent the residents share the social benefits of urban life. The levels of share contribute to the social and environmental sustainability of the city. By evaluating how cities are organized, it is possible to gain insight into what factors influence their shape and composition, and how these influences might be controlled or altered to achieve desirable urban environments. Three main theories are commonly employed to describe the spatial arrangement of modern urban spaces and also influence the transport systems:

1. Concentric Zone Concept (Burgess, 1924)

2. Sector Concept (Hoyt, 1939)

3. Multiple Nuclei Concept (Harris and Ullman, 1945)

These theories are complementary to one another; each capturing a different aspect of urban evolution in American cities. They provide broad theories about how cities have grown and changed over the past century.

2.5.1 Concentric Zone Model.

Maleche (1993) further highlights that the early land economists frequently used the Burgess (1925) conventionalized diagram to explain the composite effect of the market forces upon land use arrangements (*figure 2.3*). Burgess concept was developed in 1920s to explain ecological processes in the city and it's consist of 5 major land use groups radiating outward from the centre of the city.

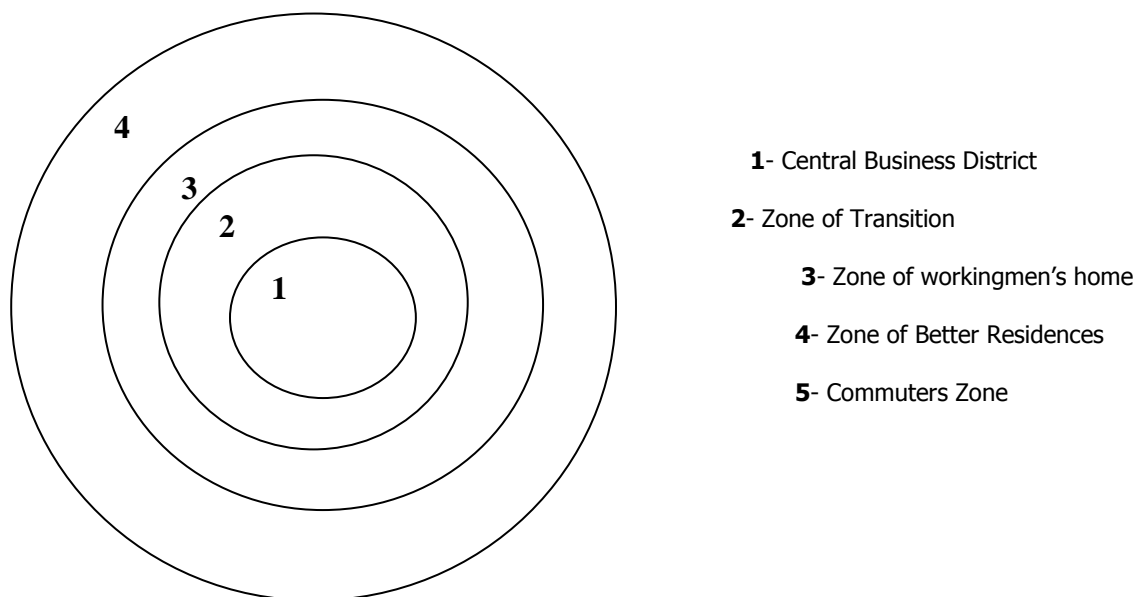


Figure 2.2 Concentric Zone concepts (Burgess, 1925))

The first zone is the central business district with its shopping area, its theatre districts, its hotels, its offices and other business which seek a central location.

Its adjoining loop into the next zone includes the market districts and the older wholesale districts and warehouses are located. *The Second zone* is the transition zone where exist variety and changing character of its uses. Within this zone residential area begins, in one portion of the ring of low-income residential neighborhoods and high rise apartments houses. The second zone blends into a *third zone* consisting largely of middle-income and industrial workers' residences commonly known as workingmen's home. The *fourth zone* is zone of better residences (Upper income single-family residences) while the *fifth zone* is commuters zone (upper income suburban commuters' residences).

Burgess further hypothesized that each ring of land-use expanded outward as the city grows, however their sequence remained intact. The resulting transition zones – areas where two land uses overlapped – led to an additional blighted zone outside of the ring of slum dwellings. He observed that, generally, the richer people are; the farther they live from the urban core (Burgess, 1924).

2.5.2 Sector Concept

According to Maleche (1993), the founder of the concept Hoyt (1939) explained through his study of residential area in the United States, the study provided some new insights into the patterning of land uses that led to a theoretical explanation of residential land uses in terms of wedge-shaped sectors radial to city's centre and along established lines of transportation. In other words, growth along a particular roadway is likely to consist of similar types of land uses. He perceived the city as a wheel, with the various land uses as spokes.

The urban model proposed by Harris and Ullman (1945) recognized that while cities typically have only one main centre, they are often surrounded by sub-centres that serve as secondary business centres for localized residential neighborhoods. These secondary centres may result because the central business district is not conveniently accessible to suburban residents. Another

reason for satellite business districts may be that certain businesses cater to markets that are located away from the central core, and perhaps in a particular quadrant of the city.

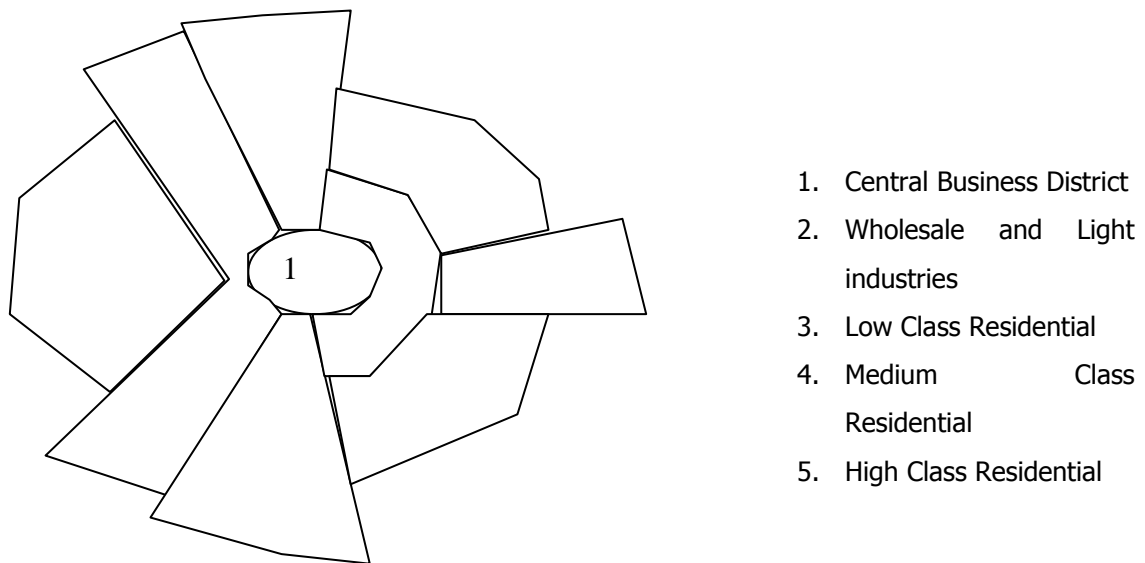


Figure 2.3 Sector concepts (Hoyt, 1939)

The sector theory provides a detailed explanation of residential patterns of land that set forth in the concentric-zone formulation, particularly in the more discriminating way in which it deals with the dynamics of growth processes. This theory has also had profound effect in stimulating awareness of the need for a theory of urban land use.

2.6 IMPACT OF URBANIZATION ON TRANSPORT IN THE THIRD WORLD

The high rate of urbanization and rapid motorization has caused conditions of urban transport systems in developing countries to deteriorate. Any growth in the city population and density of buildings only add further to the difficulties of

traffic and in many cases this situation caused developing countries cities (GTZ, 2002). Urban population growth thus plays a very important role in determining supply and demand of transport. As towns and cities sizes expand geographically, transport demand increases proportionately as distances to services and workplace may become more dispersed. Hung, (2002) noted that there would also be a greater propensity to travel when income had risen and vice versa. The relation between the level of income and travel distance done in Kenya is similar to western experiences when the jobs and businesses were at the cities centre. , urbanizing the suburb in the process.

In most countries, employment remains at the heart of the cities; the commercial activities are now relocated from the city centre to suburb due to serious traffic congestions which had made the city centre unattractive. According to Replogle (2009) the experiences in Cairo and Bangkok show most of cities' urban traffic problems are caused by missing links (secondary roads) in the road network that connect with the interior of the city, especially in the downtown area. In Singapore and Kuala Lumpur are perhaps the only two cities in which affluence could be associated with urbanization. Replogle (2009) further stated that Parnwell (1993) that Manila became urbanized, but as many as 80% of its inhabitants are poor and had to rely on the cheaper jeeps for public transport. Yuri (2002) indicated that any increase in the demand for transport would naturally mean that the government public transport facilities and services to be made available.

The concentration of employment opportunities, wealth and the enhancement of development opportunities in urban locations had in way, created a false image of urban areas. These conditions led to a widespread rise in land values, a new way of life that is totally different from those in traditional or indigenous societies (Tao, C. et al, 2002). High motorcycle ownership and use is a phenomenon in poorer cities particularly in Asia, though not consistently so. Motorcycles were

able to gain a foothold in the presence of chronic congestion, in the absence of effective public transport systems and with decaying and neglected conditions for pedestrian and cyclists in Kenya. Motorcycles in poor cities are the forerunner of cars, encouraging urban sprawl and are symptomatic of the failure of government transport planners to provide access and mobility to low and even middle-income people. Although many people own cars in big cities and towns, an even greater proportion of people do not own cars and have to rely on non-motorized modes.

2.7 SUSTAINABLE URBAN TRANSPORT IN DEVELOPING COUNTRIES

The urban slum dwellers ("urban poor") makes less trips, and more of their trips are undertaken on foot. For most purposes they are restricted to whatever services can be accessed within walking distance. The journey to work may be relatively long for poor if they live several miles from their places of work. Even if it is not, it will use slow modes and may be very time consuming, so they are also "*time-poor*." For poor people, and particularly women, children and the elderly, trip making is often discouraged by their vulnerability as pedestrian both to traffic accidents and to personal violence, making them "*safety poor*" (The World Bank, 2002).

The appropriate urban and land use planning is required to reduce poor access and increase the accessibility by all modes of transport. As a derived demand, a transport infrastructure enabling low-cost transport (access) can make a crucial contribution to poverty reduction. However, poverty-oriented urban transport and traffic policy has to focus on the majority of the population rather than on marginalized groups, as has often been claimed (GTZ, 2002). Until the seventies, urban transport projects initially planned on the premise of being beneficial to the population as a whole, which expressed in the overall economic (net) benefit on the base of cost-benefit analyses. At the same time with the introduction of environmental impact assessments in the eighties, ecological sustainability,

economic efficiency, and competitiveness of urban transport systems came to the fore against the background of increasingly deficit-ridden budgets in the cities of the developing countries. However, in most cities in the developing countries, traditional transport planning resulted in worsening condition of LPT (local public transport) access for the (growing) poorer sections of the population. Over the last two years, the introduction of targeting poverty as an additional element of urban transport policy and planning in the framework of the new poverty alleviation policy the international donor organizations have adopted. However, targeting poverty only remains a partial goal of sustainable urban transport policy and planning, alongside such as economic and operational efficiency and long-term ecological sustainability (GTZ, 2002).

2.8 OVERSEAS PERSPECTIVES OF SUSTAINABLE TRANSPORTATION

The Australia government has developed a sustainability code of practice for government road and other related agencies to support in the achievement of a sustainable development in all sectors. Amongst other things, it recognizes the significance of transportation in the sustainability debate: "Agencies shall ensure that ... the numbers of vehicles are minimized, vehicle use is reduced, fuel efficiency is maximized and travel alternatives are promoted." There has been considerable sustainable transportation policy development work done in the United Kingdom including work on "travel plans" for schools and businesses (James J. 2008). The National Travel Wise Association (NTWA) is "a partnership of local authorities and other organization's working together to promote sustainable transport". "Car share" schemes are increasingly common in the UK and Europe, where cars are communally owned and rented by the hour or day as necessary by members of the group. In this way, typically ten people own a car. (In New Zealand, ten people on average own five cars).

Gwilliam (2003) indicates that in London, a congestion charging programme was introduced in February 2003 in a major initiative to combat traffic congestion.

The scheme, which is widely regarded as being highly successful, charges motorists £5 per day to enter or park on a street in the central part of London. The area covered by the scheme is 22 square kilometres. For comparison, Auckland City (part of the greater Auckland metropolitan area) has an area of 60 square kilometres and a population of about 400,000 people (*making it New Zealand's fourth most populous city*) (Department of Transport, 2008).

The World Bank, (2006) reported that the United States of America, "Natural Capitalism" (written by Paul Hawken, Amory Lovins and Hunter Lovins and published by the Rocky Mountain Institute in 1999), argued that: "A fleet of 200 miles per gallon (mpg) , roomy, clean, safe, recyclable, renewably fueled cars might keep drivers from running out of oil, climate, or clean air, but they'd instead run out of roads, land, and patience—the new constraints du jour. Many of the social costs of driving have less to do with fuel use than with congestion, traffic delays, accidents, roadway damage, land use, and other side effects of driving itself. Those social costs approach a trillion dollars a year—about an eighth of America's gross domestic product. Because that figure is not reflected in drivers' direct costs, the expenses are in effect subsidized by everyone." In the USA, many agencies are using the "parking cash out" system. Under parking cash out programme, an employer gives employees the choice of keeping a parking space at work, or accepting a cash payment and giving up the parking space.

High occupancy vehicle (HOV) lanes (where lanes on motorways or arterial roads are reserved for use by buses and cars with three or more people) are also in widespread use in the United States Of America and Canada. Variants of this such as high occupancy toll (HOT) lanes (where not only are the lanes reserved for these vehicles but users also pay for the use of the lane) are also in use. The Association of Professional Engineers and Geoscientists of British Columbia (APEGBC) have developed a Primer on Sustainability to raise knowledge of

sustainability amongst its members. One section of this is devoted to sustainable transportation (Jeroen, 2009).

2.9 OPERATIONAL DEFINITION OF CONCEPTS

Accessibility the ease with which a facility or location can be reached from other locations. Mosseley et al (1977) define accessibility as 'mobility for opportunities' that is mobility which allows the person to get to the desired destinations.

Average Daily Traffic (ADT) is the representation of the typical daily traffic volume for a link.

Average Peak hour traffic is mean calculated when traffic data collected only during peak hours on multiple days.

Bicycle is a pedal-driven land vehicle with two wheels in tandem, usually propelled by pedals connected to the rear wheel by a chain arranged in line, and having handlebars for steering and a saddlelike seat.

Central Business District The heart of an urban area, usually located at the meeting point of the city's transport systems, which contains the highest percentage of shops and offices. Land values are high because of high accessibility, therefore land use is at its most intense in order to offset rent costs. In consequence, in many countries development is upwards rather than sideways.

Cities A center of population, commerce, and culture; a town of significant size and importance.

Cycling The act, sport, or technique of riding or racing on a bicycle, motorcycle, or similar vehicle.

Development the process of adding improvements to a parcel of land, such as grading, subdivisions, advertisements, drainage, access, roads, and utilities.

Design Capacity is the maximum numbers of vehicles that can pass the end of a link within a given time period without causing traffic delay.

Design Speed is the maximum travel speed for a given link when there is no delay. It reflects the function of a road and is normally limited by physical, social, economic and aesthetic conditions.

Destination is the trip end at the end of a trip

Environment- Sum total of all surroundings of a living organism, including natural forces and other living things, which provide conditions for development and growth as well as of danger and damage.

Environmental sustainability is the process of making sure current processes of interaction with the environment are pursued with the idea of keeping the environment as pristine as naturally possible based on ideal-seeking behavior.

Land use planning- means the scientific, aesthetic, and orderly disposition of land, resources, facilities and services with a view to securing the best use of private and public land to satisfy long-term urban and rural communities.

Mobility is defined as the ability to move from place to place and is measured by the number of trips made by a person per day (Vasconcellos, 2001).

Personal mobility' refers to the use of personal transport; a car or a motorcycle or other non-motorized.

Non-Motorized transport (NMT) is all forms of movement that are human powered and do not rely on engines or motors for movement. This includes walking, cycling, rickshaws, wheelchairs, animal-drawn carts and recreational activities such as equestrian, rollerblades, skates and scooters.

Street Network is all surfaces of the road that are connected to each other and to different places of human activities, and it includes segments and nodes.

