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DEPARTMENT OF ARCHITECTURE
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IMPACT OF A ROAD PROJECT ON LAND USE: A CASE STUDY OF NGONG ROAD CORRIDOR IN NAIROBI

BY

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DECLARATION

I, Nyambok Silas Ogut, do hereby declare that this Research Project is my original work and has not been presented for a degree in any other university.

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DEDICATION

This work is dedicated to my late wife Adeline and my children Garang, Moreno Asure and Hapruoth for their endurance and comfort during the study period. To my late wife, you left us during the process of bringing forth Baby Hapruoth as I made final touches to this report. It's regrettable that you didn't see me graduate. Nevertheless, the radiance on the face of Baby Hapruoth brings us more hope. May your soul rest in eternal peace. To my Late Mother Teresa Nyosindi, your prayers still ring in my memory.

Eccl 9: 11-12 (NKJV)

"I returned and saw under the sun, that the race is not to the swift, nor the battle to the strong, nor bread to the wise, nor riches to men of understanding, nor favour to the skillful; but time and chance happens to them all"

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ABSTRACT

Several studies have been done on the "egg-hen" relationship between transportation and land use. It is considered a egg-hen relationship because several scholars have differed on what comes first. Some argue that it is land use that comes first while to others transportation is the driving force for land use. Nevertheless, transportation is a cascading phenomenon in its relationship with land use whereby one event triggers a sequence of secondary events or spontaneous developments. Being an important parameter in any urban area, management of transportation system should be a major focus for any urban manager for it is through free movement of people, goods and services that cities thrive and act as engines of development in any country.

Because of its cascading nature, transportation must be considered as a dynamic system. This therefore implies no development in transportation should be viewed in isolation but its impact on the functioning of the system. Due to the high density of transport networks within urban areas, the cascading phenomenon is even more spontaneous within such agglomerations and always result in negative consequences. This therefore implies that urban authorities must have transport departments that can be responsive to the dynamics to ensure that new developments do not create crises but integrate with the system.

Expansion of an urban corridor like Ngong Road always bring a sigh of relief to the people served by it and those who live within the neighbourhood and those in the sub-urban nodes that it serves. However, such upgrades only results into temporary solution to the transport crisis along the corridors before the situation deteriorates and may even worsen in comparison to what previously existed. This is because the upgrade triggers a series of land use changes that in return affects the functionality of the corridors.

This research was thus focused at examining the effect of Ngong Road upgrading on land use with a view to ensuring that the quality of service of the corridor with regard to the transport utility that it offers is maintained at optimum levels. The research explores the influence of the upgrade on the neighbourhood land use changes and assesses the developing land use patterns as precipitated by the upgrade. The major goals of the research were to determine the urban land use change patterns and their link to the urban transportation system and to investigate the issues that emerge out of the upgrade of Ngong Road.

The research technique adopted is survey that aided in the delimitation of the study region and relied on both primary and secondary data gathered via questionnaires, informal interviews alongside direct participant observation and field photography of key characteristics. For data gathering, the research depended on secondary information while the main data was acquired by procedures such as questionnaire administration, informal interviews alongside direct participant observation and field photography of significant aspects. The spatial frame for the study was defined by the area sandwiched between the intersection of Valley Road and Argwings Kodhek Road, City Mortuary Roundabout, Ngong Road up to Ring Road Kilimani then Southwards up to intersection of Joseph Kangethe Road, Ole Dume Road and looping back to start point through Argwings Kodhek Road. The scope of the variables looked at in terms of infrastructure were

transportation characteristics of Ngong Road and its neighbourhood, the design parameters for the road especially the level of service and the land use changes from inception to completion of project. The land use changes evaluated in the study are those that define housing typologies, plot ratios and plot coverage and the applicable zoning ordinances. The study relied on sample size of 400 respondents divided equally among households and road users.

Among the findings of the study included the revelation that at the end of the design life for the road which was the year 2020, the level of service would deteriorate to irregular traffic flow or congestion implying that another intervention should needed to be introduced to maintain it to stable vehicular flow. However, this coincided with the time the project was completed. The study also disclosed that there is poor enforcement of development control in Kilimani Area with minimal compliance to regulations on plot ratios and ground coverages. Highrise residential apartments constitute the dominant housing typology in the area followed closely by multiple dwelling units and office blocks. Subsequently, there is rapid densification of the area without any corresponding expansion of infrastructure. The study also found out that there was little understanding among citizens on the relationship between transportation and land use with most people viewing the upgrade of the corridor as the panacea to the transportation challenges within the neighbourhood.

The study acknowledges the importance of constant monitoring and evaluation of urban mobility with timely interventions, strengthening of development control, embracing of public-private partnership in infrastructure provision and focusing more on transport demand management rather than supply management.

The study concludes that for sustainable integration of transportation and land use in a neighbourhood like Kilimani, a traffic demand management policy should be pursued as a national goal with clear definition of which institution ensures that the infrastructure mix provided is adequate to meet the needs.

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List of Abbreviations

AASHTO American Association of State Highways and Transportation Officials

CBD Central Business District

CoP Conference of Parties

EPI Eastern Planning Initiative

FY Financial Year

GHG Green House Gases

GOK Government of Kenya

ICLEI International Council for Local Environmental Initiatives

JICA Japan International Cooperation Agency

KBS Kenya Bus Service

KENHA Kenya National Highways Authority

KEPSA Kenya Private Sector Alliance

KNLS Kenya National Library Service

KPHC Kenya Population and Housing Census

KUR Kenya Uganda Railway

KURA Kenya Urban Roads Authority

LASDAP Local Authority Service Delivery Action Plan

LoS Level of Service

NACOSTI National Council of Science and Technology

NAMATA Nairobi Metropolitan Area Transport Authority

NCC Nairobi City Council

NCCG Nairobi City County Government

NEMA National Environment Management Authority

NIUPLAN Integrated Urban Planning Master Plan for Nairobi City

NMT Non-Motorized Transport

NUTRANS Master Plan for Urban Transport in Nairobi Metropolitan Area

OTREC Organization of Tropical East Pacific Convention

pcu Passenger car units

PTE Passenger Transport Executive

SPSS Statistical Package for Social Sciences

TCSP Transportation and Community System Preservation Programme

TDM Traffic Demand Management

TfGM Transport for Greater Manchester

UN United Nations

UNCHS United Nations Centre for Human Settlement (UN-Habitat)

WHO World Health Organization

CHAPTER ONE: INTRODUCTION

1.1 Background

Transportation is a cascading phenomenon whereby on occurrence triggers a series of secondary or spontaneous events (May, 2007). Its role in the functioning of an urban area cannot be overemphasized as it stands as an indispensable instrument of development for any urban agglomeration. Because urban centers all over the globe depend on reliable transportation to operate smoothly, it has been referred to as the bedrock of city life and is an essential tool for their growth and sustainability (Solanke, 2013). Being an important parameter in any urban area, management of transportation system should be a major focus for any urban manager. It is through unhindered circulation of goods, services and even people that cities thrive and act as engines of development to any country. Because of its domino effect, transportation is best seen as a living system. Therefore, it is essential that the effects of any transportation advancement on the whole system's efficiency be taken into account.

Transportation and land use patterns are intrinsically linked, with the latter having repercussions throughout the economic, social, and environmental spectrum. Facilities and indirect repercussions resulting from changes in land use development patterns are within this constellation's purview. While some transportation policies favor sprawling, car-dependent development on the outside of cities, others encourage denser, transit-oriented expansion in urban cores (smart growth). The economic, social, and environmental effects of these changes are multi-faceted (Litman, 2017).

During planning for transportation, decisions are reached on which land or its sections should be delineated for roads, parking lots and ports. This finally has an impact on the relative accessibility and development costs in different locations (Boarnet et al, 2008).

Accessibility and mobility (the capacity to transport people and products) are sometimes competing goals in planning choices (the ability to reach desired goods and activities). When the number of roads and parking lots expands, land is used more sparsely, resulting in longer commutes for the same degree of convenience. This is helpful for car travel but detrimental to other forms of transportation. Higher road and parking requirements encourage growth on the urban perimeter, where land values are cheaper, since they increase the quantity of land needed for a given level of development.

When making transit planning decisions, it may be challenging to identify the direct and indirect effects on land use. The degree to which a certain transportation project will increase accessibility and decrease costs, and the degree to which a transportation policy or project interacts with other elements, are all important considerations when assessing potential impacts. The city's master plans are an attempt to bring together transportation and land use.

There was a need for improved road design and alignment in Nairobi, which began taking form in the 1920s. The city of Nairobi's zoning and segregated land use patterns were established under the 1948 Nairobi Master Plan for a colonial metropolis, which also largely delineated the city's urban transit system. However, the city's transportation infrastructure has significant holes since not all master plan suggestions were executed.

To lessen the high (staff) density in the Central Business District, the Nairobi Urban Study Group of 1973 advocated for the decentralization and establishment of alternative service hubs among the various districts of the city. This plan became known as the Nairobi Metropolitan Growth Strategy. The secondary centers farther afield might grow into significant communities on their own, apart from the city's core. They could have distinct sub-zones for manufacturing, commerce, and government. Service centers would be placed along major highways and bus lines to attract customers from surrounding communities and those using those routes.

The roadways were supposed to be laid out in a modified grid pattern, making it easy to travel to and from any combination of business, industrial, and residential locations. However, due to capacity shortages on the part of the now-defunct City Council of Nairobi, as well as a lack of commitment and political will, many of the proposals included in the 1973 Nairobi metropolitan growth strategy plan were not implemented, greatly worsening the condition of many roads in the city.

Used cars, especially minibuses and buses, flooded Nairobi in the 1990s. This happened as a result of liberalization and the free market in the Kenyan economy. The increase of walkers, cyclists, and drivers in the Central Business District was not unexpected. That occurred despite the fact that the terminals and highways weren't extended. It caused massive, unanticipated traffic jams in the city of Nairobi, despite no increase in the city's capital works program or anti-traffic-jam efforts.

There seems to be no overarching strategy for the development and administration of the city's transportation system, and instead, infrastructure spending are being directed in accordance with the politics of the day. Several deficiencies in legislation, planning, and

institutions contribute to the lack of concern for transportation system integration. Negative environmental consequences, including as increased traffic congestion, pollution, road accidents, a drop in public transportation, environmental degradation, and inaccessibility for the urban poor, have come from Nairobi's rapid urbanization and high traffic growth rates. As a consequence of gridlock, the city's central business district has been overrun by motor-cycle taxis known as boda bodas. Since motor bikes cannot be effectively used as public transportation in a city, it is commonly anticipated that the invasion would cause more disruptions to the system.

Ngong Road is an important thoroughfare that connects the city of Nairobi with the suburb of Ngong. Upper Hill, Kilimani/Hurlingham, Woodley, Jamhuri, and Lavington are all areas that are expanding rapidly, and this road is a major thoroughfare that connects them to the rest of Nairobi. It serves the rapidly expanding communities of Ngong, Karen, Kawangware, Riruta Satellite, Kikuyu, and Uthiru, in addition to the western suburbs of Nairobi. As part of the Nairobi Roads Network Improvement Programme, which seeks to widen, repair, and re-carpet most roads in the city, this one is currently undergoing construction. Nairobi serves as a major entry point and point of view into Kenya, so this is very important. The Japanese government is providing funding for the entire three-stage endeavor through the Japan International Cooperation Agency (JICA). Phase I includes the first 2.5 kilometers of the route from the Kenya National Library Service (KNLS) to the Prestige Plaza. The distance covered by Phase II, from Prestige Plaza to Dagoretti Corner, is 3.3 kilometers. Phase III consists of the intersection of Dagoretti Corner and Karen Road, as well as the Karen Road Section and the Langata Road Section.

Critical works are being done in Phase I. These include a box culvert, drainage facilities, and bus bays, as well as a four-lane dual carriageway, three crossroads, and provision for non-motorized transport in the form of walkways and bike tracks on both sides of the road. Congestion in this corridor is a cause for worry. Not only does it link a populated and rising catchment region with the city, but it also has one of the largest concentrations of automobile traffic in the nation, which had admittedly delayed the upgrading operations. The dualization of Ngong Road was envisioned as a benefit for the city as a whole and its sprawling suburbs. The overarching goal was to minimize air pollution from a large number of cars travelling at a slow pace, which would lead to a cleaner environment and boost socio-economic development in the regions that would be serviced.

1.2 Problem Statement

Transportation is a cascading phenomenon and this implies that any development in the transport system in a city like Nairobi is bound to cause a ripple effect into the system with both positive and negative consequences. The lack of a responsive transport management system in the city implies that the cascading effects of any new development are merely left to fit into the system with serious negative 'back flow' effects on the system. The back-flow effects if left unchecked over a long period of time results into disastrous impacts like traffic speeds tending towards stagnation during peak hours, air pollution, unruly traffic behaviour and frequent road accidents as currently witnessed in Nairobi.

The fundamental aspect in the production of trips is the interplay between land use and transportation. Investments in transportation continue to have a significant impact on land

use patterns, urban density, and housing costs (Cervero, 1995). For the most part, sprawl is enabled by our transportation infrastructure (Behan, et al, 2008). Land use choices and the concentration of people in their homes must be carefully planned out in order to have an efficient transportation network. According to Handy (2005), more roadways mean greater sprawl, which means more people driving. One centralized transportation system is not the best answer. Planning that follows the traditional paradigm focuses on infrastructure development and environmental upkeep after transportation issues have already been identified and addressed (Gulhan et al (2013). The consequences of land use choices become permanently embedded once the building phase ends. Traffic impact studies are a useful tool for measuring and controlling the effects of changes in land use and transportation.

Making cities and human settlements inclusive, safe, resilient, and sustainable, is enshrined in United Nations Sustainable Development Goal No. 11. According to the European Commission (2013), the primary objective of the Sustainable Urban Mobility Plan is to increase urban residents' access to and use of high-quality, environmentally friendly means of getting around and within cities. Therefore, rather than just expanding the length of urban transport infrastructure or increasing the mobility of the people, urban planning and design should concentrate on ways to link people and places together by creating cities that focus on accessibility.

The combination of all these factors indicates that there is a need to examine the cascading phenomenon of transportation whenever new developments occur within the city’s transport network. This ensures that management strategies are in place such that the level of service is maintained at or above the optimum characterized by adequate

mobility with acceptable levels of traffic congestion, adequate access to various services and opportunities (land uses), availability of travel options through mainstreaming of infrastructure that facilitate modal split in travel, emphasizes on non-motorized modes of transport, improved safety to road users, citizen satisfaction with the transport system as well as provision of clean and livable environment where levels of air pollution does not exceed limits recommended by World Health Organization (WHO).

Such a system should culminate in sustainable transportation system with the following attributes:

When seen from a social viewpoint, a sustainable transport system is one that keeps current and future generations connected while also meeting the fundamental needs of people, businesses, and the community at large. Economically, it should boost competitiveness, equity and regional development and finally, from an environmental viewpoint; it should encourage the use of renewable resources and the limitation of emissions and waste in relation to the planet's absorption capacity. Possessing these characteristics may help avert potential future harm.

Just as had been observed with the upgrade of other arteries within the City of Nairobi including Jogoo Road, Langata Road, Thika Road; the upgrade of Ngong Road was expected to promote ribbon development towards the Southern periphery of the city as well as densification within the neighbourhood of the artery. The carrying capacity of the artery was therefore bound to be exceeded due to increased generated traffic and subsequently, as per the usual trend with expanded arteries, this corridor was bound to also fail in meeting its functionality.

The study therefore sought to establish the prevailing transport and neighborhood land use conditions and to review the ongoing and proposed corridor improvements and plans within the study area using appropriate analytical methods, procedures and manuals then make appropriate recommendations on how the expected transportation impacts due to the upgrade may be mitigated.

1.3 Study Goal

The study sought to evaluate the impact of Ngong Road corridor upgrade on land use.

1.4 Research Objectives

Accordingly, the research objectives were:

(i) To identify the urban land use transformation patterns and their relationship to the urban transportation system.

(ii) To examine the challenges that result out of the upgrading of Ngong Road.

(iii) To make recommendations on effective transport management strategies to maintain the level of service of the artery.

1.5 Research Questions

The study seeks to answer the following questions:

(i) What are the urban land use transformation patterns likely to occur due to upgrade of Ngong Road and what is their relationship to the urban transportation system?

(ii) What are the challenges that result out of the upgrading of Ngong Road?

(iii) What transport management strategies can be used to maintain the level of service of the artery?

1.6 Research Assumptions

The study made the following assumptions:

(i) Due to the documented trends of urbanization in Kenya and Nairobi in particular, the city will continue to grow in population resulting in high densities along Ngong Road Corridor. This this will result into increased traffic in terms of volumes and density with heavy congestion during peak hours.

(ii) Unrestrained car use will persist alongside use of low capacity passenger vehicles and growth in traffic volumes will follow the current trends. Subsequently, there will be a need for management interventions to maintain the operation of transportation system at optimal levels.

(iii) The profit maximization motive will play a key role in determining development trends along the corridor. The upgrade of the corridor will result in increased land values shifting preferences for investment towards commercial development leveraged on the urge to maximize profits from the high land values. Commercial developments require large plot coverages resulting in space limitations and the need to maximize the use of available spaces. This will result in emergence of high-rise development culminating in population increase and increased vehicular traffic along the corridor. The end result will be increased traffic congestion and other negative consequences on transportation functionality.

1.7 Research Proposition

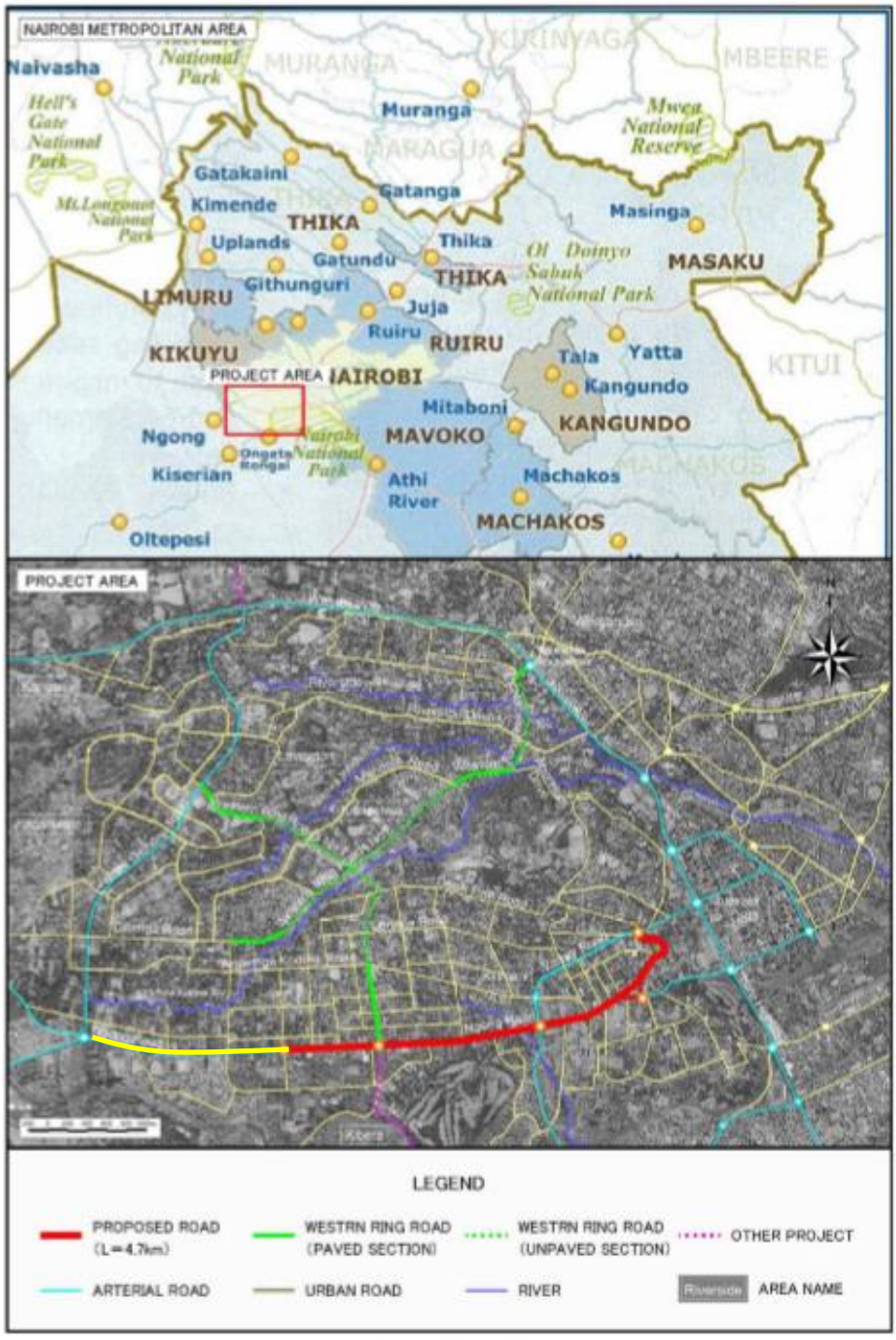
Transportation influences land values, land uses, development densities and typologies and leads to adverse and positive neighborhood transformation that has ripple effect on the transportation corridor.

1.8 Geographical Scope of the Study

The research was conducted in the Nairobi region, namely along Ngong Road. The study's nodes may be located in the Central Business District as well as in outlying communities such as Ngong and Kiserian. Urban land use transformation patterns and their connection to the urban transportation system were taken into account, as well as the difficulties that may arise as a consequence of the road improvement, in the course of the research.

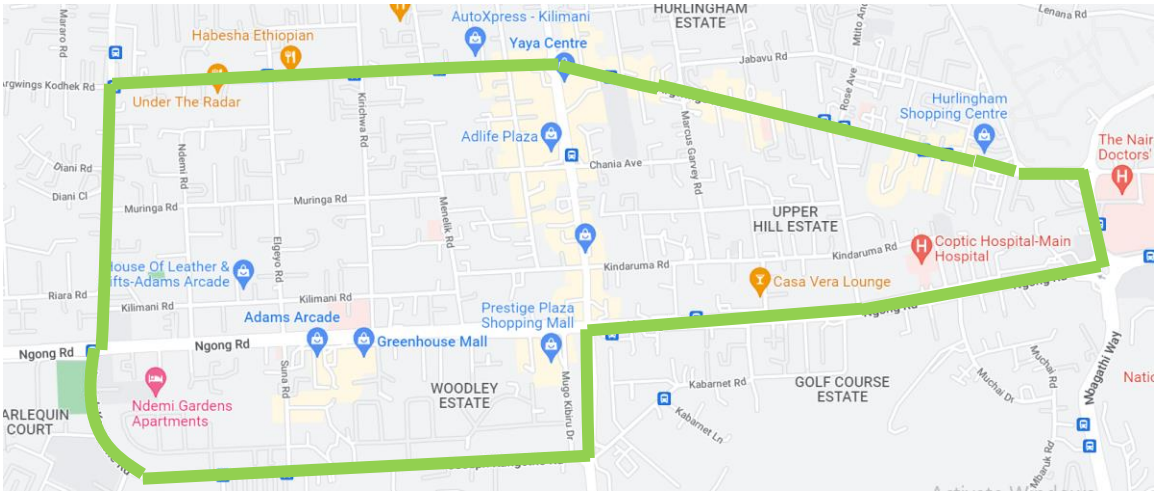
The beginning of the artery at Kenyatta Avenue and its ending point at Dagoreti Corner were taken into account in order to draw conclusions about the artery's health and efficiency. That's the equivalent of 10.6 miles. The study area encompasses the area between the junction of Valley Road and Argwings Kodhek Road; the City Mortuary Roundabout; Ngong Road; Ring Road Kilimani; the junction of Joseph Kangethe Road and Ole Dume Road; and finally, the junction of Argwings Kodhek Road and Valley Road, where the study began. The project route and the physical framework of the research area are shown in Maps 1.1 and 1.2 below.

Map 1.1: Nairobi Metropolitan Area showing project Road



(Source: KURA)

Map 1.2: The Study Area



Source: Google Maps

1.9 Justification of the study

Transportation has been called the city's "engine" and the "software" that runs the city's operations. Cities with well-developed transportation networks are magnets for investment, innovation, and productivity, and their prosperity has a multiplier effect on the national economy.

Increased land prices brought about by improving the Ngong' Road corridor would cause investors to change their focus from residential to commercial construction so that they could reap the most possible financial benefit from the latter. This would lead to the proliferation of high-rise buildings, which in turn would lead to an increase in the corridor's population and the number of cars using it. As a result, there will be more congestion and other problems with how well transportation systems work.

It is expected that the peri-urban communities, which are outside the reach of the already established urban services and authorities, would see some expansion as a result of the corridor renovation. The poor, in particular, may find it more difficult to get access to

jobs and urban amenities as a result of expansion that mostly consists of urban sprawl and an increased reliance on personal automobiles.

Transportation issues are hurting city economies due to urban expansion and growing car use. Careful coordination of transport policies within a larger city development strategy is essential for the success of structural policies like well-planned transport infrastructure growth, planned deconcentration, complete management of land-use structure, or liberalization of land markets. In fact, the government may utilize the study's findings to inform policy decisions that would help alleviate congestion along the corridor, and such policies might be applied to other corridors as well.

1.10 Limitations of the Study

Improving a city's transportation spine requires extensive preparation, investigation, and implementation on the engineering and planning fronts. This research, however, did not focus on the specifics of road planning and engineering but rather on the projected effects of a finished project and the related management difficulties surrounding integration. Research projects of the past have shown that there is a lot of apathy towards researchers and access to information, particularly from government offices. This meant that not all of the information could be officially received.

Due to the numerous nodes, accesses, and diverse land uses associated with Ngong Road, a comprehensive transportation study requires enormous resources, time, and several research assistants for data collection and analysis. Nonetheless, the researcher tried to make the most of limited resources and a small team of helpers to ensure that data collection and analysis went smoothly. This resulted from a review of existing patterns rather than projections based on the acquired data. Real-world data, or information

collected by government agencies, engineering firms, and commercial parties (such as real estate companies), was also used to solve the issue.

1.11 Operational Definitions of Terms Used in the Text

Level of Service (LoS): This is a qualitative index that is used to compare different traffic services for automobiles. Using performance metrics such as vehicle speed, density, and congestion, it classifies traffic flow and assigns quality levels of traffic on roads and crossings. Smooth driving is represented by Level A, whereas heavy congestion is indicated by Level F.

Vision 2030: Kenya's long-term economic strategy, which stretches from 2008 to 2030. The plan's end goal is for Kenya to become an industrialized middle-income nation by 2030, ensuring that all of its residents may enjoy a safe and prosperous lifestyle. The plan was anchored on social, political, and economic tenets. It was to be carried out in a series of five-year programs, the first of which ran from 2008 to 2012.

Zones 3, 4 and 5: Show the full extent of the land that was intended for specific development ordinances under the planning regulations. Zone 3 includes the neighborhoods of Parklands, City Park Estate, and Westlands. Zone 4 consists of the areas around Lower Spring Valley and Riverside Drive as well as Kileleshwa, Kilimani, Thompson, and Woodley, whereas Zone 5 includes the areas of Upper Spring Valley, Kyuna, Loresho, and Lavington.

Missing Link number 7: According to the 2006 Master Plan for Urban Transport in Nairobi, among 19 others, this marks the expansion of Ring Road Kilimani from Yaya Centre via Lavington linking to James Gichuru Road (NUTRANS). The link roads alleviate traffic on the main thoroughfares by providing essential radial connection.

Real World Data: Data collected by systematic observation rather than experimentation; examples include statistics on traffic accidents, home sales and pricing, satellite images and others.

Conference of Parties (COP): As a delivery mechanism for the UN Framework Convention on Climate Change (UNFCC), this biennial (since 1995) two-week meeting is held each year. While its primary purpose remains that of a formal negotiation session during which countries advance their climate commitments and actions, it has also become an important forum for a wide variety of stakeholders from around the world to gather and discuss the climate crisis and potential solutions.

Public-Private Partnership: An agreement or contract for the financing, development, operation, and maintenance of public facilities that is signed between public and private sectors.

Outcome: The results that a program or activity aims to achieve.

Outputs: The goods and services that a program or project produces by applying inputs

Climate Change: Long term and large-scale changes to the Earth's climate attributed to changes in the Earth's atmosphere.

Green House Gases: These gases contribute to the green house effect by absorbing infrared radiation (net heat energy) released from Earth's surface and re-radiating it back to the planet. Included in this category are carbon dioxide, methane, water vapor, nitrous oxides, and even, to a lesser degree, ozone from the earth's surface. Currently, atmospheric carbon dioxide and other greenhouse gases keep Earth's surface at a comfortable 15 degrees Celsius, but without them, that number drops to a frigid 18.

Urban Areas and Cities Act (UACA): A law enacted by the Kenyan legislature in response to Article 184 of the country's constitution (2010), this piece of legislation establishes guidelines for the organization, administration, and management of urban areas and cities, as well as criteria for their creation and a foundation for citizen participation in their management.

LASDAP: It stands for Local Area Service Delivery Action Plan. The goal of this planning instrument that was under Kenya's now-defunct local governments was to increase citizen engagement via the use of participatory monitoring and evaluation. Money from the Local Authority Transfer Fund (LATF) was distributed to the previous local governments. Authorities at the local level were obligated to dedicate some of the money they received from the national government as part of the LASDAP procedure, which encouraged citizen participation. County Budget and Economic Forums (CBEF) have succeeded LASDAP with the advent of county governments under the devolved form of government.

Accesibility: The ability to reach desired goods, services, activities and destinations.

Automobile Dependency: Patterns of land use and transportation that encourage heavy reliance on private automobiles while providing few other viable options for getting about. Various motorized vehicles, such as passenger cars, minivans, SUVs, and motorbikes, are all included under the umbrella term "automobile" here.

Density: The number residents, households or employees in an area.

Smart Growth: Practice of land use planning and design whose emphasis lies in improving community accessibility and resource efficiency. It is the alternative to sprawl.

Sprawl: Land use patterns that are spread out, low-density, and single-use (i.e., residential, commercial, and institutional land uses are separated) favours car use over provision of walking facilities and as a result, they are characterized by wide roads, ample parking, massive blocks, and no regard for pedestrians.

Transit Oriented Development (TOD): The term "transit-oriented development" (TOD) is used to describe residential and commercial areas that prioritize accessibility by public transit and non-motorized modes of transportation and that include additional elements to promote transit utilization. The hub of a TOD is usually a train or bus station, and the surrounding area is often densely developed, with less dense areas located farther away.

1.12 Organization of the Study

This study is arranged into six chapters. Chapter one discusses the study concept by detailing out the objectives, research questions, study assumptions, as well as the operational definition of key terms used in the text. Chapter two presents background information to the study area which in this case is Ngong Road and its neighbourhood alongside its spatial and geographical niche in the city of Nairobi and in the region. Chapter three delves on the literature review and the dialectics of transportation and land use as presented by previous scholars. The conceptual framework for the study is also built and presented in this chapter. Chapter four tackles the research methods and techniques used in data collection and preparation while chapter five which is an analysis chapter presents land use and transportation dynamics and the existing situation alongside the trends and determinants. Chapter six is a presentation of recommendations and proposals towards a sustainable coherence between transport and land use within the neighbourhood of Ngong Road.

