A STUDY OF THE ADOPTION AND MAINTENANCE OF GREEN ROOFS AS PART OF THE URBAN GREEN SPACES FOR THE CITY OF NAIROBI.

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C50/14599/2018

A research project submitted in partial fulfilment of the requirements for the degree of Master of Arts in Urban Geography from the Department of Geography and Environmental Studies, University of Nairobi.

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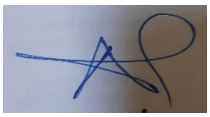
DECLARATION

I hereby declare that this Research Project is my personal work, and it has not been submitted to any other universities or institutions for a degree or any other award.

Signature ……  …… Date: **11th November, 2020**……

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This Research Project has been submitted for examination with approval of my University supervisors.

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DEDICATION

To those who mourn the loss of conventional urban green spaces and pursue innovative strategies to solve this problem. To my Unknown Parents.

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It was a long and quite challenging journey to get to this stage of completion. I am thrilled to be here. I hereby recognize the assistance and guidance of my lecturers, and friends. Their contribution is greatly appreciated. Foremost, I thank my supervisors, Dr. Mbatia and Mr. Karingi. Dr. Mbatia motivated me to think critically in my analysis, opinions, and writing. Mr. Karingi's commitment to the details in my writing offered me an invaluable space, freedom, and time during the writing of this research paper. I am grateful to all academic and non-academic staffs at the Department of Geography and Environmental Studies, University of Nairobi, whose direct and indirect contributions were instrumental from the beginning to the end of this research paper.

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ACRONYMS AND ABBREVIATIONS

UTUL	Unified Theory of Urban Living
USGBC	U.S. Green Building Council
UN	United Nations
UHI	Urban Heat Island
UGS	Urban Green Space
SP	Sampling Point
SGR	Semi -intensive Green Roof
SDG	Sustainable Development Goals
RSA	Rapid Site Assessments
NUIPLAN	Nairobi Integrated Urban Development Master Plan
NUGS	Nairobi Urban Green Spaces
NNP	Nairobi National Park
NEMA	National Environment and Management Authority
EIA	Environmental Impact Assessment
NCCRS	National Climate Change Response Strategy
NCA	National Construction Authority
MASL	Meters above Sea Level

LEED	Leadership in Energy and Environmental Design
KG	Kikuyu Grass
KENHA	Kenya National Highways Authority
IPDC	Innovative Planning and Design Consultants
IGR	Intensive Green Roof
GTC	Global Trade Center
GRs	Green Roofs
GRP	Green Roof Professional
GGEP	Green Growth and Employment Program
EGR	Extensive Green Roof
ECT	Eco City Theory
DIT	Diffusion of Innovations Theory
DG	Director General
BORAQS	Board of Registration of Architects and Quantity Surveyors of Kenya
ART	Attention Restoration Theory
AAK	Architectural Association of Kenya
EoS	Embassy of Switzerland
HT	Haveli Towers

ABSTRACT

This research investigated green (vegetated) roofs in the city of Nairobi in terms of adoption and maintenance as part of the urban green spaces. The information drawn from worldwide studies show that vegetated roofs are integral in urban green spaces and urban infrastructure and has the potential to address the dynamic multifaceted environmental threats caused by urban population. These threats include reduced urban biodiversity, urban flash floods and impacts of changes in climate in the urban areas. This paper makes a general argument that the rooftops of the contemporary urban buildings can be used as green (vegetated) roofs. This would increase chances of having more green spaces in the city of Nairobi and solve the issue of loss of green spaces. The purpose of this study was to investigate the possibility of adoption and management of green roofs in the city of Nairobi. The study's specific objectives were; 1) to investigate the location, type and nature of green roofs in the city of Nairobi, 2) to establish how the city of Nairobi residents perceive the maintenance and adoption of green roofs in terms of (technology, costs, maintenance, and installation, 3) to review the existing policies, planning guidelines, regulations, and laws that discourage or encourage maintenance and adoption of green roofs in the city of Nairobi and, 4) to identify strategies and practices that can be pursued in the promotion of the adoption and maintenance of green roofs in the city of Nairobi.