Sustainable using methods, systems and materials that won't deplete resources or harm natural cycles (Rosenbaum, 1993).

Sustainable development (SD) has been defined by the Brundtland Commission¹ as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Sustainability it is the identification concept and attitude in development that looks at a site's natural land, water, and energy resources as integral aspects of the development" (Vieira,1993).

Sustainable Transportation it is a transport system that satisfies current transportation and mobility needs without compromising the ability of future generations to meet their own needs

Transport To carry or bear from one place to another; to remove; to convey; as, to transport goods; to transport troops.

Transportation planners are persons who will eliminate the amount of traffic associated with the planned land use allocation, the options of travels modes, the alternatives routes and the required roadways features to transport the estimated traffic volume.

Transportation planning is a process of finding feasible alternatives and components of transportation system to support human activities in a community.

Traffic Analysis zones (TAZ) is delineated as a smallest area of the study region.

Traffic congestion is a condition on road networks that occurs as use increases, and is characterized by slower speeds, longer trip times, and increased vehicular queuing.

Trip it is the path people make from one place to another, for instance from home to office.

Trip ends is the two places connecting a trip.

Origin is the trip end at the beginning of a trip

Person trip is the number of people travelling through the transportation system.

Pollution The act or process of polluting or the state of being polluted, especially the contamination of soil, water, or the atmosphere by the discharge of harmful substances.

Vehicle occupancy is the number of people travelling together on one vehicle.

Vehicle trip is the number of automobile trips travelling in a transportation systems.

Volume is the actual number of number of vehicles going through the link within a given time period.

Walking To move along on foot; to advance by steps; to go on at a moderate pace; specifically, of two-legged creatures, to proceed at a slower or

faster rate, but without running, or lifting one foot entirely before the other touches the ground.

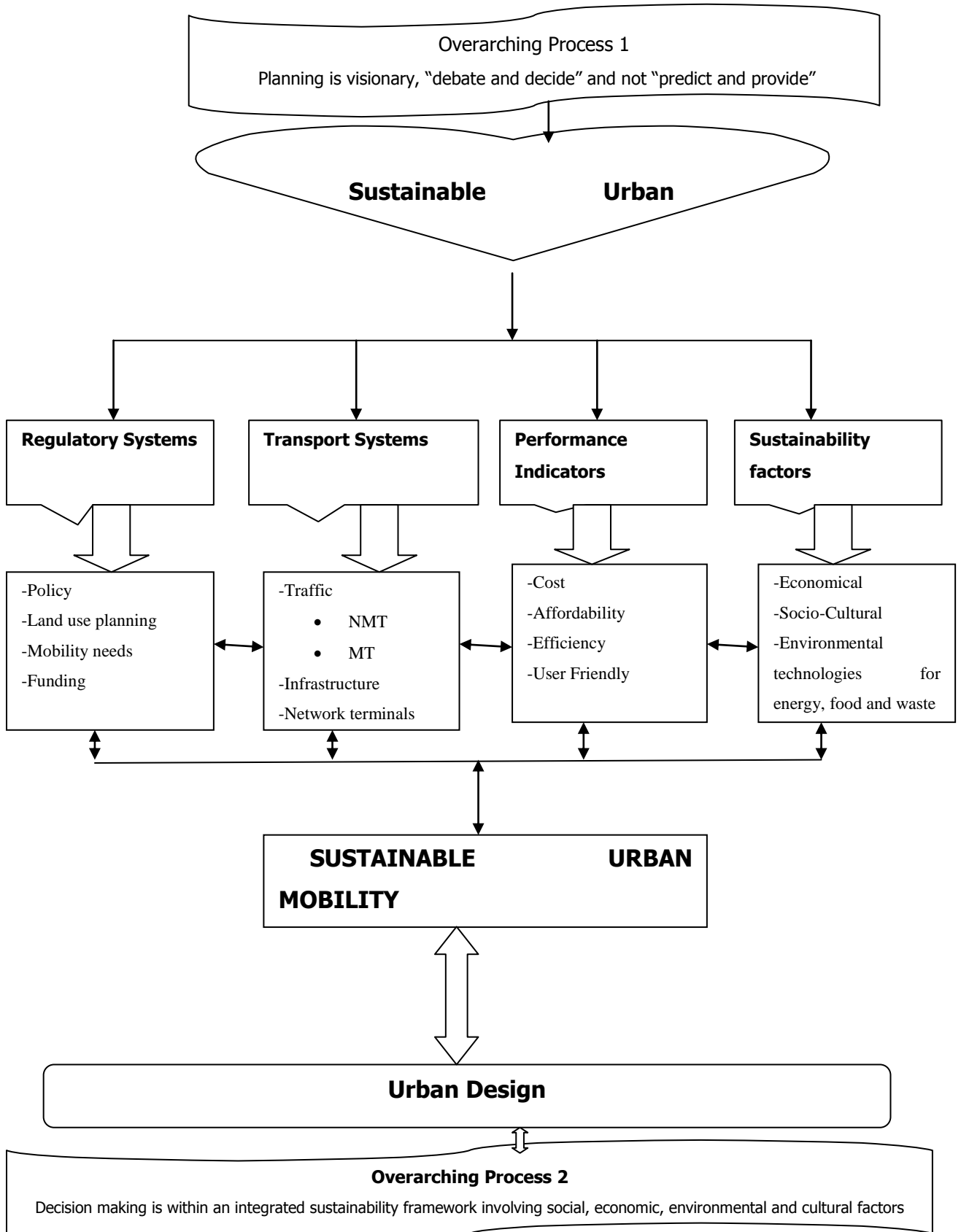
Zoning the prohibitions of certain developments or activities in designated area, is undoubtedly the most common deliberate control over land use.

2.10 CONCEPTUAL FRAMEWORK

This research has proposed a comprehensive future sustainable urban transport strategy that suits particular city according to its social-cultural, economic, political, and environmental needs. The key components to sustainable urban transport are regulatory systems, transport systems, performance indicators and sustainability. Physical interventional policies are formulated in relation to town planning, mobility needs, funding and in consultation with stakeholders in consideration to all transport indicators. This conceptual model is summarized as indicated in figure 2.4.

This research conceptual model highlights the transport sustainability which includes the environmental, socio-cultural, political, economical and land use planning concepts. For ***environmentally sustainable transport***, a strategy is to be proposed to address the health-threatening impact of transport in terms of improving road safety and reducing air pollution. An environmentally sensitive strategic framework needs to be developed to make policies for congestion, pollution and road user charges, public transport fares, integration of urban structure and transport planning, changing the balance of modes and to make environmental and economic policies complement each other.

Figure 2.4: A conceptual Model for eco-cities based on urban planning, urban transport and urban design considerations (Source: Author, 2011)



To achieve ***socially sustainable transport***, policies are to be formulated to provide the poor and other disadvantaged groups with better physical access to employment, education and health services. Transport equity and justice is given priority in a socially sustainable transport policy. The overall objective of an ***economically sustainable transport*** strategy is to increase the responsiveness of transport supply to user needs by creating competition and by enhancing user participation. True charges for the use of infrastructure and services, commercialization of public sector firms and proper public transport pricing are other principles of this policy (Deakin, 1998).

Finally, ***land use planning measures*** provide some of the most promising transport planning policies in the growing “tool kit” of ways to bring us closer to sustainable urban transport in Nairobi. There is a strong emphasis on approaches that are integrated, long term, pro-poor, holistic, and focused on accessibility, aiming to enhance urban quality of life and economic thrift and prosperity by providing town friendly transport modes. Strategy have been proposed for replacing old policies regarding parking, car growth, road buildings, vehicle speeds and formulating new policies for good governance, telecommuting, and community transport.

Several studies have been carried and have shown that, the modal split by key transport mode. The study by Aligula, E. and others (April, 2005) indicated that 49% of residents of Nairobi use non-motorized (walking and cycling) means of transport as their main means of mobility. Private transport, mainly the private car, is used by only 9% of the residents and forty two (42) percent of residents use public transport as their main means of transport.

The sustainable transport system can't be achieved without empowering all stakeholders; strategies must be formulated to incorporate these elements in a

integrated way. This research conceptual model developed the sustainable urban transport strategy for Nyamakima area in Nairobi bearing in mind the need to right balance between ability of transport to serve economic development, ability of the environment to sustain future quality of life and ability of society to fulfill their needs of accessibility freely.

CHAPTER THREE

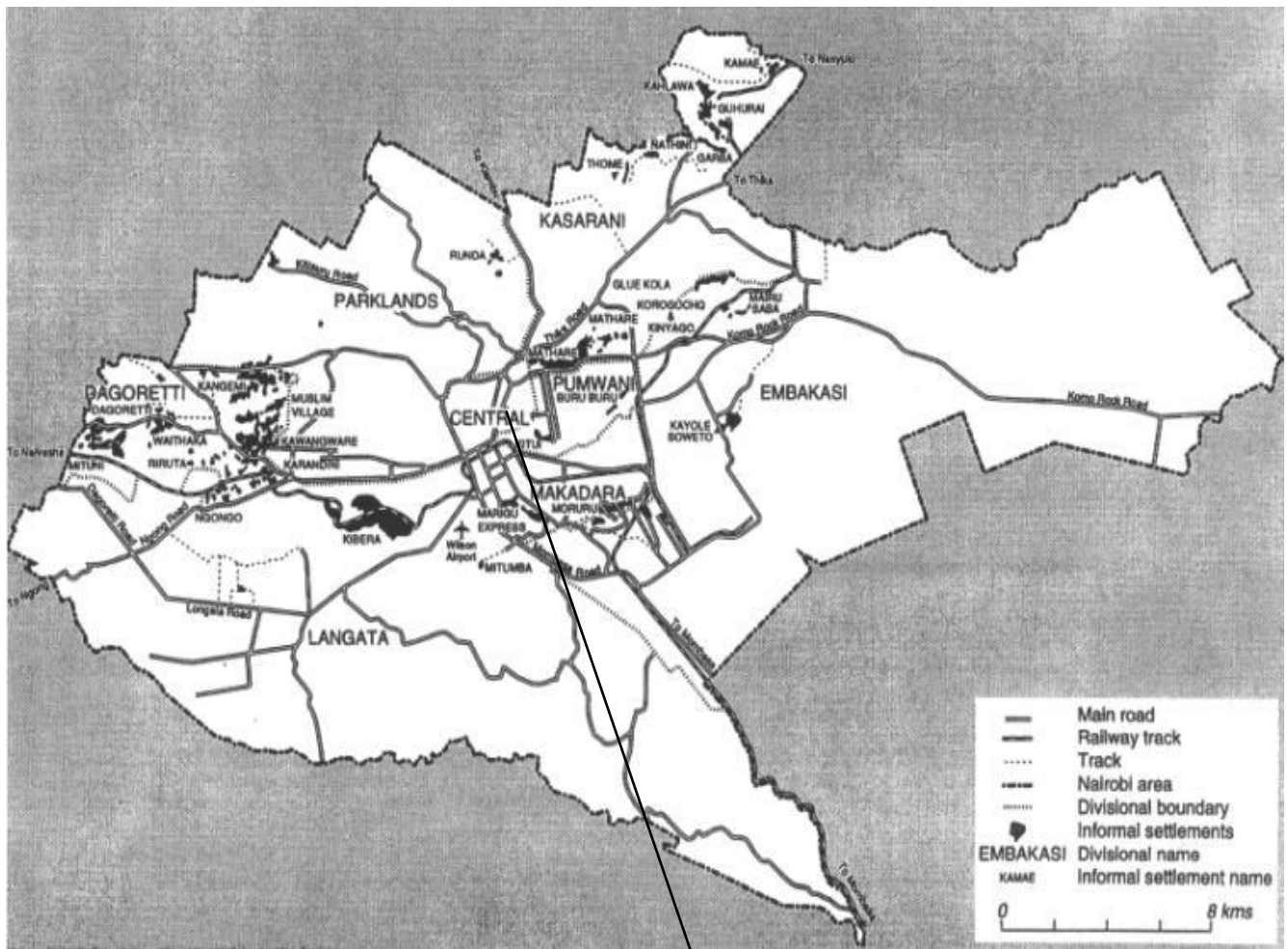
RESEARCH METHODOLOGY

3.0 INTRODUCTION

This chapter covers the study area, data types and collections methods adopted in the research. The sampling frame, data analysis and interpretation techniques employed are also covered in the chapter.

3.1 STUDY AREA

The research is based on a case study, Nyamakima area within Nairobi Central Business district Kenya.



Nyamakima area within CBD

Map 3.1 Map of Nairobi City (Source: Nairobi Metro)



Map 3.2: Satellite Image of Nyamakima area.

Nairobi, being a capital city represents a true picture of Kenyan and African urban centres. Although each major city of Kenya has a particular character, Nairobi offers more opportunities and challenges to implement new policies because it is the economic, social, cultural and political hub of the country.

3.2 DATA SOURCES, TYPES AND COLLECTION METHODS

The different types and sources of data that were required to support this study were identified. The data were collected by administering questionnaires, direct observations, interviewing key informants, photographs, Global positioning Systems (GPS) and digitization of maps

amongst others to gather data from two set of respondents classified into road users and transport users.

| Type of Data | Data on | Sources | Method of collection |
|------------------|--|---|---|
| Primary | Socio-economic characteristics of sample | field | Administering questionnaire |
| | Modal used | field | Direct observations, photographs |
| | Trip purpose | field | Administering questionnaire |
| | Trip ends | field | Administering questionnaire |
| | Duration of the journey | field | Administering questionnaire |
| | Preferred mode of transport | field | Administering questionnaire |
| | Footpaths character | field | Administering questionnaire, direct observations and photography |
| | Cycle tracks character | field | Administering questionnaire, direct observations and photography |
| | Potentials of NMT | field | Administering questionnaire, direct observations, interviewing key informants and photography |
| | Key players in NMT | field | Administering questionnaire, direct observations, interviewing key informants and photography |
| | Traffic Tally | field | direct observations and photography |
| | Digital and analogue Map | Field observations | Global positioning Systems (GPS) and Digitization |
| Secondary | Types of NMT, Potentials of NMT Key players in NMT | libraries, internet and journal | Visiting the library and internet, also reading the journals |
| | analogue and Digital Map | Survey of Kenya, City council of Nairobi, Ministry of Roads | Visiting the Survey of Kenya, City council of Nairobi and Ministry of Roads |

Table 3.1 Data, type of data, sources and method of collections (sources: Author, 2012)

The data collected (from table 3.1) targeted the road users and traders addressed the following issues:-

- The sustainability for NMT (cycling and walking) within the Nairobi Nyamakima area and its effects in the reduction traffic congestion.
- The existing challenges affecting the NMT within the study area.
- The current levels of cycling and walking within the Nairobi Nyamakima area compared other modes of transport.
- The desired physical infrastructural intervention that can be implemented to promote the NMT within the Nairobi Nyamakima area.

Interviewing Key Informants

Personal interviews and discussions were held with key informants from relevant institutions and authorities such as UNEP, ministry of roads, NEMA, and city council of Nairobi, Kenya railways, Kenya airport authority, department of physical planning, civil society and academicians.

Participatory transect walk and Photography

Participatory transect walks for two (2) weeks was undertaken to document challenges and opportunity for the sustainable urban transport. The photographs were taken to document the existing challenges on the mobility facing the Nairobi residents and more specifically the Nyamakima area.

Secondary Data

The secondary data were obtained mainly through literature review of the existing work by academicians and researchers on Non-Motorized transport, land use and transport planning, institutional setup and policy administration. Other sources of secondary data included universities libraries, internet, UN-Habitat and UNEP library, NEMA library, survey of Kenya, local authorities' records, Nairobi Development plans and government documents on transport and environment.

Spatial Data

To strengthen illustrations, visual aids such as maps and sketches was used to propose the physical infrastructural intervention that can promote the NMT within the Nairobi Nyamakima area. The spatial data were collected from Survey of Kenya, City council of Nairobi, Ministry of Roads and through GPS observations. The data capture and acquisition, physical planning techniques, GIS and Auto CAD software's was considered in the study. The information that was obtained from questionnaires, secondary sources, field observations and interviews was triangulated to ascertain reliability and validity.

3.3 SAMPLING FRAME

3.3.1 Sample Sizes and Method

The study population was stratified in such a way that the population within a stratum was homogenous with respect to the characteristics on the basis of which was stratified in order to capture the heterogeneity of the study population. The sample of one hundred and twenty (120) from respondents was considered from traders, pedestrians, cyclist, public transport sector, private car owners, UNEP, civil society and academicians.