CHAPTER TWO: THE STUDY AREA

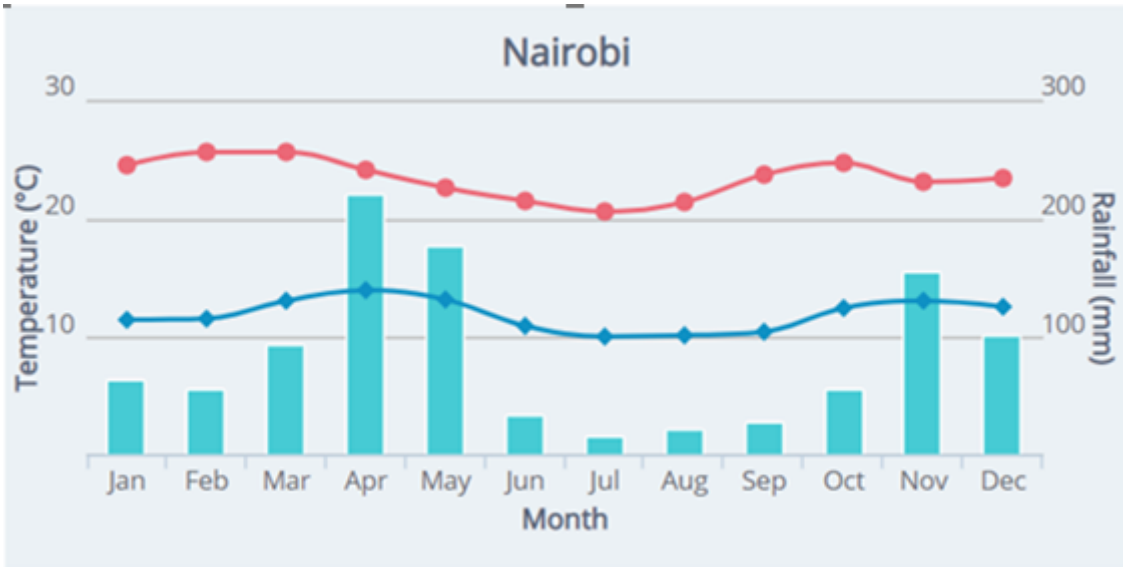
2.1 Introduction

This chapter presents a description of the location of the study area in relation to the transportation and land use challenges inside the corridor and its neighbourhood. It sets the research area within the national, regional and local context with an intention of highlighting the physical link between Ngong Road and the greater Nairobi. To achieve this it is vital to emphasize the historical evolution of the studied region both in time and space as well as the physical and environmental aspects of the same. It aimed to determine the transportation function of Ngong Road in conjunction with land use changes that it supports.

2.2 Location of the City

Nairobi's GPS coordinates are 1o 17' 11.0004" S and 36o 49' 2.0028" E, putting it on the southern edge of Kenya's agricultural heartland. Nairobi has a temperate climate thanks to its elevation of 1,795 meters (5,889 feet) above sea level. Even in the summer months of June and July, the altitude may cause nighttime lows of 10 °C (50 °F). From December through March, daily highs average in the middle 20s and the sun shines the most. The average high at this time is about 75 degrees Fahrenheit (24 Celsius). There are two wet seasons, however the precipitation is usually not excessive. After the first rainy season ends, the cloudiest period of the year begins, lasting until around September. Nairobi's proximity to the equator means that seasonal changes are mild. There is a rainy season and a dry season. Due to Nairobi's closeness to the equator, there is not a great deal of variation in the times of dawn and sunset throughout the year (UN, 2007). Table 2.1 below shows the current weather averages for Nairobi:

Figure 2.1: Weather Averages for Nairobi City



(Source: worldweather.wmo.int - 2020)

2.2 Historical Background of Nairobi

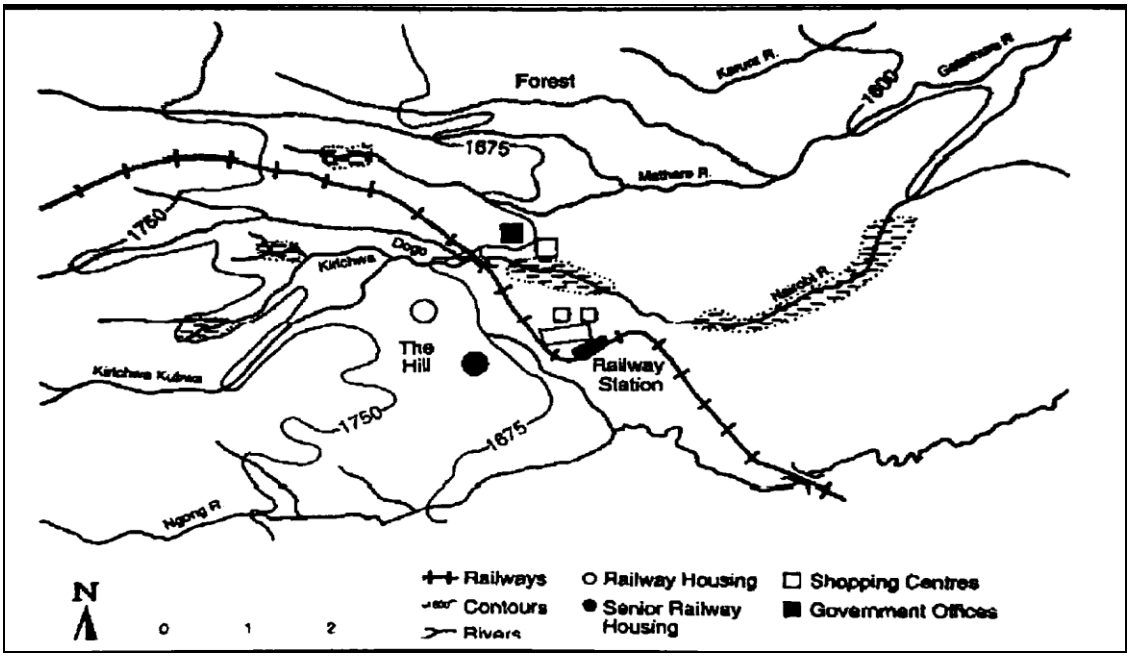
During the construction of Kenya Uganda Railway (KUR), Nairobi was found to be an ideal stopping point between Mombasa and Kisumu because of its proximity to the Nairobi and Mbagathi rivers, the availability of level land for railway tracks and the elevated cooler ground to the west that was suitable for residential purposes. Its seemingly deserted nature came in handy in granting freedom for land appropriation. The absence of tropical illnesses, such as malaria, was also a major factor in the final decision to choose this location. A Maasai name, Enkare Nairobi, meaning "a site of cold waters," was chosen for the new town. However, the area had previously served only as pasture ground and a cattle watering station, therefore no permanent African community had ever been there. As early as 1896, the location served as a modest transit station where rations for oxen and mules were stored (White et al., 1948).

In June 1899, the railhead was extended to the area, and by July, it had become the KUR headquarters (Boedecker, 1936; White et al., 1948; Foran, 1950; Hallman, 1967; Hake, 1977; Obudho and Aduwo, 1992). The Government of Kenya (GOK) had chosen a location for its administrative headquarters by the end of 1899, and that location was on high terrain on the northern bank of the Nairobi River, far from the railway station (Morgan, 1968). The urban center was designated by the GOK in 1900 as "the region within a radius of one and a half miles from the offices of the sub-commissioner of the Ukambani Province" (Nairobi Municipal Community (NMC) rules) (Morgan, 1976). It was necessary to select a midway location where a well-equipped maintenance depot could be erected since by that time a limited number of settlers had started settling in the urban center (Obundo and Aduwo, 1992).

The Engineer at the time said, "Nairobi has been picked as the location for the primary workshops with remarkable judgment." Because of its elevation of around 5,500 meters above sea level, the weather is milder than in lower-lying areas; there is enough of flat land to meet any need; and there are great places to put officers' and soldiers' quarters. There is a decent water supply on the higher terrain, but reservoirs and tanks will need to be built (Walmsey, 1957). There were previously undetected spatial patterns surrounding the Nairobi train station and the depot when KUR officials decided to establish a presence there. To avoid contact with Asians and Africans, Europeans built their dwellings on the western hill. Meanwhile, Asian workers who had been let go by KUR set up business in a district near the train station that became known as the Indian Bazaar. A small number of African KUR employees lived in the Asian structures, while the rest of the KUR workforce resided in employee apartments and makeshift slums to the east

(White et al., 1948). By 1906, the initial KUR station and camp had expanded into a bustling metropolis of over 10,000 people, with distinct land-use zones emerging (albeit not systematically), with Europeans settling in the Westlands, Indians in the north, and African labourers mostly clustered around the perimeter. Rapid growth occurred after the KUR was finished and more non-African people began to live there. Roads in the central business district were mostly completed by 1909. Nairobi, as seen on the following map, about 1906.

Map 2.1: Nairobi circa 1906

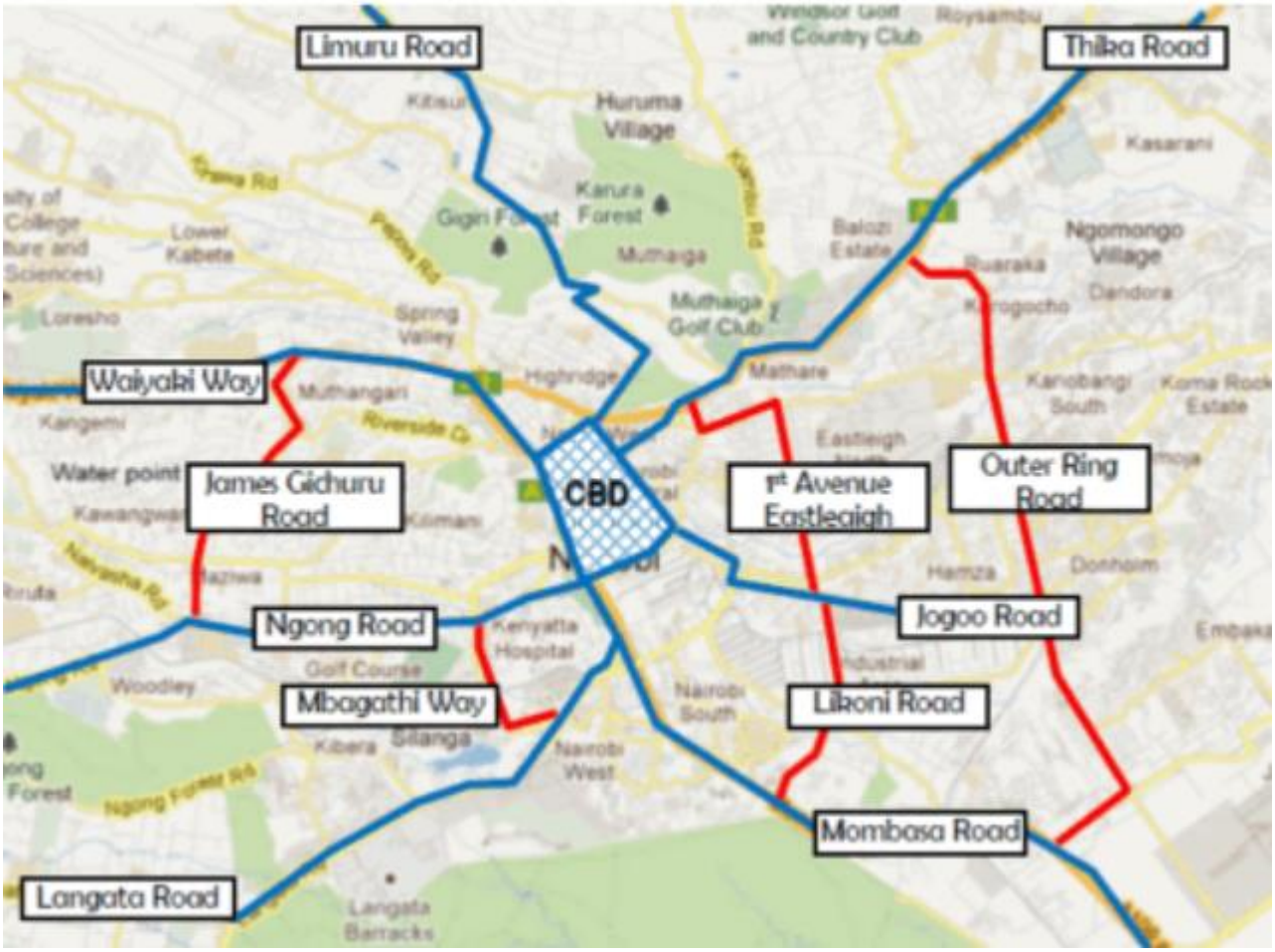


(Source: White, 1948)

The Nairobi Municipal Community was dissolved in 1919, and the Nairobi City Council took its place (NCC). Simultaneously, the limit was expanded to cover suburban and urban areas (Croix, 1950). Once again in 1927, an additional 30 square miles were added to the boundaries (White et al., 1948). This border was established in 1928 and changed very little up until 1963, when Kenya gained its independence. By 1950, permanent

residential zones had been formed, with boundaries that closely followed those drawn in the early part of the century. Nairobi's current 696 km2 limit was established in 1963 when the city had expanded to that size. The 20 square miles of black cotton soil and ranching property to the east of the original community were seen as prime real estate for future development (Obudho and Aduwo, 1992). The road system of Nairobi and its suburbs is shown in Map 2.2 below.

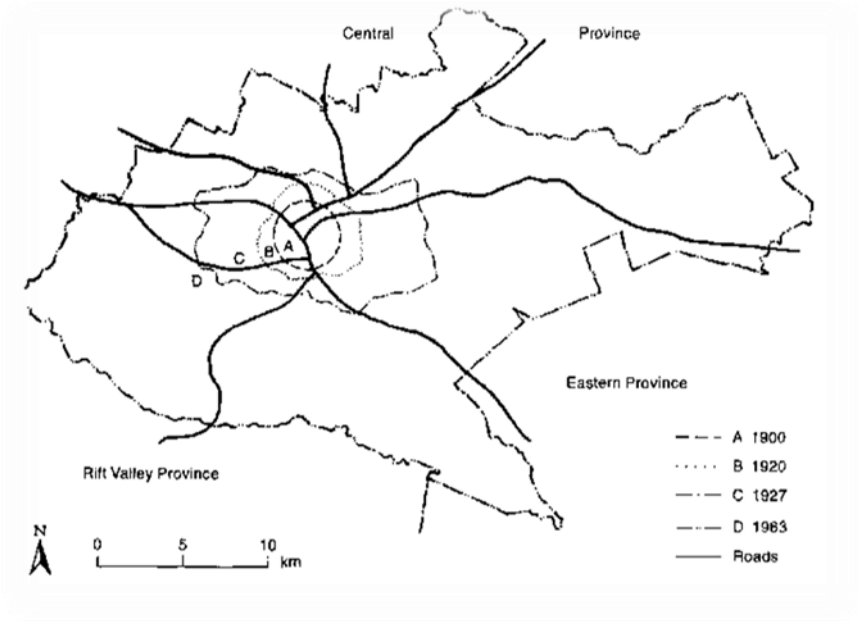
Map 2.2: Nairobi and suburbs road network



(Source: Executive Task Force Report on Nairobi City Decongestion, 2015)

In the years following, the city's infrastructure and services grew to the point that it now dominates the political, social, cultural, and economic lives of Kenyans and the rest of the Eastern African area. Below is a map showing the different boundaries for Nairobi from 1900 to 1963.

Map 2.3: Nairobi Boundary Changes: 1900-1963



(Source: Obudho and Aduwo, *1992*)

2.3 Evolution of Land Use Management Paradigms in Nairobi

Over the years and because of planning efforts made to address urban issues, land usage in Nairobi particularly along the Ngong Corridor, have changed. The first was the Master Plan Study from 1948, which was put together by a joint team of South African and British planners. Through the allocation of specific parcels of land, this plan established the parameters for the city's development as a colonial metropolis (White et al., 1948). It is significantly responsible for the current layout of the industrial sector, the expansion of

the road network, and the replacement of the railway line with the current dual highways, as well as the introduction of the neighborhood idea in city planning. For aesthetic and practical reasons, the garden city idea informed this land use design, which prioritized broad boulevards with grass medians and spacious walkways, landscaped traffic roundabouts, huge parks, forest reserves, and wide riparian reserves. Ngong Road corridor and its surrounding neighborhood were designated as a residential zone, complete with parks and other open spaces. The plan, which was drawn up by British colonialists in the middle of the twentieth century, may have been aesthetically pleasing, but also served to separate the city's different racial groups by designating the Kilimani region through which Ngong Road now passes as a whites-only residential neighborhood. Integration along racial lines did not occur until the 1960s (Irungu and Houghton, 2014). The idea seemed to be successful at first because the colonial government put so much effort into making it happen. After independence, however, the political and socioeconomic elements that had been driving the city's growth began to shift in ways that were counterproductive to the plan, and the blueprint quickly became obsolete (Obudho and Aduwo, 1992).

The Metropolitan Growth Policy of 1973 was an additional effort at city planning; it was a multi-sectoral growth plan that laid emphasis on future space needs in light of the city's expanding population. The report suggested relocating the city's industrial core to the east and northeast, along with the development of additional satellite centers, the construction of three major bypasses, and a cap of 100,000 on the number of people employed in the Central Business District. Foreign and government funds were essential to the launch of this initiative. This plan also flopped and this was attributed to lack of clarity on the

legislative norms and regulations that govern planning systems and plan implementation, as well as a time horizon that expired in the year 2000. There was also a failure to execute the initiative since the government and donors did not offer the expected financial and technical assistance (Oyugi and K'Akumu, 2007).

These developments led to the 1979 Rezoning Policy, which, contrary to the metropolitan policy's underlying precepts, advocated for a more concentrated Central Business District and permitted greater densities of construction across the city. Urban infrastructure services and utilities, including water supply, parking, and recreational facilities, among others, are commonly impacted by greater density projects (Oyugi and K'Akumu, 2007). Despite such awareness, no steps were made to examine and/or enhance these areas. As a result, the Kilimani neighborhood, which had previously been predominantly a low-density residential neighbourhood, gradually transformed into a high-density mixed residential and commercial zone. Since then, planning for the expansion of the city has been conducted on an ad hoc basis, disconnected from the city's master plan and focused on isolated features. The Omamo Commission Report, the Single Issue Plan for Nairobi, the Local Authority Service Delivery Action Plan (LASDAP) and the Informal Settlements Development Strategy are all examples of such focused programs. The failure of the aforementioned management interventions over the decades can be attributed to a number of factors, including a lack of stakeholder participation in the plan formulation and implementation, a failure to link the plans to the city's financial resource base and development trends in the city, a lack of political good will, and a poor institutional framework for plan preparation and implementation. The aforementioned flaws provide weight to the argument for a Strategic Metropolitan Plan that is both

inclusive of all relevant parties and far-sighted enough to offer priority-based long-range projections that are tied to the city's financial resources (Oyugi & K'Akumu, 2007).

As shown by the Rezoning Policy of 1979, the city's fundamental attempts to bring about land use changes throughout the years have been centered on intensification of projects by revising development densities, alterations, and/or expansion of users. Historically, public utility capacity and availability have determined the intensity level (water, sewerage and transportation corridors). For instance, between 1974 and 1979, when the first phase of the Chania Water Scheme was finished, the zoning situation in the city was altered, leading to a more reliable water supply. These procedures have been crucial in boosting the land inside the city's limits, even if they are reactive rather than proactive (Kiamba, 1988). Seven unique land uses—including residential, commercial, industrial, institutional, recreational, transportation, and agricultural, which is not technically an urban land use but persists in peri-urban areas—have evolved in the city thanks to these processes. The developed uses for residential property may be broken down into four broad groups according to economic indicators:

- The upper-income (low-density) areas of the city comprise of around 11,000 hectares, all of which are occupied by single-family houses on plots as large as five acres.
- Medium-income zones which are either under the control by the public sector or are privately held, hence the density and amount of development varies widely. They occupied an area of about 4,070 hectares.

- The city's low-income (high-density) areas occupy an area of 4,500 hectares and mainly occupy the Eastern side of the city. The City Council of Nairobi once held these but about 2,190 hectares have been taken up by the informal settlements.

The Nairobi Metropolitan Growth Strategy from 1973 suggested limiting growth in the current industrial zones so that seven secondary industrial regions could be built near to residential neighborhoods thus increasing income and decreasing commute times and/or expenses. Massive growth has occurred in the city since then, and there are now 2,370 hectares dedicated to industrial use (Rutto, 2009). However, there is a severe lack of serviced outdoor industrial workplaces since the policy on placement of small-scale industrial sites has not been fully implemented. Additionally to the Central Business District's commercial activities, seven satellite commercial centres adjacent to the projected industrial regions were suggested for rapid construction to fulfill the local requirements of different communities. The incorporation of at least one commercial center within new large-scale home building plans helped spur the expansion of such centers inside residential regions. Most of the planned commercial centers, with the exception of Westlands Shopping Centre, which occupies ten hectares, are not performing as envisioned, necessitating intensification of the Central Business District through the revision of the plot ratios and coverage, which will push employment spaces beyond parking and utility services. At present, the Central Business District occupies 220 ha (520 acres) of the total 260 ha (520 acres) of land used for commercial purposes. About 10.9 percent of urban land is used for institutional purposes, such as airports, airfields, government facilities, hospitals, schools, universities, colleges, correctional facilities and military bases.

Ngong and Karura are the city's two main forest reserves, covering 1,240 and 940 hectares, respectively, while the remaining 20,950 hectares are still used for farming. From this, it is clear that a major challenge for Nairobi's management in general and planning in particular over the years has been striking a balance between the city's physical environment and the socio-economic functions that are essential to the city's continued existence and the well-being of its residents. Nevertheless, the city's physical, economic, and environmental limits have not been well identified due to the ad hoc nature of municipal design and administration. Distinct land uses in the city with various levels of growth have been the major focus of this kind of planning (Rutto, 2009).

The Nairobi City Council rezoned Ngong Road neighbourhood in 1979 in response to demand from local landowners who wanted to see the region developed more thoroughly. Hill and Kilimani were considered for further replanning and rezoning by the Nairobi Town Planning Liaison Committee in 1993. These plans called for the Hill area to be redeveloped into high-rise office buildings while both apartment and office dwellers were permitted in the Kilimani district (Gathuri, 2007).

A policy review was conducted in 2006 for Zones 3, 4, and 5 to assess the state of affairs. The principles of sustainable urban development, which prioritizes on growth in the economy, resource preservation and environmental health, served as the foundation for this analysis (NCC, 2006). The policy assessment suggested regulating the already-built apartments in Kilimani, allowing for 10% vegetation and harmonizing the Argwings Kodhek Road to 24 meters wide up to Ole Odume Road.

After a rezoning permitted for large-scale construction in the neighborhood, various businesses and residential complexes began to set up shop there. As a result of

densification, shift from low density to high density residential development has become lucrative and attractive (Gathuri, 2007). Densification, on the other hand, has emerged without first assessing whether or not the existing infrastructure and ecosystems can support it, leading to unsustainable development that might ultimately cause a drop in land prices, rents, and environmental deterioration.

2.3 Transportation

Congestion on the city's roads was an early issue for Nairobi. It has been said that in 1928 Nairobi had the highest rate of non-African automobile ownership of any major city in the world (Aduwo, 1990). Authorities often addressed growing concerns about parking and speeding. Starting in 1929, the whole central business district's roadways were paved with asphalt. Population density in the western side of Nairobi was as low as 6.1 persons per acre by 1962, compared to the African residential zone in the east, which had a density of 125.9 people per acre during the same time period (Hake, 1977). In the meanwhile, a public bus service was launched after negotiations with United Transport International resulted in an agreement (Aduwo, 1990). As a consequence of the pact, the Kenya Bus Service (KBS) was formed and awarded the exclusive franchise for transporting fare-paying customers in and around the Nairobi area. Demand for public transportation was quite modest at the time, with most riders being Asian and European expats and an increasing number of African employees. Commuter trains, taxis, matatus, private cars, and public buses make up Nairobi's current transportation system. Due to the significant initial investment and ongoing upkeep costs, private automobile ownership is virtually exclusively a luxury item enjoyed by those in the middle to upper classes. Recent deregulation has led to an increase in the number of motor bike taxis, widely

known as boda bodas, despite the fact that they are not a viable mode of urban public transportation.

2.3.1 Transformation of Transport Means in Nairobi City

In 2004, just 16% of Nairobi's daily 4.8 million journeys were done in private automobiles, 36% were made using public transportation, and 48% were conducted on foot. Minibuses and shared taxis called matatus make up the lion's share (approximately 80%) of Nairobi's public transportation fleet. Traditional fixed route buses, a commuter rail line, and other shuttle services, such as those sponsored by schools, cover the remaining public transportation journeys. Matatus are a large part of the traffic on Nairobi's roads, accounting for anything from 15 percent to 50 percent of the cars on the road on the busiest corridors. As the population of Nairobi increased in the years after Kenya's independence and more people needed to go to the city's central business district for employment, the need for public transportation increased. It wasn't always the case that matatus were the most common method of transportation in Nairobi; they arose to fill a need that the British-established official bus business ignored. KBS has been rapidly losing market share since 1973, when matatus were first permitted to legally compete with professional bus operators after previously being prohibited. Regular bus service has diminished over time as routes are dropped and replaced with matatus (Gonzales et al., 2009).

Dropping from 36% of all trips in 1994 to just 3% in 2004 in Nairobi, regular public bus services have been losing ridership (Aligula et al., 2005). As a result of the decline of the formal public transportation system, the matatus of the informal sector have stepped up to

meet the majority of the public's transportation needs. However, the richest people of Nairobi choose to commute by private car or cab, and their motivation is mostly safety and security concerns, hence matatus play an important part in Nairobi's transport system since they fill a demand that is not supplied by other modes. The great majority of the world's population, on the other hand, cannot afford any mode of transportation but walking. Most of the city's main slums are located within a walking distance of the downtown area. When it comes to bridging the gap between the city proper and its suburbs, matatu service assumes paramount importance. When traveling long distances, many people rely on matatus since they are the only reasonably priced option. Because matatus play such a crucial role in the regional transportation system, any problems with them have far-reaching consequences for the general public. As a result, strategies to reduce traffic congestion need to take into account the needs of matatu riders as well as those of drivers of single-occupancy vehicles (Gathumbi, 2015).

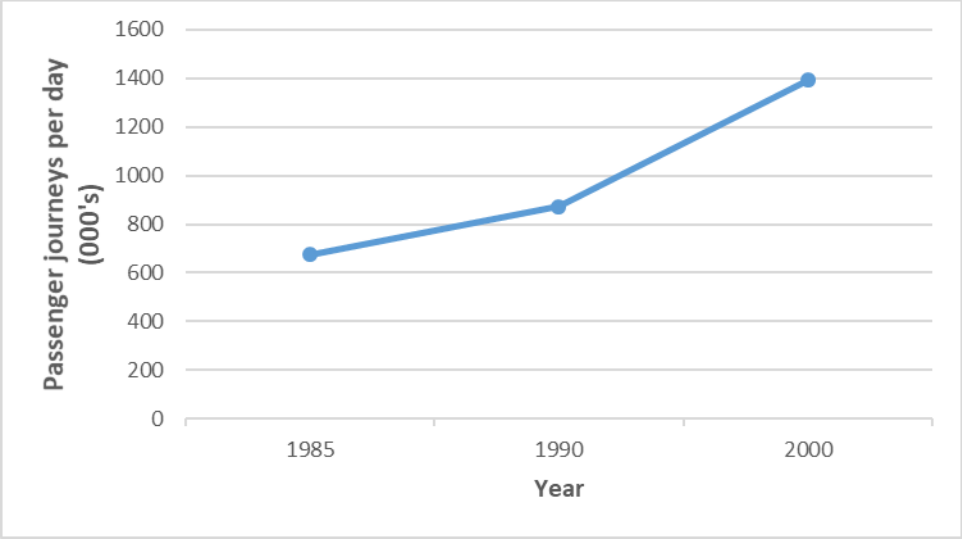
Inherent transport patterns, along with the additional travel generated primarily by an increase in population, placed strains on existing infrastructure. It is estimated that more than 75% of commuters are working in the central business district and industrial region, which presents a significant challenge due to the concentration of government, commerce, and other service activities in this area. The Central Business District (CBD) is plagued by traffic congestion due to the high concentration of businesses and workers engaged in wholesale and retail commerce, food service, transportation and communication, banking, insurance, real estate, and business services.

Even more crucial is the fact that many low-income public transit riders now reside in areas far from the central business district. Unfortunately, the development of new

transportation options has lagged behind the growth of the metropolis to the east, south, and north. Current estimates place the yearly growth rate of daily passenger travels at close to 6 percent. The daily crush and jostling at most of the city's transport terminals, particularly during rush hours, and the overflowing number of people conveyed by the current means of public transport are indicative of the unmet need for public transport services (Wahome, 2013). Figure 2.2 shows the rising number of passengers in Nairobi over time.

Figure 2.2: Growth of passenger journeys in Nairobi

The trend of growth of public transport demand is as shown in the figure below.



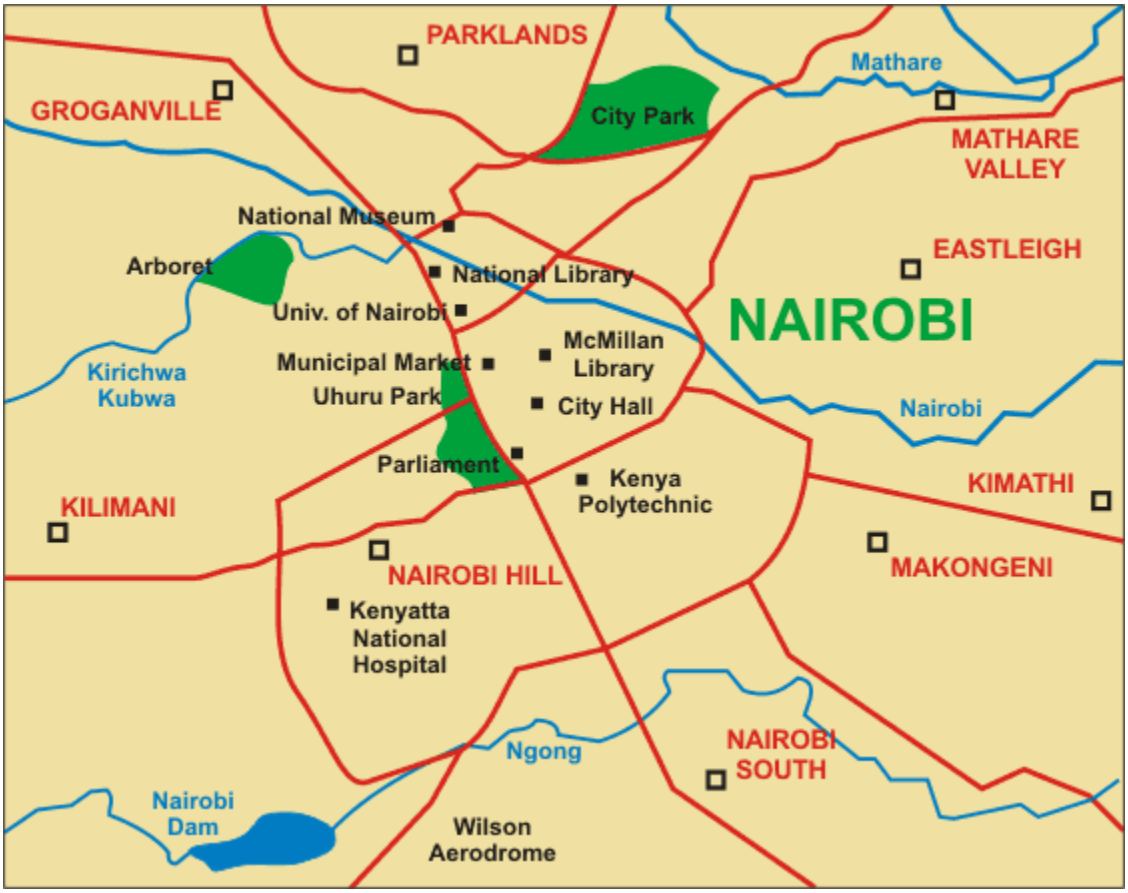
Source: Obudho, *1993*

2.4 Road network in Nairobi

In 1905, feeder pathways to the railway were built, marking the beginning of road building in Kenya (White et al., 1948). The highways from Mombasa, Fort Hall, Uganda, Ngong, and Karen provided the most direct routes into the heart of Nairobi. The Mombasa port and the countries to the south, west, and north were all linked by the Uhuru highway, which was a part of the East African trunk Roads. If this main route

were to avoid Nairobi, a secondary road leading into the city would need to branch off of it. Most drivers would take this secondary road into the city, and then circle back to the main road. Consequently, the Nairobi Master Plan for a Colonial Capital (1948) suggested that this trunk route be timed to meet with Nairobi's main parkways and that the parkway be enlarged to accommodate the anticipated increase in traffic. Several arterial highways connect the city's outlying neighborhoods to the central business district as a consequence of revisions to Nairobi's transport planning. A few examples include Langata Road, Jogoo Road, Limuru Road, Thika Road, Mombasa Road, Waiyaki route, and Ngong Road. The main thoroughfares of Nairobi are shown in Map 2.4.