This research used case study research design whereby six case studies of accessible and available vegetated roofs were identified; 1) the Haveli Towers in Parklands, 2) the former Coca-Cola Building in Upper Hill, 3) the Swiss Embassy in Gigiri, 4) the French Embassy in Westlands, 5) the Morningside office in Kilimani, and 6) GTC in Westlands. The IEBC demarcation data was used in mapping the distribution of the green (vegetated) roof case studies across the city of

Nairobi. Qualitative data was collected and analyzed based on this mapping. This study found that the existing urban policies neither do they promote nor discourage the adoption and maintenance of green (vegetated) roofs in the city of Nairobi. Therefore, the few green (vegetated) roofs installed in the city of Nairobi have been adopted without any specific government policy. Apart from the lack of urban legal framework, the study identified other barriers within the city of Nairobi that discourage the adoption of green (vegetated) roofs in the city of Nairobi; 1) Challenges in repair of GRs which make leak detections almost impossible, 2) lack of skilled manpower to install and maintain the green (vegetated) roofs, 3) high cost of both installation and management of the vegetated roofs. Further, this study found out that most residents of the city of Nairobi are not aware of the green (vegetated) roofs. The distribution of green (vegetated) roofs in the city of Nairobi was found to be uneven. Most of the case studies were found to be in the western part of the city of Nairobi. The study recommends; 1) provision of favorable policies, laws, planning guidelines as well as incentives by the Nairobi County government to encourage city of Nairobi residents and investors to adopt green (vegetated) roofs, 2) The issuance of EIA licenses by NEMA should include a condition to encourage the city developers to use a section of their rooftops as a green roof, 3) More research is to be done to quantify the challenges facing maintenance and adoption of green (vegetative) roofs in the city of Nairobi.

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1 CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND OF THE STUDY

According to Seto et al., (2011), the existing global urban areas cover about 3 percent of the world's surface area. Urban areas provide habitat for over fifty percent of the world's total population (Satterwaite, 2000; Abukakar & Aina, 2019; UN, 2014; Vidal, 2010; Duggar, 2007; Foken & Owour, 2000). In the year 2007, an international survey of density and spatial distribution of impervious surface area indicated that about 0.43 per cent of the world's total surface area (579,703 km2) was developed as impermeable surfaces (Elvidge et al., 2007). These ISA includes man-made structures like buildings and roads. The total ISA in the world is approximately 579,703 km2 which is almost Kenya's size of (584,659 km2), and greater than France's size of 546,962 km2 or the size of Spain which 505,735 km2 (Liu, 2014; Elvidge et al., 2007; Elvidge et al., 2009).

More than half of the world's population is projected to be urbanized by 2050 (Raleigh, 1999; Cohen, 2001; Goldstone, 2010; United Nations, 2014; Owuor et al., 2014; Mwangi, 2019). It means there will be an influx of concrete structural development, especially in the developing cities such as the city of Nairobi. Urban centers are metamorphosing with time (Bollini & Begotti, 2017; Mwaura, 2006) and with no exception, the city of Nairobi, with time shall change. Urban growth is unavoidable (JI & LIU, 2010; Xu 2013; Owuor et al., 2014). The fasted urbanization is being experienced in the developing countries (Cohen 2006; United Nations 2018) in which Kenya is part of them. This phenomenon will lead to increased concrete development on the already existing natural Urban Green Spaces (UGS).

As per Schneider, (2010) and Peschardt et al., (2012) urbanization leads to urban green occupation and this has led to the increased depletion of UGS resulting to different problems related to urban

environments. Singh et al., (2017), argued that the air, water, and soils in urban areas are highly contaminated with pollutants and decrease in urban vegetation has resulted to higher urban heat posing health complications to the urban population. Fuller & Gaston, (2009) noted that the shrinking of the UGS deprives the urban populations the chances to interact with nature as also confirmed by Rigolon et al., (2018). Green (vegetated) Roofs (GRs) are amongst the emerging urban greening innovations that are being implemented to mitigate urban environmental concerns stemming from urbanization (Blair & Osmond, 2020; Saaroniet et al., 2017; Pérez-Urestarazu et al., 2015).