The researcher administered seventy (70) questionnaires to various randomly selected road users and transport users in the Nyamakima area. The researcher employed the use of research assistants to assist in administering the questionnaires. These helped in having the questionnaires being administered on the spot and thus respondents were not allowed to carry the questionnaires with them to hand them back at a later date. This was due to the nature of the respondents as they were not stationed at the Nyamakima area and the certainty of tracing them later was not guaranteed. Even where tracing them later would be possible, it would be time consuming and costly as the logistics involved for this kind of operation would be demanding.

Thereafter a sample of 5 respondents each from UNEP, Ministry of Roads, City Council of Nairobi, Traffic police officers, Kenya railways, NEMA, Kenya Airport Authority, Department of physical planning, civil society and academicians were selected through purposive sampling. This study also adopted purposive sampling methods on key informants. This is a non-probability sampling techniques that gave the opportunity to select the sample based on key informant and focus group discussion. Again this type of technique was adopted based on the fact that there is no accurate and adequate data base for various stakeholders of this mode of transport.

3.3.2 Road Users Origin-Destinations (O-D) surveys

Fourteen (14) surveys sites were selected within the area of study spread to cover roads (River, Cross road, Kumasi, Duruma, Mwimbi, Kirinyaga and Ambala roads) within the study area. These sites were selected in areas where there is high of human and motorist traffic as illustrated in map 3.2



Map 3.2 Nyamakima survey site Map (source: Author 2012)

3.3.3 Traffic Counts

The traffic tallies were conducted at two or more cordon stations on each road within the Nyamakima area of the study. Since there is high traffic in this area it was done between 6.00 am to 9.00 am, noon to 2.00 pm and also between 5.00 pm to

7.00 pm for two consecutive days of Friday and Saturday of which could be used to give representation on the volume of traffic during weekdays and weekends.

3.4 DATA ANALYSIS AND INTERPRETATION

The data that were collected from field was edited to ascertain its suitability and accuracy. The quantitative data was analyzed using descriptive statistics and presented in the form of tables, percentages, graphs and charts. The qualitative data was analyzed through the use of content analysis of the questions administered with reference to the study objectives. Results of the data analysis provided information that formed the basis for discussion, conclusion, and interpretation of the findings and recommendations of the study. The use of Ms Excel and Statistical Package for Social Sciences (SPSS), and GIS software to carry out data handling, data management (case selection, file reshaping, creating derived data) and data documentation , and to represent the data and findings, graphs, pie charts, cartographic maps, photographs and tables were used where applicable.

Bar charts/histogram, pie charts and percentages were applied in assessing variables related to use of different modes of transport within the Nyamakima Area. Descriptive statistics was attained through cross tabulation, frequencies, and descriptive ratio statistics. Cross tabulation involved the process of creating a contingency table from the multivariate frequency distribution of statistical variables. Content analysis was extensively used to access, organize and analyze unstructured information in the questionnaires. It allowed for the classification, sorting and enabled the researcher arrange information and examine the relationships in the data; and enabled the analysis with linking, shaping, searching and modeling of the data. The analyzed data was later exported to Microsoft Word where the researcher was able to come up with the emerging issues, recommendations and conclusions of the analysis.

CHAPTER FOUR

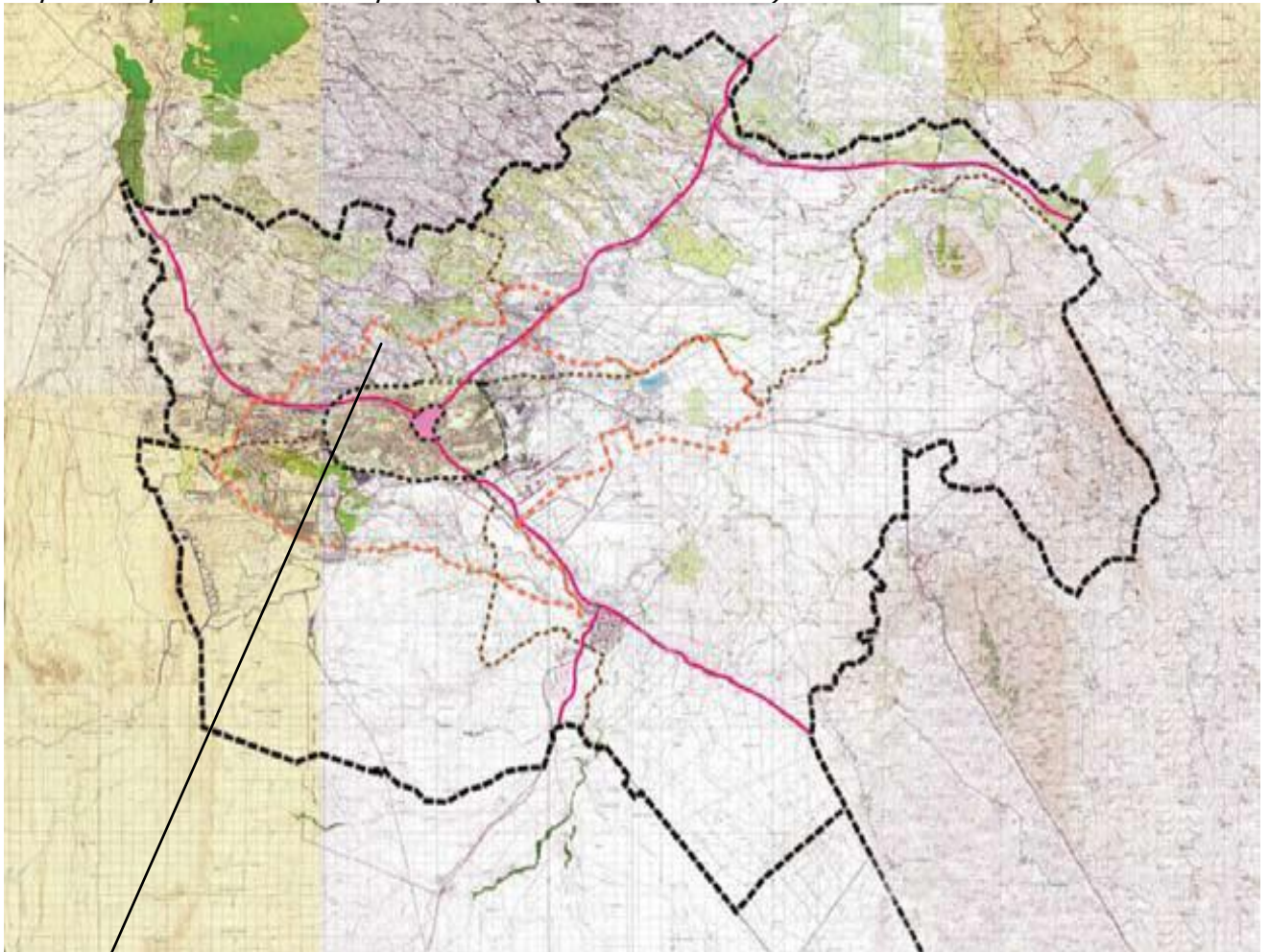
STUDY AREA ANALYSIS

4.0 INTRODUCTION

This chapter provides the baseline information of the study area pertaining the subject of the study. It also gives an overview of the study location within the county, transport history, the spatial developments of the city, the city economy and the current transport situations of the city.

4.1 Location of Nairobi

Map 4.1 Map of Nairobi metropolitan area (Source: JICA 2004)



Nyamakima area within CBD

Aligula (2005) indicated that Nairobi area was originally grazing land and a livestock watering point and there was no permanent African settlement. Nairobi took its name from the Maasai phrase “enkare nairobi”, which means “a place of cold waters”. Kenya’s capital city, Nairobi, is an international, regional, national and local hub for commerce, transport, regional cooperation and economic development. It connects together eastern, central and southern African countries. Nairobi lies at the southern end of Kenya’s agricultural heartland, 1.19 degrees south of the Equator and 36.59 degrees East of the Prime Meridian 70. Its altitude is between 1600 and 1850 metres above sea level.

The climate displayed is generally a temperate tropical climate, with cool evenings and mornings becoming distinctly cold during the rainy seasons. Long rains fall between April and June, while the short rains are received in November and early December. Nairobi has a constant 12 hours of daylight all year round. Average daily temperatures range from 29 degrees Centigrade in the dry season to 24 degrees Centigrade during the rest of the year (*Sclara, et al 2007*).

Nairobi city occupies an area of about 696 km² (CBS 2001) and the altitude varies between 1,600 and 1,850 metres above sea level. The western part of Nairobi is on high ground (approximately 1700–1800 msl) with rugged topography, the eastern side is generally low (approximately 1600 msl) and flat according to Sclar, et al in 2007. The Ngong hills stand towards the west, Mount Kenya towards the north and Mount Kilimanjaro towards the south-east. As Nairobi is adjacent to the Rift Valley, minor earthquakes and tremors occasionally occur.

4.2 HISTORICAL BACKGROUND AND TRANSPORT HISTORY OF NAIROBI

The City of Nairobi owes its birth and growth to the Kenya Uganda Railway line. The railhead reached Nairobi in May 1899 “enroute” to the present day Kisumu, which was then part of what is Uganda. Moving of the railway headquarters from Mombasa to Nairobi resulted in the subsequent growth of Nairobi as a commercial and business hub of the then British East Africa protectorate as was indicated by Aligula et al (2005) did referenced from Situma (1992). By 1900, Nairobi had already become a large and flourishing settlement consisting mainly of railway buildings and separate areas for Europeans and Indians, the latter being mainly the labourers employed on the construction of the railway.



Plate 5: Railway network within Kibera slums in Nairobi (Source: Author 2012)

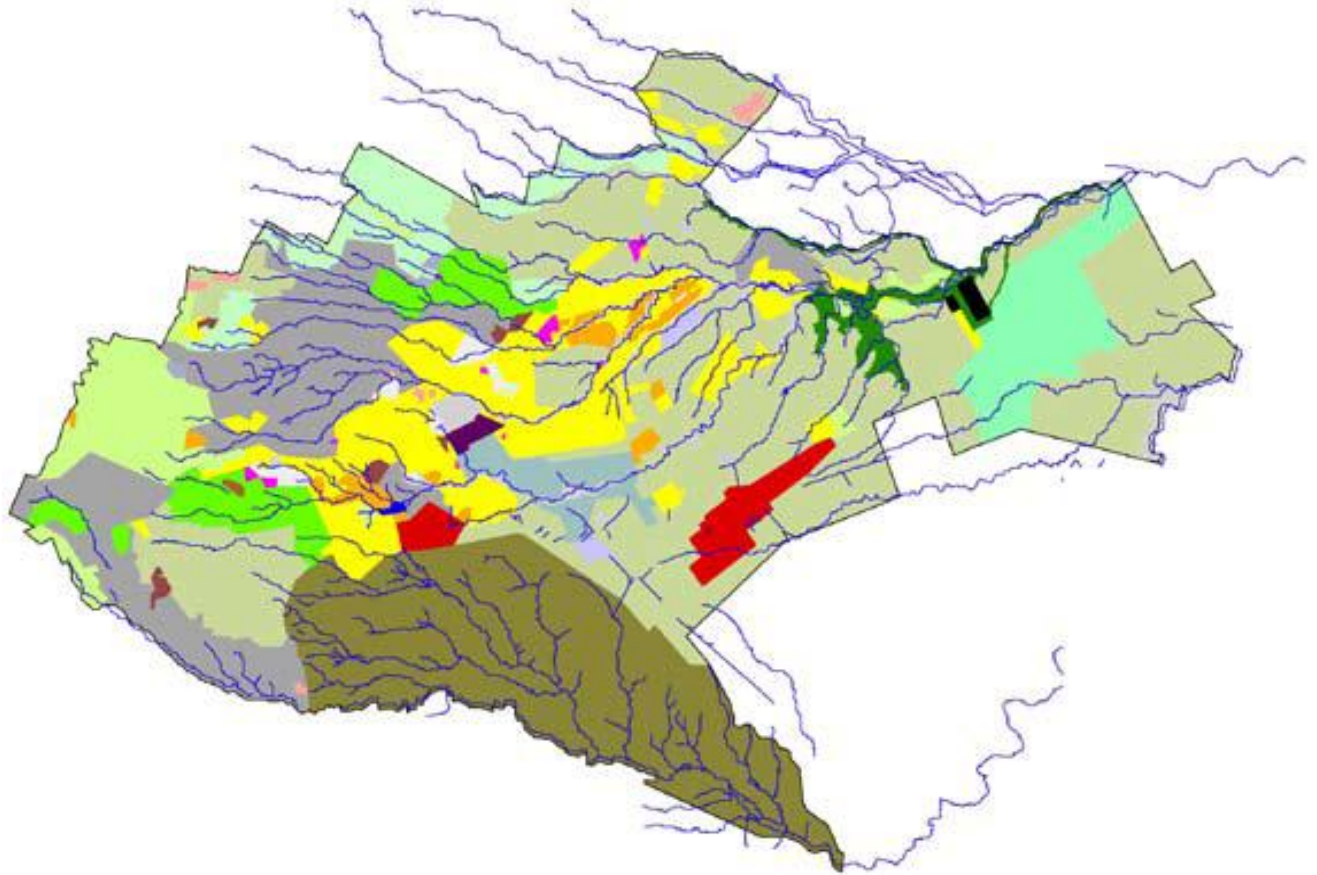
The evolution of transport in Nairobi is closely linked to its colonial and post-colonial history and its political, social, economic and geographical interactions.

Colonialism and its political legacy have had major negative and positive effects on the modern transport policies of, and much of the development of post-independence transport systems in East Africa. Urban land use development portrays a classic example of colonial influence (Aduwo, 1990). For example, street layout, residential location, CBD location, racial residential separation and architectural peculiarities portray colonial and alien planning concepts. These concepts have inevitably influenced the urban transport system.

It is worth noting as was highlighted by Aligula in 2005 that within this configuration, the residential areas of the Europeans, were located in low density and better side of the urban centre were well-served with communication and transportation facilities. Therefore, they were relatively trouble free in terms of movement problems. Typically, the earliest urban form pattern in 1920s Nairobi was dominated by a major trunk road commencing from the CBD to the upland with a spur to industrial area.

4.3 SPATIAL DEVELOPMENT OF NAIROBI CITY

Nairobi was made the capital of Kenya in 1907 and later, in 1950, became a city. The Nairobi Municipal Committee Regulations of 1960 defined the initial boundaries for the then Nairobi town. These, at that time defined the boundaries *of Nairobi*. "The area within a radius of one and a half miles from the offices of the sub-commissioner of the then Ukambani Province" (Olima, 1997).



Map 4.2 Land Use map of Nairobi (Source: DRSRS, 1994)

Nairobi displays a complex surface structure, making it difficult to decipher the city surface into distinct land uses. Inevitably, there are wide variations in population density reflecting different land utilisation patterns within what Obudho and Aduwo (1988) see as six distinct and different land use divisions, namely: the Central Business District (CBD); Industrial Area; public and private open spaces; public land; residential areas; and undeveloped land. Urban land use refers to spatial distribution of social and economic activities.

Accordingly, an up-to-date land use inventory is frequently required to facilitate urban planning and growth patterns as well as monitoring of urban expansion. A study by the Department of Resource Surveys and Remote Sensing (DRSRS, 1994) identified eight major land-use classes in Nairobi



Map 4.3: Satellite Image of Nairobi (Source: Google Map, 2012)

Nairobi's 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. From its early times, emerging spatial patterns in Nairobi showed segregation between the Central Business District (CBD) together with European, Asian and African residential areas. By 1963, Africans who formed a major part of the population lived in the eastern part of Nairobi, while the Europeans and Asians lived in the western suburbs, which

had access to better services. This position is reflected today not so much in terms of race, but rather in terms of incomes and population densities. The people living in the western suburbs are generally more affluent while the lower and middle-income population of Nairobi dominates the eastern suburbs.