Map 2.4: Nairobi Arterial Roads



(Source: Trillo, 2016)

2.5 Conclusion

Nairobi, formerly only a stop on the Kenya-Uganda Railway, has blossomed into East Africa's most prosperous metropolis. Known for its tropical climate and breathtaking skyscrapers, the city is a popular tourist destination. Since the city's culture is a unique fusion of traditional African elements with Western, Eastern, and other influences, it has become a popular destination for those looking to start new lives and businesses in a welcoming setting. Those from the countryside who move to the city in search of better economic prospects have also kept the city at the top of their list. For the city's future expansion and development, four master plans have been drafted so far, but only two have been partially executed owing to lack of political goodwill and changing government priorities. A number of arterial roads and arterial linkages like Ngong Road were planned, their corridors designated, and footprinciples developed as a result of the piecemeal construction of elements of the master plan. The Ngong Road corridor was designed to connect the rapidly expanding western suburbs of Nairobi to the outlying satellite communities and neighborhoods of Ngong, Karen, Kawangware, and Riruta Satelite.

Well-organized public bus companies provided public transportation to Nairobi's population from the outset, but they were forced out of business by economic liberalization policies and lax regulatory enforcement. Minibuses or share-taxis known as matatus now dominate the city's public transportation, although their services are highly panned.

NUIPLANS is the current master plan being implemented, and it includes some too-little-too-late proposals like the expansion of arterial roads and arterial connectors, the

modernization of commuter railway stations in the city, the construction of by-passes and missing link roads, and the development of pilot bus-rapid transport infrastructure in some arterial roads like Thika Highway.

CHAPTER THREE: LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

3.1 Introduction

This chapter reviews the relationship between urbanization, transportation and land uses. It further reviews how transport decisions affect neighbourhood land use patterns and how the land use changes in turn affect transport functionality of the corridor. The most common ripple effect of land use changes on transport is traffic congestion which has several negative consequences which are either physical, social, economic or environmental.

3.2 Development of Road Transport in Urban Areas

During the time of the Roman Empire, roads developed into a crucial mode of transportation. According to Berechman (2002), the ancient Romans developed an outstanding network of roadways that required careful planning, innovative design, and skilled construction and maintenance. The Empire made great use of the road system, with oxen, humans, chariots, camels, and bulls serving as the system's primary carriers. However, with the advent of the automobile, roadways have ceased to be designed for foot, chariot and animal traffic.

The state of nation's transportation network is a major factor in the country's overall economic and social growth. As a result, transportation infrastructure is a driving force in economic and social progress of a country (Gichaga, 2017). As the population of major cities and their surrounding metropolitan areas grow, the immediate response is to build new roads or to expand the existing ones as a way of mitigating challenges attributed to rise in traffic volumes. When the number of vehicles on the road equals or surpasses the available capacity of the road system, congestion results. (Raheem et al., 2015).

Traffic congestion is a common occurrence in many cities around the globe, both established and developing, and there are indications that the trend will continue. It manifests mostly as a gradual slowing of traffic, which leads to lengthier commute times, higher fuel and operational expenses and more pollutants (Bull, 2003).

The traffic situation in Nairobi is not any better. However, the overall effect of congestion on major corridors in Nairobi may not be accurately quantified due to the uncounted and diverse effects it has on the national capacity. However, its significant effect can be felt in goods and services delivery, pollution, discomfort, excessive fuel consumption and high vehicle maintenance costs, all of which accounts for economic loss.

Nairobi's traffic congestion has reached precarious levels and other cities like Mombasa and Kisumu seem to be following closely. There is lack of free flow of traffic and this manifests itself through a number of difficulties that includes: delay, that is, the time wasted while traffic flow is obstructed; and accidents. Inaccurate travel time estimates, which forces drivers to spend more time on the road and less on their work. Idling vehicles that causes wastage of fuel and additional air pollution, both of which are bad for the environment and people's health. Vehicles experience more wear and tear from constant acceleration and braking, necessitating more frequent repairs and replacements; passengers and drivers experience greater stress and frustration from the discomfort brought on by the constant stopping and starting, resulting in lower productivity and lower quality of work. The likelihood of a collision, the source of many injuries and deaths, is also heightened by traffic congestion.

3.3 Transportation Theory

The first step in comprehending urban transportation is to answer the question, "Why do cities exist?" This raises the second issue I have: what part does transportation play here? To this end, there have been several schools of thought developed, including economic theory. Traditional economics centers on production, consumption, and trade carried out by rational, self-interested, and atomistic actors. The spatial component is provided by economic geography. Agents' economic judgments must take into account the increased cost of overcoming the friction created by physical space.

Due to the high cost of overcoming friction, economic players (both producers and consumers) want to reduce it wherever possible. The two most obvious ways to reduce these costs are to reduce the amount of friction encountered, thereby reducing the distances that need to be traveled, or to reduce the amount of money spent on transportation, thus reducing the cost of transportation, by employing transport innovations or constructing efficient transportation networks. The first cost-cutting measure, minimizing geographical dispersion, creates economic "centers" and "peripheries" in physical space. Denser, higher-order economic functions are often located in the core of a region, whereas lower-order functions are typically located at the region's periphery. This is the core idea behind central place theory, which offers a monetary explanation for why cities exist (Mulligan, 1984).

This process's dynamics are simple. To begin, agents minimize frictional costs by locating production, consumption, and other economic activities near one another or near sources of the inputs and intermediates needed to produce the final products and services. Concentrating buyers and sellers in one area reduces the negative effects of distance on economic activity, which is a major argument used by economic geographers to justify

the presence of urban areas. Costs may be reduced when manufacturing expands, a phenomenon known as "economies of scale." It's difficult to conceive of such economies functioning without some kind of physical concentration of output, making them intrinsically "internal" to the economic actor. Economic synergies that come from the concentration of distinct producers, customers, and/or input sources in one site are referred to as agglomeration economies, which are "external" to the agent and hence have a much more direct relationship to physical space. Agglomeration economies occur when producers and consumers are geographically adjacent to one another, allowing for the free flow of information and services with low search, transit, and other transaction costs. These factors contribute to the trend toward urban forms as opposed to more scattered ones.

One may reasonably wonder why cities become differentiated at all, rather than being on a single plane, maybe bordered by natural or governmental boundaries, with a central point that gradually gives way to progressively less densely populated and active peripheries. The reason for this is that whereas economies of scale and agglomeration are what contribute to the growth of cities, diseconomies along the same dimensions act to constrain urban growth. Multiple cities of appropriate size maximize profits from commerce, concentration, and specialization, which would be impossible in a single megacity. Economies of scale and agglomeration economies may be found inside a single city, and they can be found across cities as well. As long as the two cities are able to trade with one another, it is possible that one city may become a center of high finance while another city will become a center of watch production. Urban hierarchy theory is an

approach that examines the interplay between cities in an effort to better understand the dynamics of metropolitan regions (Krugman, 1996).

Although reducing the frictional cost of physical space has been the primary emphasis of this discussion thus far, it is important to note that transportation is also a major factor in this regard. Transport of products, services, and people will be necessary even in a highly concentrated tiny metropolis. There are two opposing forces at work when it comes to the effects of transportation advancements: (1) Since the unit travel time over a given distance is decreasing, cities and their peripheries may expand, expanding the area of equivalent "friction," and (2) cities can specialize and remain within narrower regions since the movement of goods and people between economic centers is enhanced and costs less.

Other theories of urban form highlight the importance of extra-economic variables. The Nested Cities theory, for example, contends that physical, economic, and institutional variables drive urban growth hierarchies. This school of thinking contends that human and institutional elements play a crucial role in shaping urban environments (Hill and Fujita, 2003). The Developmental State theory is a separate but similar philosophical framework that places an emphasis on state-centered rational strategies for directing urban expansion, which is especially pertinent in certain regions of Europe and Asia (Newman and Thornley, 2005). There is no established theoretical consensus on the appropriate number of cities, city sizes, or transportation investments. They are conditional on the unique features of the location under investigation. The growth of cities affects the expansion of transportation systems and vice versa; both of these

spheres of influence are in turn influenced by a wide range of economic and other variables.

3.4 Transportation and Urban growth

More over half of the world's projected population resides in urban regions as of 2004; this is expected to rise to 61 percent by 2030. (UN, 2004). As a result, cities will continue to see brisk population increases, presenting new issues for city planners. Growth in metropolitan places isn't some kind of emerging phenomenon that can be seen with the naked eye. Transportation and communication (Hart et al., 2001); domestic and international migration (Thorns, 2002); public policy (Caruthers et al., 2002); and globalization of economic activity are all aspects that contribute to urbanization (Marcotullio et al, 2003). It is of utmost importance for urban planners to comprehend the dynamics of urbanization, including the factors that contribute to it and the potential consequences for the city's environment (Al-Ahmadi et al, 2009).

The importance of transportation to city growth cannot be overstated. The ease with which people and products may move from one place to another is directly related to the quality of the transportation infrastructure in place (Meyer and Miller, 2001). There is a close connection between urbanization and transportation problems. The expansion of a city's population and the number of people who live there both increase the demand for transportation services and raise the stakes for the quality of such services.

3.5 Transport System and Land Use

The concentration of various economic, administrative, and industrial functions, as well as residential usage, is reflected in the distribution of urban land. Transport networks

thrive because of the flows they create. The social, cultural, and economic activities that make up urban areas are spread out over the city in what is called a "activity system." Some things, like commuting and going to the store, are routine because they happen often and can be planned ahead of time. Other activities, such as sports and leisure, are more sporadic and are molded by individual preferences or requirements (e.g. healthcare). These actions are often associated with the transportation of people. Additionally, there are industrial and distribution-related production operations with local, regional, and worldwide connections. Transportability of goods is often a factor in these sorts of activities. Transportation is necessary because it facilitates the movement of people and goods from one place to another. Therefore, transportation and land use are like a chicken and egg: each cannot exist without the other (Morimoto, 2021).

The production, consumption, and distribution of goods are just a few of the many functions implied by most economic, social, or cultural endeavors. There is a lot of variety in urban land use, and the transportation network plays a role in creating that variety. Central areas have emerged in cities for various reasons, including economic (management and retail), political (seats of government), institutional (universities), and cultural (tourism) (religious institutions). The level of spatial accumulation and the types of land use that go along with them are highest in the city's core, where things like shopping malls and office towers can be found, while in the city's periphery, places like homes and warehouses predominate.

Land use is influenced by the locational preferences of individuals, institutions, and businesses. This imprint has to be represented in some way, and that way might be formal

or functionally via a typology of land use. Descriptional in nature, formal land use representations focus on the shape, arrangement, and look of a given area. Functional land use representations are primarily a socioeconomic description of place that focuses on the economic character of activities including production, consumption, dwelling, and transportation.

About 3% of the Earth's surface is taken up by urban areas. Although the proportion of different land uses inside a city varies widely according to its purpose, residential land use typically accounts for anywhere from 65% to 75% of the built area. Between 5 and 15 percent and 15 to 25 percent of the footprint are devoted to commercial and industrial purposes, respectively. Density, the prevalence of private automobiles, and planning methods all have a role in the observable differences across urban regions. Roads and parking lots use between 35 and 50 percent of the land area in car-dependent urban centers. About 40% of a parking lot's area is used for parking cars, while the other 60% is used for roads and access to individual parking spots. These dissimilarities emerge as a result of a confluence of elements that reflect the distinct nature of each city's geography, history, economics, and urban design (Rodrigue, 2020)

The representation of land use, whether it be formal or functional, involves a network of connections between different types of land use. Relationships with suppliers and consumers are essential to the success of any commercial land use. While freight mobility will be crucial to supplier connections, consumer interactions will also include the mobility of individuals. Therefore, it is necessary to have both circulation networks available at some level for a transportation / land use system to work well. Transportation

considerations play a role in deciding where to put an activity since different land uses have different mobility needs.

Each economic activity inside a city system finds a place that is adequate, if not optimum, for it to collect rent. Interactions between transportation and land use often focus on the historical connections between land use-related activities and transportation-related accessibility. Since it is difficult to determine whether factor, alterations to transportation or land use, comes first, this set of interrelationships has been likened to the traditional "chicken-and-egg" conundrum. Large infrastructure investments often foresee and initiate land-use shifts, whereas smaller-scale transportation initiatives are more likely to supplement preexisting patterns. Urban land uses may grow in a number of distinct contexts, including infilling (closer to the city center) and sprawling (far from the city center), with transportation playing varying roles in each. Congestion may be tolerated if the land value is high enough, as is the case with infilling, whereas for sprawl, accessibility must have improved enough to tolerate development (Rodrigue, 2020).

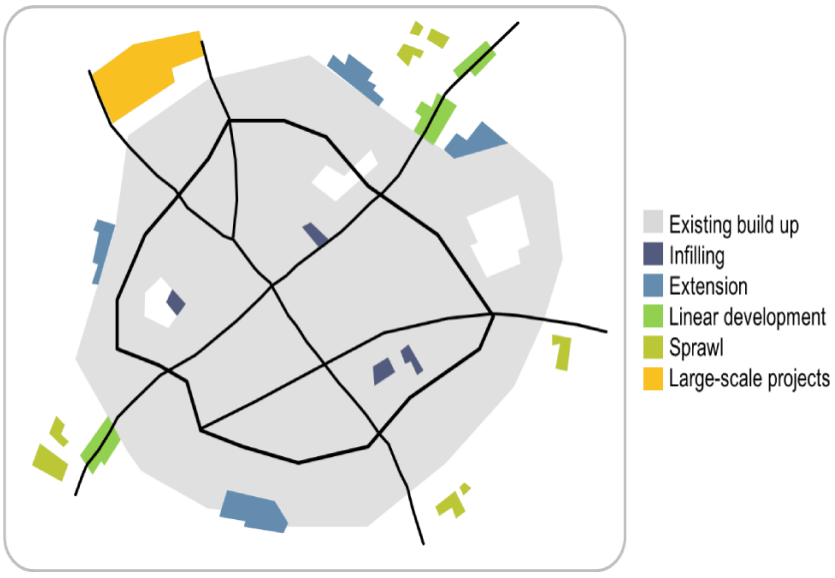
The urban expansion of land uses can take place in five general forms:

- Infilling. Areas that were previously underutilized or were slated for repurposing are now home to a variety of different types of buildings and communities. Opportunities for urban growth on areas that have lost their economic relevance, such as old industrial sites or abandoned ports, may be found via brownfield redevelopments (waterfronts or rail yards).
- Extension. A common method of growth in which new construction is situated immediately next to already existing structures. Streets and utility lines are among the enhanced infrastructures.

- Growth that is linear in nature. Expansion that follows the path of an existing circulation corridor, such as a highway or a subway line, is conceptually similar to extension (subway, light rail). It makes immediate use of the convenience afforded by the existing network of transportation facilities. The expansion of a corridor may be necessitated by the growth in certain circumstances.
- Sprawl. Common suburban layout that makes use of individual parcels. Each builder makes use of an available piece of land without giving much thought to the neighborhood as a whole.
- Large-scale projects. It takes a lot of space to build a new port, airport, industrial zone, logistics zone, or intermodal rail terminal. In many cases, its operating reasoning is fundamentally at odds with the surrounding environment, making integration with current land uses difficult..

Figure 3.1 below illustrates the various forms of urban expansion.

Figure 3.1: Forms of Urban Expansion



(Source: Camagni *et al*, 2002)

One of the most fundamental uses of land in urban settings is for transportation and this may occupy up to 30% of a city's entire land area. As a land use type, it affects how cities are built and how they look. The fundamental connections between transportation connectivity and land use are the trip making patterns, volumes and modal distribution. The combination of all these are largely the outcome of regional distribution of land use. Land-use patterns are largely determined by the ease with which people may travel from one location to another. People and things are always on the move throughout the metropolis thanks to this circulation. Due to the potential for traffic congestion brought on by these movements, urban traffic management is a need in today's cities.

As urbanization spreads rapidly throughout the globe, more people will be making excursions inside cities. To accommodate rising demand for transportation, cities often construct additional roads and/or public transit routes. In the industrialized world, this has meant building brand-new urban infrastructure, mostly in the form of wider roadways. In response, a variety of urban spatial configurations have arisen, the most salient feature of which is their respective levels of automotive dependence.

At the size of big cities, four distinct patterns emerge [Thomson, 1977]:

Type I, the "Completely Motorized Network," depicts a city that relies heavily on cars yet has a decentralized infrastructure.

Many American cities have a spatial organization of Type II, that is, weak center with many activity situated towards the perimeter.

Especially prevalent in Europe and Asia is Type III with strong centers, high population and highly developed public transportation networks.

Type IV (Traffic Restriction) urban settings are those that have traffic management and modal preference built into their physical layout. Public transportation hubs are often located in the core business district.

In response to urbanization, traffic congestion, and the growing significance of interurban transportation, several ring roads have been constructed around large cities. Cities, especially in North America, began to include them as a significant part of their spatial layouts. New centers of urbanization are often best exemplified by highway interchanges in the suburbs. There are now places that may be labeled peri-urban because of the expansion (and sometimes over-expansion) of urban centers. They are outside of the city itself and the suburbs, but yet within practical commuting distances.

Most land-use models are predicated on an assumption about the nature of future urbanization. Following Von Thunen's ideas, we may see cities expanding in a circular manner, with their hubs situated on flat, uniform terrain so that people can get there from any direction. Land use patterns like this suggest that the urban core is where all the action occurs, with residential neighborhoods radiating out from it. The bands will expand toward the rural periphery as far as is necessary to maintain the central business district's economic basis. As the economic foundation of a city expands, new residential rings form around the central business district (CBD), and the CBD itself extends in length as formerly rural area is converted to urban usage. In this hypothetical scenario, residents have no preference over which way to take public transportation into the heart of the city, and businesses have the same amount of access to foot traffic coming from any of the city's neighborhoods. Travel convenience, ease of movement, and other factors may all be considered in the abstract. It is also assumed that the majority of travels take

people to the central business district (CBD) for services, causing congestion that is relieved by the network of radial and concentric ring roads that surround the CBD (Andrews, 1976).

A corpus of theory has been established to explain urban shape and urban spatial feature, with its roots in Christeller's writings of the 1930s. Christeller understood that a location serves dual purposes in terms of space and transportation and communication. Both of these characteristics contribute to the city's traffic congestion, but notably in the city's core Business districts where they are most noticeable. The term "central location" refers to a region in the heart of the Central Business District whose primary function is to bring together people from all directions. The two theories work together to provide light on the many roles played by the CBD. Once a decision-making hub has been formed, the 'central spot' feature is more useful for keeping it in the same area. (Hovel, 1975).

Alonzo expanded Walter Christeller's talk by adding his own insights. As a result of route convergence, central places are more desirable than those farther away. Understanding the centrifugal forces that are altering the conventional urban landscape requires an appreciation of the shift in accessibility (Hovel, 1975).

3.6 Transportation and Urban Structure

There are three main descriptive models used in the field of urban land use analysis. Despite their widespread use, no one model has proven capable of capturing the diversity of urban land use in all major metropolitan areas. The models are unchanging descriptions of static urban land use patterns. They are still helpful overarching

descriptions of how various urban spaces are used. The urban land use models of the Concentric Zone, the Sector, and the Multiple Nuclei are analyzed.

3.6.1 Concentric Zone Model

Earnest Burgess developed the concentric zone paradigm in the early 20th century. Different types of land use are represented by concentric rings in the concentric zone model of urban land use (see Figure 3.2 below).

The central business district (CBD) was the most convenient place to be since all major roads led there. Burgess predicted the formation of five rings of land use around the central business district. Five distinct areas may be distinguished: (1) the CBD, (2) the transition area, (3) the independent worker housing area, (4) the affluent residential area, and (5) the commuter area. The positive link between the socioeconomic status of homes and their proximity to the CBD is a key aspect of this model.

3.6.2 Sector Model

Homer Hoyt saw the merit in the concentric ring approach, but he reimagined it in a different way. He noticed that low-income neighborhoods tend to cluster along train tracks, whereas commercial districts tend to cluster around major roads. Hoyt revised the concentric zone method in 1939 to include significant transportation corridors. The transportation hubs of most major cities, including railways, seaports, and trolley lines, all grew up around the city's core.

Hoyt believed that cities would expand outward in wedge-shaped patterns, or sectors, centered on important transportation arteries, since these roads (and subsequently metropolitan expressways and interstate highways) indicated lines of increased access. In

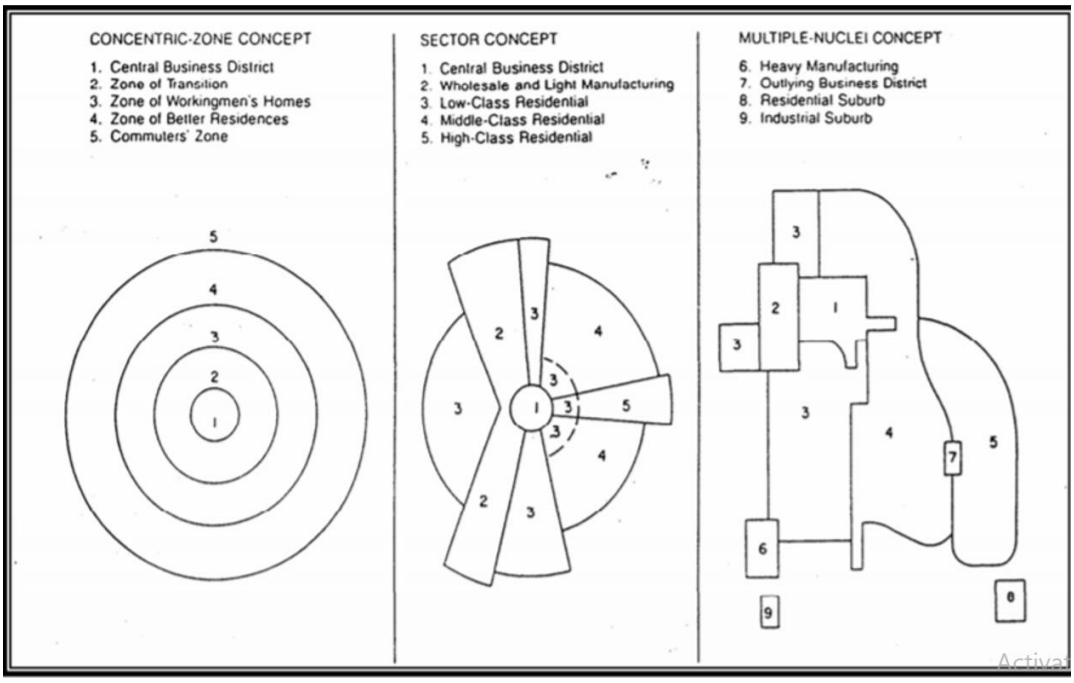
general, land is worth more when access to it is improved. As a result, the Central Business District (CBD) would continue to serve as the hub for many commercial operations, while a manufacturing wedge sprang up around major transportation hubs.

Wedge-shaped growth patterns in residential land use would also emerge, with lower-income households clustered near the manufacturing/warehousing sector (because to traffic, noise, and pollution), and middle- and upper-income homes clustered away from industrial areas. To take into consideration the role of transportation networks in determining access, Hoyt's sector model is essentially a modified concentric zone model.

3.6.3 Multiple Nuclei Model

As Chauncy Harris and Edward Ullman discovered, many urban areas do not conform to the canonical grid of concentric zones and sectors. Larger cities were annexing vast suburban regions, and some of these suburbs had grown to such an extent that they acted much like smaller commercial districts. Land use trends clustered around these secondary hubs of commerce. Although the Central Business District (CBD) is where most business is conducted, surrounding it are smaller, more specialized commercial districts that have emerged in response to the unique needs of various industries, the varying rents they can command, and the natural tendency for certain types of economic activity to cluster in certain areas. Their plan revolves around the central business district (CBD), with distribution hubs and light manufacturing situated near major thoroughfares. Low-income neighborhoods surround the city's heavy industries on its outskirts. The outskirts of cities are home to smaller service centers. Figure 3.2 below illustrates the various urban land use models.

Figure 3.2: Urban land use models



(Source: Harris and Ullman, 1945)

3.7 Public Transportation and Traffic Congestion

When it comes to moving large numbers of people around congested metropolitan areas, public transportation is inherently more effective than individual automobile use. In exchange for financial compensation, the public receives the services of a public transportation enterprise (Wells, 1975). Traffic congestion in the city's central business district may be alleviated with the use of public transportation (Croswell, 1979). Decision-makers have a limited grasp of the nuances of the interplay between public and private modes of transportation. In the midst of heavy traffic congestion in the city's central business district, several efforts have been made to enhance public transportation's general accessibility and functioning (Giannopoulos et al., 1989).

Despite the fact that private automobile usage has grown and public transit's share of the transportation pie has shrunk due to shifting lifestyles and patterns of development, public transportation still serves as a vital component in the lives of city people (Bus and Coach Council, 1986). Consequently, the primary function of public transportation in urban areas is to help those who lack access to personal vehicles get to work and other social and economic destinations that are outside of their immediate vicinity on foot, and to offer an alternative to the private automobile in cases where geographical or financial constraints prevent their use in the Central Business District (Bus and coach council, 1986; Giannopoulos, 1989). The primary function of urban public transportation is to gather people from dispersed residential and/or work locations or across cities, and it also assists in distributing these people to their respective destinations, such as workplaces, shopping centers, and homes.

Here, we focus on the online computers and traffic management signal equipment that may significantly aid in enhancing the efficiency of urban traffic. Detectors, signals, local controllers, inter-linking, data transmission computers, and other central office, equipment are only some of the tools used for urban traffic management on freeways and streets. Open and closed loop control systems, as well as central office computers with stored programs, are further examples of management and control approaches. There are two primary kinds of freeway urban traffic management systems now in use for traffic controls: the traffic responsive pre-timed area control system and the completely flexible vehicle actuated area control system.

3.8 Dialectics of Urban Growth

Cities may be identified by the variety and concentration of their economic, social, and cultural activities, as well as by the unique composition of their residents and their enterprises and organizations. Nairobi, Kampala, Dar-es-Salaam, and the Federal Buildings in Washington, DC are just a few examples of cities that each have their own particular attractions. Cities are most easily recognized by the shape of their physical environment, which often has high-rise structures in the downtown core, industrial and distribution zones on the outskirts, and denser residential districts closer to the city center than in the suburbs.

In urban settings, patterns of land use are defined by the placement of these and other uses. Many different sorts of businesses found it helpful to group together as industrialization progressed, creating economic hubs. The notion of agglomeration economics, which refers to the advantages that come from the concentration of people and businesses, is crucial to grasping the reasons for the emergence of urban areas. Innovations in manufacturing, shipping, communications, and construction methods paved the way for cities to expand. The urban fabric has proven to be quite sturdy.

Urban centers often formed at the intersection of major transportation arteries (roads, streetcar lines, railways, ports, etc.) that were essential to the movement of manufactured goods. People traveled to the central business district (CBD) by the same routes that got them there. Reinforced concrete and other innovations in construction techniques made it possible to construct enormous buildings that still have a profound impact on the urban landscape. Urban land use has shifted in response to these and other advances. Households and companies may now settle outside of the core city in suburban settings,

where densities and land prices are cheaper, thanks to the widespread usage of trucks and vehicles traveling on interstate highways and beltways.

When describing suburban expansion, the word "sprawl" is often used to describe the pattern of horizontal growth seen in the built environment as opposed to the vertical growth typical of the central business district. Suburbanization has led to a shift from the traditional, centrally concentrated layout of cities to a more diffuse, polycentric pattern in which companies and residents are dispersed across the metropolitan region. Though many cities have their own distinct personalities, they all have a number of remarkable characteristics. Prices of land often decrease further from the central business district. As a result, the density of land uses rises toward the heart of a city. Accessibility is a significant factor in determining property values everywhere, even in dense metropolitan regions with extensive suburban business developments known as edge cities (i.e. more accessible parcels of land are more expensive). Location, accessibility, quality, and other features of land all factor into the price at which it is sold. Business areas, commercial centers, government centers, and residential neighborhoods all comprise the complex urban mosaic that results from multiple placement choices made by firms, families, and governments.

The term "clustering" is used to describe a collection of frequently visited locations that are situated in close proximity to one another. Travel patterns are modified by clustering. By decreasing travel times and increasing the number of walkable centers that are well-served by public transportation, ridesharing, and personal automobiles, clustered land use generally improves accessibility. Complementary land uses are essential to the success of clustering in terms of increasing accessibility (Haughwout, 2000). To maximize its

potential for cutting down on car usage, clustering should be combined with other methods of making better use of available land. When businesses are located in close proximity to residential areas, schools, and other amenities, the number of people who commute to work by automobile decreases. Strategies to reduce the number of times employees have to travel between locations tend to work best when businesses are located close together.

Clusters may be seen in places like office parks, college campuses, retail centers, business areas, and even whole cities. When buildings have varying land uses and peak demand periods, as is often the case in clusters, it becomes easier to implement shared parking. By sharing parking and reducing overall parking needs, a cluster of buildings with peak parking demand during the weekdays may accommodate a restaurant with peak parking demand during the nights and a church with high parking demand during the weekend mornings. Higher density and more adaptable parking rules are generally necessary for clustering to be successful.

This has the potential to lessen the burdens of urban sprawl, pollution, energy use, vehicle collisions, and energy prices for residents in the area. These benefits tend to be greatest if complementary land uses are mixed and supported by other Traffic Demand Management (TDM) and land use management strategies (Coffey et al., 1997). According to one research, production at the state level increases by six percentage points for every one-point rise in the density index at the county level. It is for this reason that urban areas and commercial hubs flourish and play such a crucial role in national and international economies: The expenses of activities that need frequent contacts may be reduced by clustering common destinations.

Noise and air pollution levels might rise as a result of cluster development. Although regional traffic and pollution emissions tend to decrease if clustering decreases overall vehicle usage; clustering does raise certain expenses, such as some kinds of infrastructure expenditures (such as certain utility prices) and traffic congestion inside the cluster. Costs for maintaining roads and parking lots may be reduced if people drive less and take use of Parking Management options.

3.9 Case Studies of Typical Best Practices in Land use and Transportation Integration

Well-planned and efficient urban transportation is essential to the functionality of urban economies because it provides access for the underprivileged to essential goods and services and mitigates key transport-induced problems such as congestion, pollution safety and sprawl that arise when proper planning, regulation, and investment are lacking. Many cities and urban authorities have made efforts to better integrate land use and transportation in order to guarantee that all present and future city inhabitants have access to affordable, healthy and livable communities. The burden is laid on the shoulders of urban authorities to make sound judgments in a timely manner.

There has been a lot of research done on the topic of transportation and land-use planning. The data overwhelmingly supports the following conclusion: when sustainable transportation options are prioritized during land use planning, non-automobile modes of transportation become the norm, whereas the opposite is true when development proceeds without sufficient attention to transportation needs.

Land use and transportation choices interplay to define a city's identity. Transportation planning laws have a significant impact on urban density, and vice versa. 20–40% of land

in residential areas and 40–60% of land in commercial centers is devoted to transportation-related uses such as highways, sidewalks, parking garages, railway stations, airports, and harbors (downtowns, shopping malls and industrial parks).

People are more likely to walk and ride bicycles in urban areas where high density and diverse land use are encouraged (Cervero et al., 1997) In contrast, oil consumption and greenhouse gas emissions would increase dramatically if transportation and land use policies favored automobile use. That's why it's possible to classify cities as either very auto-dependent or pedestrian-friendly. In car-dependent neighborhoods, the automobile and its supporting infrastructure are given priority over other modes of mobility including public transportation, walking, and bicycling. Because automobiles are given special care, more space is needed. Due to the increased space requirements of faster driving, factors such as wider lanes and farther apart parking spots are more relevant (Kodukula, 2011). Unfortunately, it is common for there to be insufficient parking space for visitors.