In Europe, the adoption of GRs has been a response to the decreased UGS due to growth in urban centers that rendered most of the European cities concrete (Köhler & Poll; 2010; Mowla, 2010; Hui, 2011; Köhler & Kaiser, 2019). The implementation of GRs across Europe has steadily increased (Köhler & Kaiser, 2019; Emilsson & Rolf, 2005). Despite the normal uses of rooftops in most city buildings, like cloth lines, Mowla, (2010) observes that the balconies and rooftops have remained unused and idle resources and, therefore, with appropriate architecture, the implementation and adoption of GRs would result to maximum exploitation of the rooftops (Bay Localize, 2007; Corcelli et al., 2019). Rooftop gardening, the ancient forms of GRs is not a recent concept (Osmundsen, 1999; Orsini, et al., 2014) it as it dates to the 6th century. In the European cities, GRs are adopted as a way of bringing back the lost urban biodiversity and fix environmental concerns (Oberndorfer et al., 2007; Connop et al., 2016). Coma et al., (2017) notes that the global acceptance of GRs has accelerated whereby they offer multiple ecological benefits just like the typical green spaces in the city. The city of Nairobi is facing a complex environmental sustainability challenges that have resulted from rapid urbanization and thus GRs can be used to

address these concerns. GRs have the capability to address the numerous issues that the city of Nairobi is facing and replace the lost UGS.

1.2 STATEMENT OF THE RESEARCH PROBLEM

Globally, urbanization has led to monstrous concrete environments that are devoid of green spaces. The new concrete environments created by urbanization have exposed the urban residents to polluted and challenging urban environments. Currently, urban areas are fighting the adverse effects of increase in greenhouse gases and climate change issues. Additionally, the reduced urban green spaces have led to rampant urban floods, loss of urban biodiversity, air pollution in the cities, and increased urban heat islands. The drastic decrease in global conventional green urban spaces necessitates the use of alternative solutions like green (vegetated) roof technology with the aim of bringing back the lost green spaces. Several cities in the newly industrialized and the developed countries encourage adoption of green roofs to solve the problem.

Several authorities of cities in newly industrialized nations like Bangkok Municipal Authority in Thailand, have recognized the need to allocate more land towards open space preservation and green spaces reintroduction amid rapid urban growth and development. Thus, building owners in these cities have been encouraged to install green roofs through the provision of incentives, including decreased land rates and other types of tax breaks. However, despite the many environmental, social, and economic benefits associated with implementation of green roofs, most of the cities in developing nations have not adopted the green roof technology to improve urban green infrastructure. The city of Nairobi counts in the cities that have the lowest rates of green roofs adoption. There is minimal research about the green roof technology in developing countries – Kenya included. Given the benefits of associated with the green roofs, low adoption rate of green roofs in Nairobi raises many questions. Therefore, this study aimed at understanding the slow and

low rate of green roofs' adoption in Nairobi. This was achieved by first defining their physical location of the green (vegetated) roofs, the profiles of the green (vegetated) roofs owners, the challenges encountered in the adoption and maintenance of green roofs with the city of Nairobi.

1.3 RESEARCH QUESTIONS

This research paper is based on the following questions.

1. What is the distribution, nature, and type of green roofs in the city of Nairobi?
2. How does the city of Nairobi residents perceive the maintenance and adoption of green roofs in terms of (technology, costs, maintenance, and installation)?
3. What are the existing policies, planning guidelines, regulations, and laws that discourage or encourage maintenance and adoption of green roofs in the city of Nairobi?
4. Which strategies and practices that can be pursued in the promotion of adoption and maintenance green (vegetated) roofs in the city of Nairobi?

1.4 THE RESEARCH OBJECTIVES

1. To achieve the goal of this study, four objectives were outlined.
2. To investigate the distribution, nature, and type of green roofs in the city of Nairobi.
3. To establish how the city of Nairobi residents perceive the maintenance and adoption of green roofs in terms of (technology, costs, maintenance, and installation).
4. To review the existing policies, planning guidelines, regulations, and laws that discourage or encourage maintenance and adoption of green roofs in the city of Nairobi.
5. To identify the strategies and practices that can be pursued in the promotion of adoption and maintenance green (vegetated) roofs in the city of Nairobi.

1.5 JUSTIFICATION AND SIGNIFICANCE OF THE STUDY

Globally, research on the adoption of Green (vegetated) roofs (GRs) and their benefits to the urban residents is limited (Simmons et al., 2008; Fernández Cañero & González Redondo, 2010). Much of the scientific studies and literature on GRs that could be obtained for this research paper were based on the first world countries like Germany where the first study on green roof technology was published in 1850s (Köhler, 2008). The culture of adopting green roofs in German has been existing since the last century (Köhler & Poll, 2010; Köhler & Kaiser, 2019). Interestingly, even in nations where research and adoption of green roof has been done, the number of people adopting green roofs GRs is minimal as compared to the benefits that come with the GRs (Köhler, 2008). The developing cities such as Nairobi, rank low not only in research but also in the adoption of GRs (Rogers, 2013) despite the socio-ecological and environmental benefits that GRs bring to the city.