4.4 DEMOGRAPHICS OF NAIROBI CITY AND ITS ENVIRONS

It is evident that Nairobi's population is rapidly rising, and is projected to reach approximately 9 million persons by the year 2030, if the current growth and settlement patterns are maintained. Table 4.1 shows the population of Nairobi's environs (UN Millennium Project, 2010).

| Year | Population | Increase in population % | Area (km²) | Density (people/km²) | Kenya | Nairobi as % of Kenya population |
|-------------|-------------------|---------------------------------|------------------------------|--|--------------|---|
| 1979 | 827 775 | 62.5 | 684 | 1 210 | 15 327 000 | 5.4 |
| 1989 | 1 324 570 | 60.0 | 684 | 1 937 | 21 445 000 | 6.2 |
| 1999 | 2 143 254 | 61.8 | 696 | 3 079 | 28 686 607 | 7.5 |
| 2000 | 2 290 049 | 6.8 | 696 | 3 290 | 30 208 365 | 7.6 |
| 2002 | 2 470 850 | 3.8 | 696 | 3 550 | 31 517 142 | 7.8 |
| 2005 | 2 656 997 | 3.7 | 696 | 3 818 | 33 808 269 | 8.1 |
| 2009 | 3 751 860 | 4.6 | 696 | 3 954 | 39 445 119 | 9.2 |

Table 4.1: Nairobi Population trends (1979-2009) *Sources: Olima 2011*

According to Olima, 2011 the projected combined urban population of the Nairobi metropolitan region will be approximately 11.4 million by 2030, compared to the current 3.5 million. Nairobi's primate position will in the context of Kenya's urban settlement size distribution. Population growth is partly explained by net migration into the city due to forces motivating rural-urban migration to Nairobi include better economic prospects, opportunities for higher education and higher wage employment, and the attraction of Nairobi as a market for goods and services. But there is also the phenomenon of diurnal migration of people from the environs who commute daily into Nairobi for purposes of employment, education or trade. Projections are that diurnal migration will continue unless

deliberate efforts are made to develop satellite towns and employ strategies to reduce the daily influx of people to the city (Olima, WHA, 1997).

4.5 EMPLOYMENT AND THE ECONOMY OF NAIROBI

Nairobi provides a significant proportion of employment, reflecting its dominance of the economic affairs of the country. Nairobi employs 25% of Kenyans and 43% of the country's urban workers; as it generates over 45% of GDP, it is a major contributor to Kenya's economy (Olima, WHA, 1997). However, according to the 1999 population census, Nairobi accounted for only 7.28% of the national population. The privatization and restructuring programmes of the 1990s may have had an influence on the employment potential within Nairobi, as reflected in the poverty profile of Nairobi which shows upto 56% of the population living in informal settlements where the various dimensions of poverty are starkly evident.

4.6 THE CURRENT SITUATION OF NAIROBI CITY

The land use of the Nairobi city can be divided into central, intermediate and outer zones. The central area has generally poor and middle class residential uses and a concentration of commercial and business land uses. The intermediate area (largely planned) is an uncontrolled mixture of housing (middle and upper income groups) and related activities and services (i.e. education, health, recreation, utilities etc.) while there is considerable dependence on the central zone due to job opportunities.

Like any other local authority in Kenya, Nairobi City Council (NCC) finds itself seriously challenged with respect to the resource requirements, leading to delays and reduced urban service delivery. Lack of services and infrastructure constrains Nairobi's economic development. Over 60% of the population lives in slums and only 22% of slum households have water connections.



Plate6: Aerial view of a Moi Avenue, Nairobi (Source: field Photo, May 2012)

The outer area presents typical characteristics of urban sprawl where the city has grown through low density housing for the rich (NESPAK 1997, p.3-1). In 1998, 3.5 million people resided in the city, 80 percent within a radius of 7 km. The greatest concentration of population is within and around the central area and there is a gradual diffusion in the outer areas of overall average density of 120 people per acre (NESPAK 1997, p.6-1). By revealing the existing urban transport situation of Nairobi, the overall picture shows that 60% of trips are non-motorized mainly pedestrian (51%). While more than half of all trips are the pedestrian, there is no serious effort to plan for NMT in Nairobi. Provision of narrow footpaths along major roads is considered sufficient pedestrian planning in Nairobi. Among motorized transport the share of road based public transport is just 14%.

According to NESPAK in 1997, the air pollution, suspended particulate matter (dust and smoke); carbon monoxide (CO) and nitrogen dioxide are most

prominent and already exceed the WHO standard within the city. The noise level of vehicles is also more than 85 dBA standard. All transport vehicles in Nairobi used non-renewable energy resources as well. Another aspect of these vehicles is the fatalities rate of which grew to 11.4% between 1990 and 1996. Moreover, in Nairobi, at least seven government organizations each with their own agenda are directly or indirectly responsible for transport and related environmental issues.

4.7 TRANSPORT CHALLENGES IN NAIROBI.

Whitelegg, in 1993 indicated that the urban transport is one of the most important sectors having a direct bearing on sustainable development because of the high growth of the transport sector's energy consumption and greenhouse gas emissions at global scale. By 2025, the transport sector's energy consumption and greenhouse gas emissions will have doubled and more and more people will become dependent on private automobiles. The health and environmental implications of this rapidly growing and poorly regulated motorization are highly problematic at local scale as well. It has a permanent and often irreversible impact on the environment through land take and intrusion. So it requires rationalization and management of demand by shifting towards environment-friendly modes and collective transport and better utilization of existing capacity. It is worth noting that without proper planning of future transport systems we can't achieve principles of sustainability. Developing a sustainable transport system has been espoused as a potential solution to transport development.



Plate7: Traffic Jam along Tom Mboya street, Nairobi (Source: field Photo, May 2012)

Adopting principles of sustainable transport becomes more important in the case of Kenya where the motor vehicle fleet is growing at two to three times the rate of the population, and motor vehicle usage even faster. The negative externalities of transport are likely to aggravate as the use of motor vehicles is growing at an alarming rate. Vehicular traffic threatens pedestrian safety especially in busy urban areas. Congestion lengthens traveling time, increases operating cost and tends to lead to a higher level of emissions as well. Especially in the city of Nairobi, designed transport strategies and programs have resulted in high growth of urban road traffic, increasing air and noise pollution, and traffic crashes. That's why Nairobi needs to develop a sustainable transport system not only to reduce the externalities of transport but also due to achieving sustainable development for the 21st century.



Plate8: Hawkers along Kamusi Road, Nairobi (Source: field Photo, March 2013)

The roads that defined the study area are local streets since they primarily provide a high degree of access. The vehicles are constantly merging or leaving traffic along streets, as well as containing pedestrians crossing. They also have low speed limits.

CHAPTER FIVE

DATA ANALYSIS AND INTERPRETATION

5.0 INTRODUCTION

The data that were collected by administering questionnaires, direct observations, interviewing key informants, photographs, Global positioning Systems (GPS) and digitization of maps are presented and discussed in this chapter. The response rate, the socio-economic characteristics, time taken during the trip, purpose of the journey, level of education, modal choice of transport, NMT facilities and traffic tally locations are analyzed as captured during the research.

5.1.1 Response Rate

The table below shows a tabulation of the respondent rate.

| Response | Road Users | | Transport users | |
|--------------|------------|------------|-----------------|------------|
| | Frequency | % | Frequency | % |
| Response | 56 | 100 | 64 | 100 |
| No Response | 0 | 0 | 0 | 0 |
| Total | 56 | 100 | 64 | 100 |

Table 5.1: Response Rate of Respondents, (Source: Author, 2012)

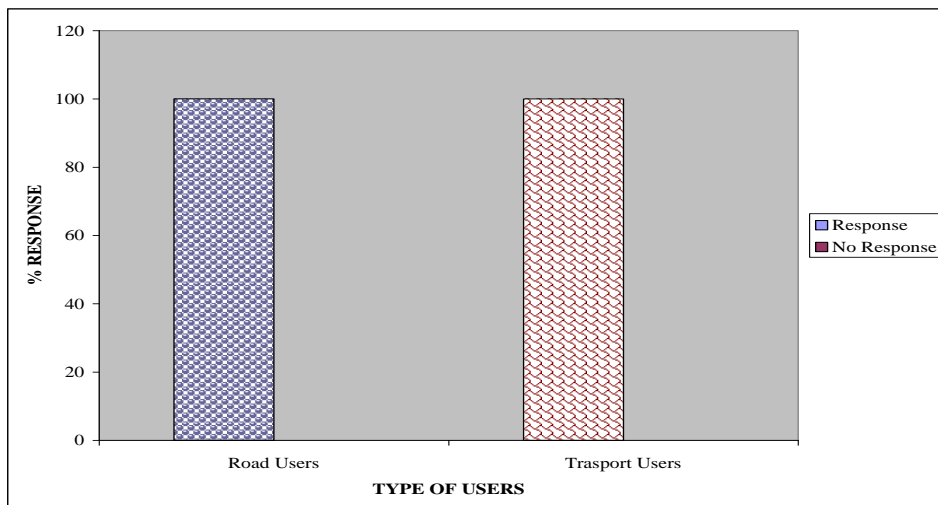


Figure 5.1: Response Rate of Respondents (Source: Author, 2012)

As indicated in the table 5.1 and figure 5.1 the response rate on both road and transport users were 100% with more than 80% of the questions are answered. This high response rate will be entirely attributed to the fact that the questions were administered directly to the respondent by the researcher and research assistants and thus no one was left with any of the questionnaires to fill at a later date.

5.2. Socio-Economic Characteristics

As against the cardinal objective of this study, the demographic survey was carried out to establish the socio-economic status of the people involved in non-motorized transport services and operations in the study area. Variable such as age, sex, marital status and educational background were used.

5.2.1 Gender of Respondents

The table presents the findings on the gender of the respondents.

| Gender | Road Users | | Transport users | |
|--------------|------------|------------|-----------------|------------|
| | Frequency | % | Frequency | % |
| Male | 28 | 50 | 43 | 66.7 |
| Female | 28 | 50 | 21 | 33.3 |
| Total | 56 | 100 | 64 | 100 |

Table 5.2 Gender of Respondents (Source: Author, 2012)

5.2.2 Age Bracket of Respondents

| Age Bracket | Frequency | Percentage (%) |
|--------------|-----------|----------------|
| Below 18 yrs | 5 | 8.9 |
| 18 - 36 yrs | 26 | 46.4 |
| 37 - 55 | 18 | 32.2 |
| Over 55 yrs | 7 | 12.5 |
| Total | 56 | 100 |

Table 5.3 Age Bracket of Respondents (Source: Author, 2012)

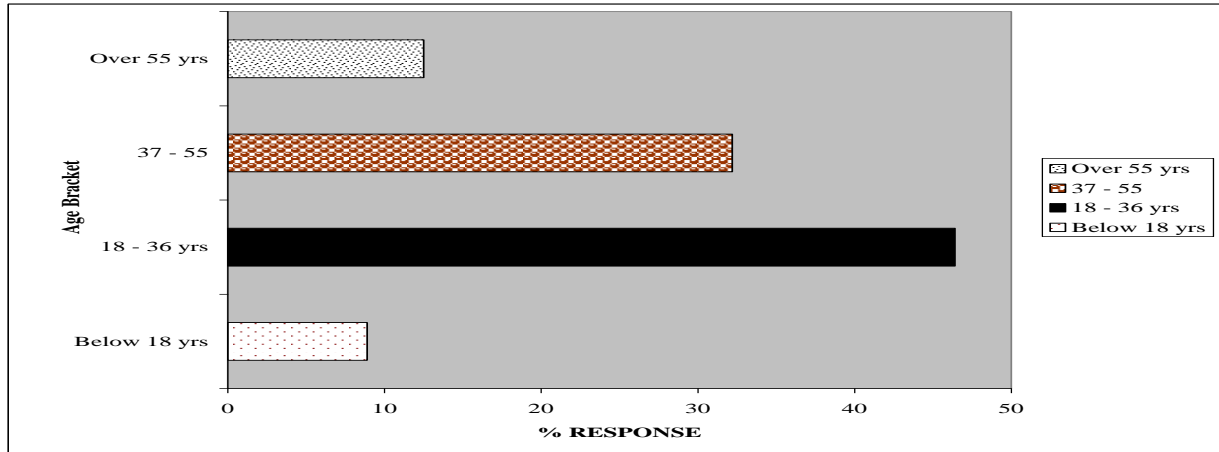


Figure 5.2 Age Bracket of Respondents (Source: Author, 2012)

Discussions

The users of non-motorized transport cut across every age group in the study area though at varying percentages. From the table 5.3 it has been illustrated that, people of different age group were involved in the study. Respondents according to the age was calculated as, below 18 years, 18-36 years, 37-55 years and over 55 years account for 8.9%, 46.4%, 32.2% and 12.5% respectively. From the age bracket of respondents rate it can be seen that the middle age is mainly involved in mechanized non-motorized transport operations in the study area. Table 5.3 further revealed that 46.2 % and 32.2 % of them falls within the age brackets of 18-36 and 37-55 years respectively. It therefore implies that people in the middle age group that is 18-55 years old, which accounts for 78.4 %, are predominantly involved in trading activities in the study area.

5.2.3 Marital Status

| Status | Road Users | | Transport users | |
|--------------|------------|------------|-----------------|------------|
| | Frequency | % | Frequency | % |
| Single | 12 | 21.4 | 10 | 15.6 |
| Married | 39 | 69.4 | 48 | 75 |
| Others | 5 | 9.2 | 6 | 9.4 |
| Total | 56 | 100 | 64 | 100 |

Table 5.4 Marital Status (Source: Author, 2012)

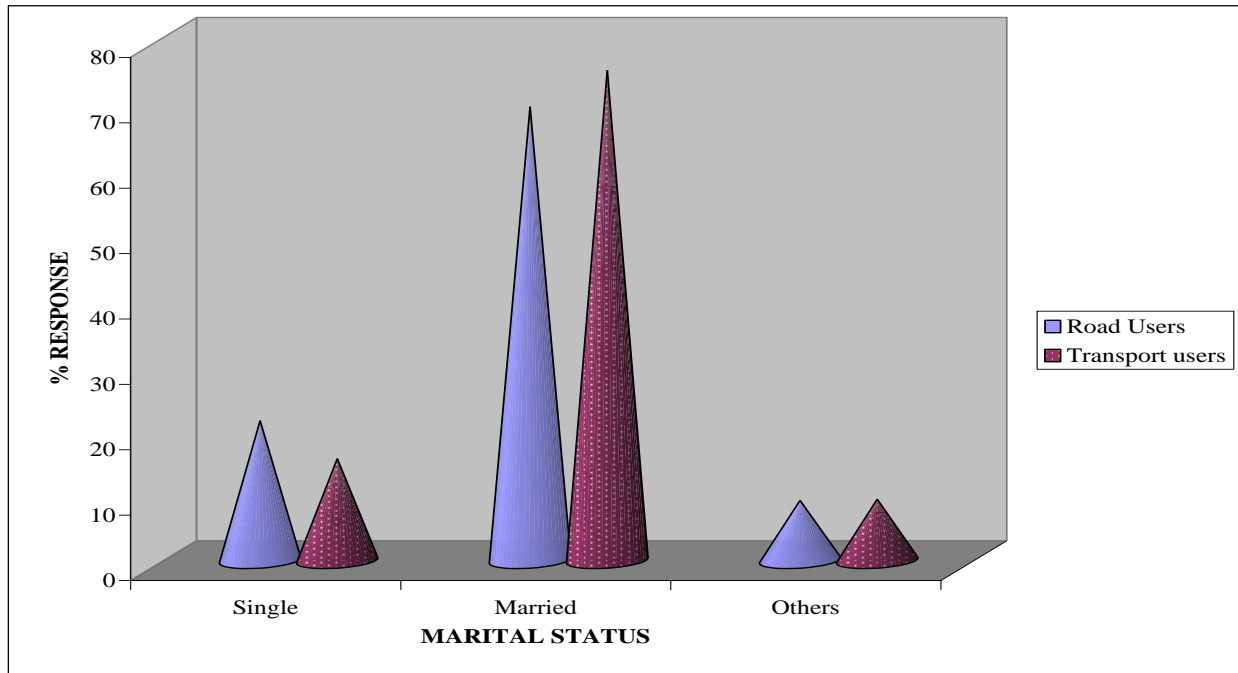


Figure 5.3 Marital status (Source: Author, 2012)

From the table 5.4 and figure 5.3 it is evident that the area is frequented by people in different marital status; the single and the married alike. From the findings the road users were composed of 21. % singles, 69.4% married and in the others category which comprised of the divorced the separated and even the students they were represented by 9.2%.

5.2.4 Satisfaction with Time Taken

The table 5.5 and figure 5.4 highlights the respondents' level of satisfaction with the time it takes to reach their destinations.

| | Road Users | | Transport users | |
|--------------|------------|------------|-----------------|------------|
| | Frequency | % | Frequency | % |
| Yes | 11 | 19.6 | 9 | 14.1 |
| No | 45 | 80.4 | 55 | 85.9 |
| Total | 56 | 100 | 64 | 100 |

Table 5.5 Satisfaction with time taken, (Source: Author 2012)



Plate9: Pedestrian walking along River Road, Nairobi (Source: field Photo, May 2012)

Most of the respondents (80.4%) were not satisfied with the time they take to reach their destination. They cited road congestion, poor state of roads, lack of pedestrians lane, lack of cyclist tracks, poor road designs, poor traffic planning, corrupt traffic police officers, lack of adequate transport policy for both NMT and MVs, narrow road reserves and ineffective public transport systems amongst others as some of the major causes of slow movement within this area and the entire CBD as a whole. Only 19.5% of the respondents were satisfied with the time it took them to get to their destination.