Walking, riding a bike, or using the bus might add considerable time to a trip. They need more room since they provide less mobility (users cannot move as far in a given period. They require that people live closer to where they work, shop and recreate. Therefore, it is clear that when urban planning prioritizes accessibility above transportation, high density and varied land-use are the result. Alternatively, placing greater focus on mobility rather than availability increases people's propensity to travel (i.e. be mobile).

It has been stressed in international climate negotiations, such as the Conference of the Parties that urban transportation has a significant role in contributing to climate change (COP). The focus of these discussions has shifted from the federal level to the state and

local levels, where it has prompted legislation requiring the development of low-emissions transportation solutions.

3.9.1 Case Studies: Lessons Learnt

3.9.1.1 Planning for car-reduced living, Vauban, Freiburg, Germany

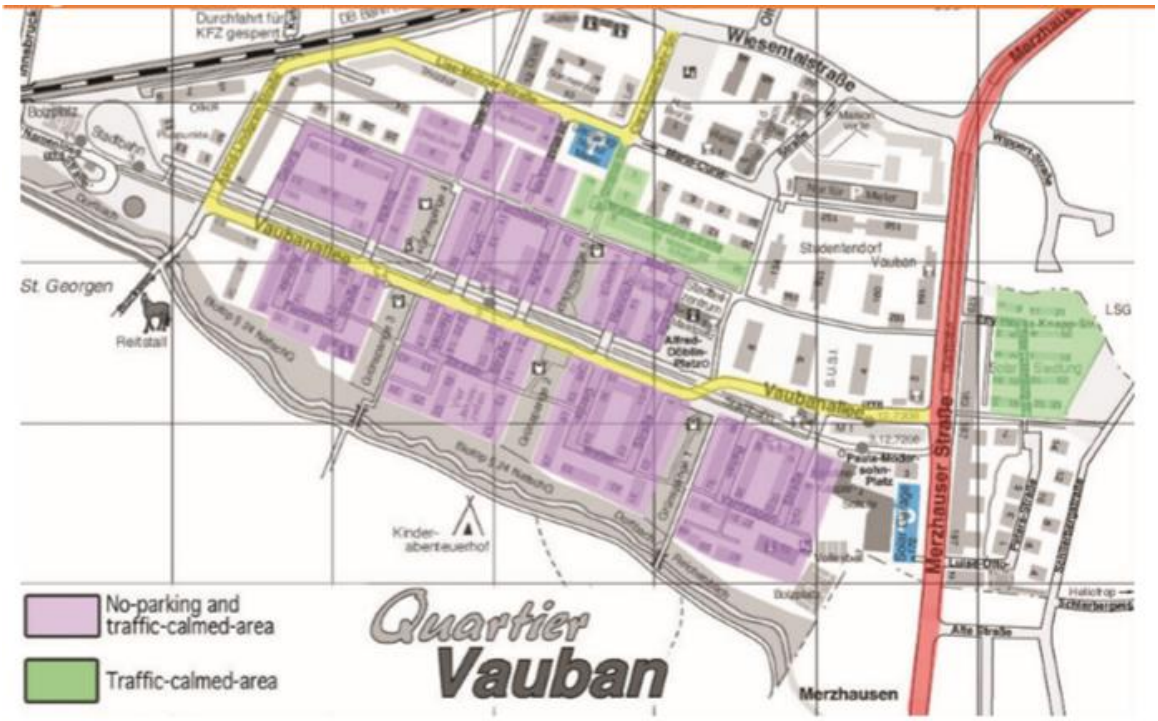
The German city of Freiburg's newest district, Vauban, lies roughly 3 kilometers away from the downtown area. The project's construction started in 2000 and was completed in 2006, by which time it had housed 5,000 people and employed 600 employees. The development covers 38 hectares of land, including the site of old barracks, and has net building densities of 90 to 100 dwellings per hectare.

Vauban's transportation system, energy use, and other variables were all designed from the start to be examples of environmental stewardship. The development's innovative parking system has been carefully examined.

The land use design made it such that amenities and occupations in the area could be reached on foot or by bike by implementing the idea of "a district of small distances." All sorts of places including malls, grocery stores, farmers' markets, food co-ops, parks, and companies are included in this category.

The development was planned and designed with pedestrians and cyclists in mind. The speed limit on the main road through the district is 30 kilometers per hour, however inside the residential area, cars are not allowed to move faster than the pace of walkers (5 kilometers per hour), as per the 'home zone' laws that require vehicles to defer to pedestrians. An outline map of the Quartier Vauban district is shown below.

Map 3.1: Neighbourhood of Quartier Vauban, Freiburg, Germany



Source: eRich Lutz, 2003

From the start of construction until the finish, regular bus service provided public transit, which was later replaced by a tram system. The Vaubanallee serves as the complex's spine, and the tram operates every five minutes during rush hour to connect riders with downtown Freiburg. About a third of the locals utilize a season ticket to use the bus or train throughout the year. This might be because of a local car club that gave its members free access to the local bus system and a discount of up to 50% on rail rides for the first year of membership.

Vauban was compared to a similar area on the other side of Freiburg in order to examine the effect of the parking strategy (Rieselfeld, with 10,000 residents). Vauban has a

substantially lower rate of automobile ownership than the national average (44 percent less, at 150 cars per thousand residents vs 270 per thousand).

People living in Vauban who do not possess cars travel quite differently from those who do (see table 3.1 below).

Table 3.1: Comparison of Travel Habits amongst Vauban Residents

Type of Trip	Car-owning Households	Non-car owning Households
'Bulk' shopping	73% by car	6% by car
'Daily' shopping	10% by car	0% by car
Leisure	28% by car	2% by car
Communting	61% by bicycle	91% by bicycle

Source: Nobis, 2003

Travel in Vauban was extremely sustainable in general. There was a much lower-than-average mode share for cars (16% of trips) compared to the rest of Freiburg (31 percent). Only one-fifth of all journeys use private automobiles, while 19% use public transportation. Sixty-four percent of visits are done by foot and bike, which is a significant number.

3.9.1.2 Curitiba, Brazil A model for Transit Oriented Development

Located in the state of Paraná in Brazil, the city of Curitiba is home to a population of 1.8 million in an area of 430 km2. The city has a greater per capita GDP and lower unemployment rates than most other Brazilian cities because to its thriving industrial, commercial, and service sectors. As a result of decades of careful urban planning methods and political resolve, Curitiba is also recognized as the "ecological capital" of Brazil. However, Curitiba's environmental triumphs have not come without facing formidable obstacles. Its population increased from 350,000 to 940,000 between 1955

and 1975. (IBGE, 2010). The city's leaders recognized the need to put an emphasis on planning for long-term, sustainable expansion in response to the unceasing influx of residents.

As urbanisation and car ownership rose in the 1960s, Curitiba seized the opportunity to improve its land-use and transportation planning. Together with the Institute of Urban Planning and Research of Curitiba (IPPUC), the City implemented a Transit Oriented Development (TOD) strategy, which resulted in the creation of dynamic, high-density, mixed-use neighbourhoods along major arteries of public transportation. With TOD in place, the city was able to lessen the burden of downtown traffic and curb the spread of sprawl. Curitiba is now seen as a leader in the field of low-carbon urban development thanks to the city's innovative policies and programmes. By encouraging TOD, the city of Curitiba has become more hospitable to pedestrians and improved the quality of life for its citizens by expanding their access to public spaces. This people-centered strategy for urban and transportation planning is particularly useful for rapidly growing metropolitan areas that lack the resources to make the necessary infrastructure improvements. The value of TOD in today's urban landscape.

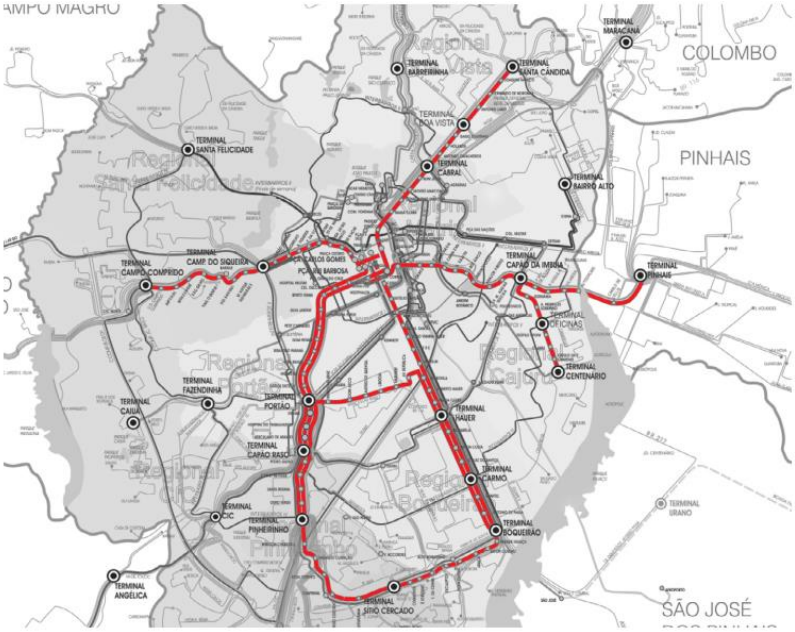
3.9.1.2.1 Planning for integrated land-use and transportation

In 1964, the city of Curitiba launched a planning competition entitled "Curitiba de Amanh" (Curitiba of Tomorrow) in response to the challenges brought on by rapid urbanisation, with the aims of better integrating transportation and land-use and lowering dependency on private automobiles. Reducing traffic and congestion in downtown Curitiba by dispersing employment providers was one of the competition's stated goals. Another was to boost social equity and well-being by enhancing the number of public

parks and pedestrian plazas in the city's core. Finally, the competition aimed to encourage a low-carbon and resilient city by encouraging more people to take public transportation and bicycles.

The competition's victorious team unveiled what was initially called a "Preliminary Plan," but which eventually became known as the "Master Plan." The concept depicted the city as a star, with five structural axes meant to direct high-density, mixed-use growth along mass public transportation lines, also known as the "Trinary Road System," radiating out from the city's core. See map 3.2 below.

Map 3.2: Showing the growth corridors of Curitiba as captured by the 1964 Master Plan



Source: ICLEI Case Study - No. 190, 2016, Curitiba, Brazil.

3.9.1.2.2 Synergizing Institutional Structures for TOD:

The Instituto de Pesquisa e Planejamento Urban de Curitiba (IPPUC) was founded in 1965 by then-Mayor Ivo Arzua as a Municipal Independent Authority. As a result, a multi-agency commission led by the IPPUC was tasked with organising the city's TOD integration. Until its implementation in 1971, the committee participated in all phases of planning and development, and the Plan was the subject of extensive public engagement processes. The city has also actively encouraged the linking of local transportation networks to those of surrounding areas. The Curitiba Metropolitan Region Coordination body (COMEC) was established in 1974, facilitating communication amongst the city's 13 individual municipalities in terms of transportation.

3.9.1.2.3 TOD implementation: Long-term policies and infrastructure for guided growth

Curitiba's TOD is built on a phase-based strategy for low-carbon urban development to guarantee compact, livable neighborhoods and to construct the infrastructure needed to sustain the system's growth over time.

Axis denotes the location: The change in planning that started in Curitiba in 1972 was predicated on increasing density along the city's axes. The city's transportation network would collapse without these main arteries. This shift was made feasible by the City's zoning and land-use regulations, which favored the growth of high-density mixed-use zones around important transit nodes.

Community planning for walkable, mixed-use areas: The Plan identified and regulated that at least fifty percent of the ground and second floors along transit corridors be allocated to shops, restaurants, and commercial services in order to promote thriving,

socially equitable, and prosperous communities. City officials also mandated inclusive zoning in Special Social Interest Housing Sectors for the city's low-income residents and created a Jobs Route Zone (Linho do Emprego, Law 9,800/2000). (Law No. 901, 1980). The mayor of Curitiba has instituted car-free zones in the downtown area and elsewhere to promote walking.

Densifying density: Law 4199 of 1972 designated North-South and Northeast-West axes as high-density residential and commercial zones, charting a course for future growth. Because of density restrictions in the outer residential zone enacted in 1975 (Law 5,234), the city has actively encouraged housing development along major transportation and infrastructure arteries since the 1980s. The city imposed FARs of 6:1 (later lowered to 5:1) along four of its five corridors and 4:1 along the axis and in high-density districts bordering the axis near transit routes in order to maximise land usage. Building owners in low-density regions, such as historic zones (protected under Historical Sector Decree 1,160/1971), were authorised to sell or transfer development rights to those in high-density areas in order to promote development.

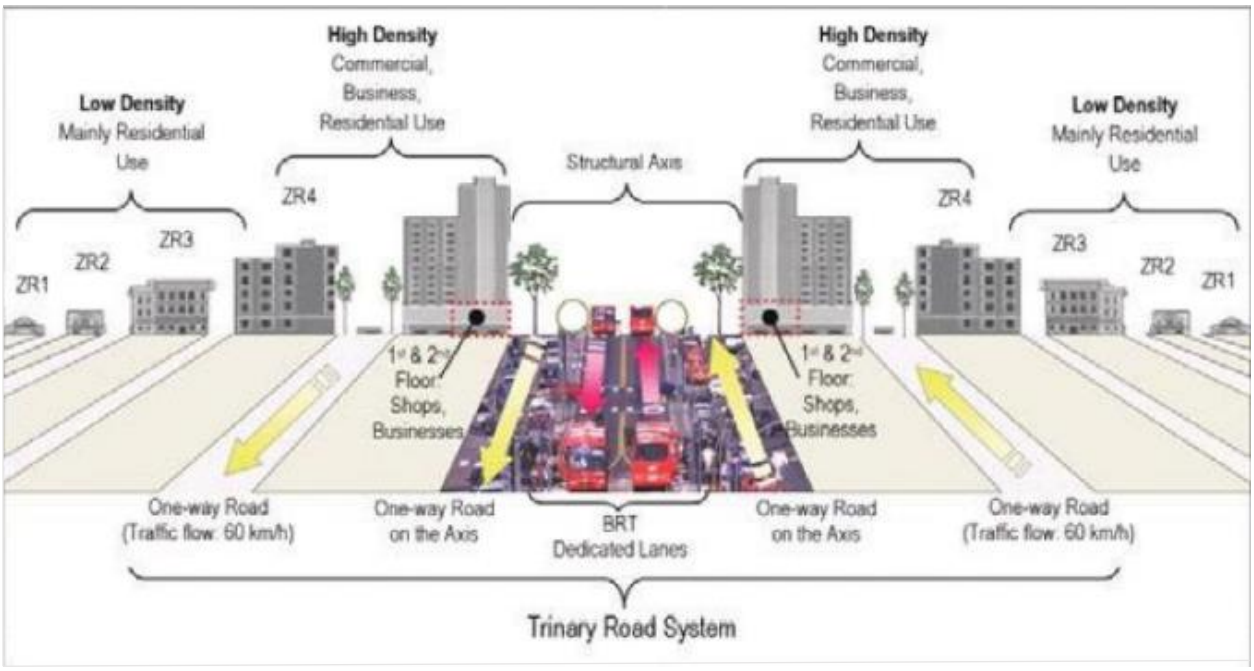
3.9.1.2.4 Scaling up existing infrastructure for pioneering innovation

Curitiba, Brazil, which had limited resources when the Master Plan was drafted, expanded its existing transportation network by adopting an adaptive BRT transit model to accommodate the City's new urban growth plans. Timely deployment of buses was possible because to this staged approach, which also allowed for the inevitably slow construction of transportation infrastructure.

Trinary Road System: One example of innovative maintenance of existing infrastructure is the Trinary Road System. In order to reduce congestion, the Trinary

Road System employs a network of three interconnected roadways. The backbone of the system is a two-lane street that is reserved for use by a Bus Rapid Transit (BRT) System, ensuring quick, easy travel between two locations. The BRT system is bordered by high-density residential and commercial areas, and by two smaller one-way streets (one fast and one slow) that direct traffic in opposite directions.

Figure 3.3: Showing different densities and traffic directions along Curitiba's structural directions



(Source: ICLEI Case Study - No. 190, 2016, Curitiba, Brazil)

3.9.1.2.5 Creating the Integrated Transit Network (RIT) with Bus Rapid Transit

The city adopted a BRT network strategy in 1972, with the rollout of the Integrated Transit Network (Rede Integrada de Transporte (RIT)). In 1974, the RIT's first two bus lines were put in place, marking the beginning of the system's original conception as a North-South integrated transit network; nevertheless, the RIT didn't fully go into effect until 1979. Similar to a major city's subway system, the RIT in Curitiba is run by a

government agency called Urbanizacao de Curitiba SA (URBS). There are five distinct bus models used by the system to transport passengers along the city's eleven bus lines and 81.5 km of corridors. In order to direct traffic efficiently and complement existing land use classifications, the RIT assigns different colours to its various bus classes (express, inter-district, and feeder buses). For instance, in less populated areas, feeder buses pick up passengers and transport them to central hubs where they can switch to express buses.

The City and the RIT have implemented measures to control traffic and increase ridership, such as elevated tube docking stations for safety, weather protection, and faster bus boarding and exit times; flat service rate pricing, which allows users to ride multiple types of buses for one fixed price; payment tube stations which accept electronic fares; and accessibility aid for the elderly and the disabled. The accessibility features such as ramps, lighted signs for the hearing impaired, and braille information packets for the visually impaired are standard on more than 90% of municipal buses, subway cars, and light rail trains.

Plate 3.1: Trinary Road System in Curitiba City

(Source: ICLE, 2016)

Expansion of walking and cycling paths: As an extra mode of transportation, the IPPUC and URBS built bike lanes. The municipal council adopted the Plano Director Cicloviario in 2013 to increase the size and quality of the city's cycling infrastructure. By 2016, the plan's 300 kilometres of new bike lanes were to have been installed. About 25 kilometres of bike lanes have been installed along BRT routes, while another 50 kilometres of lanes have been installed within eight of Curitiba's parks.

To further improve cycling infrastructure, a pilot electric bike rental system has been designed, which will feed into bus station stops and along the major BRT routes in the city and public parks. PlanCal, an all-encompassing sidewalk plan for Curitiba, was also developed. PlanCal's guidelines for repairing sidewalks may boost accessibility in cities around the country.

Addressing private vehicle use/parking management: With the implementation of parking regulations and regulated street parking, the cost of leaving a private vehicle parked anywhere in Curitiba has increased. The city of Curitiba has implemented car-free zones and used "push factors" such limiting the use of certain cars to encourage its citizens to switch to public transportation. In the city's central traffic zone, Curitiba restricts the circulation of large and lengthy trucks. Since 1997, these regulations have been in effect, and the Municipal Decree (973), which regulates loading and unloading periods based on vehicle length and payload capacity, specifies when each can occur.

Lessons Learned

- Striking a balance between population density, building design, and development; in 1990, the City of Curitiba lowered the maximum density along the city's main arteries because of "excessively high occupancy," which had a negative effect on

the area's ecological sustainability. The urban heat island effect is triggered by high-rise and high-density building.

- The development of Urban NEXUS TOD was made possible by the establishment of the IPPUC as the central coordinating organization, which facilitated the participation of several essential multi-sectoral stakeholders.
- The stepwise BRT method allowed the City to execute quick change for high quality and low cost, demonstrating the need of setting realistic goals for long-term change.
- All things have room for improvement. To better understand how people in Curitiba and the Metropolitan Region utilize different modes of transportation, studies are now being conducted. New policies based on the findings of the study will be implemented to enhance the city of Curitiba and the metropolitan region's transportation networks.

3.9.1.3 Eastern Planning Initiative (EPI), Montana State, US

Rolling hills surround Charlottesville, Virginia, a city in the state of Virginia at the foothills of the Blue Ridge Mountains. Newcomers are drawn to the area because of its attractive scenery, cultural opportunities, and historic significance. Rapid expansion is taking place as a consequence, affecting not only the city itself but also the five-county area around it.

However, many people worry that the area's distinctive traits may be lost due to the increased traffic and poor planning that have resulted from this boom. For example, the idea of a four-lane freeway bypassing Charlottesville has been met with widespread opposition from locals. Highway advocates argue that it would alleviate congestion,

while others say it will just lead to greater development and the destruction of a beautiful rural area.

Following a regional visioning exercise led by the Thomas Jefferson Planning District Commission in 1998, the "Sustainability Accords and a Vision of Sustainability" was written to address these issues. All parties involved in the agreements recognized the need to update regional development practices. By using an innovative public process and modeling methodology, the Commission has developed a transportation and land use vision for the Charlottesville metropolitan region that will be utilized to implement these agreements.

In fiscal year 1999, the Transportation and Community and System Preservation Pilot Program (TCSP) contributed $518,000 for the Jefferson Area Eastern Planning Initiative. (EPI). Initiative goals included 1) developing a set of modeling tools to simultaneously analyze transportation and land use options, and 2) developing a 50-year transportation and land use vision for the five-county region around Charlottesville.

The first objective was completed with the use of a cutting-edge model called CorPlan. CorPlan is an innovative GIS-based methodology that uses common "community characteristics" as its building blocks to estimate regional land development potential. The CorPlan model was used in the EPI study to allocate different types of future development throughout the region for different potential land uses. The regional travel demand model was fed this allocation, and from that, transportation estimates were created for each of the options. Furthermore, architectural renderings of the city's amenities were employed to provide residents a glimpse of the future.

For the second goal, the Commission conducted an 18-month research that solicited answers to the following three questions from the public:

- How will we live? Where will we live and work in the year 2050, and what kinds of places will they be?
- Can you tell me where we can get housing? Which parts of this territory can be developed into cities, and which cannot?
- Getting There: How Do We Do It? How do we go from where we are today to the communities and urban expansion zones that we envision?

Residents strongly favor a compact, nodal type of development and the transportation networks that would enable this pattern, according to public workshops. In order to realize the 50-year vision, the Commission must now tackle the difficult task of updating municipal comprehensive plans and capital improvement projects..

The process

In order to help direct the Eastern Planning Initiative, the Commission formed a 35-member Advisory Committee comprising of elected officials, business executives, representatives from environmental and community organizations, and citizens from the study area. There were a total of nine meetings and four open workshops held by the committee throughout the course of the investigation. The Commission received assistance from a team of urban planners from the University of Virginia's School of Architecture.

At the first meeting, attendees took stock of the neighborhood as it now stands and gave ideas for how it may be made more hospitable to residents. Suburban aspects such as houses, shops, and workplaces were discussed, and participants indicated a significant

desire to "improve" these typical features. Ideas for improvement included a central gathering place and clear borders, improved accessibility for pedestrians, a wider range of uses, more open areas, and more compact development.

The second workshop requested attendees to prioritize "community aspects" while deciding how to distribute future growth in the area. As a consequence of the workshop, participants agreed that urban and "improved suburban" components should play a more prominent role in the region's progress.

A "nodal" scenario, two "core" scenarios, and a "dispersed" or trend scenario were developed by the research team based on the outcomes of the workshop. In order to back up the different land use possibilities, the research team built transportation scenarios, which included a variety of highway, transit, and non-motorized facility configurations. At the third workshop, the public was shown these scenarios and asked for input; attendees were also tasked with coming up with transportation and land use objectives and reaching a consensus on them.

For the rest of the study, researchers zeroed down on what it would take to fulfill the public's demand for a version of the "nodal" or "core" scenarios.

The EPI study's principal output was a collection of "important success criteria" to back up the public's desire for a clustered development pattern. Local communities are tasked with refining the proposals' suggested development regions and their potential scales of growth.

Lessons Learned

Many lessons were learned during the Eastern Planning Initiative in Charlottesville on how planning agencies may work with residents to craft a transport and land use strategy.

Develop a plan for future land use based on "community factors." Due to the uncertainty of future development, the EPI effectively employed the community element concept to apportion population and jobs associated with diverse growth patterns. In addition, the community characteristics served as a straightforward method of summarizing various growth trends.

Start your planning with "visioning": When planning a community, it is not enough to rely just on figures and words; residents need to be able to see what their future home will be like. People were able to have a deeper knowledge of the planning principles they were embracing thanks to the visual representations of alternate development patterns and transportation infrastructure.

Tend to the big picture: At the start of the research, communities were worried that the suggestions might run counter to the comprehensive plans they had just passed. The Commission somewhat addressed this worry by settling on a 50-year horizon rather than a 20-year one. Instead of rushing through this process or (alternatively) retaining a local plan that clearly contradicts the regional plan, the 50-year period gave jurisdictions time to prepare for adjustments in the next update of the comprehensive plan.

Participants in the study were aware that fixed-guideway transit was not a good financial fit for the area at the time of the study, but they nevertheless wanted to make sure it was an option in the future in case the area saw substantial expansion. A consensus was reached among the participants that conserving transit right-of-ways and instituting transit-oriented development patterns were two measures that would incur low upfront costs while promising high long-term returns.

Think about the monetary and economic effects on fairness: Concern regarding the equitable consequences of the suggested land use patterns emerged as an unexpected

finding during the study's analysis phase. Affordability of housing in the area and the effects on local government finances were among the top concerns voiced by participants. These monetary and financial effects will be examined in more depth in a subsequent research.

It will take a long time to fully implement the Eastern Planning Initiative's findings, which are simply the beginning of the process. But the research shows how innovative modeling and public participation may aid in regional planning and preserve the quality of life that its inhabitants cherish.

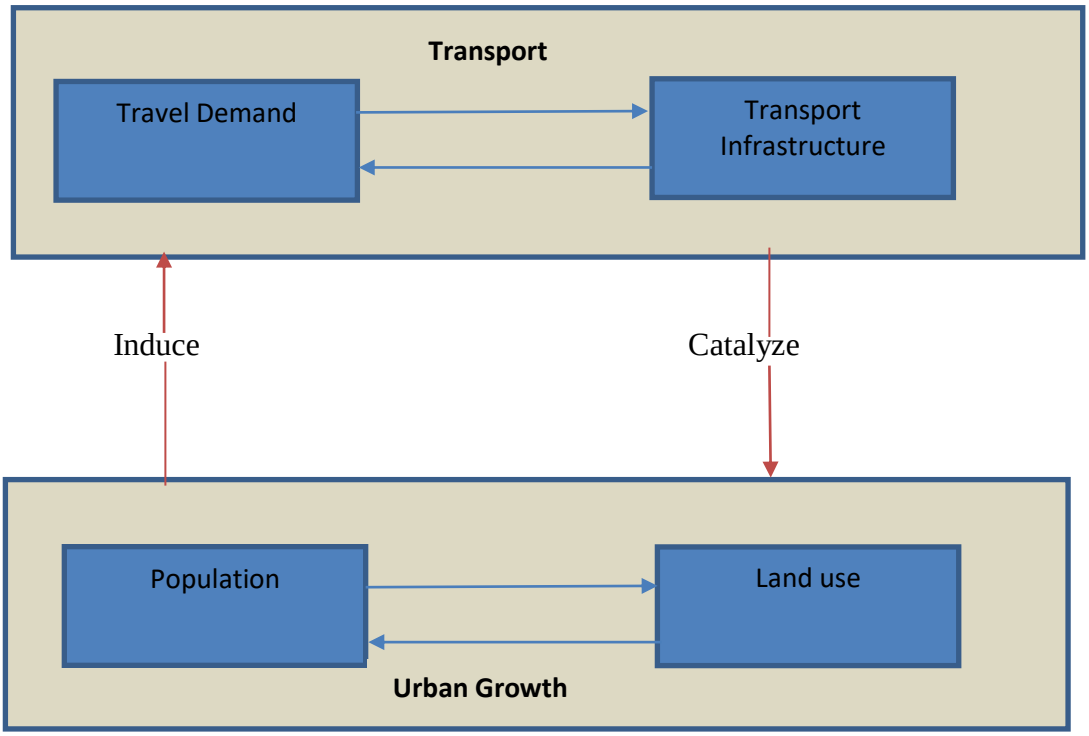
3.10 The Conceptual Framework

By their very definition; cities are dynamic, complex entities that play a crucial role in the development of the physical, economic, and demographic factors otherwise known as urban growth. The growth of cities is a multifaceted process including not only physical and economic factors but also changes in geography and time (Han et al, 2009). Many different factors and causes converge here. To that end, transit is regarded as a major factor in city growth and transportation improvements have decreased the price of commuting inside urban areas and encouraged suburban growth (Johnson, 1967; Jackson, 1985). This has been shown elsewhere (Johnson, 1967; Jackson, 1985). In a similar vein, the expansion of roads has facilitated urbanization and changes in the pattern of land use (Castells, 1989; Hall et al, 2000; Hart, 2001; Bhatta, 2010).

Likewise, urban development has an effect on public transportation and the process of urban growth influence the spatial form of cities, which in turn affects how people get about. Traffic congestion is a direct result of the pressure placed on infrastructure as a result of urban growth (mro, 2003; Cameron et al. 2004; Millot, 2004). (Bhatta, 2010;

Brueckner, 2000; Allen, 2003). Evidence for this may be found in many sources (Bhatta, 2010; Brueckner, 2000; Allen, 2003). Therefore, urbanization and transportation are inextricably linked, one contributing to and being affected by the other. An obvious facet of the relationship between urban growth and transportation is that it is characterized by causation, repercussions, and causes. However, as shown in fig. 3.4 below, the connection may be inferred from four key interacting aspects: transport infrastructure, travel demands, population, and land use change.

Figure 3.4: Conceptual reciprocal relationship of urban growth and transport

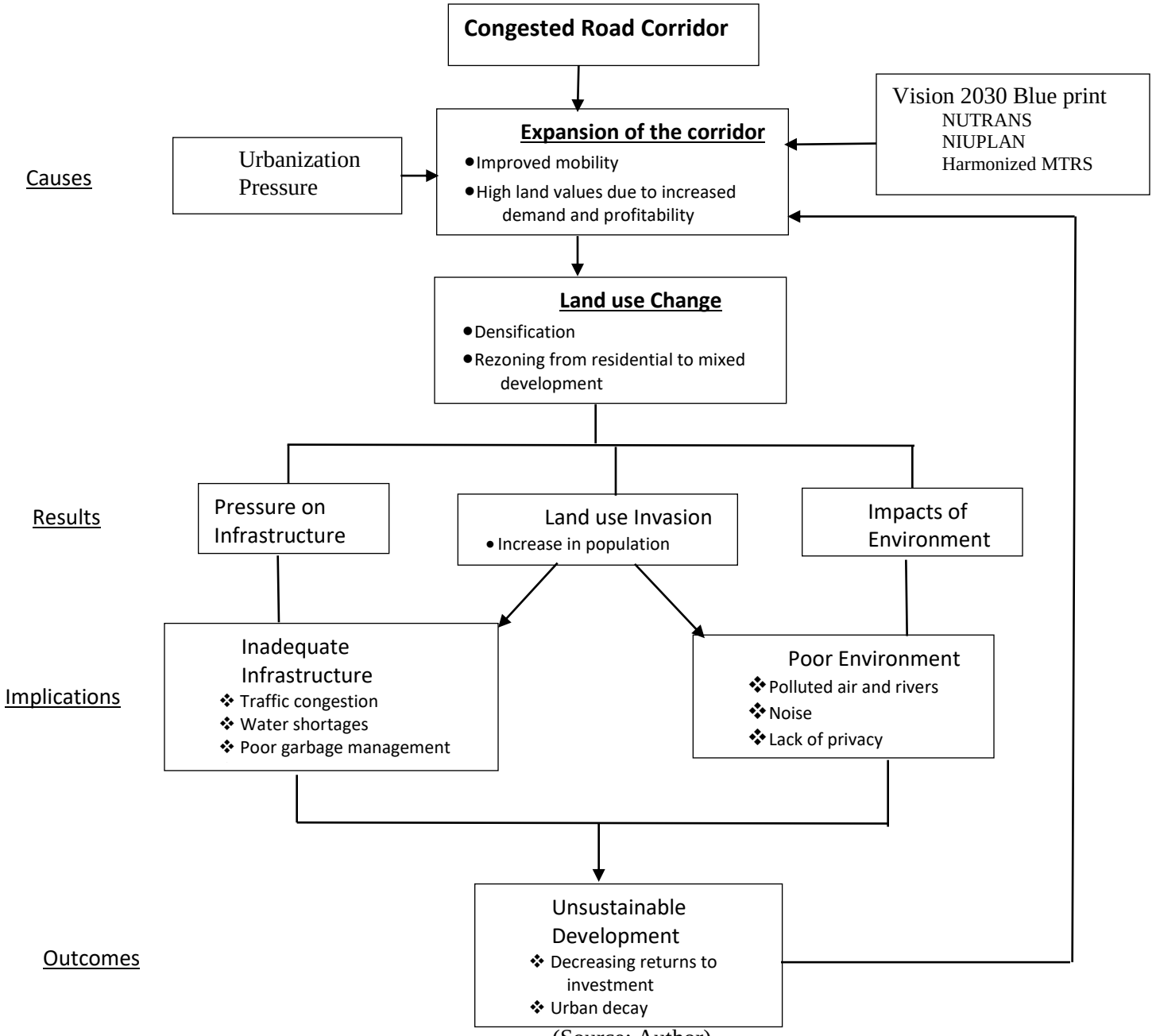


(Source: Aljoufie *et al*, 2011)

Ever since humans first began settling in considerable numbers, cities and traffic have grown together. The same factors that encourage people to live in dense metropolitan areas also contribute to traffic congestion that may become unbearable. To effectively rule a city, it is necessary to strike a balance between the advantages of concentration and the drawbacks of congestion.