There is indeed an immediate need for research into the acquisition and maintenance of GRs in cities of developing countries, such as city of Nairobi, particularly since the city is struggling to cope with rapid urbanization. The GRs, if adopted would preserve the existing open UGS and develop new ones. This research is long overdue and urgent in the case of city of Nairobi, particularly now in an era of growing adverse impacts of climate change in the urban areas. This research paper has come in the right time when the whole world is focused on the achievement of better and sustainable cities as indicated in the New Urban Agenda (NUA) and SDGs. At the local level, the achievement of the SDG 11 (Sustainable cities and Communities), SDG 2 (Zero Hunger) and, SDG 13 (Climate Action) can be accelerated by the adoption of GRs in Nairobi City (Herrera-Gomez et al.,2017; Akbari et al., 2016; Li & Babcock, 2014; Getter & Rowe, 2006; Pérez-Urrestarazu et al.,2015). Globally, rooftop farming has being practiced which has provided an

avenue for food production for the urban residents (Hui, 2011). Further, GRs in the city of Nairobi can be used to facilitate the actualization of the Kenya's big four agenda, specifically on food security and nutrition. This is because GRs have the potentials of being used as food production avenues (Hui, 2011; Beacham et al., 2019).

In addition, this research aimed at introducing innovative suggestions to the field of UGS. It was among the few research that have focused on UGS in Kenya. It would therefore form a relevant source for reference to interested readers, urban users and managers and scholars interested in adopting, installing, maintaining, or teaching about innovative urban green spaces such as GRs. This research would be of significant use to the urban policy makers as it could help in provision of relevant local recommendations to the City of Nairobi on matters of UGS. In addition, the study aimed at giving insights and propositions on how to regain the lost UGS for city of Nairobi. The study would guide and direct those involved in formulation of urban policies in the in the city of Nairobi as well as the government agencies like Nairobi County Physical planners, NCA, and NEMA. This research would re-shape the practice of urban space management in the City of Nairobi.

1.6 SCOPE AND LIMITS OF THE STUDY

The aim of the research paper was to study green (vegetated) roofs in the city of Nairobi in terms of adoption and maintenance. In the city of Nairobi, there are few known cases of GRs. The few known GRs cases are uniformly distributed throughout Nairobi city. Having established the numerous case studies of GRs in Nairobi and their locations, the extent of the study area was chosen. This research was limited to the regions of Nairobi city where green roof case studies are found. Geographically, this research was limited to Kilimani/Ngong road, Upper Hill, Parklands, Gigiri, and Westlands based accessibility and reachability of the few known green (vegetated)

roofs. The case studies were all located within the middle and upper socio-economic areas of the city of Nairobi. The desktop review done and the pre-field work did not find any existing green (vegetated) green roofs within the low social-economic regions of the city. The research was restricted to the artificial green (vegetation) roofs and not the natural vegetation colonizing the rooftops and balconies of the city of Nairobi buildings. The research has also omitted potted plants on roof balconies, and verandahs. The study did not recognize old urban structures which have undergone urban decay resulting to invasion by various animals and plants. It was very essential that during collection of data for the study, GRs case studies were in use, either for residential purposes or as a business building. The study did not consider buildings that had been abandoned. This biasness came in because green roofs include vegetated landscapes made from a key series of spectrum and established on flattened surfaces like prepared layered trays and modulars. The building sector of Nairobi is too wide (Igunza, 2014) so this research was specific to existing, known, accessible and available green roofs in Nairobi. Afterwards, the case studies were subjected into a detailed analysis.

1.7 OPERATIONAL TERMS

Green Roof Professional (GRP): this is the certification indicating that an individual has attained particular know-how levels and knowledge based on maintenance, installation, managements, and design of green roofs. For this study, GRP refers to a skilled person who can install a green roof.

Green (Vegetated) Roof(s) (GRs): Conventional rooftops that have artificially amended vegetation cover and are well maintained (rooftops that are partly or almost fully covered with vegetation; several structural layers exist between the roofing layer and the vegetation).