These users are often confident riders who prefer to share the road with automobiles if doing so will allow them to reach their destinations faster. This research paper is primarily directed toward meeting the needs of the latter type of utility cyclist.

5.2.5 Purpose of the Journey

| Reason | Road Users | | Transport users | |
|--------------|------------|------------|-----------------|------------|
| | Frequency | % | Frequency | % |
| Work | 7 | 14.6 | 9 | 15 |
| School | 2 | 4.2 | 2 | 3.3 |
| Shopping | 15 | 31.3 | 18 | 30 |
| Business | 22 | 45.8 | 28 | 46.7 |
| Others | 2 | 4.2 | 3 | 5 |
| Total | 48 | 100 | 60 | 100 |

Table 5.6 Purpose of Journey (Source: Author, 2012)

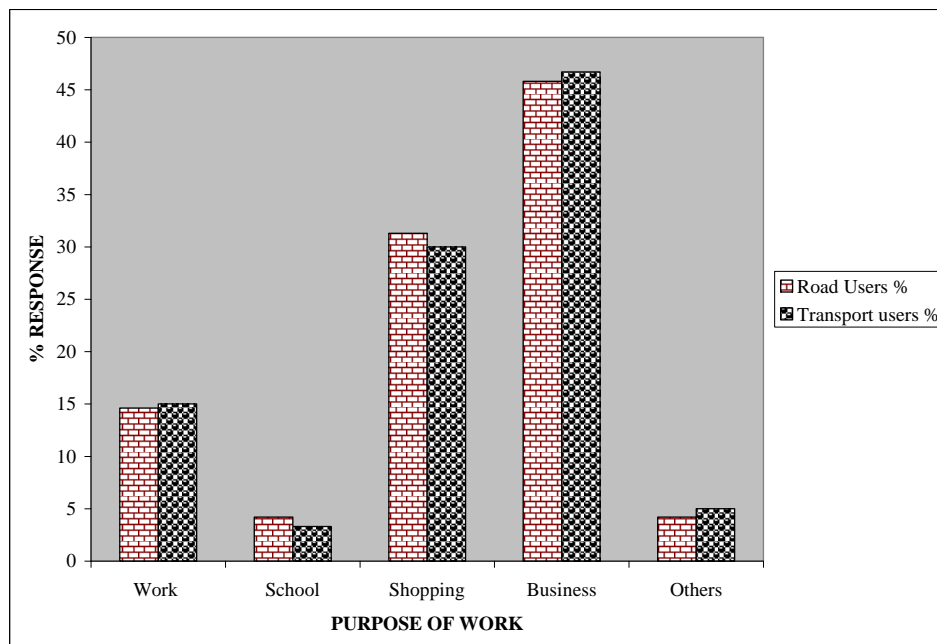


Figure 5.5 Purpose of the Journey (Source: Author, 2012)

From the study results it can be seen that the majority of road users and transport users are people use go to do business and shopping purposes. The trip purpose for business for road users and transport users are 45.8% and 46.7% respectively. The area also registered 31.3% and 30% of road and transport users respectively for shopping purposes.

5.2.6 Educational Level of Road Users

| Level of Education | Frequency | Percentage (%) |
|---------------------|-----------|----------------|
| None | 1 | 1.8 |
| Primary | 8 | 14.3 |
| Secondary | 18 | 32.1 |
| Tertiary | 16 | 28.6 |
| Village Polytechnic | 5 | 8.9 |
| University | 8 | 14.3 |
| Total | 56 | 100 |

Table 5.7 Educational Level of Road Users (Source: Author, 2012)

From Table 5.7 shows that out of the 56 people interviewed (operators and users) only 1.8 % of the respondents had no formal education while 14.3%, 32.1% and 28.6% of the respondents had Primary, secondary and tertiary education respectively. This indicates that majority of the respondents that involved in this activities in the study area did not go beyond secondary school education. Similarly 23.1% of the respondents had Teachers College /ND/NCE and University/Polytechnic education respectively. This implies that non-motorized transport operations and services and trading or marketing activities require no detailed education and therefore are left for the less educated in the study area while educated ones are engaged in using other mode of transport.

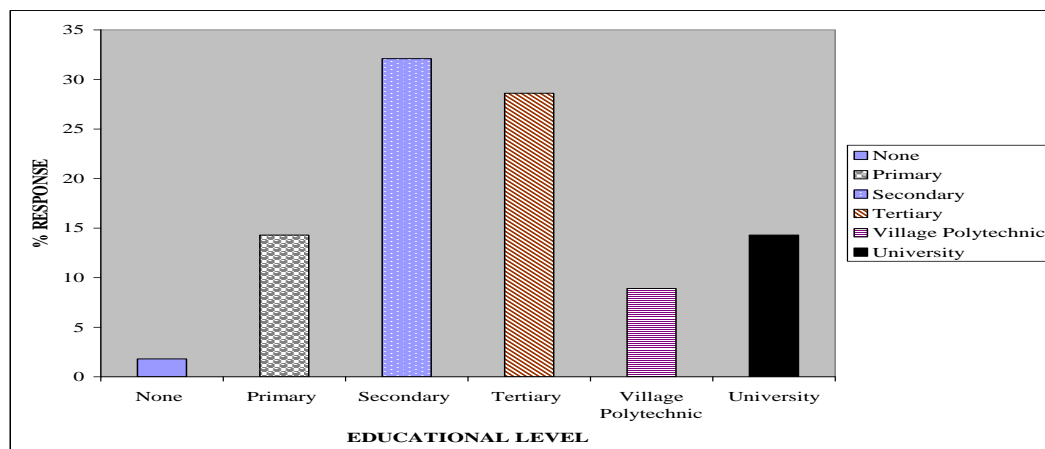


Figure 5.6 Educational Levels of Road Users (Source: Author, 2012)

5.2.7 Occupation of the Respondent

| Type of occupation | Frequency | Percentage (%) |
|--------------------|------------|----------------|
| Formal | 15 | 13.9 |
| Self employed | 36 | 33.3 |
| Farmer | 4 | 3.7 |
| Manual | 30 | 27.7 |
| Others | 5 | 4.6 |
| Total | 108 | 100 |

Table 5.8 Occupations of Respondents (Source: Author, 2012)



Plate10: Traders and casual workers along cross Road, Nairobi (Source: field Photo, May 2012)

From Table 5.8 shows that out of the 108 people interviewed (operators and users) only 13.9 % of the respondents have formal employment, while 33.3%, 3.7% and 27.7% of the respondents had self-employed, farmer and manual employment respectively. This indicates that majority of the respondents that are within the Area of study are self-employed.

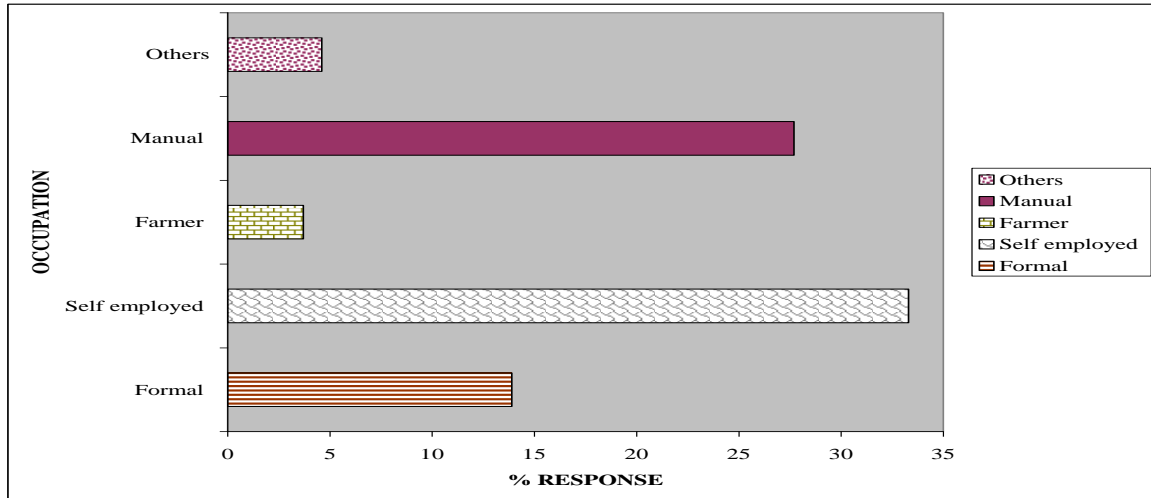


Figure 5.7 Occupations of Respondents (Source: Author, 2012)

5.2.8 Preferred Mode of Transport within the Area

Despite significant differences in the apparent incidence of the level of income for the persons within the area of study both during the weekday and weekend preferred walking within the Nyamakima. The table 5.8 indicates that many people like walking and should be promoted by the relevant authorities.

| Transport | Frequency | Percentage (%) |
|-------------------|------------|----------------|
| Walking | 77 | 68.8 |
| Cycling | 5 | 4.5 |
| Motor bike | 10 | 8.9 |
| Private transport | 20 | 17.9 |
| Total | 112 | 100 |

Table 5.8 Model Choice (Source: Author, 2012)

5.2.9 Footpaths Rating

| Rating | Frequency | Percentage (%) |
|--------------|-----------|----------------|
| Excellent | 0 | 0.0 |
| Good | 4 | 5 |
| Satisfactory | 20 | 25 |
| Poor | 56 | 70 |
| Total | 80 | 100 |

Table 5.9 Footpaths rating (Source: Author, 2012)



Plate11: Researcher along Ronald Ngala Road Nairobi (Source: field Photo, May 2012)

Footpaths are often cluttered with street furniture and services and wide roads and busy intersections are often difficult for pedestrians and cyclists to cross. Footpaths are often non-existent or of poor quality, forcing pedestrians into the street.

5.2.10 Cycling Lane Rating

| Rating | Frequency | Percentage (%) |
|---------------|------------------|-----------------------|
| Excellent | 0 | 0.0 |
| Good | 1 | 2.2 |
| Satisfactory | 5 | 11.1 |
| Poor | 39 | 86.7 |
| Total | 45 | 100 |

Table 5.10 cycle traits rating (Source: Author, 2012)

Among the main threats to cyclist safety are collisions with automobiles at intersections, and falls resulting from poor surface conditions. Intersections

represent the highest area of major accidents for urban cyclists (Doherty et al., 2000; Garder et al., 1994). In Nyamakima Area, the study shows that, nearly 87% of serious bicycling injuries and fatalities occur at when cyclists cross roadways due to lack of cycle tracks since the respondent are not happy with the state of the cycle tracks.

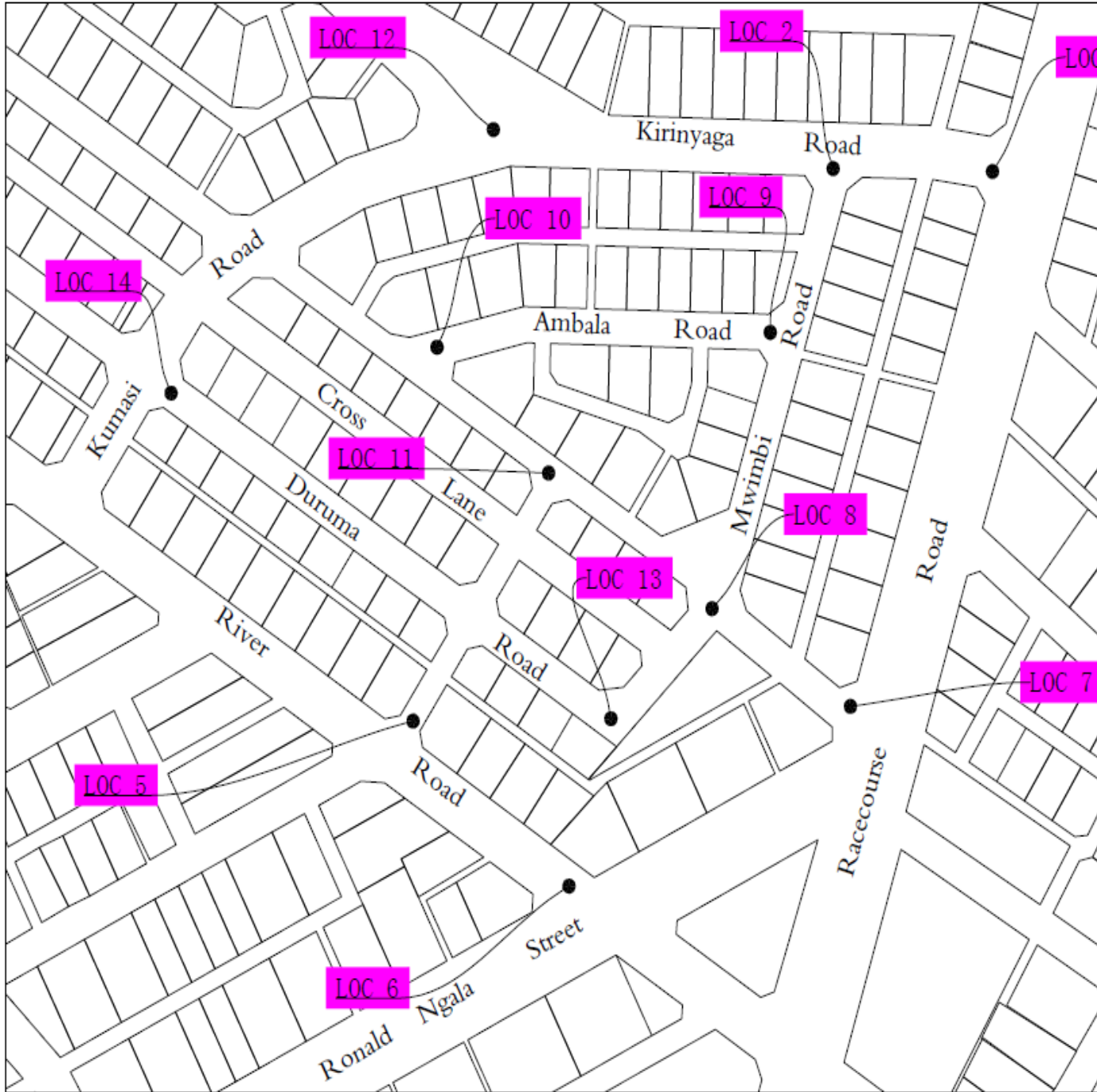
Discussions

Nyamakima area lacks proper pedestrian's lane and cycle tracks and signage for cyclist, this was demonstrated by low satisfaction of the time taken to reach the destination by the road and transport users. The arterial and Collector streets should be retrofitted with bicycle lanes where there is enough roadway width to accommodate them. Existing street and pavement conditions on all six test routes are in a sorry state. Drainages are always blocked by dirt and debris due to poor design and maintenance. This may require re-designing and planning of the road carriage way.

5.2.11 Traffic Tally Locations

The traffic data were collected from 14 locations as indicated in map 5.1 within the study area. Within the study area, the locations were designed such that 10 trips were generated to help in the traffic data analysis.