Transport, urban expansion, and land use all play a part in the wider picture, which is represented by the above conceptual framework. Figure 3.5 shows how this data might be further disaggregated to provide light on the cascading interaction between transportation and land use.

Figure 3.5: Conceptual cascading relationship of an urban corridor upgrade and land use



(Source: Author)

Increases in road capacity in already-saturated urban areas actually create and contribute to traffic growth. This is due to a number of factors operating at different scales and velocities, such as changes in land use, developments in transportation infrastructure, and individual patterns of movement. Direct mechanisms can be activated almost immediately and often strengthened later; these include mode shifts from other modes to cars when auto travel becomes relatively faster, more comfortable, etc. than other modes of transport, and longer auto journeys as time and cost of travel per kilometer are reduced.

Indirectly, the development of housing, workplaces, retail, and so on on the outskirts of cities and urban regions is a direct result of land-use mechanisms involving the expansion of road capacity, which in turn reduces travel times by car and causes the relocation of households and businesses in existing built structures in ways that are more transport demanding and car-dependent. This trend toward more car-dependent and suburban neighborhoods also increases traffic by encouraging more people to drive, which in turn leads to longer commutes and more vehicle miles traveled.

These dynamics persist in high-sprawl cities until increased traffic leads to fresh congestion, decreasing the allure of building at the city's periphery and making personal automobile usage less competitive. As a result of the increased demand for real estate in the area around the widened road corridor, property owners in the region have felt pressure to maximize their profit from the increased value of their holdings. As a result, there is a need for a review of current land-use planning laws and regulations, with the hope that current restrictions on growth might be loosened. Changes to land use rules along Ngong Road neighborhood include the 1979 Rezoning policy by the Nairobi City

Council that rezoned the Kilimani area to allow for comprehensive development. Zones 3, 4, and 5 were subjected to a policy review in 2006, with the results mandating the harmonization of Argwings Kodhek Road to 24 meters from Ole Odume Road and the regularization of the current flats developments in Kilimani. These recommendations were originally proposed by the Nairobi Town Planning Liaison Committee in 1993.

With rezoning, land use capacity may be increased from single units to multiple units, transforming a formerly low density high class residential land use area into a high density mixed development area. Unsustainable development, which may ultimately lead to a drop in land prices, rents, and environmental degradation, may occur when densification occurs without first conducting an audit of the carrying capacity of the existing infrastructure and ecosystems. Another round of infrastructure construction is set in motion, this time with an emphasis on improving arterial linkages for growth. Kenya's government has created the Vision 2030[1] Economic Blue Print, from which NIUPLANS[2] and NIUTRANS[3] have emerged as blueprints for the future of Nairobi's infrastructure.

[1] Vision 2030: An economic blueprint developed by the Government of Kenya in 2008 to help transform Kenya into a newly industrializing middle-income country providing a high quality life to all its citizens by the year 2030

[2] NIUPLANS: Nairobi Integrated Urban Development Master Plan

[3] NIUTRANS: Nairobi Integrated Urban Transport Master Plan

CHAPTER FOUR: RESEARCH DESIGN AND METHODS

4.1 Introduction

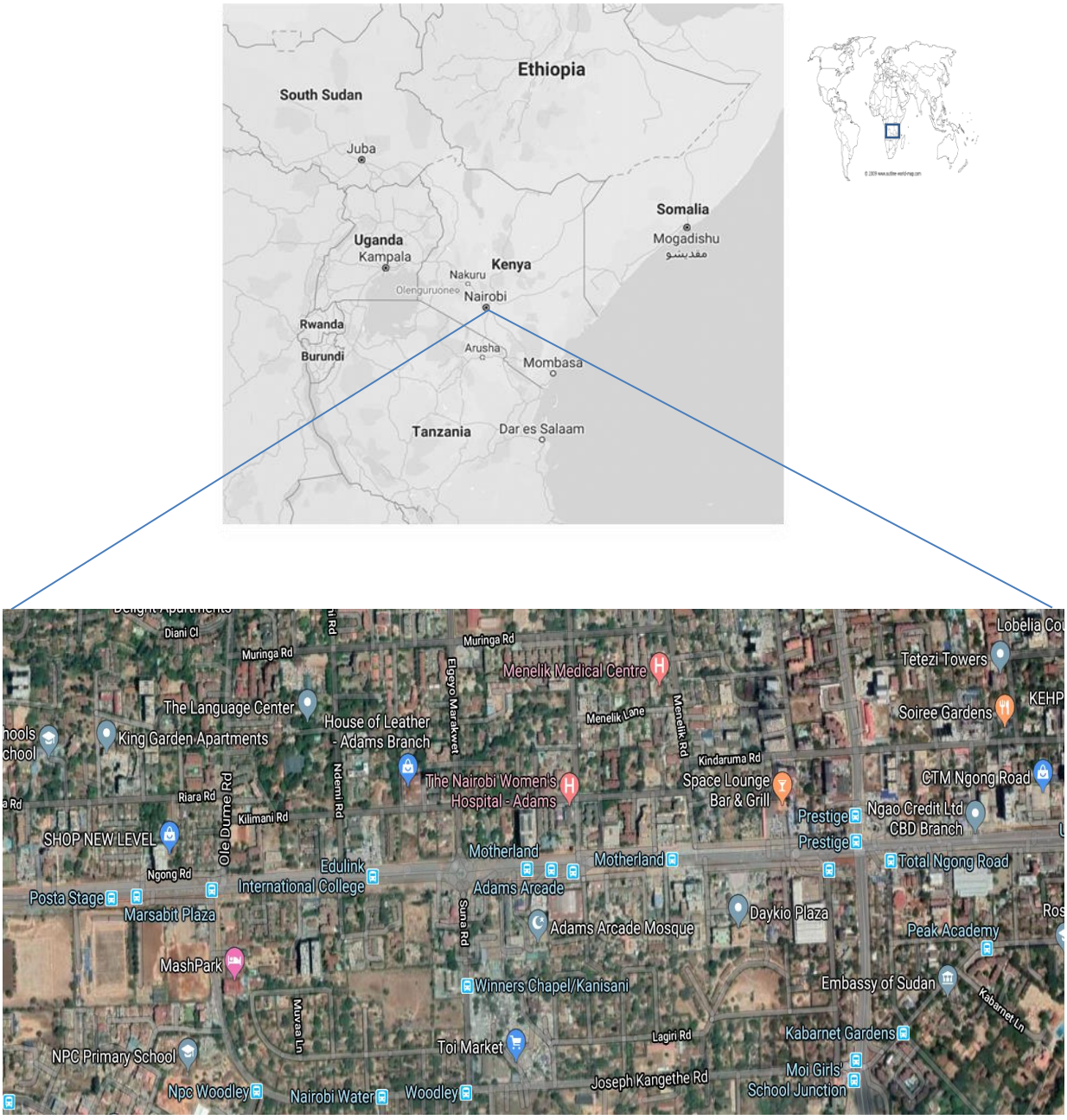
In this section, we will go through the study design, methodology, and techniques that were used, as well as the steps taken to gather and organize the data. Land use patterns in the corridor impacted by a substantial alteration to the city's transportation system are likely to undergo a significant shift. This sets in motion a series of events that, if uncontrolled, will have a detrimental effect on the corridor's transit efficiency. This chapter aims to provide the methodology used to conduct the research for this study. It explains the approach used to the study, how the samples were selected, how the instruments were created, and how the data was collected and analyzed. Near the conclusion of this chapter, you'll get a brief overview of the data need matrix.

4.2 Focus of Study

The study collected information on the following main factors: general conditions of the corridor and existing neighborhood transport system, existing land use pattern within the neighborhood and their relationship to urban traffic congestion, housing typologies, population densities, traffic speeds along the corridor at various times and the design speed along the corridor, the various institutions involved in transport management in the city and the level of coordination amongst them; urban traffic congestion management Policies, laws and institutional frameworks and whether they are applicable whenever a crisis is anticipated following a new development. The study also assessed if there exists any short-term and long-term intervention plans whenever a development in the city's

transport system produces negative impacts. Figure 4.1 below gives the geographical location of the study area from global to local context.

Figure 4.1: Geographical location of Study Area



(Source: Google maps)

4.3 Research Design

A researcher's research design lays out the steps he or she took to investigate and address a problem (Anene, 1998). The researchers used a descriptive survey strategy, which integrates quantitative and qualitative data to produce reliable results. The study's goal was to assess how changing land-use patterns due to the corridor upgrade might affect transportation efficiency. An overview of the procedures followed to bring this study to fruition follows.

First, an idea and a problem were conceived, which served as the impetus for the research. Afterwards, the research assistants were given instruction in how to properly collect data from the respondents. Data collection ethics were discussed, with a focus on the importance of open dialogue, careful analysis, and careful handling of sensitive information. The researcher also emphasized the significance of obtaining informed consent before implementing any survey or interview procedures.

Second, we conducted a thorough literature review to better understand the nature of the issue and locate the knowledge gap. At this point, the researcher also went on a site visit to get a feel for the situation firsthand.

Third, the methodological stage, which provided a synopsis of the survey design and data collection procedures used. All the relevant parties were analyzed at this point, and a budget was created. Before conducting the actual study, a pilot study was conducted to identify and address any potential problems and make any necessary adjustments.

Obtaining research permits from University of Nairobi and National Council for Science Technology and Innovation (NACOSTI) was the first step in conducting the actual field survey (Step 4). Following the development of appropriate methods and instruments in

the methodological stage, extensive data collection was carried out through the administration of instruments like questionnaires and interviews with key informants and relevant stakeholders. Since the survey was conducted during the era of Covid-19 restrictions, face-to-face meetings were minimized with most questionnaires being administered online or through phone calls. Structured questionnaire was used for the survey to lower the cognitive load on the respondents.

Step 5: This step was followed by analysis of the collected data. It involved data editing coding and finally analysis of the findings for purposes of scenario building.

Step 6: The final step the compilation of the report and presentation of the research findings, recommendations and conclusions

See appendix IX for schedule of research activities.

4.4 Target Population and Sampling Plan

Populations inside estates next to Ngong Road, road users, property developers, and different statutory bodies including KURA and the planning department of Nairobi City County were selected by the researcher as major stakeholders pertinent to the study.

Commuters who use Ngong Road to go to and from work were also included in the research, as were residents of homes along Ngong Road between the City Mortuary junction and Dagoretti Corner. It was not feasible to survey every single person that uses Ngong Road during rush hour. Then, commuters who used various modes of transportation were sampled, including motorists, bicycles, and pedestrians. For the bikers, a suitable sample approach was used in the evening peak hours. Household surveys were also sent to the neighborhoods that Ngong Road connects, including Kibera, Jamhuri, Dagoretti Corner, and Kawangware. Moreover, we spoke with authorities from

the Kenya Urban Roads Authority, the Nairobi City County Government, and the Department of Urban Development to get their perspectives on the matter.

4.4.1 Sampling Design

This study employed the following:

- Purposive Sampling - People who have an interest in the research subject were chosen using a sampling technique called "purposeful sampling" (Ritchie et al, 2003). Given the researcher's restricted means, this method was selected for the purpose of locating and choosing relevant information sources. Ngong Road landowners, business owners, and government officials were among the major informants, groups, and organizations sought out. Professionals in fields such as engineering, planning, property valuation, and policy formulation were surveyed for this study and presumed to have relevant expertise.
- Random sampling - Household questionnaires were administered randomly within the study area neighboring the corridor.
- Ngong Road from City Mortuary intersection to Dagoretti Corner intersection and the surrounding estates. To do this cluster random sampling method was employed.

The study area was located in Kilimani Ward within Dagoretti North Sub-county and had an estimated population of about 43,122 persons according to KPHC (2019) with an estimated area of about 1.2 Km^2. The sample size was determined according to a formula proposed by Using Yamane (1973) to determine the sample size;

Using Yamane (1973) formulae

$$n = N/ (1+N^*) (e)^2$$

Where

n = sample size

N = the population size

e = the acceptable sampling error (5%) at 95% confidence level

Thus;

$n = 43,122 / (1+43,122) (0.05)^2$

n = 400

Therefore, 400 people were included in the sample. This was divided in half for the study's two focus groups: 200 homes and 200 road users, both of whom were selected at random from the region included by the geographical frame. Using stratified sampling, the number of households from each estate was proportionally distributed throughout the several estates.

4.4.2 Unit of Analysis

This pertains to the next phase of data analysis and the degree to which the data is aggregated. The unit of analysis is the person, even though the data would center on randomly chosen homes and road users. Transformations in land use and their effects on the Ngong Road corridor's transport functioning have been the primary foci of this research. Household members and motorists were consequently the intended responders. Respondents from households were chosen using a Kish Grid modified by the International Labor Organization (ILO), while those from the general public were approached at random on randomly selected streets at various times.

4.5 Data Needs and Sources

A comprehensive data collection exercise was carried out in line with the objectives of this study. Two sets of data types was used i.e. primary and secondary data.

4.5.1 Primary Data

Primary data is information gathered in its purest form, as in a field survey. Land use practices along Ngong Road; housing typologies; settlement patterns in the study area; land values; rental income; household characteristics such as education, household income, household size, and others were all collected from households, road users, property valuers, developers, and tenants.

The property appraisers were selected by cluster sampling, with respondents (companies) categorized into three clusters: big, medium, and small. Cluster sampling, which took into account the different types of homes, was also used to choose developers and renters. Single-family detached houses, duplexes, triplexes, and high-rise residentials (apartments) were the four types of housing examined.

4.5.2 Secondary Data

Data that has already been acquired, evaluated, and recorded by other researchers provides what is called secondary data. Information gathered for this research included road design studies for the corridor, rental income trend records, municipal zoning policy documents, and property valuation data.

Reviewing the existing literature on topics such as national development plans, the Nairobi transport masterplan, relevant textbooks, the internet, relevant journals, existing policy documents, published and unpublished research documents; newspaper articles,

local TV programmes on Counties, the University of Nairobi libraries, and so on allowed us to compile secondary data.

4.6 Data Collection Methods

The research used different methods for gathering the two sets of data, i.e. primary and secondary data. These will be as follows:

4.6.1 Primary data

This formed the main data source that informed the study. The main methods used to collect primary data included:

- **Questionnaires**

This included both open-ended and closed-ended questions, as well as additional prompts, with the goal of collecting data from commuters and inhabitants of estates along Ngong Road. People were asked to fill out questionnaires by hand. By surveying residents and motorists directly, we learned how they feel about the difficulties brought on by the corridor's upgrade, what they think about the patterns of urban land use transition, how they feel about the city's transportation infrastructure, and how they may improve it. This was significant since it filled in gaps in our knowledge that couldn't be filled by direct observation or conversation amongst peers. Land use and transportation planning regulations, the difficulties of providing sustainable urban mobility, and other design factors were all discussed in length, allowing for a more thorough grasp of these issues.

- **Interview Schedules**

Schedules for interviews were made with representatives from the Kenya Urban Roads Authority, the NCCG officer in charge of the Road and Transport department, the

Directorate of Urban Development, the National Transport and Safety Authority, and the Ministry of Transport and Infrastructure. Key informants were interviewed one-on-one, following a preset schedule of directed, structured, open-ended, or unstructured questionnaires.

- **Direct observation**

This evaluation method comprised on-site checks of Ngong Road and surrounding areas, including non-motorized transportation amenities, street lighting, transport safety infrastructure, etc.

- **Traffic Counts**

An analysis of the peak-hour traffic on Ngong Road, including the number of bicycles, matatus, pedestrians, private automobiles, and buses. The research assistants received training on how to cluster different types of vehicles and how to perform traffic counts based on origins and destinations before the traffic census was carried out. The relevance of morning and evening rush hour traffic was emphasized.

- **Mapping and Photography**

The location of Ngong Road and the scope of the research area were both determined with the use of maps. As a result of the arterial improvement, photographs of the region were taken to aid in the study of transformation patterns and the identification of any new home typologies that may have arisen as a result.

4.6.2 Secondary data

Literature on the supply of national development plans, past research on or connected to the subject and geographical entity of the study region, existing and changed policy guidelines, and papers on transportation and land uses were combed through to acquire

secondary data. Understanding the field and determining what other researchers in the same field had found was facilitated by this. Journals, websites, papers, maps, and official government documents were used to compile this information.

4.7 Data Analysis and Presentation

Along with descriptive and inferential statistical procedures including the computation of frequencies, percentages, tables, and charts, maps and pictures were also used to visually decrease the size of the phenomena under investigation.

In accordance with the detailed structure established for the methodology, both qualitative and quantitative data were analyzed. All of the information gathered by the surveys was put into a database, coded, cleaned, and analyzed using SPSS 20 once the fieldwork was over. This software produced a wide range of frequency counts, cross tabulations, simple tables, pie charts, bar graphs, and other graphical representations of the data. Information gathered from key informants was subjected to a content analysis, and the results were included into the overall picture. Key informant interviews helped to shed light on ambiguous areas, allowing for triangulation of results.

Visual aids such as charts, maps, plans, sketches, and pictures were used to display the gathered qualitative data. To further explain the data addressed in descriptive analysis, photographs were utilized to depict, for instance, the state of the transportation infrastructure along Ngong Road, the dwelling typologies in the region under consideration, etc. Analysis and organization of in-depth interviews and studies of rules and regulations relevant to the corridor upgrading were also conducted, with the results provided in descriptive and analytical reports.

4.8 Validity and Reliability of the study

Cronbach's Alpha Value was employed in this research to evaluate the level of internal consistency, or how closely connected a collection of items is as a whole, between the scales of the instrument. Problems with Ngong Road upgrades, urban land use transition patterns, and transport management techniques were all taken into account.

You may express Cronbach's alpha as a function of the total number of items on the test and their average correlation with one another. Cronbach's alpha has a formula, however it is only used for theoretical purposes:

$$\alpha = \frac{N\check{c}}{\tilde{v} + (N-1)\check{c}}$$

Here N is equal to the number of items, $\check{c}$ is the average inter-item covariance among the items and $\tilde{v}$ equals the average variance. It can be seen from the formula that if the number of items is increased then the value of Cronbach's alpha also increase. Additionally, if the average inter-item correlation is low, alpha will be low. As the average inter-item correlation increases, Cronbach's alpha increases as well. The finer details of the model is out of scope for this study. The model is among the instruments developed and simplified within SPSS software where only the variables were input and the results interpreted.

The findings are as presented in the next chapter.

4.9 Ethical issues in the study

The goal of doing research is to add to and improve upon the body of existing knowledge. The only way for such information to be useful is if it is disseminated to other individuals or other researchers. Journal articles, theses, dissertations, and books all have a role in spreading this information. Research ethics apply to all facets of academic writing, including the conduct of research and the presentation of results (Blumberg et al.,

2014). In light of this, it is essential that the process be carried out in accordance with established ethical norms.

Among the ethical concerns used in this study was the protection of the privacy of those who participated in the surveys and interviews. It should be emphasized once again that nobody was forced to take part in the study. Even when respondents used foul language, the researcher and field assistants tried to keep their cool and not "speak to" or be unpleasant to them.

Regarding intellectual property, the researcher used accessible ethical resources in publications and made use of freely referenced sources of data and material, without attempting to claim credit for work that was not originally his.

Table 4.1: Research Operationalization Matrix

Main Research Question	What are the transportation challenges that occur as a result of expansion of Ngong Road and what are the mitigation measures (if any) to address them?					
Sub Question	**Independent Variable**	**Indicators**	**Data Source**	**Data Collection**	**Data Method**	**Data Type**
What volume of traffic was used in the design then and those projected for the future? Will the design meet future thresholds? Level of service?	Change in volumes of traffic at the design stage for the road expansion.	Traffic volume in 2013 when the project conceived	KURA/Design Consultant	Semi-structured interviews	Primary and Secondary data	Qualitative and Quantitative
	Changes in traffic volumes on completion of construction	Traffic volume in 2020 when the project was completed	Statistical data	Field survey	Primary Data	Quantitative ie modal split
Was there any change in land use pattern within the neighbourhood due to the upgrade of the artery?	Predominant land use in the study area before the project	Predominant land use pattern in 2013 when the project started	Satellite images Focus group transcripts Real estate agents	Semi-structured interviews Satellite Image census	Primary and Secondary data	Qualitative and Quantitative Quantitative and quantitative
	Predominant land use on completion of road expansion	Predominant land use pattern in 2020 after road expansion.	Satellite images Focus group transcripts Real estate agents	Semi-structured interviews	Primary and Secondary data	Qualitative and Quantitative
What were the increments in land values along Ngong	Increments in land values before road	Land price before road construction (2010 -	Real Estate Agents/Developers	Semi Structured Interviews	Primary Data	Qualitative and Quantitative data

Road before and after construction	construction	2013) per M2				
		Land price after announcement of road construction (2016) per M2	Valuation/ Surveyors	Semi-structured Interviews	Primary Data	Qualitative and Quantitative data
		Land price during construction (2016 - 2020) per M2	Valuation	Semi-structured Interviews	Primary Data	Qualitative and Quantitative data
	Increments in land values after road construction	Land price after construction (2020) per M2	Valuation	Semi-structured Interviews	Primary Data	Qualitative and Quantitative data
What were the changes in housing typologies	Changes in housing typologies within the neighbourhood of project area before road construction	Predominant housing typology after announcement of road construction (2016)	Satellite images Focus group transcripts	Semi-structured interviews	Primary and Secondary data	Qualitative and Quantitative
How prepared are the authorities in mitigating the cascading effects of expansion of Ngong Road	Medium term and long-term plans to guarantee sustainable mobility along the artery	Planned interventions to check on traffic congestion	Nairobi Transport Masterplan	Semi-structured interviews	Primary and Secondary data	Qualitative and Quantitative

CHAPTER 5: DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSIONS

5.1 Introduction

In this chapter, the findings from the analysis of questionnaire data are presented. The analysis of the data was guided by the goals of the research. Each variable's data was evaluated using descriptive and inferential statistics, with the results summarized in tables and figures, and their significance explained.

5.1.1 Questionnaire Return Rate

The research was conducted on a sample of 400 respondents from the target group that is, 200 questionnaires were administered to households and 200 were administered randomly to road users within the area enclosed in the spatial frame of the study. The statistics analyzed were used to show the relationships between variables without any bias towards any target group.

The response rate was 87.5 percent, with 350 out of 400 surveys being completed as shown in table 5.1 below. This level of participation is adequate for drawing research findings.

Table 5.1: Questionnaire Return Rate

No. of questionnaires Returned	Target No. of respondents	Response Rate (%)
350	400	87.5%

There was a high response rate to the questionnaire (87.5 percent) since the researcher in person conducted the administration of the instrument. According to Mugenda & Mugenda, this is acceptable (2003). This strategy not only decreased the impacts of language barrier, but also secured a high instrument response and scoring rate by ensuring that respondents' questions about clarity were addressed at the time of data collection.

5.2 Reliability Analysis

Cronbach's Alpha was employed in this research to test the reliability of the questionnaire. The construct dependability is often tested using the Cronbach Alpha value. As a result, it was put to use verifying the validity of the suggested frameworks. Challenges in improving Ngong Road were found to have a coefficient of 0.788, while Urban Land Use Transformation Patterns had a value of 0.998, and Effective Transport Management Strategy Recommendations had a coefficient of 0.848. Cronbach's Alpha values for all measures in the research were more than the minimum threshold of 0.7, indicating that the results may be trusted (Nunnally & Bernstein, 1994). It was assumed, based on reliability analyses, that the scales used in this research accurately captured the components of interest.

Table 5.2: Reliability Analysis

Research Variable	Reliability Value	Remarks
Challenges associated with upgrading of Ngong Road	0.788	Adequate
Urban Land Use Transformation Patterns	0.998	Adequate
Recommendations on Effective Transport Management Strategies	0.753	Adequate

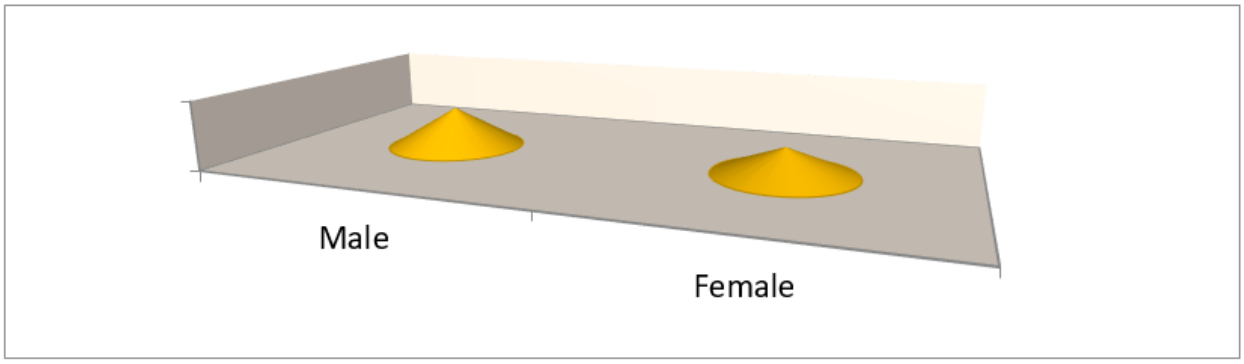
5.3 Profile of Respondents

This section presents the key characteristics of the respondents in this in terms of Gender of the respondent, age bracket, level of educational qualification, the period they have lived in this area and the mode of transport they commonly use to and from their place of work/ school.

5.3.1 Gender

The study sought to establish the gender of the respondents' parents/guardians. This is important because the conclusion reached with one gender group might not be representative of experience of the other group. The findings are as shown in Figure 5.1.

Figure 5.1: Gender of Respondents

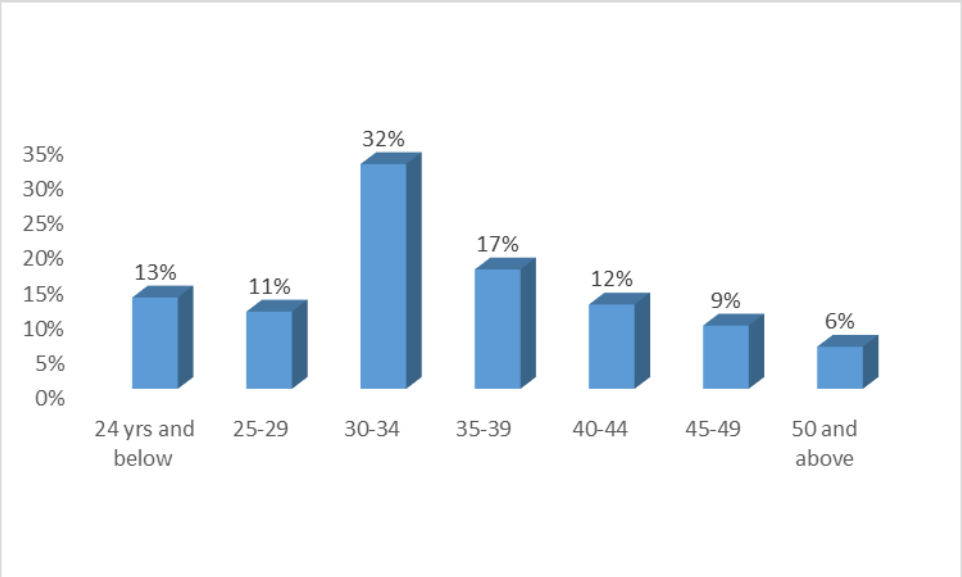


From the study findings, most (59.6%) of the respondent were males, while 40.4% were females. This implies that majority of the respondents who use Ngong Road Corridor in Nairobi were males.

5.3.2 Age bracket

The study sought to find out the age of the respondents. There is a strong correlation between age and opinions and/or behaviours and this ensures that the data obtained is not biased towards a particular age group. The findings are as shown in Figure 5.2.

Figure 5.2: Age Distribution of Respondents

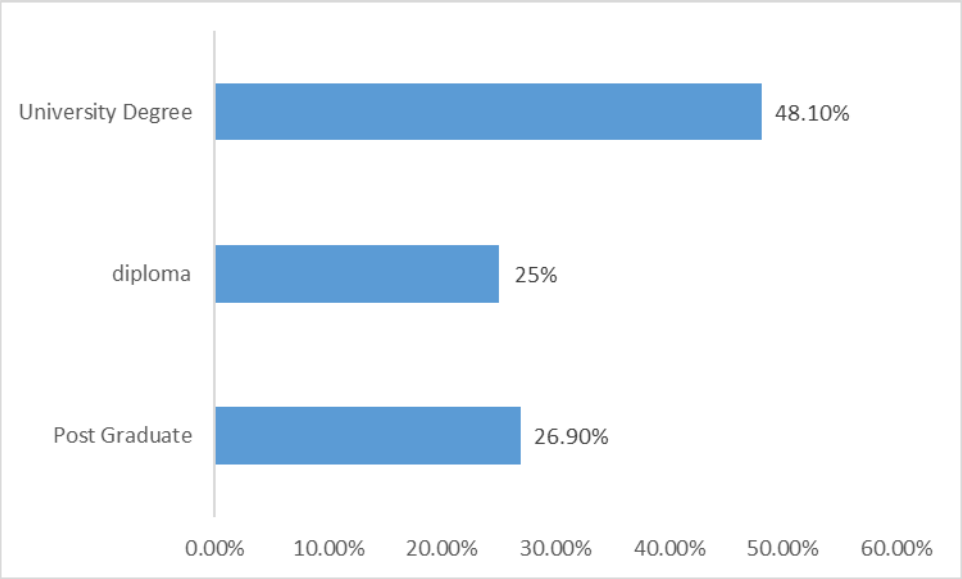


Based on the data collected, 32% of respondents were between the ages of 30 and 34, 17% were between the ages of 35 and 39, 13% were 24 or younger, 12% were between the ages of 40 and 44, 12% were between the ages of 25 and 29, 9% were between the ages of 45 and 49, and 6% were beyond the age of 50. This suggested that the majority of respondents were between the ages of 30 and 34, with those between the ages of 35 and 39 coming in second.

5.3.3 Level of Education

The respondents were asked to state their level of education. The study findings are as presented in Figure 5.3.