- 1). From Loc1- Loc2- Loc8- loc7
- 2). From Loc2- Loc19- loc8
- 3). From Loc3- Loc10- loc8-Loc7
- 4). From Loc9- Loc110
- 5). From Loc3- Loc10- Loc8-Loc7
- 6). From Loc8- Loc13- loc14
- 7). From Loc5- Loc11
- 8). From Loc4- Loc14- Loc12
- 9). From Loc4- Loc5- Loc6
- 10). From Loc6- Loc7- Loc1



Map 5.1 Study area map indicating the Survey location (Source: Source-Author, 2012)

Key: LOC – Location

| | Time | LOC 2 | LOC 1 | LOC 3 | LOC 8 | LOC 12 | Average |
|--|---------------|-------|-------|-------|-------|--------|---------------|
| Private Car - One Passenger | 07:00 - 09:00 | 35 | 158 | 165 | 43 | 215 | 123.2 |
| | 16:00 - 18:00 | 20 | 123 | 170 | 35 | 220 | 113.6 |
| Private Car - Two or more passenger | 07:00 - 09:00 | 40 | 253 | 140 | 35 | 218 | 137.2 |
| | 16:00 - 18:00 | 30 | 131 | 170 | 45 | 30 | 81.2 |
| Public Transport - 14 seater Matatu | 07:00 - 09:00 | 45 | 69 | 80 | 30 | 20 | 48.8 |
| | 16:00 - 18:00 | 50 | 93 | 72 | 45 | 50 | 62 |
| Public Transport - more than 14 seater | 07:00 - 09:00 | 45 | 40 | 5 | 4 | 10 | 20.8 |
| | 16:00 - 18:00 | 25 | 47 | 9 | 9 | 8 | 19.6 |
| Private Bicycle | 07:00 - 09:00 | 1 | 5 | 2 | 5 | 4 | 3.4 |
| | 16:00 - 18:00 | 2 | 1 | 5 | 8 | 1 | 3.4 |
| Commercial vehicle (Heavy trucks) | 07:00 - 09:00 | 3 | 9 | 7 | 3 | 5 | 5.4 |
| | 16:00 - 18:00 | 5 | 3 | 8 | 2 | 1 | 3.8 |
| Motor-Cycle | 07:00 - 09:00 | 10 | 30 | 26 | 19 | 26 | 22.2 |
| | 16:00 - 18:00 | 15 | 38 | 35 | 23 | 27 | 27.6 |
| Hand Cart | 07:00 - 09:00 | 10 | 5 | 6 | 5 | 3 | 5.8 |
| | 16:00 - 18:00 | 2 | 2 | 5 | 5 | 7 | 4.2 |
| Pedestrian | 07:00 - 09:00 | 1150 | 1225 | 1395 | 1460 | 1531 | 1352.2 |
| | 16:00 - 18:00 | 1230 | 1301 | 1561 | 1420 | 1630 | 1428.4 |

Table 5.11 Traffic Tally for Morning (7.00 – 8.30) and Evening Hours (16:00) Day 1 (Source: Author, 2012)

| | Time | LOC 9 | LOC 10 | LOC 13 | LOC 7 | Average |
|--|---------------|-------|--------|--------|-------|----------------|
| Private Car - One Passenger | 07:00 - 09:00 | 18 | 158 | 165 | 15 | 89 |
| | 16:00 - 18:00 | 15 | 123 | 170 | 20 | 82 |
| Private Car - Two or more passenger | 07:00 - 09:00 | 25 | 253 | 140 | 18 | 109 |
| | 16:00 - 18:00 | 23 | 131 | 170 | 30 | 88.5 |
| Public Transport - 14 seater Matatu | 07:00 - 09:00 | 21 | 69 | 80 | 20 | 47.5 |
| | 16:00 - 18:00 | 24 | 93 | 72 | 50 | 59.75 |
| Public Transport - more than 14 seater | 07:00 - 09:00 | 3 | 140 | 75 | 10 | 57 |
| | 16:00 - 18:00 | 2 | 47 | 135 | 8 | 48 |
| Private Bicycle | 07:00 - 09:00 | 10 | 5 | 2 | 4 | 5.25 |
| | 16:00 - 18:00 | 12 | 1 | 5 | 1 | 4.75 |
| Commercial vehicle (Heavy trucks) | 07:00 - 09:00 | 5 | 9 | 7 | 5 | 6.5 |
| | 16:00 - 18:00 | 4 | 3 | 8 | 1 | 4 |
| Motor-Cycle | 07:00 - 09:00 | 30 | 3 | 6 | 6 | 11.25 |
| | 16:00 - 18:00 | 23 | 38 | 75 | 7 | 35.75 |
| Hand Cart | 07:00 - 09:00 | 7 | 5 | 6 | 3 | 5.25 |
| | 16:00 - 18:00 | 2 | 2 | 5 | 7 | 4 |
| Pedestrian | 07:00 - 09:00 | 1350 | 1425 | 1365 | 1721 | 1465.25 |
| | 16:00 - 18:00 | 1452 | 1401 | 1561 | 1353 | 1441.75 |

Table 5.12 Traffic Tally for Morning (7.00 – 8.30) and Evening Hours (16:00) Day 1 (Source: Author, 2012)

| | Time | LOC 3 | LOC 10 | LOC 8 | LOC 7 | LOC 11 | Average |
|--|---------------|-------|--------|-------|-------|--------|---------------|
| Private Car - One Passenger | 07:00 - 09:00 | 165 | 141 | 48 | 45 | 10 | 81.8 |
| | 16:00 - 18:00 | 180 | 128 | 36 | 30 | 11 | 77 |
| Private Car - Two or more passenger | 07:00 - 09:00 | 145 | 256 | 31 | 22 | 1 | 91 |
| | 16:00 - 18:00 | 141 | 130 | 45 | 34 | 3 | 70.6 |
| Public Transport - 14 seater Matatu | 07:00 - 09:00 | 80 | 72 | 30 | 30 | 2 | 42.8 |
| | 16:00 - 18:00 | 72 | 87 | 45 | 45 | 5 | 50.8 |
| Public Transport - more than 14 seater | 07:00 - 09:00 | 5 | 80 | 4 | 45 | 1 | 27 |
| | 16:00 - 18:00 | 9 | 37 | 9 | 30 | 2 | 17.4 |
| Private Bicycle | 07:00 - 09:00 | 2 | 5 | 5 | 5 | 4 | 4.2 |
| | 16:00 - 18:00 | 5 | 1 | 8 | 8 | 1 | 4.6 |
| Commercial vehicle (Heavy trucks) | 07:00 - 09:00 | 7 | 9 | 1 | 5 | 5 | 5.4 |
| | 16:00 - 18:00 | 8 | 3 | 4 | 7 | 1 | 4.6 |
| Motor-Cycle | 07:00 - 09:00 | 36 | 3 | 19 | 39 | 19 | 23.2 |
| | 16:00 - 18:00 | 45 | 38 | 19 | 30 | 27 | 31.8 |
| Hand Cart | 07:00 - 09:00 | 7 | 5 | 4 | 9 | 22 | 9.4 |
| | 16:00 - 18:00 | 5 | 2 | 5 | 10 | 7 | 5.8 |
| Pedestrian | 07:00 - 09:00 | 1654 | 1433 | 1444 | 1850 | 1530 | 1582.2 |
| | 16:00 - 18:00 | 1764 | 1492 | 1523 | 1900 | 1933 | 1722.4 |

Table 5.13 Traffic Tally for Morning (7.00 – 8.30) and Evening Hours (16:00) Day 2 (Source: Author ,2012)

| | Time | LOC 4 | LOC 5 | LOC 6 | LOC 1 | LOC 14 | Average |
|--|---------------|-------|-------|-------|-------|--------|---------------|
| Private Car - One Passenger | 07:00 - 09:00 | 35 | 158 | 165 | 172 | 15 | 109 |
| | 16:00 - 18:00 | 20 | 123 | 170 | 113 | 20 | 89.2 |
| Private Car - Two or more passenger | 07:00 - 09:00 | 40 | 253 | 140 | 247 | 18 | 139.6 |
| | 16:00 - 18:00 | 30 | 131 | 170 | 138 | 30 | 99.8 |
| Public Transport - 14 seater Matatu | 07:00 - 09:00 | 45 | 69 | 80 | 73 | 20 | 57.4 |
| | 16:00 - 18:00 | 50 | 93 | 72 | 98 | 50 | 72.6 |
| Public Transport - more than 14 seater | 07:00 - 09:00 | 45 | 140 | 75 | 47 | 10 | 63.4 |
| | 16:00 - 18:00 | 25 | 47 | 135 | 49 | 8 | 52.8 |
| Private Bicycle | 07:00 - 09:00 | 1 | 5 | 2 | 5 | 4 | 3.4 |
| | 16:00 - 18:00 | 2 | 1 | 5 | 1 | 1 | 2 |
| Commercial vehicle (Heavy trucks) | 07:00 - 09:00 | 3 | 9 | 7 | 9 | 5 | 6.6 |
| | 16:00 - 18:00 | 5 | 3 | 8 | 3 | 1 | 4 |
| Motor-Cycle | 07:00 - 09:00 | 10 | 3 | 6 | 30 | 6 | 11 |
| | 16:00 - 18:00 | 5 | 38 | 75 | 38 | 7 | 32.6 |
| Hand Cart | 07:00 - 09:00 | 10 | 5 | 6 | 5 | 3 | 5.8 |
| | 16:00 - 18:00 | 2 | 2 | 5 | 3 | 7 | 3.8 |
| Pedestrian | 07:00 - 09:00 | 1245 | 1765 | 1786 | 1425 | 1984 | 1641 |
| | 16:00 - 18:00 | 1983 | 1876 | 1888 | 1355 | 1985 | 1817.4 |

Table 5.14 Traffic Tally for Morning (7.00 – 8.30) and Evening Hours (16:00) Day 2 (Source: Author, 2012)

The above tables 5.11 to 5.14 illustrates traffic tally matrix for the fourteen locations within study area here referred as travel analysis zones.

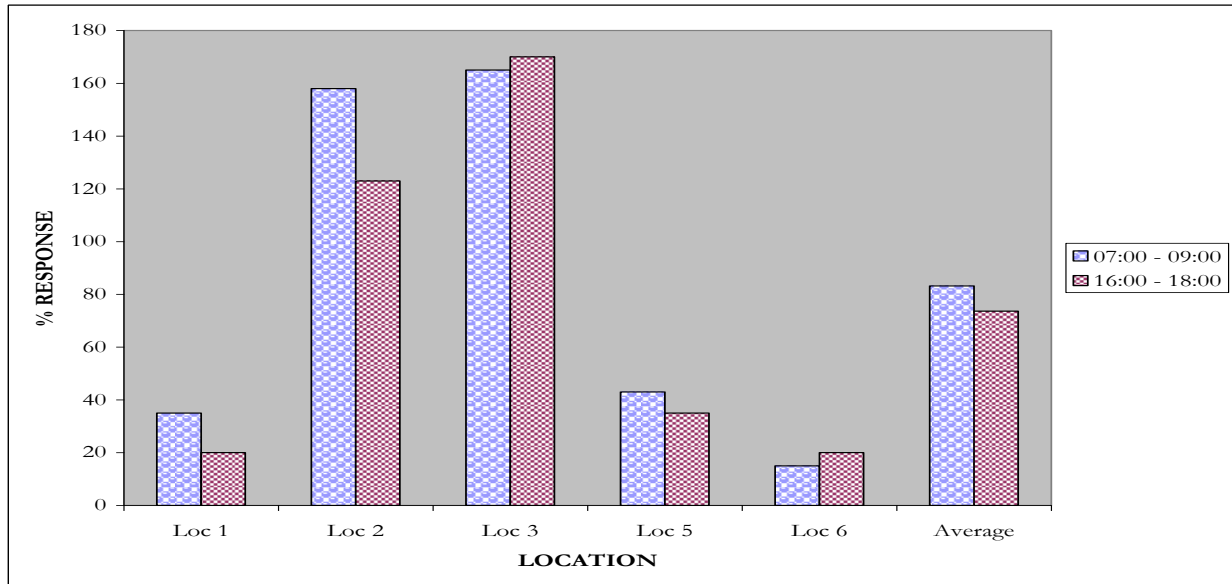


Figure 5.2.13 Traffic Tally for Private Car - One Passenger (Source: Author, 2012)

Discussions

Wang et al (2007) indicated that the travel time index which is the measure of additional time for a peak hour trip compared with the same trip during non-peak hours, it can be computed from traffic data collected from traffic tally. It is expressed as the ration of the peak hour trip and the non-peak hour trip time. From the study the travel time index from location 7 to location 3 can be computed for NMT and MT. The trip using MT takes 20 minutes during peak hours and 5 minutes during non-peak hours. The travel time index $20/5=4$.

From the findings the researcher noted that there were more private cars in the morning using the area than they were in the evening. Of concern to the researcher was that most of the private cars had only the driver as the only one passenger. Considering that the average number of the vehicles in the morning and evening hours was 83 and 73 respectively, then if all the passengers in

these personal vehicles were to use 14 seater matatus it clear that the number of vehicles would decrease drastically and thus reducing traffic jam in a massive way. All the 83 passengers would fit in six 14 seater matatus while the 73 would fit in a similar number. This reduces the number of vehicles in the morning by 69 and 59 by evening respectively.

The data collected estimate the traffic flow based population and economic activities. It can also be used to evaluate the social economic and environmental impacts of the environmental impacts of transportation projects. From the study data it has been demonstrated that the majority of the traffic within the area are pedestrian with public transport taking the second slot. It is further demonstrated that majority of people going to the area are going to do business followed shopping.

5.3 OPPORTUNITIES AND CHALLENGES OF THE INSTITUTIONAL FRAMEWORK FOR NMT.

5.3.1 Opportunities for NMT

Availability of multidisciplinary expertise in the key ministries and City Council of Nairobi with regard to urban planning, land management and road engineers is an added advantage to both NMT and MT sector. There are several organizations that are ready to support the NMT sector; they are only lacking someone to lead them in pooling of financial resources and prioritization of programmes and projects on urban transport. Another key opportunity is the availability of economic instruments that can be tapped for the improvements of urban transport (road pricing, vehicle registration taxes, import duties, fuel taxes) but not yet fully exploited. The financial opportunities at the local level not fully exploited and possibilities of private sector participation with regard to road pricing is now possible using the public road toll act Cap 407 and street Adoption Act Cap 407 amongst other acts of parliament.

5.3.2 NMT challenges

There are several challenges affecting the NMT sector, this has affected the positive improvement that can ensure the sustainability. The key challenge is the institutional amongst others.

The Institutional challenges are several and it includes; Firstly, the multiplicity of institutions involved and therefore coordination of programmes and projects and sharing of information becomes difficult and confusing. Secondly, the dual nature of governance at the local level with both the structure of the local government and provincial administration sometimes generates conflicts, overlaps and coordination problems. Thirdly, the centralization tendencies in the governance structures reduce the autonomy of the council and interfere in the *modus operandi* of the local state (administrative and legal constraints within the local Government Act, infrastructure research done outside Nairobi and only requested to implement and activities permitted within the jurisdiction of the council without technical consideration from council, etc.). This weakens capacity building at the local level and reduces local authorities to implementing agencies of the central government. Fourthly, the coordination within the council with regard to transport issues and land use planning is inadequate. Transport planning and land use planning must go hand in hand for an efficient lasting solution to transport problems.

The other challenge is the functional organization of the governance structure is top down in terms of authority and communication relations, which impedes upwards as well as horizontal communication. The current legislation hardly recognizes the importance of non-motorized transport as a form of urban mobility used by many people.

5.4 ANALYSIS OF ROAD USERS AND SPACE ALLOCATION BETWEEN MVS AND NMVS

The capacity of different types of rights-of-way to move people at different speeds has been the subject of some debate in recent years. Different analysts have calculated different relative efficiencies in road space utilization or person-throughput for transportation facilities. According to Hung in 2002, the global theoretical analysis has sometimes been misused to castigate entire modes of transport as inefficient and worthy of being suppressed, not recognizing the complementary function of different transport modes.

Proper analysis of transport modal efficiency must differentiate based on *trip length, cost, and function*. For a given amount of road or corridor space, the most efficient modes of transportation are generally rail or bus modes operating on their own dedicated rights-of-way. The current situation within the area of study along River road, cross road, Kirinyanga and Racecourse intersection indicates that the traffic systems in the area had been designed to increase motor vehicle use, at the expense of pedestrian and bicycle safety. The least efficient use of road space is low occupancy automobiles. Bicycles fall in between this range, with road space utilization approaching that of buses in mixed traffic as was stated by MacIntyre in 2006.

All of these estimates of road space utilization are subject to a great deal of variation in the real world, depending on vehicle occupancy, level of traffic congestion and traffic mix, topography, frequency of public transport stops and other details of public transport operations, quality of track or road surface, and other factors. The study findings indicate that Non-motorized transport is neglected by transport planning and road designs for this area as no or few pedestrian or cycling facilities are in existing. From the observations it has been established that over 90% of the roads sidewalks within the area are heavily obstructed by hawkers, trash and open sewer and drainage ditches.

5.5 PROPOSED PHYSICAL INTERVENTIONS

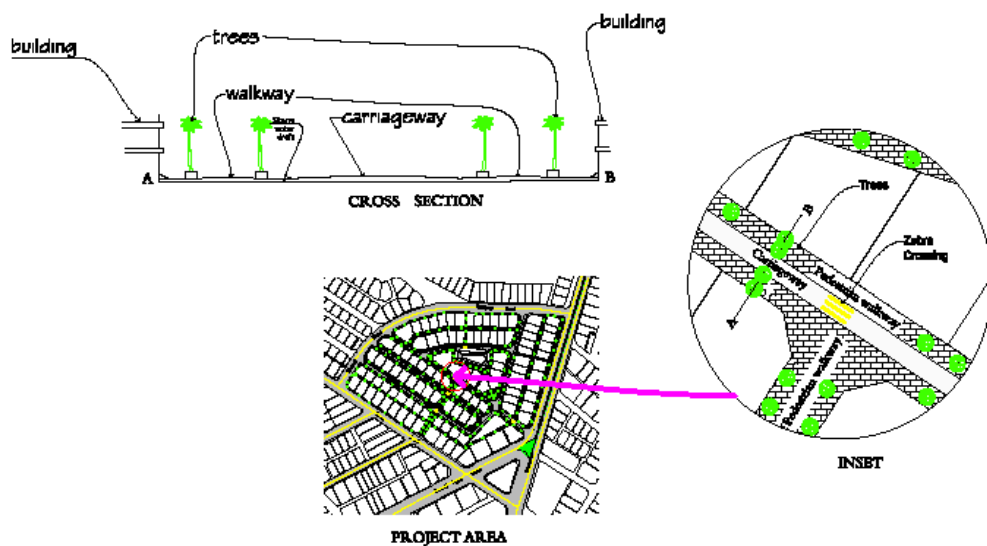
It is now generally understood that the problems facing the cities in the developing world can be tackled effectively only by recognizing that they are interconnected, and that policies across a range of issues must be developed and executed in an integrated fashion. The force of the concept of sustainable development is that it is based on just such integration across environmental, social and economic dimensions as was highlighted by Walter, H. in 2010. This has been argued strongly by the environmental movement for some time but is also supported by those with a more social or economic interest, and in particular those committed to the reduction of poverty are recognizing that environmental issues and poverty must be tackled together.

In most travel corridors travel demand is in fact composed of a spectrum of trip lengths, some short, some long. According to Catherine O' Brien in 2005, it is uncommon for a single mode of transport to be the most efficient for a corridor. Rather, a combination of modes need to be accommodated in a complementary fashion to meet the needs of diverse travel markets, recognizing limitations on road space, affordability of transport modes in the community, and the required speed and distance of trips made in the corridor. Where road space is most scarce, traffic management should be the first step in dealing with traffic congestion problems. This can include turn restrictions at intersections, introduction of one-way street systems, improved traffic signalization, and management of encroachments on transportation rights-of-way. These steps can all affect the relative efficiency of different modes in using road space.

5.6 RE-PLANNING AND RE-DESIGNING OF THE CARRIAGE WAY

A sustainable transport system must meet the mobility and accessibility needs of people by providing safe and environmentally friendly modes of transportation. This is a complex and difficult task in the mega-cities of developing countries because the needs of people belonging to various income groups are not only

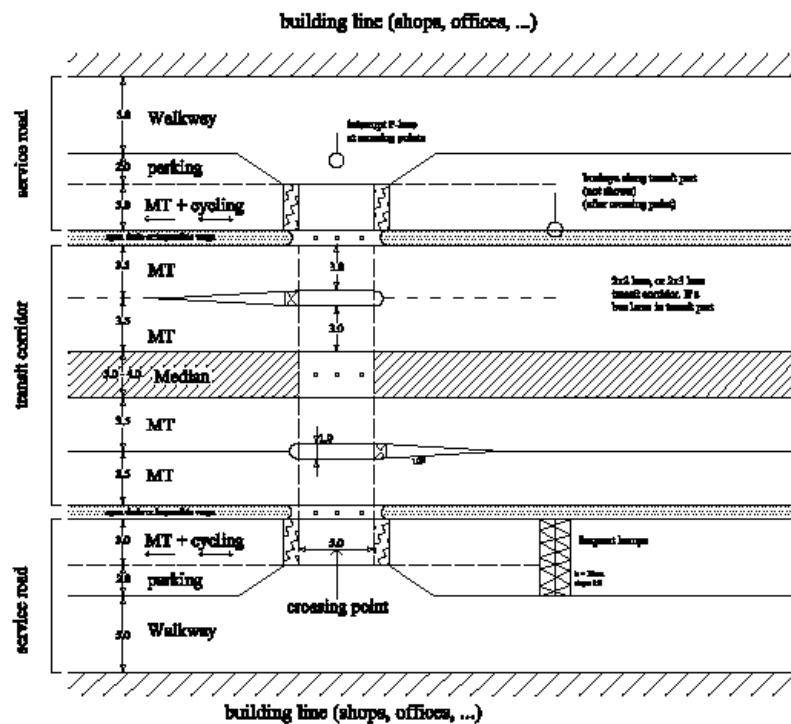
different, but also often conflicting in nature. Lack NMT lanes and the encroachment by motor vehicles have forced the pedestrians and cyclist to operate in dangerous mixed traffic. The **model 1 and model 2** shows the proposed intervention on the re-designing of the road carriage way to accommodate the NMT.



Model 1: Proposed Cross-sectional Road (Carriage way) Design plan (Source: Author, 2012)

To enhance the development of the integrated non-motorized and motorized transport networks the existing roads within the area must be re-planned and re-designed. The road design should lead to separate pedestrian's lanes, bicycle tracks and the automobile traffic. This would allow motorists and cyclists to see each other, and coordinate road crossings. To achieve this it will involve reducing the carriage from current 9metres to 4metres, hence making it one way and giving more room to the pedestrian's walkway, cycle tracks and trees for aesthetic and beauty for the area. This model will improve the traffic circulation,

reduce human congestion and hence improve security to the business community, enhances the business activities, and also reduces cyclist and pedestrians accidents.



Model 2: Proposed Cross-sectional Road (Carriage way) Design plan (Source: Author, 2012)

5.5.2 Re- development of Mini Matatus and Cycle Terminus

The study area lacks matatus and cycle terminus, this has led to most of them being parked on the road carriage way as indicated in plate 9. Ministry of Roads and County Government of Nairobi should consider acquiring the 3 plots along Ambala road as indicated in Map 5.1. There are relevant acts of parliament that support the acquisition of private property so long there is genuine public interest and the owners compensated as per the market value. Provision of

secure bicycle parking at bus stops and stations is central to accommodating the use of bicycles to access bus service (see model 3).



Model 3: Proposed site for Matatus and Cycle Terminus (Source: Author, 2012)

Bicycle racks should be located in the most convenient location possible to facilitate direct access to buses. This will usually be immediately adjacent to bus shelters, which adds to their security by increasing public surveillance. Bicycle racks on buses can facilitate extended transportation range at both ends of the bus trip.

CHAPTER SIX

FINDINGS AND RECOMMENDATIONS

6.0 INTRODUCTION

This chapter sums up the research by highlighting the emerging issues and it also contains the conclusive proposal for a sustainable urban mobility. The policy recommendations and conclusions are drawn based on the research findings that will address the study objective.

6.1 EMERGING ISSUES

Changing urban development from its present unsustainable forms and patterns is very challenging process. Not only do urban form, transportation systems, water, waste and energy technologies have to change, but the value systems and underlying processes of urban governance and planning need to be reformed to reflect a sustainability agenda (KenWorthy, J. 2006). The physical structure and urban design of the city, especially its public environment are highly legible, permeable, robust, varied, rich, visually appropriate and personalized for human needs. From the study the following are some of the findings and emerging issues after the analysis of the primary and secondary data:-

6.1.1 Traffic Congestion

The area of study experiences the human and traffic congestion which is an environmental problem and most of the respondents are not satisfied with the time they take to reach their destination. Nyamakima area lacks proper walking and cycling facilities, this includes sidewalks, crosswalks, paths, bike lanes, bicycle parking and changing facilities that can support or promote the use bicycle and walking amongst others, this was demonstrated by low satisfaction of the time taken by respondents to reach the destination. The lack of proper NMT

facilities has caused the slow movement of MT and NMT within this area and the entire CBD as a whole. Bicycling on a road shoulder (common on highways), a wide curb lane (common in suburban and urban areas), or a bike lane contributes little traffic congestion. Wang et al (2007) indicated that the travel time index which is the measure of additional time for a peak hour trip compared with the same trip during non-peak hours. From the study the travel time index from location 7 to location 3 can be computed for NMT and MT. The trip using MT takes 20 minutes during peak hours and 5 minutes during non-peak hours. The travel time index $20/5=4$.

Through this research it has been confirmed that the other cause of traffic jam within the capital city is the high proportion of all motor vehicles in the Nairobi city being private cars, where more than 70% only carry one passenger and the use of bicycles is very limited within the Central Business District. Other than causing delays, it causes noise and fumes and increases health risks to road users, traders and residents. The congestion leads to poor air quality and a poor environment, it may act as a deterrent to cyclist since policies which promote cycling would in themselves help to relieve congestion because cyclists and pedestrians require so much less road space than motorists do, both when travelling and parking.

The roads within the area lack the connectivity that can promote the NMT within the urban centers. More connected roadways and pathways systems allow more direct travel between destinations. Walking and cycling shortcuts are particularly effective at encouraging motorized to non-motorized travel shifts. The road intersections pose a challenge for cyclists as they are typically areas with confusing signals, striping, and automobile behaviour. Not surprisingly, the majority of bicycle-vehicle accidents occur at intersections. Experienced cyclists may feel comfortable jousting with automobile traffic. However, the majority of users are uncomfortable moving through intersections.

6.1.2 Lack of NMT programs

The lack of non-motorized promotion and safety programs being undertaken by the relevant authorities has contributed to inefficient NMT. From the study it has been found that more than 98% of the respondents have some formal education which includes the Primary, secondary and tertiary education. This indicates that majority of the people can be trained on the NMT benefits and safety programs to promote its use within the CBD. The absence of the special programs that encourage people to walk and bicycle for transport, and teach safety skills is a major setback for NMT in Nairobi county.

The dominant NMT within the study area are pedestrians, goods bicycles and non-motorized handcarts which are used for the delivery of household's goods, shops items and luggage for people on transit and business. The demand for bicycles and handcarts is therefore considerable at present and is likely to continue to be so. This situation is not explicitly recognized in policy documents and very little thought is given to programs that promote the NMT.

The availability of multidisciplinary expertise in the key ministries and City Council of Nairobi with regard to urban planning, land management and road engineers is an added advantage to both NMT and MT sector. There are several organizations that are ready to support the NMT sector; they are only lacking someone to lead them in pooling of financial resources and prioritization of programs and projects on urban transport. The Institutional challenges that include the multiplicity of institutions involved and therefore coordination of programs can be handling so long appropriate policies are worked on.

6.1.3 Lack of NMT Infrastructures

The study found that the area lacks of pedestrian's lane and cycle tracks and signage, roadways designs, including traffic calming, road diets, and traffic speed controls. Traffic calming can change roadways design to reduce traffic speeds while the road diets reduce the number of traffic lanes. Within the Study area if

was observed that the bicycles were placed against walls, trees, windows, and on the walkways may prove hazardous to pedestrians, automobiles and private property. In addition, bicycles are improperly parked are more prone to theft and vandalism. Bicyclists, like motorists, require convenient and safe parking at their origins and destinations. As the bike network develops and ridership increases, the need for adequate parking facilities should also increase. Bicycle facilities are important not only to encourage use by bicyclists, but also to avert problems associated with improvised parking. Existing street and pavement conditions on all six test routes are in a sorry state. Drainages are always blocked by dirt and debris due to poor design and maintenance.

6.2 RECOMMENDATIONS

The study recommends for systems approach to the management of the urban mobility challenges. This means that the sustainable urban mobility is achieved if the effective regulations, transport, performance indicators and sustainability factors are balanced during the planning and urban design process are initiated. Practically the large number of the components of environmental, social and economic systems needs to be factored to make the transport sustainable within the urban centres. From the study results, emerging issues and the discussions it can be recommended that:-

6.2.1 Inclusion of NMT facilities in all Roads Designs.

The lack of non-motorized safety programs and NMT infrastructure is a major setback for NMT in Nairobi County. The bicycle lanes and sidewalks should be included when new arterial or collector roads are designed, constructed, or when existing facilities are reconstructed as conditions permit. The integration of the bicycle/pedestrian facilities on all roads projects within the county will ensure that human circulation is maximized and hence increment of business activities as demonstrated in *model 1*. This model will lead to reduction of the existing carriage way and hence reducing the roads to a single one way direction. The

Nairobi County's Engineers department should work closely with the Ministry of Roads and public works in consultation with the stakeholders to improve bicycle/pedestrian facilities on the roads system. According to Midgley (1994) as was quoted by Alugula non-motorized transport form the back bone of transport system for the poor in many cities for both personal and good movements.

The reduction of the existing carriage way to be only one way and the MT traffic movement direction is controlled as shown in model 2. The road linking the river road and cross road should also be turned to pedestrian walkway. The design of transportation facilities can significantly affect traffic safety as the segregation of slow from fast traffic, careful design of intersections to maintain good sight distances, to reduce turning conflicts, and to channelize traffic to enhance predictability of flows can all reduce safety problems while improving operational performance. Poorly designed and improperly maintained separate cycle facilities has lead to an increase in safety problems, particularly if there are many intersections or driveways crossing the cycle paths and sight distances are poor.

6.2 Construction of Mini Matatus and NMT Terminus

The second recommendation is development of a central mini matatus and cycle terminus within the zone. This will be only possible by acquisition of the three plots along Ambala road by county Government to be used as the matatu and cycle terminus. It is important to note that a sustainable transport system must provide mobility and accessibility to all urban residents with safe and environmentally friendly modes of transport. From the study a large section of the population uses non-motorized transport– they either have to walk or cycle to their place of work. The cyclists and pedestrians needs to be provided with a safe infrastructure, either road space for them must be physically segregated from motorized traffic, or the speed of the motorized traffic must be reduced. It is worth noting that the major arterial roads of the city must be made NMV-friendly, and hence the dedicated NMV routes through parks, green belts and

narrow city streets could serve as additional network capacity for cyclists must be encouraged.

6.3 CONCLUSIONS

The development and implementation of sustainable urban transport systems requires quite radical departures from normal planning and decision-making processes as cities around the world are establishing visions of sustainable development and how they can realize their dreams. The key defining characteristics of these efforts are their engagement with diverse stakeholders that constitute any city today, and their capacity to infuse a new sense of hope about the urban futures. All decision making must be sustainability-based by integrating social, economic, environmental and cultural considerations as well as compact, transit-oriented urban form principles.

From the study it can be concluded that logical integration of walking, NMV modes, and motorized transport will enhance the modernization of urban transport. The Kenya cities, where major shares of trips are made by walking and cycling, NMVs have an important role to play in urban transport systems. This research have demonstrated that successful integration of non- motorized transport in environmentally sustainable transport strategies, aimed at creation of well-balanced transport system, depends on the developments of NMT facilities, educations, encouragements and enforcement of traffic laws availability that will promote road safety, and image of non-motorized vehicles.

Secondly, it can be concluded that the key barriers to NMV use includes; affordability of vehicles, NMV-hostile street environments, lack of central cycle terminus, negative social and government attitudes to NMVs, and excessive and inappropriate regulation of NMVs. Overcoming these barriers may require changes in transport investment patterns, infrastructure design standards, street space allocation, credit and financing systems, regulatory policy, public

education, and marketing, depending on local circumstances. Such changes should be part of much larger efforts to manage the modal mix of cities to favor greater efficiency of resource utilization in the transport sector while enhancing accessibility.

6.4 REFERENCES

- Aduwo, I. G. (1990)" *The role, efficiency and quality of service of the Matatu mode of public transport in Nairobi: A geographical analysis.*" M. A. Thesis, University of Nairobi.
- Aligula, E. Garly, Z. A. Mutua, J. Owegi, F. Osengo, C. and Olelo, R. (2005), *Urban Public transport pattern in Kenya: A Case Study of Nairobi City.* Nairobi, Kenya.
- Asian development bank, (2009), *Lanzhou Sustainable Urban transport project: for People's Republic of China*, Financial proposal for Board of Directors.
- Brittany Montgomery and Peter Roberts (2008), *Walk Urban: demand, Constraints and Measurement of the Urban Pedestrian environment*, Washington, D. C.
- Catherine O' Brien (2005), *Planning for Sustainable Happiness: Harmonizing our Internal and external Landscapes*, Rethinking development 2nd International conference on Gross National Happiness, Antigonish, Nova Scotia.
- City of Johannesburg, ARUP, 2007, *Planning Framework for Non-Motorised Transportation -Infrastructure Improvements*, ARUP
- DEAKIN Elizabeth (1998), *"Land Use for Sustainable Urban Transport: An Assessment of Problems and Options"*, USA: University of California, Berkeley
- Department of Transport (2008), *A sustainable Future for Cycling, Cycling England.* London SW1P 4DR
- Duncan, B. Hartman, J (1996), *Sustainable Transportation initiatives in Canada : to the APEC Forum on Urban Transportation Seoul, Korea, November 20-22, 1996*
- FHWA (1997 and 2000), 1997 *Federal Highway cost allocation study*, USDOT (www.ota.fhwa.dot.gov 2012).
- FHWA (2008), *2008 Highways Statistics*, FHWA, USDOT ([www.ota.fhwa.dot.gov/policy information/stastics/2008](http://www.ota.fhwa.dot.gov/policy_information/stastics/2008))
- FHWA (2012b), *"Traffic Monitoring For Non-Motorized Traffic," Traffic Monitoring Guide. US Federal Highway Administration* (<http://fhwatmupdate.Camsys.com>).
- Gwilliam, K., (2003) *"Urban Transport in Developing Countries," Transport Reviews*, Vol 23, No. 2, (2003): 197-216.
- GTZ (2002) *Urban Transport and Poverty in Developing Countries: Analysis and Options for Transport Policy and Planning*, Division 44 Environmental Management, Water, Energy, Transport, Eschborn.