Figure 5.3: Highest academic qualification

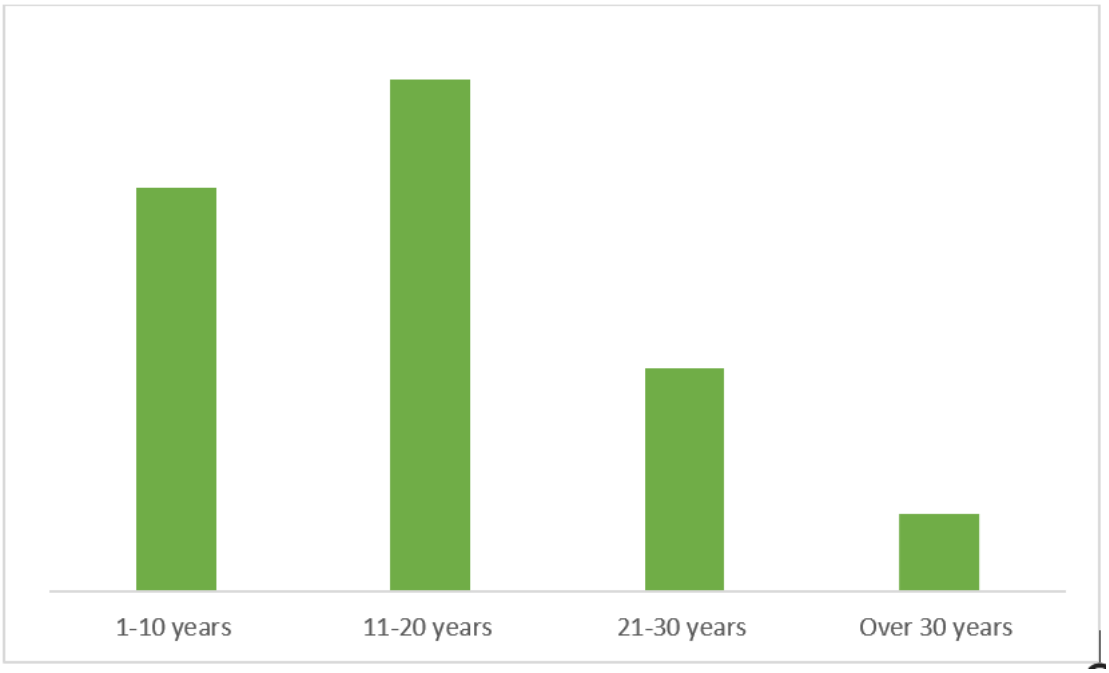


As shown in figure 5.3, majority (48.1%) of the respondents had a university degree, 26.9% had had postgraduate qualifications while 25% had diploma. The results showed that on average, respondents are well educated with high academic qualifications. This showed that users of Ngong Road Corridor in Nairobi are highly educated and thus higher reliable information with regards to impact of a road project on urban development: a case study of Ngong Road corridor in Nairobi.

5.3.4 Number of years lived in current area

Respondents were asked to indicate the number of years they have lived in the current area. Figure 5.4 presents the findings of the study.

Figure 5.4: Number of years lived in current area

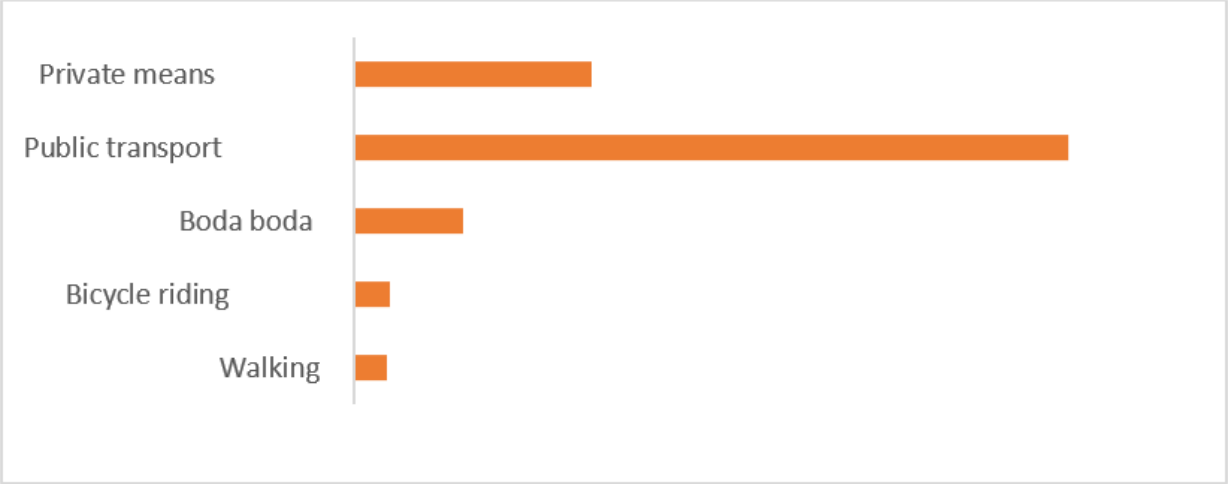


The findings reveals that majority of the respondents (42.1%) have lived in the current area for 11-20 years, 33.2% between 1-10 years, 18.3% between 21-30 years while the remaining 6.4 % had lived in the current area for 6-11 years. This implies that majority of users of Ngong Road Corridor in Nairobi have lived in the current area for a long period and thus higher chances of giving out reliable information.

5.3.5 Mode of Transport

Respondents were asked to indicate the mode of transport they commonly use to and from their place of work/ school.

Figure 5.5: Mode of Transport



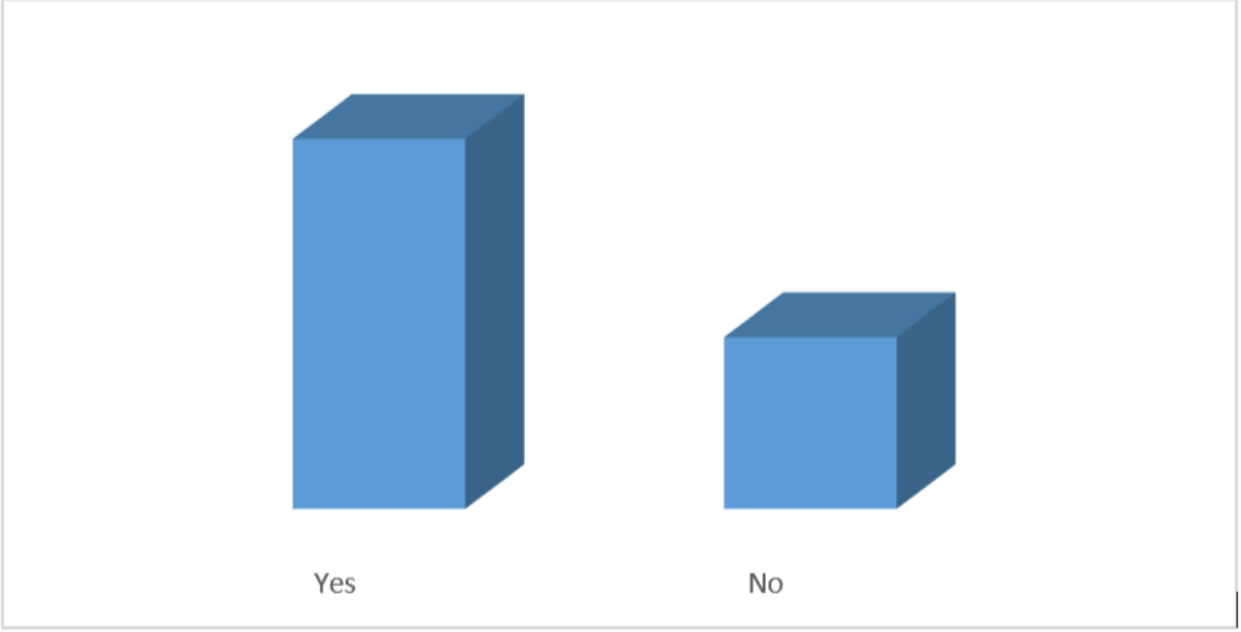
Based on the study findings, majority of the respondents 63.4% use public transport means, 21.1% use private means, 9.6% use *boda boda*, 3.1% use bicycle riding while 2.8% walk.

5.4 Urban Land Use Transformation Patterns

5.4.1 Effects of transportation on land use transformation patterns

Respondents were asked to indicate whether transportation have an effect on land use transformation patterns i.e. change in building typologies, densities, usage etcetera. Figure 5.6 summarizes the findings of the study.

Figure 5.6: Effects of transportation on land use transformation patterns

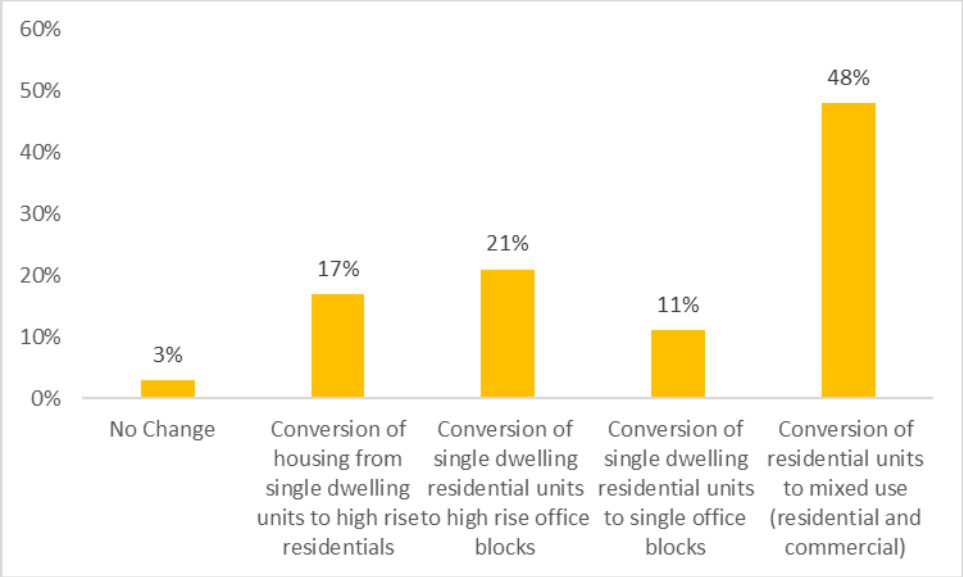


Based on the study findings, majority of the respondents (68.3%) agreed that transportation have an effect on land use transformation patterns i.e. change in building typologies, densities, usage etc. while 31.7% were on the contrary opinion. This is an implication that transportation has an effect on land use transformation patterns i.e. change in building typologies, densities, usage etcetera.

5.4.2 Transformation in land use patterns since conception of the project to upgrade the corridor

Respondents were asked to indicate major transformation has occurred in land use pattern since conception of the project to upgrade the corridor. The findings of the study are as shown in Figure 5.7 below.

Figure 5.7: Transformation pattern in land use since conception of the project to upgrade the corridor



According to the study findings, majority of the respondents (48%) indicated the major transformation that has occurred in land use pattern since conception of the project to upgrade the corridor to include conversion of residential units to mixed use (residential and commercial), 21% indicated Conversion of single dwelling residential units to high rise office blocks, 17% indicated Conversion of housing from single dwelling units to high rise residential, 11% indicated Conversion of single dwelling residential units to single office blocks while 3% indicated no change.

5.4.3 Extent of agreement with urban land use transformation patterns as a result of the upgrading of Ngong Road.

A statement was made on the trends in urban land use change, and the respondents were asked to rate the amount to which they agreed. Severely agree (5), agree (4), neutral (3), disagree (2), and strongly disagree (1) represented the five possible ratings of this variable's state on a 5-point Likert scale (1). Table 5.3 displays the results of this analysis.

Table 5.3: Extent of agreement with urban land use transformation patterns as a result of the upgrading of Ngong Road.

	Mean	Std. Deviation
The value of land has a direct link with the accessibility of transportation, which in turn affects the pattern of land use.	4.0319	0.61263
The value of land affects the pattern of land use because it determines where and how people live and work.	4.0957	0.46534
As a result of people moving around from one place to another, traffic hotspots are a natural consequence of urbanization.	3.9362	0.70036
The trip making patterns, volumes, and modal distribution are generally a result of geographical distributions of land use, and hence are the primary linkages between transportation connectivity and land use.	4.0106	0.37373
The amount of land or space available for any given economic, social, or physical usage is finite.	4.0638	0.50393

Source: Researcher

According to the results, the vast majority of respondents agreed that the value of land has a direct correlation with the level of accessibility provided by the transportation system (Mean=4.0957), that each land use has an optional limited space or location suitable for its economic, social, or physical activity (Mean=4.0638), and that the pattern of land use is influenced by the level of accessibility provided by the transportation system. In addition, the majority of respondents (Mean=3.9362) agreed that traffic generating points are a direct result of urban land use, which necessitates transportation links between different

hubs of economic activity. Therefore, the pattern of land use is influenced by the accessibility provided by the transportation system between different activity areas, and the fundamental relationships between different land uses are based on the value of land, which is directly correlated with the level of accessibility provided by the transportation system.

5.5 Challenges associated with upgrading of Ngong Road

The study sought to establish from the frequent users of the road and those who lived or worked within the neighbourhood the challenges they encountered that were associated with upgrading of Ngong Road. The findings of the study were as shown in subsequent sub-headings.

5.5.1 Challenges by Frequent Users of Ngong Road before the Upgrade

The study sought to establish the major challenges respondents faced as frequent users of Ngong Road before the upgrade. Respondents indicated the major challenges faced before the upgrade of Ngong Road to include traffic congestion, lack of footpaths, frequent accidents, disorderliness and air pollution.

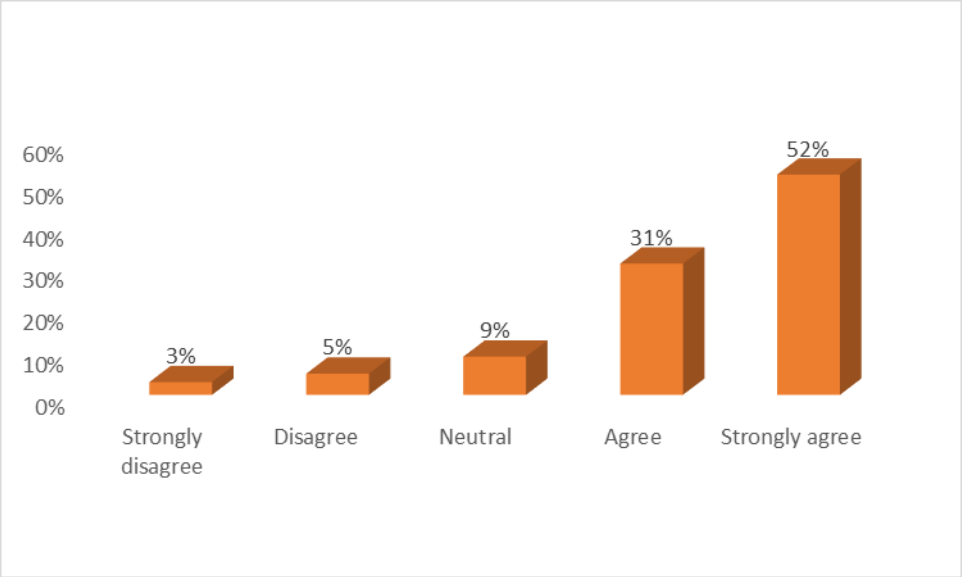
5.5.2 Problems Faced During the Construction Phase

The study sought to establish the respondents faced face during the construction phase. The problems identified include traffic congestion, disruption of water and electricity, dust pollution and matatus menace within the estates.

`5.5.3 Extent to which problems will be solved after completion of the Upgrade of the Road

Respondents were asked to indicate their opinion on whether once the road is complete, then the problems will be solved. Figure 5.8 illustrates the findings of the study.

Figure 5.8: Extent to which problems will be solved after completion of the Upgrade of the Road



Based on the findings, Majority of the respondents (52%) strongly agreed that problems would be solved after completion of the upgrade of the Road, 31% agreed, 9% were neutral, 5% disagreed while 3% strongly disagreed. This is an implication that users of the corridor were optimistic that it would solve the various transportation challenges they faced and that it was a viable project.

5.5.4 Problems likely to recur some years after the road is completed

Respondents were asked to indicate the problems that were likely to recur some years after the road is completed. Respondents indicated the problems, which are likely to recur some years after the road was completed to road accidents because of over speeding vehicles causing heavy traffic congestion.

5.5.5 Extent of agreement with challenges that result out of the upgrading of Ngong Road.

Participants were asked to rate how much they agreed with each statement about difficulties that might arise as a consequence of the Ngong Road improvement project. The

rating was captured using a five-point Likert scale with severely agree (5), agree (4), neutral (3), disagree (2), and strongly disagree (1). The analyzed data were summarized and shown in Table 5.4 below.

Table 5.4: Extent of agreement with challenges that result out of the upgrading of Ngong Road.

	Mean	Std. Deviation
The Ngong Road upgrade project has resulted in a rise in traffic accidents, which, during rush hour, have completely blocked the road in the Nairobi central business district.	4.0426	1.33533
Ngong Route upgrades have resulted in regular, predictable delays in city traffic due to the increased amount of cars utilizing the road at the same times.	4.2298	0.66621
Upgrading of Ngong Road has led to temporarily or permanently disruption of livelihood or economic dependency from commercial activities near and around the highway	3.8936	0.59511
Upgrade has led to high rate of disruption of services like water and electricity within neighbourhoods around the corridor thus increasing the cost of living.	4.0761	1.27731
Upgrading of Ngong Road will lead to a permanent solution to traffic congestion along the corridor	4.3787	0.73292
The problem of traffic congestion is still likely to recur despite the upgrade of Ngong Road	3.7852	0.8575

Source: Researcher

Based on the study findings, majority of the respondents strongly agreed that upgrading of Ngong Road would lead to a permanent solution to traffic congestion along the corridor (Mean=4.3787), This was followed closely by those who agreed that it would lead to recurring traffic congestion (Mean=4.2298) and those who agreed that it would lead to disruption of services like water and electricity within the neighbourhood thus increasing the cost of living (Mean= 4.0761).

Other respondents felt that the upgrade would lead to increased road accidents causing heavy traffic congestion in the CBD of Nairobi, especially during peak hours (Mean=4.0426). In addition to that, a category of respondents believed that that upgrading of the corridor would lead to temporary or permanent disruption of livelihood around the highway (Mean=3.8936) and the last segment who agreed that the problem of traffic congestion was still likely to recur despite the upgrade (Mean=3.7852).

5.6 Implications of corridor upgrade on Neighbourhood Land Use

This section discusses the status of Ngong Road and its functionality as an urban artery and the land use patterns within the neighbourhood enclosed in the spatial frame for the study. It covers the data and trends for the period of inception of the project for upgrade of the corridor, during construction and completion of the project and illuminates the condition of the road, the design information in relation to its functionality, neighbourhood land use transformation and the dynamics of property values.

5.6.2 Condition of Ngong Road

Ngong Road was planned as an arterial street and hence was purposed for through traffic on a continuous route that served to carry longer distance traffic to satellite towns of Ngong and Kiserian. At the onset of the project, it was mainly a single carriageway with

exception of the section between City Mortuary Roundabout and Ring Road Kilimani where it was a four-lane road with two lanes in both directions. This dual section finally tapered into a single carriageway in the direction of Ngong Town. As an arterial street, the road should have had restricted and regulated parking, loading and unloading activities. However, as shall be pointed out, this was not the case.

Even though such a road should have restrictions such that pedestrians are only allowed to cross at intersections or designated crossings, the corridor had few restrictions for pedestrian movement. The road has a corridor of between 40 and 55m therefore has adequate room for expansion. Prior to the upgrade, traders dealing in different wares ranging from decorative ceramics, furniture and tree seedlings occupied the road reserve. There were random parkings and yards for second hand motor vehicles.

Ngong Road is served by arterial collectors such as Ring Road Kilimani, Joseph Kangethe Road, Ole Dume Road, Kibera Drive and several collector streets. Contrary to the recommended restriction of access to an arterial street, most of the collector roads directly join it due to lack of service lanes. These include Ndemi Road, Elgeyo Marakwet Road, Kirichwa Road, Suna Road, Menelik Road, Kabarnet Road and many others. Nevertheless, direct access to the first line of plots has been adequately and favourably curtailed. Map 5.1 below shows the road network of the study area.

Map 5.1: Kilimani Suburb

Source: Google maps

The road lacked adequate drainage facilities with only open earth drains on both sides of each carriageway. This was confirmed by perennial flooding on some sections after heavy downpour implying that the capacity of drainage facilities had been exceeded. Pedestrian footpaths were naturally curved by foot along the road reserve with paved footpaths only existing around major shopping centres. These included Prestige Plaza, Junction Mall, Uchumi Hyper, KISM Towers, The Green House and Adams Arcade.

The road was upgraded to a four-lane dual carriageway with two lanes in both directions for a distance of 4.7 kilometres. Other upgrades included intersection improvement, improvement of drainage works, footpaths, cycle tracks and installation of road furniture (markings and signage). All direct accesses were thenceforth channelized with acceleration and deceleration lanes to eliminate right turns that are known for creating logjams. Traffic lights were installed in major intersections like City Mortuary, All Saints Ring Road Kilimani Joseph Kangethe etcetera. Other intersections like National Library, Nairobi Hospital and Missing Link No. 7 were improved but without traffic signalization.

5.6.3 Road Design Information and Level of Service

From the information received from the project implementer KURA, the traffic condition and topographic condition were noted to be different between the suburban section (from Adams Arcade to City Mortuary Intersection) and Community section (from City Mortuary Intersection to All Saints Intersection). Subsequently the design speeds were as follows:

Table 5.5: Designs speeds for the two sections of Ngong Road

Item	Between City Mortuary and Adams Arcade	Community Area
Design Speed (Km/Hr)	60	40

Source: Design Report for Dualling of Nairobi-Dagoreti Corner Road, KURA

The stretch of the road under upgrade from All Saints intersection to Adams Arcade intersection was designed to reduce travel time at peak hour from 29 minutes to 9 minutes for the 4.7 Km stretch. Being an urban road, it was given a design life of 10 yrs.

The then volume of traffic of the project road surveyed in May 2010 and the forecasted future traffic volume as of 2022 (10 years after the planned improvement) are as shown in table 5.5 below. The traffic volume as of 2022 was forecasted using the growth rate assumed in the study on Master plan for Urban Transport in the Nairobi Metropolitan Area (See full table in appendix).

Table 5.6: Traffic Volumes during study and projected volumes after 10 years

Station	Location	Traffic Volume (Veh./day)		Traffic Volume (pcu/day)	
		2010	2022	2010	2022
Sta. 0+450	A-Plus Auto Dealer	27,316	46,841	31,460	53,947
Sta. 2+350	Nairobi Baptist Church	37,341	64,032	43,788	75,087
Sta. 3+000	Kenyatta Hospital	27,073	46,424	31,859	54,631
Sta. 3+850	Transcom House	15,306	26,247	18,860	32,341

(Source: KURA)

The maximum traffic volume along the project road was the location in front of Nairobi Baptist Church. Its peak hour traffic volume as of 2022 was obtained as 3,600 pcu/h/direction based on the assumption that the peak hour rate was 8 % and direction rate was 60 % (75,087 x 0.08 x 0.6 =3,600). The forecasted peak hour traffic volume as of 2022 did not exceed the traffic capacity of 2-lane road that is 4,400 pcu/h (2,200 pcu/h x 2-lane) as per the Road Capacity Design Manual. Therefore, widening into 4-lane road was appropriate.

The capacity of a transport facility is measured by the Level of Service (LOS), which is used to ascertain how much the facility can accommodate. LOS relates the quality of service to a given flow rate. Table 5.7 below enlists the parameters attached to six levels of service.

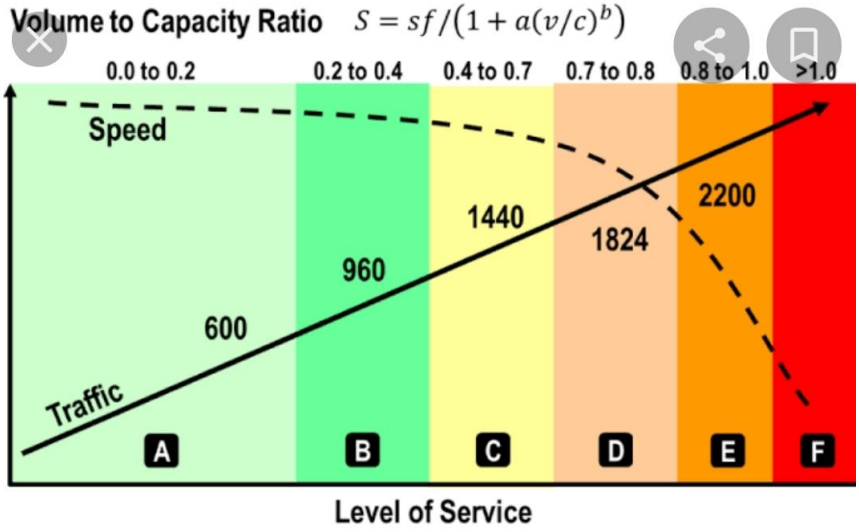
Table 5.7: Relationship between parameters of Levels of Service

Level Of Service	Vehicle Flow State	Average Vehicle Speed	V/C	Remarks
Level A	Driving smoothly	>48km/h	0 ≤ V/C <60%	• Light traffic
Level B	Stable vehicle flow	>40km/h	60 ≤ V/C< 70%	• Slightly increased. • Traffic levels still free flow speeds
Level C	Stable vehicle flow	>32km/h	70 ≤ V/C <80%	• Approaching moderate congestion levels • Speeds near free flow
Level D	Less stable vehicle flow	>24km/h	80 ≤ V/C <90%	• Speeds reduced • Lane changes restricted due to traffic
Level E	Unstable vehicle flow	≈24km/h	90 ≤ V/C< 100%	• Congestion • Irregular traffic flow
Level F	Traffic congestion	<24km/h	≤ 100%	• Road at capacity • Gridlock with frequent stops

Source: Roadway Levels of Service (Source: AASHTO)

The ratio of volume to capacity for the road in 2022 would be obtained from 3600/4400 that gives 0.82. From the above, the best achievable LOS for Ngong Road 10 years after planned improvement is Level D. In other words, traffic flow would become unstable in 2022 and this could be established right at the design stage. Subsequently, after 15 years or 20 years from 2011, it was possible to predict that the level of service would deteriorate to level E or even F if nothing was done.

Fig.5.9: Relationship between Traffic Volume/Capacity ratio and the level of service



Graph 10: Showing [Source: Transportation Research Board (1994) Highway capacity manual, 3rd Edition, *sf=free flow speed, v=volume, c=capacity, a=0.15 and b=4]*

It implies that at 10 years, the road was expected to be overstretched in capacity and subsequently had to be revisited to guarantee uninterrupted traffic flow.

5.7 Neighbourhood land use

Historically, the homes in Kilimani were mostly one-story "maisonette" styles, while the surrounding properties averaged 0.5 acres. One thousand and five hundred half-acre plots with maisonettes complete with servant quarters were initially built in the study area. An average of 300 square meters was devoted to the plinth of each dwelling unit. As a consequence, the combined plinth area reached 450,000 square meters (Ruto RC, 2008). Previously, the allowed plot ratio was 75%, while the maximum ground coverage was 35%.

The Nairobi Town Planning Liaison Committee's proposal of 1993 for replanning and rezoning of Upper Hill and Kilimani areas allowed the latter to transform from residential to mixed use. The recommendations approved densification, the half-acre plots began to be

subdivided, and this study has established that subdivision continued without consideration to the regulations to a level where minimum area has been lowered to an eighth of an acre in some sections.

There are instances when the City Hall authorities alluded to revising plot ratio restriction to 200 per cent from 75 per cent, yet on the ground, these were already exceeded with the proliferation of highrise developments. As a result of the above-mentioned updated development standard, many homes have been transformed into shops, and new high-rise apartment complexes have been built. There have been calls to replace plot ratio with other devices, such as minimum finishing criteria, in order to protect the economic worth of existing communities.

The last zoning exercise was carried out in 2004 and opened up parts of Kileleshwa, Kilimani and Woodley alongside Parklands. The high rates of development in these areas is attributed to developers moving faster than planners and due to the rising property prices, they have been forced to make maximum use of available space.

Even though Kilimani is zoned as a residential area, the study revealed that it is a mixed use zone with a combination of housing, offices, retail, medical, recreational and other commercial activities. Nevertheless, with rapid proliferation of high-rise apartments in the area, more development still favours residential use.

5.8 Neighbourhood Open Spaces

Kilimani, like formerly low-density residential districts like Parklands, Westlands, and Lavington, has witnessed high density settlement permitted by municipal officials. There is more strain placed on public open spaces as a result of the informal transformation of low-density neighborhoods into high-density ones. Public open space planning and

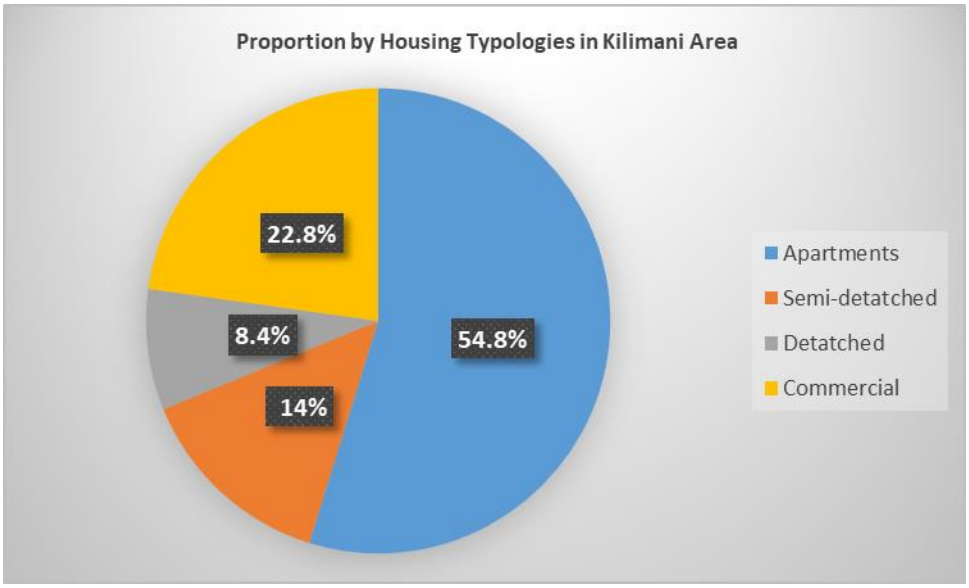
development has been shown to be low on the municipal government's agenda in other research. The lack of a well defined idea of an African metropolis may be to blame for the under-prioritization of public open spaces in newly independent Kenya (Makworo and Mireri, 2011)

The neighborhood underwent mostly organic changes that lacked a definite order, structure, and purpose. This is due to the fact that municipal officials have not yet conceptualized the role of public open spaces in a city, instead focusing on providing for the more immediate needs of residents via housing, small and micro enterprises (MSEs), and industry. As a result, many public parklands have been converted into private residences via questionable land deals.

5.9 Housing typologies

From the study, the most common housing typology in Kilimani are the high-rise residentials (apartments), whose uses were changed from single-family dwelling units. While apartments account for 54.8 percent of residential housing, semi-detached units accounts for 14 percent, with detached units accounting for 8.4 percent. The rest were commercial at 22.8 percent. This is as illustrated in figure 5.10 below.

Fig.5.10: Proportion of Housing typologies in Kilimani Area



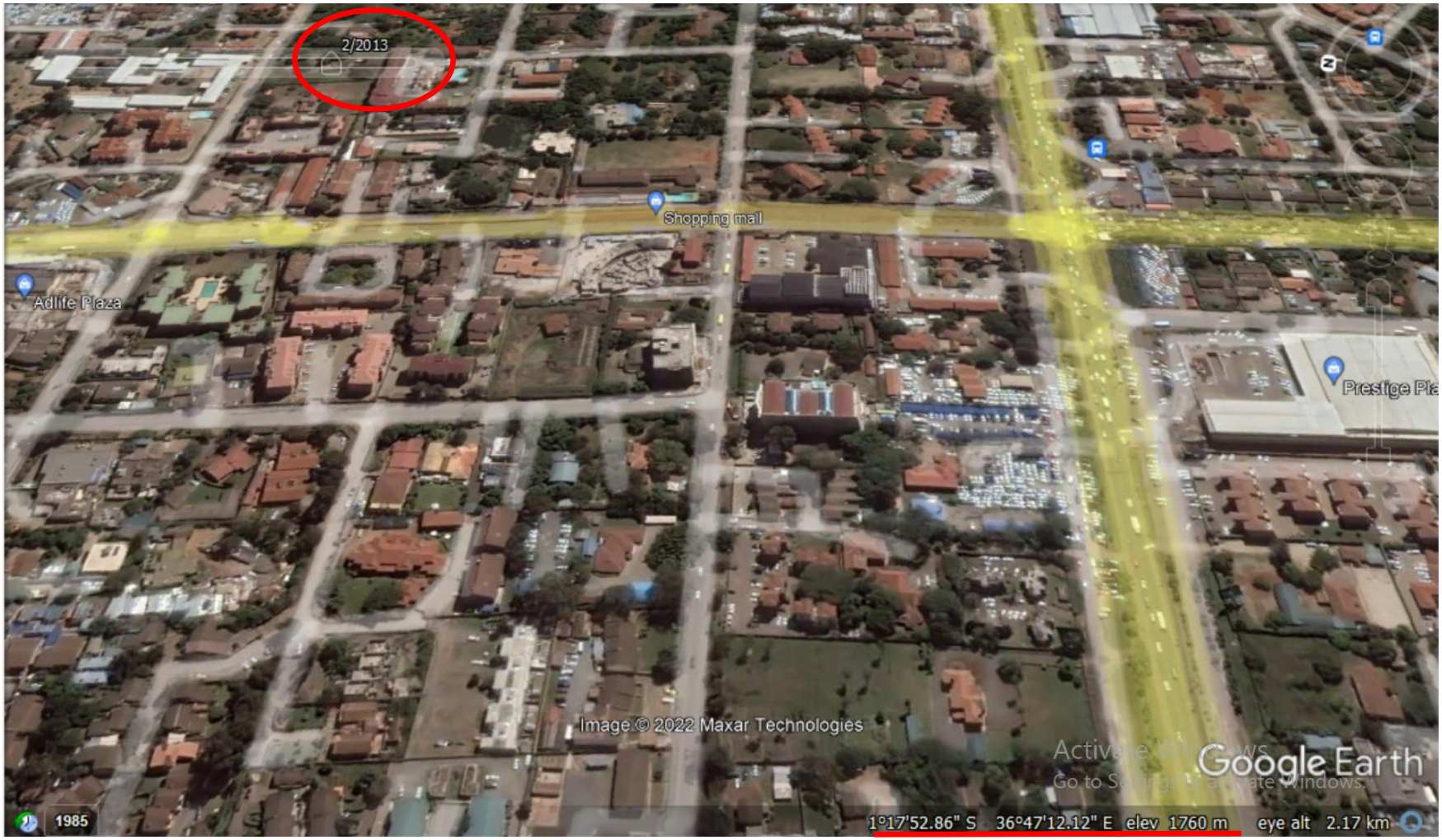
(Source: Researcher)

5.10 Land Use Changes

The price of land in Kilimani has been pushed up due to rapid developments. This has resulted in developers preference for investing in high-end apartments from pieces of land previously occupied by old bungalows and maisonettes. A bungalow is a single-story residence often inhabited by a single family, whereas a maisonette is a two-story dwelling typically occupied by a single family.

Plates 5.1 to 5.3 below shows satellite images of trends in land use transformation within a selected section within Kilimani area between 2013 and 2021.

Plate 5.1: Showing status of land use within Ngong Road neighbourhood in 2013



Source: Google Earth images highlighted by researcher

Plate 5.2: Google Earth image showing status of land use for neighbourhood in plate 5.1 above in 2015

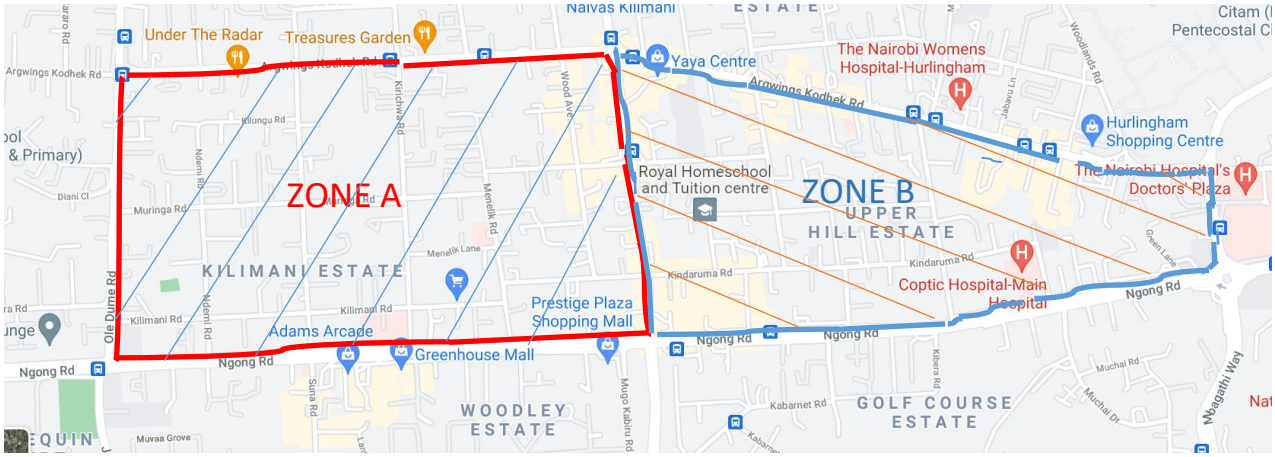
Source: Google Earth images highlighted by researcher

Plate 5.3: Status of land use for the neighbourhood in 2021

Source: Google Earth images highlighted by researcher

From the study findings, highrise residential apartments attracted more investment at 66.3% followed by commercial units at 24.8%. Mixed user took 8.7% with multiple dwelling units and single dwelling units coming way behind at 4.3% and 0.2% respectively. However, it was noted that there is rapid commercial development within the area sandwiched between Ngong Road, Ring Road Kilimani and Argwings Kodhek Road in comparison to the upper section between Ring Road Kilimani, Argwings Kodhek, Ole Dume and Ngong Road where residential development exceeds commercial development. these are marked as zones A and B in the map below.

Map 5.2: Land use relationship in Kilimani along Ngong Road



(Source: Google maps highlighted by author)

An observation of the trend of development along the artery revealed a discrepancy from what had been observed in other arteries for instance, Thika Road. There has been a slow ribbon commercial development along Ngong Road except at major intersections. This was attributed to the fact that the road lacked service lanes and direct access to the first line of plots in many sections, a semblance with planning regulation that arterial streets should not have direct access to immediate properties. The existence of restricted development on the Southern side has curtailed rapid commercial development on this side of the artery,

thus reducing densification and ribbon commercial development. These include Woodley Estate, Kenya Meteorological Department, Kenya Science Teachers College, Impala Club, Rugby Football Union of East Africa (RFUEA) Grounds etcetera.

5.10.1 Trends Land Values

An analysis of the trends of land values was achieved from the online data provided by renowned property companies that also carry out extensive market research. These include Hass Consult Ltd, Knight Frank Kenya Limited and Cytonns Investment Management Plc. This was possible by analyzing the standard international indices that have been developed and provides the trend of property values. These include land index, sales index and rental indices.

Table 5.8 shows the 10-year change in land index for Nairobi suburbs from January 2011 to the last quarter of 2020. From the table, the price of land in Kilimani area has increased 3.09 fold since 2011.

Table 5.8: Change in Land Index for Nairobi Suburbs from 2011 to 2020

Nairobi Suburbs Land Index	Quarter % Change	Annual % Change	10 Year Change From Jan 2011	Average Value Per Acre (KShs)	25 Percentile	75 Percentile
Donholm	0.7 %	2.1 %	3.46 FOLD	70,800,000	70,000,000	80,000,000
Gigiri	0.05 %	-3.4 %	2.99 FOLD	229,300,000	160,000,000	320,000,000
Karen	0.3 %	-0.2 %	3.03 FOLD	62,300,000	55,000,000	68,000,000
Kileleshwa	0.1 %	-2.4 %	2.89 FOLD	301,400,000	256,000,000	320,000,000
Kilimani	0.5 %	-2.9%	3.09 FOLD	413,800,000	380,000,000	475,000,000
Kitisuru	0.4 %	-0.2 %	2.53 FOLD	89,800,000	70,000,000	110,000,000
Langata	-0.05 %	-3.0 %	3.01 FOLD	63,700,000	49,500,000	70,000,000
Lavington	-0.1 %	-2.5 %	2.66 FOLD	229,400,000	181,800,000	260,000,000
Loresho	0.4 %	-3.6 %	3.81 FOLD	87,900,000	72,700,000	105,000,000
Muthaiga	0.3 %	3.9 %	2.29 FOLD	185,200,000	158,200,000	211,100,000
Nyari	1.4 %	-0.9 %	2.36 FOLD	105,600,000	92,000,000	119,000,000
Parklands	-0.9 %	-7.3 %	1.90 FOLD	378,500,000	300,800,000	430,000,000
Ridgeways	0.4 %	-1.9 %	3.18 FOLD	75,300,000	64,000,000	80,000,000
Riverside	-1.3 %	-7.2 %	2.16 FOLD	343,900,000	307,500,000	366,700,000
Runda	0.5 %	2.7 %	2.66 FOLD	87,200,000	70,000,000	100,000,000
Spring Valley	-0.5 %	1.1 %	1.62 FOLD	174,500,000	110,700,000	190,000,000
Upperhill	-0.4 %	-5.4 %	3.04 FOLD	509,900,000	450,000,000	560,000,000
Westlands	-0.3 %	0.5 %	2.70 FOLD	420,200,000	350,000,000	500,000,000

Source: Hass Consult, 2020

The trend is land prices for Nairobi satellite towns for the last 10 years is as shown in table 5.9 below.

Table 5.9: Trends in Land Prices for Nairobi Satellite Towns from 2011 to 2020

Nairobi Satellite Town Land Index	Quarter % Change	Annual % Change	10 Year Change From Jan 2011	Average Value Per Acre (KShs)	25 Percentile	75 Percentile
Athi River	1.1 %	2.6 %	3.65 FOLD	13,900,000	6,800,000	18,900,000
Juja	-0.5 %	-0.3 %	5.01 FOLD	14,500,000	6,000,000	20,500,000
Kiambu	-2.9 %	-11.4 %	3.26 FOLD	38,600,000	19,400,000	50,000,000
Kiserian	4.5 %	-0.1 %	2.68 FOLD	7,700,000	3,600,000	9,600,000
Kitengela	0.7 %	2.8 %	4.13 FOLD	12,600,000	6,400,000	16,000,000
Limuru	-1.7 %	-3.0 %	3.13 FOLD	22,800,000	12,000,000	32,500,000
Mlolongo	2.9 %	5.4 %	2.14 FOLD	28,600,000	14,700,000	40,000,000
Ngong	5.4 %	9.9%	3.12 FOLD	23,700,000	13,800,000	35,000,000
Ongata Rongai	2.5 %	8.2 %	3.15 FOLD	23,800,000	10,800,000	30,000,000
Ruaka	1.3 %	-1.5 %	3.15 FOLD	90,200,000	55,500,000	136,000,000
Ruiru	-2.5 %	-6.0 %	3.29 FOLD	24,900,000	12,500,000	32,000,000
Syokimau	0.9 %	-2.6 %	2.61 FOLD	21,800,000	12,400,000	29,200,000
Thika	1.5 %	-0.9 %	2.66 FOLD	18,700,000	10,000,000	23,600,000
Tigoni	2.3 %	1.9 %	3.52 FOLD	24,400,000	17,000,000	30,000,000

*Price Values rounded to nearest Kshs. 100,000

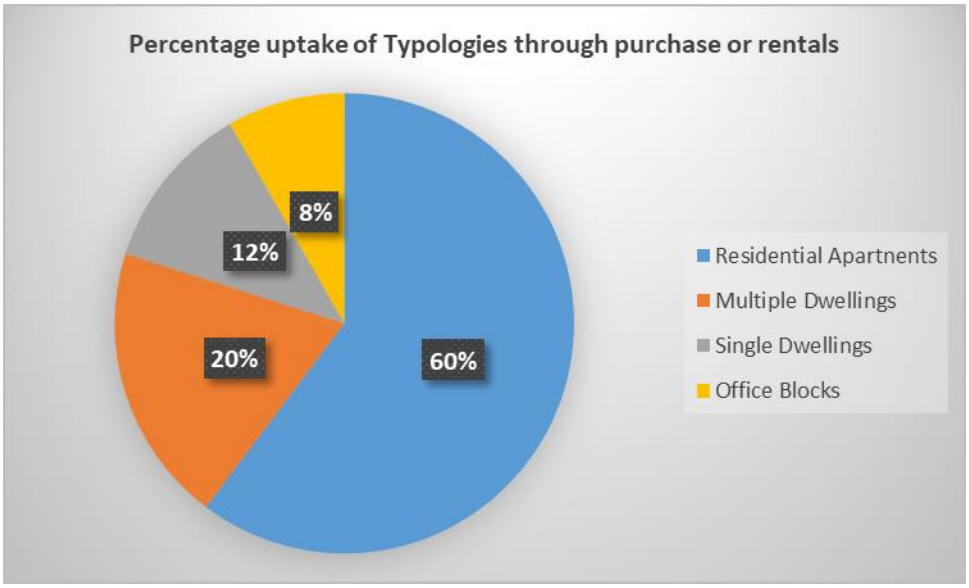
Source: Hass Consult, 2020

From the table, the highest annual change in property value occurred in the Satelite town of Ngong. The above data points to the fact that upgrading of Ngong Road had no significant effect on property values within Kilimani area in comparison to other suburbs in Nairobi. The general increase in property values within the Nairobi Metropolitan Area was attributed to growth in household incomes, high population growth that created demand for more dwelling units and improved access to credit. Nevertheless, the upgrade of the corridor could have increased land values in Ngong Town neighbourhood.

With respect to the sales and rental index, there has been more preference for apartments at 60.3%. This is followed by multiple dwelling units at 19.6%, office blocks at 11.8% and single dwelling units at 8.3%. This significantly corresponds to the data available from research by Hass Consultants that apartments took a larger percentage of the market

followed by semi-detached units. Figure 5.11 below shows the proportion of uptake of various property types.

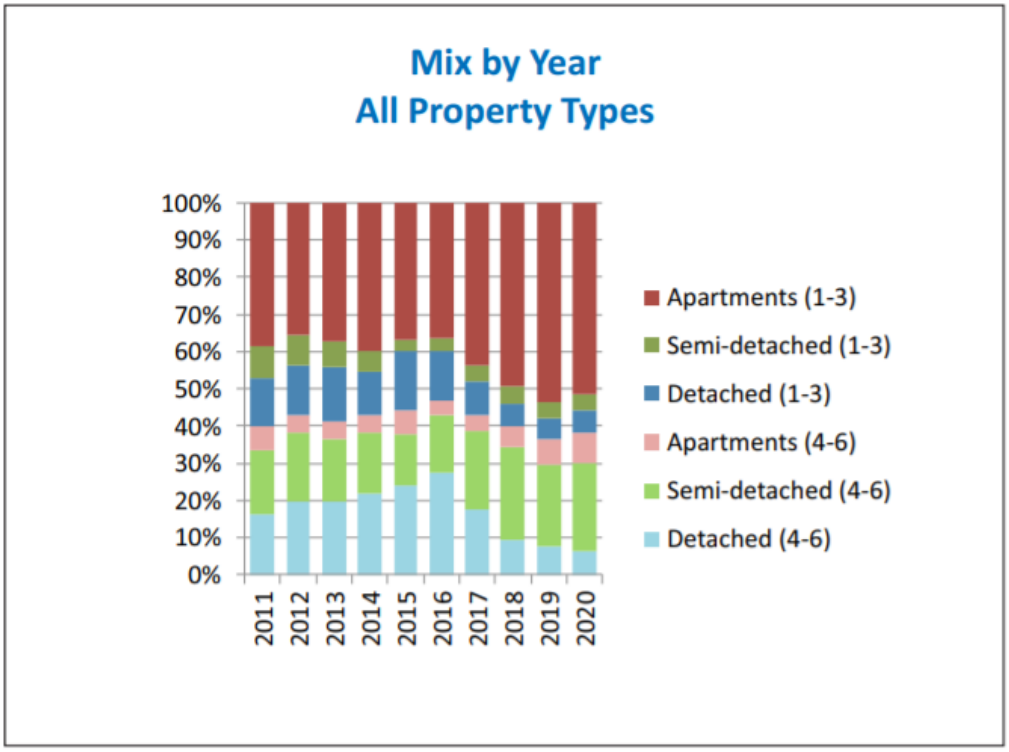
Figure 5.11: Proportion of Uptake of Various Housing Typologies



(Source: Researcher)

Distribution of Property Types by Year indicates the relative abundance of various real estate categories across time. In 2011, the market share of apartments was 44%, followed by 26% for semi-detached homes and 20% for single-family homes. However, in 2020, apartments accounted for 58.8 percent of the market, semi-detached homes for 28.8 percent, and single-family homes for 12.4 percent. Figure 5.12 shows a visual depiction of this.

Figure 5.12: Trend of Proportion of housing typologies in Kilimani Area



(Source: Hassconsult)

The above results points to the fact that Kilimani area is fast moving from a low density to a high-density residential neighbourhood with residential apartments blocks getting predominant.

5.11 Policy on Sustainable Land use and Transportation within the neighbourhood

According to Section 29 of the Physical Planning Act (Cap 286) and section 166 of the Local Government Act (Cap 265) of the former constitution, the defunct Local Authorities were responsible for development management prior to the introduction of the Kenyan Constitution in 2010. Section 13 of the Urban Areas and Cities Act places this authority with the Municipal Boards (or City Boards for cities) under the new constitution (Cap 184).

The City Board is responsible for ensuring that the city's property is used and developed in accordance with the city's spatial and master plans. In order to reach this goal. Multiple builders in Nairobi have sidestepped proper permission processes by ignoring development control measures due to lax enforcement on the part of the County Government. For example, although the zoning ordinance stated that residential construction in Kilimani regions should not exceed four stories, the study found that there are many apartment towers that have violated this restriction, with some reaching as high as 15 floors. Two1% of homes said that unlawful construction expansion was a problem in their area. The majority of respondents (51%), for example, say that private developers have expanded into formerly public green areas.

With respect to sustainable mobility within the neighbourhood, there is virtually no policy guideline being enforced to ensure that the carrying capacities of the transport facilities is not exceeded with the increased development in the area. The mushrooming apartments and office blocks have attracted more passenger cars to the neighbourhood and yet there's negligible provision of parking facilities and improvement of intersections of the arterial collectors and the collector streets. The same predicament is faced in the provision of other services like water, sewerage and solid waste management where the carrying capacity is exceeded with rapid development with little attention paid to this concern.

Another major challenge is lack of parking spaces prompting motorists to pack on road shoulders most of the time blocking the available narrow footpaths that have also deteriorated or are non-existent. The parking space provided within the compounds by various developers are inadequate and few developers have complied with the regulation to provide basement parking that is equivalent to their floor areas. This has also been

worsened by the scenario where former detached residential units have been converted to offices and every office attracts one or more passenger cars.

Subsequently, despite some semblance of development control being enforced, the neighbourhood is fast taking a decay trajectory characterized by poor quality of urban services, dilapidated housing, lack of open spaces, decayed urban streets and environmental pollution. Subsequently, unless the County Government revisits the integration of land use and transportation, the neighbourhood is expected to deteriorate to a state where it will become less attractive.

CHAPTER SIX: TOWARDS SUSTAINABLE TRANSPORTATION AND LANDUSE ALONG NGONG ROAD AND ITS NEIGHBOURHOOD: FINDINGS, RECOMMENDATIONS AND CONCLUSION

6.1 Introduction

This chapter presents the summary of the findings on the impact of Ngong Road upgrade on land use, and based on this; recommend strategic policy interventions towards mitigating against the negative cascading effects on the transport functionality.

6.2 The Study Findings

Pursuant to the specific objectives of the study, the following are the findings.

6.2.1 Land use Transformation patterns

To identify the land use transformation pattern and their relationship to the urban transportation System:

As our research has demonstrated, the Kilimani neighborhood is a business and residential hub. According to zoning laws, however, such area is prohibited from any commercial use. Most of the land is used for residential purposes (73%), while just roughly 27% is used for commercial purposes. Apartments now make up 52% of all residential buildings, up from 38% in 2011. This has led to a huge rise in both population and automobile use in the region.

No other collector roads have been upgraded or improved upon, with the exception of Ngong Road and a section of Ring Road Kilimani to the south of Ngong Road. Intersection upgrades, non-motorized transport facility rehabilitation, drainage system upgrades, and so on are all examples. In spite of the requirement that all residential and business buildings with more than five units have underground parking, just roughly 8 percent have complied. As a result, the neighborhood has transformed from a low-density to a high-density residential zone.

Greater commercial growth occurred eastward, toward the Central Business District (CBD), than westward, despite the area's predominance as a residential neighborhood (towards Ngong Town).

The research also showed that owing to institutional land use constraints, the southern Ngong Road neighborhood did not undergo significant land use change. The Rugby Football Union of East Africa (RFUEA) grounds, the Meteorological Department, the Impala Club, the Kenya Science Teachers College, and a number of other institutions are located in this region of Nairobi County, which is controlled by the government.

It is important to note that the research did not identify any association between the improvement of Ngong Road and the redevelopment of land use in the study region. This phenomenon was therefore connected to the broader pattern seen in all Nairobi suburbs. There has not been ribbon commercial growth along Ngong Road, which may be ascribed to the absence of service lanes and direct plot entrances, in contrast to the pattern seen along other arteries such as Waiyaki road and Thika Road, where the upgrading encouraged such development.

To examine the challenges that result out of upgrading of Ngong Road:

6.2.2 Neighbourhood Development Control

According to the findings of the research conducted, development control measures are not being strictly enforced, which has resulted in the proliferation of illegally constructed high-rise residential and commercial structures. Zoning regulations were enforced, although it was unclear which ones were in effect since the only ones that seemed to be final were really drafts or proposals. The Kilimani neighborhood is located in Zone 4 of the most recent development regulations and zones guide, which was released in 2004 and is partially summarized in table 6.1 below.

Table 6.1: Partial Development Control Regulations for Kilimani Area

Ground coverage (per cent)	Plot ratio (per cent)	Type of Development allowed	Minimum Area
35 (s) 25 (u)	75 (s) 25(u)	Residential (apartment allowed on sewer only) - four storeys only	0.05 Ha

Source: Guide of development and zones by planning committee of Nairobi City (2004)

It is worth noting that the above regulations were not adhered to by developers as there were buildings within the area of up to 10 floors.

6.2.3 Limitations on Design for Capacity for Ngong Road

According to KURA's design data, Ngong Road was built to last for 10 years. That meant that after 10 years, the road's traffic characteristics were likely to have altered dramatically, necessitating an update to account for the new conditions. Based on the design parameters, it is obvious that the best LoS that the road could provide was LoS D, which is associated with less steady vehicular flow. This meant that even during the planning phase, traffic congestion was a real possibility, and that in 15 or 20 years, if nothing was done, traffic would be a nightmare. Even though the researcher attempted a confirmatory drive between All Saints Intersection and Adams Arcade, they were unable to complete the 4.7 km route in under the allotted nine minutes.

What's more, the fact that the road wasn't finished until 2020, just two years before its intended life expired, only made the aforementioned situation worse. Moreover, even if there were a road reserve where extra lanes might be created, this would not significantly improve service quality. This indicated that transport supply management's attempts to alleviate congestion along the arterial had been unsuccessful, and that demand management should be prioritized instead.

6.2.4 Changes in Property Values

According to the research, real estate prices in the Kilimani region of Nairobi have increased steadily over the last decade, mirroring trends seen in the rest of the city's suburbs. The average value of land climbed 3.09 times between 2011 and 2020, a span of nine years. Donholm, Karen, Loresho, Upper Hill, and Ridgeways are just some of the other Nairobi suburbs whose home prices have risen dramatically in recent years. Nonetheless, it is significant to note that in 2020, Kilimani had the third highest land value per acre of any suburb in the country, at a whopping Kshs. 413 million. Prices in Upper Hill, the most affluent area of Nairobi, averaged Kshs. 512 million per acre in 2017, while those in Westlands were Kshs. 420 million. Consequently, the improvements to the corridor do not seem to have increased property prices. Ngong and Ongata Rongai were the only sub-urban towns to see a 9 percent and 8.2 percent growth in land prices in 2020, therefore the renovation of the corridor may have stimulated sprawl-related development in those directions (Hassconsult, 2020).

Therefore, developers in the Kilimani neighborhood were driven to construct high-rise flats to recover their substantial land investment, and this has considerably aided in the densification process.

6.2.5 Level of Appreciation of relationship between Transportation and Land Use

The research showed that most people don't realize how complex the interplay between transportation and land use really is. It was determined that road accidents caused by speeding cars and the resulting traffic congestion would remain a significant issue despite the improvement of the corridor. The majority of residents likewise held the opinion that transportation issues will be resolved if the corridor was improved. This suggests that the general public is only aware of the "direct consequences," and not the counterintuitive connections that

exist among things like transportation infrastructure improvement, land-use modification, travel behavior, traffic volume, and congestion. This has implications for the way policymakers think generally and may explain why long-term goals are abandoned after the deployment of quick-wins, which in turn exacerbates the issue.

6.3 General Recommendations

To make Recommendations on effective transport management strategies to maintain the level of service of the artery:

6.3.1 Constant Monitoring of Urban Mobility

The effects of substantial road construction on urban traffic tend to ripple outward, and vice versa. To meet the population's real transportation demands, it is essential that mobility management be implemented with regular monitoring and assessment. The planning division of Nairobi County, the Ministry of Transport, KURA, the National Transport and Safety Authority, NEMA, KENHA, KEPSA, and NAMATA should all be represented on a multi-agency team as a short-term solution. The group's goal would be to prevent a reactive response to the rising mobility difficulties. In spite of this, a legal and administrative structure should be established so that transportation management is assigned to a single entity.

6.3.2 Integration of Urban Land use and Transportation

Transportation effectiveness, livability, public health, and environmental preservation are all things that may be enhanced by well-planned land use and transportation infrastructure. To do this, we must implement a "zero-growth policy," which ensures that the increasing demand for transportation services caused by population growth is fulfilled without a commensurate increase in vehicle traffic or funding for infrastructure development. Through a smart expansion strategy that incorporates employment, dwelling, commerce, and entertainment, any neighborhood may

become all-inclusive or "self-contained." These goals can be attained through the creation of a short-, medium-, and long-term implementation plan that prioritizes land use development as central to urban densification and transformation rather than sprawl; the enhancement of public transportation services to make the use of personal automobiles less appealing; and the imposition of physical and fiscal restrictions on the use of automobiles.

6.3.3 Strengthening of Development Control

As shown in the Kilimani Area, a neighborhood cannot be allowed to continue decaying if sustainable development objectives are to be met. The ideals of neighborhood development should include the supply of enough housing, infrastructure, and the use of suitable building technologies. In a broader sense, this should include enhancing waste management infrastructure, ensuring reliable access to water and electricity, and facilitating more mobility inside residential areas. The new City Board, which succeeded a City Council widely perceived as ineffective at enforcement of development control, should provide a solid policy framework for development control and enforcement of the same. Instead of having suggestions or recommendations exist in draft form without the necessary legal foundations, it should be obvious which development legislation and zoning is relevant.

This will provide for the possibility of funding infrastructure investment via value capture or developers selling off portions of their plots for infrastructure development, improving the livability of the neighborhood. Non-motorized transportation, public parking, and public parks are all examples of areas that might benefit from an increase in infrastructure.

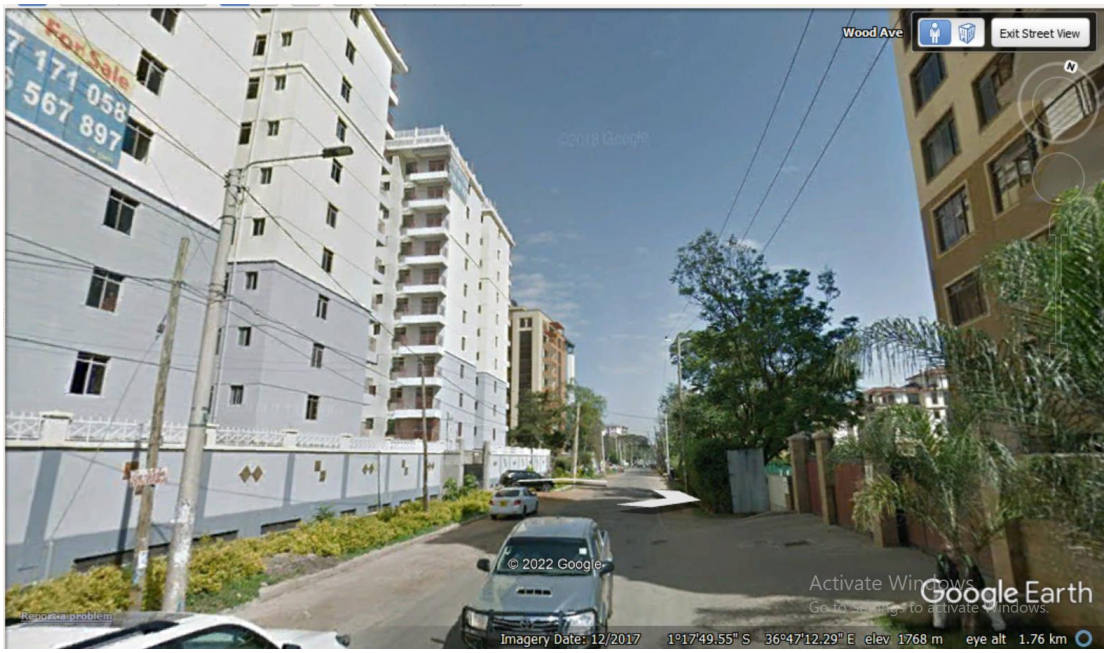
6.4 Additional recommendations

6.4.1 Proper Management and coordination of Developer Exaction in Provision of

Infrastructure.

However, there is still a need to address infrastructure gaps for sustainable mobility despite the advice that the supply side of transport requirements surrounding Ngong Road be prioritized. Walking and bicycling are great forms of non-motorized transportation for making several short excursions around the neighborhood for errands, work, and school. However, this is impossible owing to a lack of non-motorized transportation (NMT) infrastructure such as sidewalks and bike lanes. In the collector and local streets, pedestrians and bicyclists are forced to use the same roadway as cars, greatly increasing their risk of being involved in an accident. This is because more parking garages and other non-motorized transportation (NMT) infrastructure are required to attract as many people as feasible.

Plate 6.1: Section of Wood Avenue showing highrise residential development with no provision of NMT infrastructure



(Source: Street Feature from Google Earth images snipped by author)

Due to the high cost of property and the lack of cooperation in the rezoning process, it has been difficult for private landowners to provide space for the growth of infrastructure. Weak legislative framework, out-of-date master plans, and a lack of coordination have made it impossible to increase the authorized floor ratio in return for shedding off some of the land for infrastructure supply.

The County Government of Nairobi City County should transfer fiscal responsibilities from current taxpayers to new projects since growth is inevitable but it must pay for itself and because the tax load on taxpayers is considerable and resources for expanding neighborhood infrastructure are limited. This ensures that the neighborhood's aesthetic attractiveness will be preserved, and that it will be able to remain sustainable, by limiting the pace at which new construction is allowed. Therefore, the County Government should adopt Development Exaction as a means to finance infrastructure expansion within the Kilimani Area through an appropriate legal and institutional framework that guarantees that the land and resources allocated for infrastructure expansion are used exclusively for that purpose.