- Heierli, U. 1993. *Environmental limits to motorization*. Switzerland: Neidermann, A.G.
- Hung, C.C. (2002), *A Study on Assessment and Valuate on Sustainable Transportation in Taiwan*. M.S. Thesis of Transportation Science, Tamkang University, Taiwan
- Imran, Muhammad (2002) "*Cities for citizens not for cars: planning for sustainable urban transport system, Case Study: Lahore, Pakistan*" unpublished M.Sc urban planning dissertation: University of Hong Kong
- James Jenkison (2008), *Eco-cities, a sustainable solution to urbanization?*, 44th ISOCARP Congress.
- Jeroen Buis (2009), *Asia and Urban Transport in Asia- interface for cycling expertise*.
- Kenworthy, J (2006), *Environment and urbanization, the eco-city: ten key transport and planning dimensions for sustainable city development*. SAGE, University of Ottawa, USA.
- L. Steg and R. Gifford (2005), . "*Sustainable transportation and quality of life*". *J. Transp. Geogr.* vol. 13, no. 1, pp. 59-69,
- Linda Baker (2009), "*How to get more bicyclists on the road*" *Scientific American*. October(www.scientific American.com).
- Macbeth, A. G. (2004), *Sustainable Transportation in new Zealand* . A paper produced by the IPENZ Presidential Task Committee on Sustainability during 2003 and 2004. *MWH New Zealand Ltd*.
- MacIntyre, S. J. (2006) *Evaluating bicycle accessibility and bike-bus Integration infrastructure in Saskatoon*. A Thesis Submitted to the College of Graduate Studies at the University of Saskatchewan Saskatoon.
- Maleche, Z. (1993), *Training Manuel for Introduction to planning*, Physical planning Training Institute (PPTI), Makerere University.
- Marius de Langen, Rustica Tembele (2001), *Productive and Liveable Cities: Guidelines for Pedestrian and Bicycle Traffic in African Cities*. Balkema Publishers, Tokyo, Japan.
- McLaoughlin, B. (1969), *Urban and Regional; A Systems Approach*
- Mugenda, G.A and Mugenda, O. G (2003), *Research Methods: Quantitative and Qualitative Approaches*. African Centre for technology srudies Nairobi, Kenya.

- Ngau, P. and Kumssa, A. (2004). *Research Design, Data Collection and Analysis : Training Manual. INCRD, Development African Office.*
- Ngyuyen Phi Thuong, (2003), Hanoi People's Committee, *Hanoi Authority for Trams and Public Transport Development Management*, sustainable Urban transport Initiatives in Hanoi, SUTP – Asia Planning Workshop, Bangkok, 23 June 2003.
- Njuguna, G. N (2007), *Environmental Planning and Management: towards Better Environmental Law, management, Evaluation and Impact Assessment.*
- Olima, WHA. , 1997): "The Conflicts, Shortcomings and Implications of the Urban Land Management System in Kenya" *Habitat International* Vol 21, No 3, (1997): 319 – 331.
- Replogle, Michael, "*The Role of Bicycles in Public Transportation Access*," Transportation Research Record, No.959, Transportation Research Board, Washington, DC, 1984, p.55-62.
- Replogle, Michael, *Bicycles and Public Transportation: New Links to Suburban Transit Markets*, *The Bicycle Federation*, Washington, DC, 1983 (available from ITDP, 1787 Columbia Rd.NW, Washington, DC 20009).
- Sclar, E. Touber, J. Alexander, C. (2007), Rethinking Privatization: The Case of Urban Transportation in Nairobi, Kenya.* The Center for Sustainable Urban Development, The Earth Institute, Columbia University.
- Tao, C.C. and Hung, C.C (2002) *Comments on Quantitative Methodologies of Urban Sustainable Transportation (in Chinese)*, **2002 Cross-Strait Conference on Urban Transportation**, Kunming, China, August 16-19, 2002.
- The SUSTRAN Network (2000), "*Taking Step: A Community Action Guide to People-Centered Equitable and Sustainable Urban Transport*", Kuala Lumpur: SUSTRAN Network press
- The World Bank (2002) *Cities in the Move, A World Bank Urban Transport Strategy Review*, Washington, D.C.
- The World Bank (2006), *China: Building Institutions for Sustainable Urban Transport* Transport Sector Unit, Infrastructure Department East Asia and Pacific Region.
- The World Commission on Environment and Development (Brundtland Commission) 1987.
- Todd Litman, (2003), *Reinventing Transportation: Exploring the Paradigm Shift Needed to Reconcile Transportation and Sustainability Objectives*, Victoria Transport Policy Institute, 1250 Rudin Street Victoria. BC. V8 3R7, Canada

- UN Millennium Project ,(2005). *Investing in Development: A Practical Plan to Achieve the Millennium Development Goals*. London, UK: Earthscan Press,.
- Walter H. (2010) *Traning course on Non-motorised transport*, commissioned by Federal Ministry for Economic Cooperation and development, D-53113 Bonn. Germany.
- Waswa F. Otor, S. Mugendi, D. (2006) *Environment and Sustainable Development: A guide for Tertiary Education in Kenya*. Kenyatta University, Kenya
- Whitelegg John (1993), "Transport for a sustainable future: The case for Europe", London: Belhaven Press
- Wilmink, A. (2001) "The Effects of an Urban Bicycle Network: Results of the Delft Bicycle Project," Proceedings of the Velo City '87 International Bicycle Congress, op.cit. p. 233-238. and several other articles in the same conference proceedings.
- Yigitcanlar, T. Fabian, L. Coiacetto, E. (2009), *Challenges to Urban Transport Sustainability and Smart Transport in a Tourist City: The Gold Coast, Australia*. Queensland University of Technology, School of Urban Development, Brisbane, Queensland, Australia
- Yuri Tevdokimov (2002) *Sustainable Transportation System: A System Dynamics Approach*, International Conference on Public Economic Theory, Paris, France, July 4-6, 2002.

APPENDICES

APPENDIX I

UNIVERSITY OF NAIROBI

| |
|---------------------------|
| Questionnaire No.----- |
|---------------------------|

| |
|-----------|
| Date..... |
|-----------|

SCHOOL OF BUILT ENVIRONMENT
DEPARTMENT OF URBAN AND REGIONAL PLANNING

Challenges and Opportunities for Sustainable Urban Mobility (Non-Motorized Transport): A case study of Nairobi central Business District- ('Nyamakima Area').

STRUCTURED QUESTIONNAIRE FOR ROAD USERS

Declaration: The information given will be treated with confidentiality and used for academic purpose only

Please answer the Questions as instructed

Name of the Road/Highway/Avenue.....

Respondents Details

1. Name (Optional).....

2. ***Age(years)***

1. Below 18 2. 18-36 3. 37-55 4. Over 55

| |
|--|
| |
|--|

3. **Sex:** 1. Male 2. Female

4. **Marital status** 1. Single 2. Married 3. Divorced 4. Separated 5) Others
Specify.....

5. **Educational Level** 1. No formal education 2. Primary
level 3. Secondary level, 4. Tertiary college 5. Village polytechnic
6. University level

6. **Occupation** 1. Formal employment 2. Self-employed 3. Farmer 4. Manual
labourer 5. Others (specify)

7. Journey mode to the study area

1. Walking 2. Cycling 3. Motor Bike 4. Pers

8. **Where is your place of origin?** 1 Westlands 2. Kasarani 3. Kamkujni 4.
Embakasi 5. Langata 6. Staraha 7. Dagoreti 8. Others

9. **Where is your destination1?** Westlands 2. Kasarani 3. Kamkujni 4. Embakasi
5. Langata 6. Staraha 7. Dagoreti 8. NCBD 9. Others

10. **How long do you take (Minutes) to reach your destination?** 1 (1-20
minutes) 2. (21-40 minutes) 3. (41-60) minutes 5
(others)

11. **Are you satisfied with the time you take?** Yes.....1). No.....

12. If No what can be done to reduce your journey time.....

.....
.....

13. **What is the purpose of your journey?** 1) work 2). school 3) Shopping 4)
Business 5) others Specify...

14. What time of the day do you take long to reach your trip

1.5.00 -7.00 am 2.7.am-9.am 3.9.01- 11am 4. 11.01-1.00pm 5. 1.01-3.00pm 6
3.01-5.00pm 7. 5.01-7.00 pm

15. **What is your preferred mode of transport within the area?** 1. Walking 2.
Cycling 3. Motor bike 4. Public transport 5. Personal car 6. Others

**16.How would you describe the condition of each of the Non-Motorized
Transport infrastructure (Foot paths and cycle tracks) along this road**

a) Foot paths 1. Excellent.... 2. Good..... 3. Satisfactory.... 4 Poor....

b) Cycle tracks 1. Excellent.... 2. Good..... 3. Satisfactory.... 4 Poor....

**17.What do you suggest the Central and County Government can do to
improve the NMT within the area?**

a)

b)

c)

d)

**18.What are the potential of NMT within the CBD and how can it be
exploited**

a)

b)

c)

d)

**19.According to you, who are the key players within the transport sectors and what
can they do to promote the NMT.**

a)

b)

c)

d)

APPENDIX II

UNIVERSITY OF NAIROBI
SCHOOL OF BUILT ENVIRONMENT
DEPARTMENT OF URBAN AND REGIONAL PLANNING

Challenges and Opportunities for Sustainable Urban Mobility (Non-Motorized Transport): A case study of Nairobi central Business District- (Nyamakima Area).

TRAFFIC TALLY SHEET FOR River Road, Location.....

| Traffic type | 06:00- 07:00 | 07:00- 07:30 | 07:30- 08:30 | 08:30- 09:00 | 16:30- 17:00 | 17:00- 18:00 |
|---|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Private car (One passenger) | | | | | | |
| Private car (two or more passenger) | | | | | | |
| Public Transport (14 seater Matatu) | | | | | | |
| Public Transport (more than 14 seater Matatu) | | | | | | |
| Private Bicycle | | | | | | |
| Commercial cycle | | | | | | |
| Motorcycle | | | | | | |
| Hand cart | | | | | | |
| Pedestrian | | | | | | |

APPENDIX III

UNIVERSITY OF NAIROBI
SCHOOL OF BUILT ENVIRONMENT
DEPARTMENT OF URBAN AND REGIONAL PLANNING

Challenges and Opportunities for Sustainable Urban Mobility (Non-Motorized Transport): A case study of Nairobi central Business District- (Nyamakima Area).

TRAFFIC TALLY SHEET FOR Kumasi Road, Location.....

| Traffic type | 06:00-07:00 | 07:00-07:30 | 07:30-08:30 | 08:30-09:00 | 16:30-17:00 | 17:00-18:00 |
|---|-------------|-------------|-------------|-------------|-------------|-------------|
| Private car (One passenger) | | | | | | |
| Private car (two or more passenger) | | | | | | |
| Public Transport (14 seater Matatu) | | | | | | |
| Public Transport (more than 14 seater Matatu) | | | | | | |
| Private Bicycle | | | | | | |
| Commercial cycle | | | | | | |
| Motorcycle | | | | | | |
| Hand cart | | | | | | |
| Pedestrian | | | | | | |

APPENDIX IV

UNIVERSITY OF NAIROBI
SCHOOL OF BUILT ENVIRONMENT
DEPARTMENT OF URBAN AND REGIONAL PLANNING

Challenges and Opportunities for Sustainable Urban Mobility (Non-Motorized Transport): A case study of Nairobi central Business District- (Nyamakima Area).

TRAFFIC TALLY SHEET FOR Kirinyaga road, Location.....

| Traffic type | 06:00- 07:00 | 07:00- 07:30 | 07:30- 08:30 | 08:30- 09:00 | 16:30- 17:00 | 17:00- 18:00 |
|---|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Private car (One passenger) | | | | | | |
| Private car (two or more passenger) | | | | | | |
| Public Transport (14 seater Matatu) | | | | | | |
| Public Transport (more than 14 seater Matatu) | | | | | | |
| Private Bicycle | | | | | | |
| Commercial cycle | | | | | | |
| Motorcycle | | | | | | |
| Hand cart | | | | | | |
| Pedestrian | | | | | | |

APPENDIX V

UNIVERSITY OF NAIROBI
SCHOOL OF BUILT ENVIRONMENT
DEPARTMENT OF URBAN AND REGIONAL PLANNING

Challenges and Opportunities for Sustainable Urban Mobility (Non-Motorized Transport): A case study of Nairobi central Business District- (Nyamakima Area).

INTERVIEW FOR KEY INFORMANTS (Transport Engineer, Spatial Planners, Traffic Police officers, Geo-spatial Engineer)

Declaration: The information given will be treated with confidentiality and used for academic purpose only

Please answer the Questions as instructed

Qtn No.....

Name of the Road/Highway/Avenue.....

Respondents Details

1. Name (Optional).....
2. **Age(years)**
1. Below 18 2. 18-36 3. 37-55 4. Over 55
3. **Sex:** 1. Male 2. Female
4. **Marital status** 1. Single 2. Married 3. Divorced 4. Separated 5) Others Specify.....
5. **Educational Level** 1. No formal education 2. Primary level 3. Secondary level, 4. Tertiary college 5. Village polytechnic
6. University level
6. **Occupation** 1. Formal employment 2. Self-employed 3. Farmer 4. Manual labourer 5. Others (specify)
7. **Journey mode to the study area**
2. Walking 2. Cycling 3. Motor Bike 4. Pers
8. Where is your place of origin 1. Westlands 2. Kasarani 3. Kamkujni 4. Embakasi 5. Langata 6. Staraha 7. Dagoreti 8. Others
9. Where is your destination 1. Westlands 2. Kasarani 3. Kamkujni 4. Embakasi 5. Langata 6. Staraha 7. Dagoreti 8. NCBD 9. Others
10. How long do you take (Minutes) to reach your destination 1 (1-20 minutes) 2. (21-40 minutes) 3. (41-60) minutes 5 (others)
11. Are you satisfied with the time you take `). Yes.....1). No.....

12. If No what can be done to reduce your journey time.....
.....
.....

13. What is the purpose of your journey 1) work 2). school 3) Shopping 4) Business 5) others Specify...

14. What time of the day do you take long to reach your trip 1.5.00 - 7.00 am 2.7.am-9.am 3.9.01- 11am 4. 11.01-1.00pm 5. 1.01-3.00pm 6 3.01-5.00pm 7. 5.01-7.00 pm

15. What is your preferred mode of transport within the area 1. Walking 2. Cycling 3. Motor bike 4. Public transport 5. Personal car 6. Others

16. How would you describe the condition of each of the Non-Motorized Transport infrastructure (Foot baths and cycle tracks) along this road
c) Foot paths 1. Excellent.... 2. Good..... 3. Satisfactory.... 4 Poor....
d) Cycle tracks 1. Excellent.... 2. Good..... 3. Satisfactory.... 4 Poor....

17. How would you describe the condition of each of the Non-Motorized Transport infrastructure (Foot baths and cycle tracks) along **Race Course Road**
e) Foot paths 1. Excellent.... 2. Good..... 3. Satisfactory.... 4 Poor....
f) Cycle tracks 1. Excellent.... 2. Good..... 3. Satisfactory.... 4 Poor....

18. What are the major sustainable transportation planning challenges of NMT within the CBD.
a)
b)
c)
d)

19. What do you suggest the Central and County Government can do to improve the NMT within the CBD.
a)
b)
c)
d)

20. What are the potential of NMT within the CBD and how can it be exploited
e)
f)
g)
h)

21. According to you, who are the key players within the transport sectors and what can they do to promote the NMT.
a)
b)
c)