6.4.2 Development of Public-Private Partnerships in provision of Transport

More drivers may be persuaded to give up their automobiles and start using public transportation if it were more reliable and convenient. Unimproved or partially developed properties (those still containing single-family homes) that may be pooled to create space for park-and-ride lots are eligible for government compensation. Modern commuter buses with regular routes could then be provided by private investors, transporting workers to and from the city center and other nearby commercial hubs like Yaya Centre, Upper Hill, Westlands, Community Area, Kenyatta National Hospital, Dagoreti Corner, and residential areas like Kileleshwa and Lavington.

Land acquisition by eminent domain is another option for providing land for park-and-ride facilities. Only in cases where the property is needed for a public purpose or is in the public interest is it permissible to acquire it under Article 40 (3) of the Constitution and the Land Act, 2012. In addition, they ensure that everyone with a stake in the property may get access to a court of law and receive equitable recompense in a timely manner.

Compulsory acquisition faces its largest obstacle in the persistent problem of development projects suffering from lengthy holdups, which are often caused by the need to acquire land and other rights. Because of this, the Land Act has established some deadlines to ease the transition for affected landowners, such as a 24-month deadline for the completion of the full purchase procedure. Furthermore, the statute stipulates that in cases where monetary compensation has been granted, it may be paid in no more than annual installments. For this reason, the competent government agency should not waste time putting this into effect, and there should be legal consequences for failing to do so.

6.4.3 Development of a monitoring Tool for Level of service

As a systemic phenomena, urban transportation need continuous monitoring of performance to enable timely actions to maintain service levels within acceptable bounds. However, no organization has created a reliable method of measuring the quality of city roads, and improvements are often implemented solely in response to user complaints, most often about traffic congestion. Multiple types of roadways, such as arterial collectors, street collectors, and junctions, might make use of the instrument.

The Nairobi Metropolitan Area Transport Authority (NAMATA), whose responsibility it is to ensure the city's residents have access to safe and reliable transportation, should create this instrument to track how well roads are serving their intended purpose. This will help prioritize

initiatives by allowing different corridors to be ranked according to the quality of service they provide. It will also aid in the evaluation of any corridor's performance, allowing the infrastructure provider to determine whether or not the corridor satisfies the bare minimal requirements. To this end, attention will move from only supplying the infrastructure to also ensuring that it is effective.

6.4.4 Introduction of Bus Rapid Transit (BRT) along Ngong Road

Large, high-capacity buses like this have their own lanes of traffic that radiate outward from a central hub in a metropolis. They have the same characteristics of a "above-ground subway," such as high speeds, large capacities, and regular service. Express buses, restricted busways, and fast busways are all examples of BRT. However, feasibility studies and the construction of bus-only lanes and designated terminal facilities along important thoroughfares are necessary before they can be implemented.

Plate 6.2: Articulated Bus Rapid Transit

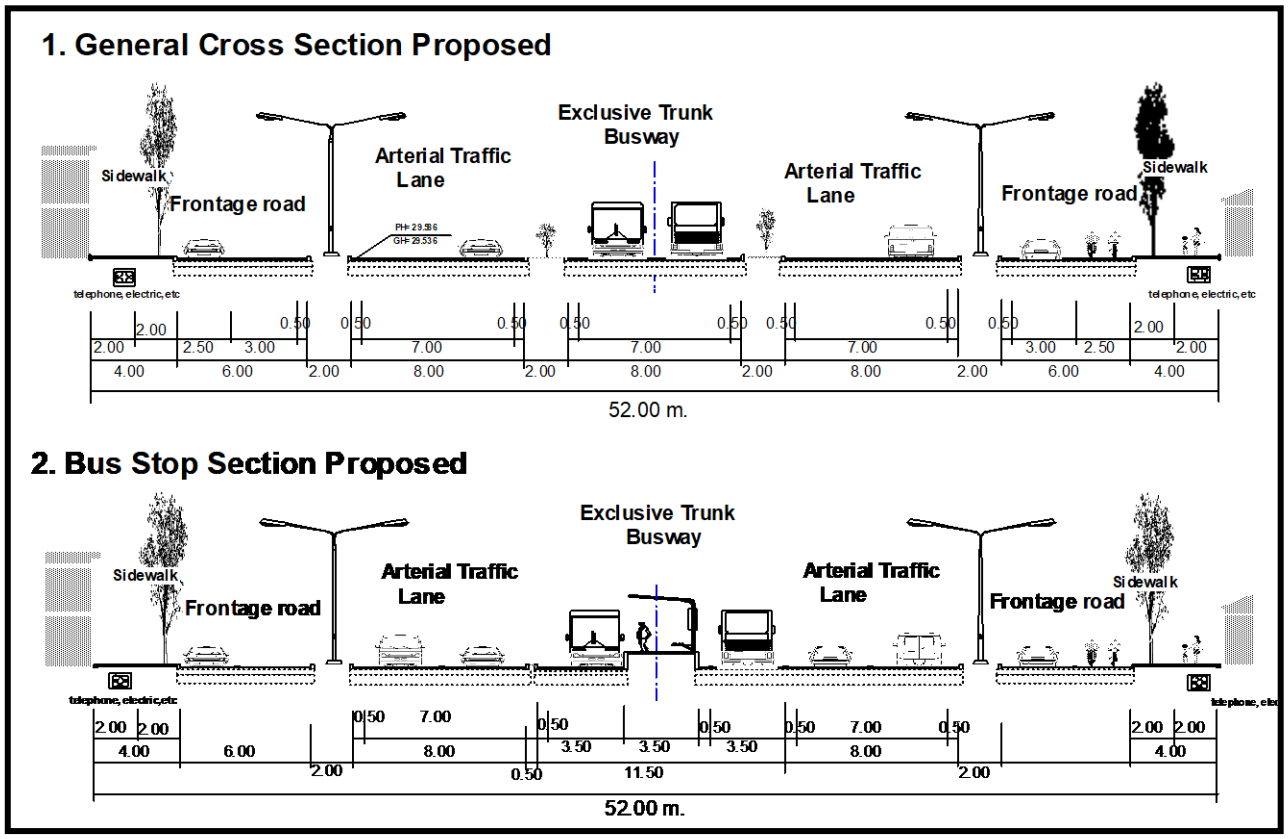
(*Source: Researcher with Photo taken in during visit to Nagoya City, Japan in 2008)*

It is vital that the city adopt a transport strategy that includes regulations for the licensing of BRT operators and the required quality of service. The criteria for service must include minimal requirements for security, convenience, and other such factors. Only by having private businesses that have been screened for capacity requirements and licensed in a competitive procedure to operate along selected routes with certain compliance standards can a BRT be viable.

There shouldn't be a free-for-all when it comes to city bus service, where anybody can buy a bus, choose their own route around the city, and then register it with a PSV business or Sacco that already operates on that route. The present situation hasn't done anything to restore normalcy to the industry. When the municipal authority (in this example, Nairobi City County Government) owns the fleet and checks for compliance with regulations via its inspectorate department, BRT operations are more efficient. The fleet's operation and maintenance are then contracted out to the private sector.

Bus stops should be placed at significant crossroads such City Mortuary Roundabout, Ring Route Kilimani, Joseph Kangethe, Adams Roundabout, and Dagoreti Corner, and dedicated lanes should be built utilizing the two middle lanes of the existing (extended) arterial road. Bus stations should be spaced apart to be no closer than 1 km, and the terminal should be located at the very end of the route.

Fig. 6.1: Showing cross-section of an arterial road incorporating BRT



Source: Proposal by researcher

Because the BRT will be operating on arterial roads, paratransit buses operating on feeder routes will need licenses. Separating BRT lines from minibus (30-40 person) trips is essential for this system to function. BRT buses should be given precedence at junctions on arterial routes. Matatus that can only seat 14 people should be phased out of the projected BRT configuration and replaced with larger buses.

Plate 6.3: Showing a typical 14-seater matatu that should not be part of the BRT plan

Source: Author

6.5 Overarching Conclusion

A national strategy for managing traffic demand should be developed, including acceptable requirements for sustainable mobility. To address this, we must move our attention from conventional methods of supply management, such as building more roads, to the zero-growth target of meeting rising transport demand without growing the number of cars on the road. You can easily determine who is responsible for the city's transportation network. It's not clear who is responsible for ensuring that the infrastructure is sufficient and functioning properly. Instead of the reactive plans that have shaped Nairobi's environment over the years, the city requires a proactive approach to urban management that incorporates a comprehensive strategy for planning, public investment, building, operation, maintenance, and rehabilitation.

For the county government to live up to citizen aspirations, it must amass sufficient capital investment via prudent financial management. This would be accomplished via the implementation of privatization and full investment cost recovery programmes in order to

acquire control in service supply, as well as the provision of necessary infrastructure to increase urban productivity (Oyugi and K'Akumu, 2007).

Providing high-quality access in crowded cities requires careful planning of land use and enough levels of public transportation service. The high quality access required in major metropolitan areas depends on careful planning of land use and transportation, as well as coordinated development of all forms of transportation (including sufficient public transportation). Drives from A to B that are dependable and stress-free are a must for most motorists. They are willing to put up with some traffic, but place a premium on having predictable driving conditions. Therefore, one authority with the ability to formulate and enforce rules is needed to keep the city moving. Given this, it follows that its own set of law enforcement agencies, such as courts, will be necessary.

More emphasis should be placed on reliability when evaluating alternatives and setting priorities among congestion mitigation strategies such as management of service levels. This means that if service along any given corridor in the city falls below a certain threshold, the one-stop authority must take responsibility. A number of credible authorities on urban transportation have stated that a transport system is more successful if it serves a larger variety of people and a wider range of incomes. That is to say, the more options there are for using contemporary transportation, the more sustainable it will be. This transportation discussion, therefore, must evaluate the existing composition of the mix to determine how "rich" or "poor" it is. There should be a prioritized effort to improve the non-motorized transport (NMT) infrastructure and encourage its usage in cities where there is an insufficient supply of such infrastructure to support walking and cycling.

Increases in traffic volume may be attributed in part to the construction of new roads. Traffic congestion, however, may be mitigated by careful planning. Due of this, the master plan should be used as a reference for any construction. Modern urban transportation networks use an integrated management system. This paves the way for the most optimum assignment of modes employing cutting-edge information and control technologies to improve usability, comfort, dependability, and security. Information transfers, management of supply and demand, and traffic control are all examples. Without a comprehensive strategy, enactment of such a system is very unlikely to succeed. When a new version of the master plan is created, it must be implemented as a high priority by municipal officials.

6.6 Suggested Areas for Further Studies

1. Evaluation of institutional and financing gaps in provision of sustainable transport in the city of Nairobi.

2. Strengthening of developer's exaction tools as a means of provision of public infrastructure in Nairobi City.

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APPENDICES

APPENDIX I: ROAD USERS QUESTIONNAIRE

Dear Respondent, I am a student in University of Nairobi taking a master of urban management. As partial fulfilment of the requirements of the course, I am carrying out a project entitled ***"Impact of a Road Project on Land Use: A Case Study of Ngong Road Corridor in Nairobi****". Kindly fill in this questionnaire as honestly as possible to be part of the data I will use to do my analysis. The information you give will be used for academic purpose only.*

Your cooperation is highly appreciated

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Section A: General Information

1. Gender of the respondent

   a) Male ( ) b) Female ( )

2. Indicate by ticking your age bracket

   a) 24 yrs. and below [ ] b) 25-29 [ ]
   c) 30-34 [ ] d) 35-39 [ ]
   e) 40-44 [ ] f) 45-49 [ ]
   g) 50 and above [ ]

3. Kindly indicate your highest level of educational qualification (tick)

   a) Secondary education [ ] c) Certificate or diploma [ ] d) Graduate [ ] e) Postgraduate [ ]

4. How long have you lived in this area?

   1-10 years [ ] 11-20 years [ ]
   21-30 years [ ] Over 30 years [ ]

5. Which mode of transport do you commonly use to and from your place of work/ school?

Tick as appropriate

Walking [ ]

Bicycle riding [ ]

Boda boda [ ]

Public transport [ ]

Private means [ ]

Section B: Challenges associated with upgrading of Ngong Road

6. What major challenges did you face as a frequent user of Ngong Road before the upgrade?

……

……

……

7. What problems did you face during the construction phase?

……

……

……

8. Do you think that once the road is complete, then the problems will be solved?

Using a scale of 1-5, where 1= strongly disagree; 2=disagree; 3=Neutral; 4=agree; 5=strongly agree;

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree

☐ Strongly disagree

9. Which problems are likely to recur some years after the road is completed?

……

……

……

7. Using a scale of 1-5, where 1= strongly disagree; 2=disagree; 3=Neutral; 4=agree; 5=strongly agree; Please indicate the extent to which you agree with the following statement on challenges that result out of the upgrading of Ngong Road.

Statement	**S.D**	**D**	**N**	**A**	**S.A**
Upgrading of Ngong Road has led to increased road accidents causing heavy traffic congestion in the CBD of Nairobi, especially when they are serious and totally blocks the road carriageway					
Upgrading of Ngong Road has led to recurring urban traffic congestion which is predictable delay caused by high volumes of vehicles using the roadway during the same daily time periods of construction					
Upgrading of Ngong Road has led to temporarily or permanently disruption of livelihood or economic dependency from commercial activities near and around the highway					
Upgrade has led to high rate of disruption of services like water and electricity within neighbourhoods around the corridor thus increasing the cost of living.					
Upgrading of Ngong Road will lead to a permanent solution to traffic congestion along the corridor					
The problem of traffic congestion is still likely to recur despite the upgrade of Ngong Road					

Section C: Urban Land Use Transformation Patterns

8. Do transportation have an effect on land use transformation patterns i.e. change in building typologies, densities, usage etc?

Yes [ ] No [ ]

If yes explain

……

……

……

9. In your opinion, what major transformation has occurred in land use pattern since conception of the project to upgrade the corridor? Tick the appropriate box below.

   No Change [ ]
   Conversion of housing from single dwelling units to high rise residentials[ ]
   Conversion of single dwelling residential units to high rise office blocks [ ]
   Conversion of single dwelling residential units to single office blocks [ ]
   Conversion of residential units to mixed use (residential and commercial) [ ]

10. Using a scale of 1-5, where 1= strongly disagree; 2=disagree; 3=Neutral; 4=agree; 5=strongly agree; Please indicate the extent to which you agree with the following statement on urban land use transformation patterns.

Statement	**S.D**	**D**	**N**	**A**	**S.A**
The pattern of land use is influenced by the level of accessibility provided by the transportation system from one activity area to another					
The pattern of land use is influenced by the value of land which has a direct correlation with the level of accessibility provided by the transportation system.					
Urban land use leads to the need of transport linkage from one site of activity to another this leads to traffic generation points					
The fundamental relationships between transportation linkage and land use is the trip making patterns, volumes and modal distribution, which are largely a function of spatial distributions of land use					
Each land use has an optional limited space or location suitable for its economic, social or physical activity					

Section D: Recommendations on Effective Transport Management Strategies

11. What do you suggest the authorities should do to facilitate efficient and uninterrupted mobility once the road upgrade is complete?

    ……

    ……

    ……

12. Using a scale of 1-5, where 1= strongly disagree; 2=disagree; 3=Neutral; 4=agree; 5=strongly agree; Please indicate the extent to which you agree with the following statement on recommendations on effective transport management strategies.

Statement	**S.D**	**D**	**N**	**A**	**S.A**
The organization framework of urban traffic management affects the productivity and the overall operation of the transport system and determines indirectly the level of service provided to the travelling public.					
Roadway capacity expansion or Flexitime (which frees up peak-period road space) is likely to generate traffic, and so will provide relatively little long-term congestion reduction.					
Strategies that improve transportation choices, such as Ridesharing or Transit Improvements are unlikely to provide significant congestion reduction.					
Transport Demand Management strategies reduce peak-period travel demand or improve transportation alternatives					
Traffic speed and flow on urban streets are determined primarily by intersection capacity, which is affected by traffic volumes on cross streets and left turn signal phases.					
Road Pricing can reduce traffic congestion on a particular roadway, particularly if implemented as part of a comprehensive transport demand management program.					
Transit Improvements and Rideshare Programs can be effective ways to reduce vehicle travel, particularly under urban-peak travel conditions when congestion problems are most severe.					

THANK YOU FOR PARTICIPATION

APPENDIX II: INTERVIEW GUIDE

1. What benefits do you enjoy as a result of the upgrade of Ngong Road?
   ……
   ……
   ……
2. What major challenges do you face as a result of upgrade of Ngong Road?
   ……
   ……
   ……
3. Will the benefits enjoyed become long-term or do you expect them to deteriorate at some stage? Explain.
   ……
   ……
   ……
4. In your opinion, what causes the transport service provided by an upgraded artery to deteriorate?
   ……
   ……
   ……
5. What changes do you expect to occur to housing typologies within the neighbourhood as a result of the upgrade?
   ……
   ……
   ……
6. Describe any other change other than housing typologies that you expect to occur within the neighbourhood due to the project?
   ……
   ……
   ……
7. Describe how urban land use transformation patterns have affected the urban settlements of the various households since the upgrade of Ngong road
   ……
   ……
   ……
8. What do you suggest the authorities should do to maintain efficient transport along Ngong Road?
   ……
   ……
   ……..

THE END
THANK YOU FOR PARTICIPATION

APPENDIX III: PROJECT IMPLEMENTER QUESTIONNAIRE
(KENYA URBAN ROADS AUTHORITY)

Dear Respondent, I am a student in University of Nairobi taking a master of urban management. As partial fulfilment of the requirements of the course, I am carrying out a project entitled ***"Impact of a Road Project on Land Use: A Case Study of Ngong Road Corridor in Nairobi****". Kindly fill in this questionnaire as honestly as possible to be part of the data I will use to do my analysis. The information you give will be used for academic purpose only.*

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SECTION A: RESPONDENT'S PERSONAL DATA

1. Designation……..
2. Years of Service……...

SECTION B: DUTIES AND RESPONSIBILITIES

1. Are you in charge of feasibility studies and preparation of detailed designs for roads within your jurisdiction?
   Yes [ ] No [ ]
   If yes, kindly explain briefly
   ……
   ……
   ……..

2. Please describe briefly the nature of standards that you implement in design of urban roads.
   ……
   ……
   ……..

3. What are your employer's targets towards uninterrupted traffic flow within any urban corridor?
   ……
   ……
   ……..

4. How do you guarantee that the level of service of an upgraded urban road is maintained throughout the design life of the road?
   ……
   ……
   ……..

5. What challenges do you face in ensuring that the level of service of an urban corridor is maintained?

……
……
……

SECTION C: NGONG ROAD DESIGN PARAMETERS

1. What was the design speed adopted in construction of Ngong Road?

……
……
……

2. What was the design life for the road?

……
……
……

3. What were the aggregated traffic volume in terms of passenger car units per hour (pcu/hr) established from traffic survey and what were the projected figures on expiry of design life of the road?

……
……
……

4. What was the predicted future traffic volume at the expiry of the design life for the road?

……
……
……

5. Are there any mitigation measures at design stage to address challenges due to generated traffic exceeding the design capacity for the road?

……
……
……

6. What arrangements are there in place to address capacity challenges that may occur due to generated traffic exceeding the design capacity?

……
……
……

7. Who should ensure that the level of service is for the corridor is maintained

……
……
……

D. LONG-TERM INTERVENTIONS

1. As the provider of road infrastructure within the city, what are the medium-term and long-term interventions towards sustainable urban mobility despite the land-use changes that generate additional traffic on the roads?

Thank You.

APPENDIX IV: PROJECT SUSTAINABILITY QUESTIONNAIRE
(NAIROBI CITY COUNTY PLANNING DEPARTMENT)

Dear Respondent, I am a student in University of Nairobi taking a master of urban management. As partial fulfilment of the requirements of the course, I am carrying out a project entitled ***"Impact of a Road Project on Land Use: A Case Study of Ngong Road Corridor in Nairobi****". Kindly fill in this questionnaire as honestly as possible to be part of the data I will use to do my analysis. The information you give will be used for academic purpose only.*

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SECTION A: RESPONDENT'S PERSONAL DATA

1. Designation……..
2. Years of Service……...

SECTION B: DUTIES AND RESPONSIBILITIES

1. Briefly describe your responsibilities in line with sustainable mobility within the city.

   ……

   …….....

   …….

2. How do you measure the transportation utility provided to establish if it meets the threshold required or not?

   ……

   …….....

   ……...

3. Please describe briefly the nature of standards that you implement to ensure that the transportation utility does not deteriorate within the city.

……

……

……

4. How do you guarantee that the level of service of an upgraded urban road is maintained throughout the design life of the road?

……

……

……..

5. Design and construction of roads within the city are implemented by different authorities i.e. KENHA, KURA and the Nairobi City County Government. Briefly describe your engagement with the said authorities during the project cycles to ensure that the completed projects serve the users sustainably.

……

……

……

6. An upgraded artery is most likely to generate more traffic culminating in traffic congestion. What policy interventions do you have in place to ensure that sustainable mobility is maintained?

……

……

……..

SECTION C: NGONG ROAD TRANSPORT SUSTAINABILITY

1. Describe your involvement in planning, design and implementation of Ngong Road upgrade project.

……

……

……

2. After how many years is Ngong Road expected to provide vehicular mobility optimally before it begins to deteriorate into congestion?

   ……
   ……
   ……

3. What land use interventions do you have to guarantee sustainable transportation along a corridor.

   ……
   ……
   ……

4. What policy interventions do you have in place to ensure that sustainable mobility is maintained?

   ……
   ……
   ……

5. What physical infrastructure interventions are lined up to guarantee sustainable interventions?

   ……
   ……
   ……

6. How is Transport along Ngong integrated with land use within the neighbourhood?

   ……
   ……
   ……

Thank You

APPENDIX VI: VALUERS QUESTIONNAIRE

Dear Respondent, I am a student in University of Nairobi taking a master of urban management. As partial fulfilment of the requirements of the course, I am carrying out a project entitled ***"Impact of a Road Project on Land Use: A Case Study of Ngong Road Corridor in Nairobi****". Kindly fill in this questionnaire as honestly as possible to be part of the data I will use to do my analysis. The information you give will be used for academic purpose only.*

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SECTION A: RESPONDENT'S PERSONAL DATA

1. Organization/Employer……
2. Designation……..
3. Years of Service/investment……

SECTION B: AREA AND MODE OF OPERATION

1. Have you carried out property valuation within Ngong Road neighbourhood between 2013 and 2021?

Yes [ ] No [ ]

If yes, which area?

……

……....

……

2. How many valuation assignments have you carried between 2013 and 2021 within Ngong Road neighbourhood?

☐ Below Five

- ☐ Between 5 and 10
- ☐ Between 10 and 15
- ☐ Between 15 and 20
- ☐ Above 20

3. What type of properties MOSTLY attracted your services within the neighbourhood of Ngong Road between 2013 and 2021?

- ☐ Land valuation
- ☐ Valuation of single-dwelling units
- ☐ Valuation of multiple dwelling units
- ☐ Valuation of highrise apartments
- ☐ Valuation of commercial units

4. In your assessment which housing typologies have attracted more investment during the period within the neighbourhood?

- ☐ Single dwelling units
- ☐ Multiple dwelling units
- ☐ Highrise residentials
- ☐ Mixed use units incorporating commercial and residential
- ☐ Pure Commercial units

SECTION C: GENERAL

5.For your choice in (4) above, what was the price per square metre during the following times?

a) Inception Phase of the project for upgrade of Ngong Road (2013)

……

……....

……

b) Construction Phase (2017-2020)

……

……

……

c) Completion phase (2020-2021)

……

……....

……

6. How has the corridor upgrade impacted on land values within your area?

……

……....

……

7. What MAJOR change in housing typologies have you experienced within the neighbourhood as a result of the upgrade?

- ☐ No Change
- ☐ Conversion of single-residential units to highrise residentials
- ☐ Conversion of single residential units to commercial blocks
- ☐ Conversion of Single commercial units to multiple multiple units
- ☐ Conversion of Single commercial units to highrise residentials

8. Describe any other change other than housing typologies that you expect to occur within the neighbourhood due to the project?

……

……....

……

9. Do you anticipate any property bubble to occur in the near future where prices may come tumbling down? If No, explain

……

……....

……

10. From the following choices, select a land use pattern, which in your opinion will be more dominant within Ngong Road neighbourhood.

☐ Residential ☐ Commercial ☐ Mixed but more residential

☐ Mixed but more commercial

11. From your experience, what is one main transportation reason why tenants and property buyers move into the neighbourhood?

☐ Ease of mobility from CBD

☐ Availability of adequate parking

☐ Close proximity to work places and commercial centres achievable by walking

☐ Better road connectivity to other places

12. What is the main reason why they move from Ngong Road to other areas?

……

……....

……

13. What major transport challenges do you anticipate within the neighbourhood as a result of upgrade of Ngong Road?

……

……....

……

14. What would you recommend as long-term neighbourhood land use for ngong Road

☐ Residential

☐ Commercial

☐ Mixed use

Explain your choice for (14) above

15. What is the best way for solving the transport challenge that may recur within Ngong Road?

Thank You

APPENDIX VII: TRAFFIC VOLUME FORECAST FROM THE MASTER PLAN FOR URBAN TRANSPORT IN THE NAIROBI METROPOLITAN AREA (JICA, 2006)

Estimate of heavy traffic volume during design period(2013-2022)

(Traffic volume per lane is assumed 80% of the direction.)

Design Period Traffic Volume at ML-7 Intersection (Section-1)

Year	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Grouth Rate
2010	934	250	135	75	18	
2011	1,014	271	147	82	19	1.09
2012	1,088	291	157	88	21	1.07
2013	1,156	309	167	93	22	1.06
2014	1,218	326	176	98	23	1.05
2015	1,277	341	185	103	24	1.05
2016	1,331	356	193	107	25	1.04
2017	1,383	370	200	112	26	1.04
2018	1,431	382	207	115	27	1.03
2019	1,477	395	214	119	28	1.03
2020	1,520	406	220	123	29	1.03
2021	1,562	417	226	126	29	1.03
2022	1,601	428	231	129	30	1.03
Total	4,395,886	1,174,943	635,673	354,555	82,993	

Note: Total = (2013 -2022) x (265 + 100 x 0.5)

Design Period Traffic Volume at Kenya Baptist Church (Section-2)

Year	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Grouth Rate
2010	1,168	282	131	71	20	
2011	1,269	306	143	77	22	1.09
2012	1,361	329	153	83	24	1.07
2013	1,446	349	162	88	25	1.06
2014	1,524	368	171	93	27	1.05
2015	1,597	386	179	97	28	1.05
2016	1,666	402	187	102	29	1.04
2017	1,730	418	194	105	30	1.04
2018	1,790	432	201	109	31	1.03
2019	1,848	446	208	113	32	1.03
2020	1,902	459	214	116	33	1.03
2021	1,954	472	219	119	34	1.03
2022	2,003	484	225	122	35	1.03
2013 - 2022	5,499,716	1,327,842	617,776	335,257	96,057	

Note: Total = (2013 -2022) x (265 + 100 x 0.5)

Design Period Traffic Volume at Kenya Hospital (Section-3)

Year	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Grouth Rate
2010	972	106	50	14	2	
2011	1,056	115	54	16	2	1.09
2012	1,132	124	58	17	3	1.07
2013	1,203	132	62	18	3	1.06
2014	1,268	139	65	19	3	1.05
2015	1,329	145	68	20	3	1.05
2016	1,386	152	71	20	3	1.04
2017	1,439	157	74	21	3	1.04
2018	1,489	163	76	22	4	1.03
2019	1,537	168	79	23	4	1.03
2020	1,582	173	81	23	4	1.03
2021	1,625	178	83	24	4	1.03
2022	1,666	182	85	24	4	1.03
2013 - 2022	4,574,988	500,263	233,994	67,240	10,758	

Note: Total = (2013 -2022) x (265 + 100 x 0.5)

Design Period Traffic Volume at MOR (Section-4)

Year	Standard & Large Bus	Mini Truck	Medium (2a) Truck	Heavy (3a) Truck	Articulated Truck	Grouth Rate
2010	951	43	25	6	1	
2011	1,033	47	27	7	1	1.09
2012	1,108	50	29	7	1	1.07
2013	1,177	53	31	8	1	1.06
2014	1,241	56	33	8	1	1.05
2015	1,301	59	34	9	1	1.05
2016	1,356	61	36	9	1	1.04
2017	1,409	63	37	10	1	1.04
2018	1,458	66	38	10	1	1.03
2019	1,504	68	40	10	1	1.03
2020	1,549	70	41	10	1	1.03
2021	1,591	72	42	11	1	1.03
2022	1,631	73	43	11	1	1.03
2013 - 2022	4,478,163	201,719	117,669	30,258	3,362	

Note: Total = (2013 -2022) x (265 + 100 x 0.5)

APPENDIX VIII: ZONING POLICY - NAIROBI

ZONE	AREAS COVERED	GC %	PR %	Dept Ref. Map	TYPE (S) OF DEVELOPMENT ALLOWED	MIN. AREA (Ha.)	REMARKS/POLICY ISSUES
1A	**Central Business District (CBD)**			CP/FP/XXX	Commercial/Residential/Light Industry	0.05	
	• Core CBD	80	600				
	• Peri-CBD	80	500				
	• West of Tom Mboya St	60	600				
	• East Of Tom Mboya St	80	350				
	• Uhuru H/W/ University Way/Kipande Rd	80	500				
1E	**Upper Hill Area**			CP/FP/XXX	Commercial/Offices/ Residential	0.05	
	• Block 1 - Offices (Community)	60	300				
	• Block 2 - Comm/Off	60	250				
	• Block 3 - Offices	60	300				
	• Block 4 - Residential	35	150				
	• Block 5 - Institutional (KNH)						
	• Block 6 - (Mixed: Inst;Htls;Offs)	60	200				
2	**Eastleigh**			CP/FP/XX X	Commercial/Residential (High-rise Flats)	0.05	
	• Eastleigh District Centre	80	250				
	• Eastleigh Comm/Residential	60	240				
	Pumwani/Califarnia	60	240	CP/FP/XXX	Commercial/Residential (High-rise Flats)	0.05	
	Ziwani/ Starehe						
	• Commercial	80	150				
	• Residential	35	75				

ZONE	AREAS COVERED	GC %	PR %	Dept Ref. Map	TYPE (S) OF DEVELOPMENT ALLOWED	MIN. AREA (Ha.)	REMARKS/POLICY ISSUES
1A	**Central Business District (CBD)**			CP/FP/XXX	Commercial/Residential/Light Industry	0.05	
	• Core CBD	80	600				
	• Peri-CBD	80	500				
	• West of Tom Mboya St	60	600				
	• East Of Tom Mboya St	80	350				
	• Uhuru H/W/ University Way/Kipande Rd	80	500				
1E	**Upper Hill Area**			CP/FP/XXX	Commercial/Offices/ Residential	0.05	
	• Block 1 - Offices (Community)	60	300				
	• Block 2 - Comm/Off	60	250				
	• Block 3 - Offices	60	300				
	• Block 4 - Residential	35	150				
	• Block 5 - Institutional (KNH)						
	• Block 6 - (Mixed: Inst;Htls;Offs)	60	200				
2	**Eastleigh**			CP/FP/XXX	Commercial/Residential (High-rise Flats)	0.05	
	• Eastleigh District Centre	80	250				
	• Eastleigh Comm/Residential	60	240				
	Pumwani/Califarnia	60	240	CP/FP/XXX	Commercial/Residential (High-rise Flats)	0.05	
	Ziwani/ Starehe						
	• Commercial	80	150				
	• Residential	35	75				

APPENDIX IX: SCHEDULE OF RESEARCH ACTIVITIES

Task	Year 2021									Year 2022				
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Supervisor meeting														
Topic Research														
finalizing Topic														
Establish hypothesis/objective														
Literature Review														
Dissertation methodology														
Questionnaire Design														
Data Collection														
Data interpretation/Analysis														
Conclusions and Findings														
References/Appendix														
Abstract														
Review														
Printing and Binding														
Submission														