Urban Green Spaces (UGS): These are open spaces covered by vegetation and are publicly or private operated for instance Uhuru Park and city of Nairobi National Park which are accessible to city dwellers.

2 CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

This chapter is very significant for this study in that, it reviewed and obtained vital information from previous research works that studied the adoption and maintenance of GRs as part of the urban green spaces at global, regional and local levels. Consequently, this information was collected for the sole purpose of identifying gaps which this study occupied. The literature review helped to note and identify the various studies on the adoption and maintenance of green (vegetated) roofs globally. Moreover, this section contains sub-sections that are relevant to the global comprehension of the adoption and maintenance of green (vegetated) roofs

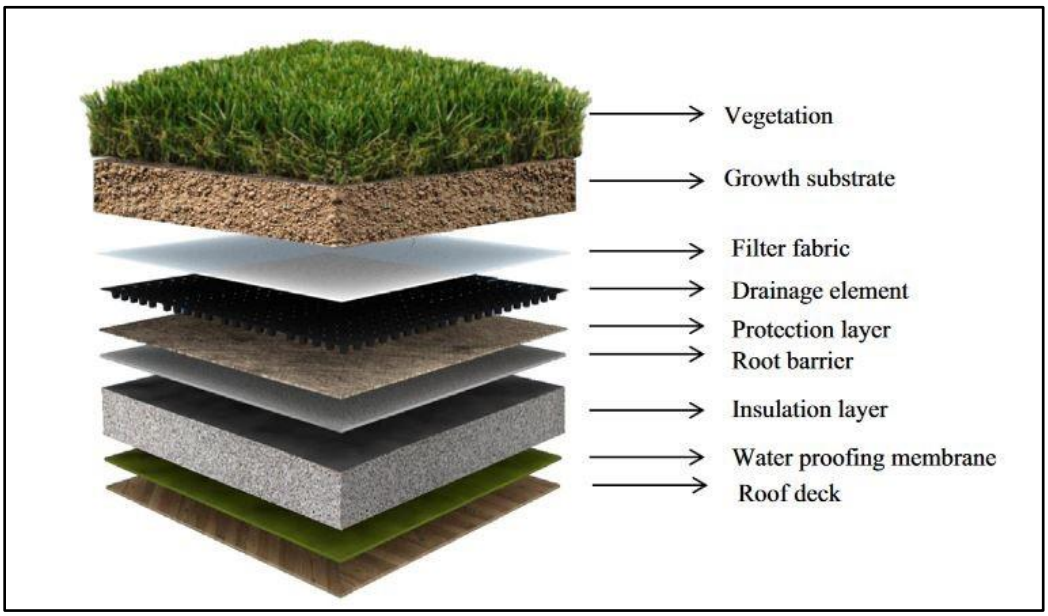
2.2 CONCEPT OF A GREEN ROOF (GR)

GRs refer to the vegetation layer constructed and structurally amalgamated above, at, or below grades on tops of artificial buildings like podium deck, at the topmost level, at the middle floor level, or of the artificial structures like building as shown in figure 1 below (Derek, 2007; Sailor, 2008; Berndtsson, 2010). There are various terms used to refer to the GRs; green roof infrastructure, brown rooftop, Eco roof, living roof, and bio rooftop (Rahman et al., 2012; Mathey et al., 2011; Hien et al., 2007). Generally, a GR is a roof covered with vegetation and can take different forms and shapes (Cantor, 2008).

For this research, a GR referred to a conventional roof, either sloping or flat, that is fully or partially modified with to have a layer that can support vegetation at the topmost roof (Bass, 2007). It is important to know that the said vegetation is not on the real ground (Derek, 2007). Although free-standing trees on the balcony of top of the roof aim to provide a practical solution to increase green

areas in urban centers, this has been rejected by the international landscape because they are not joined with the roof structure. The type of the GRs is determined by the choices of the buildings' owner. A GR can also be formed by a Series of trays with vegetation on top of a roof. It is important to note that not every rooftop is a good site for green roofing; for instance, exposed galvanized metal roof that is not coated is not appropriate for green roofing (Clark et al., .2008).

Figure 1 Typical Green (Vegetated) roof layout



Source: 1http://www.buildup.eu/sites/default/files/t2.jpg

The modern GRs originated from the ancient roof gardens (Magill et al. 2011, Oberndorfer et al., 2007). The Semiramis' hanging gardens were the earliest forms of roof gardens found in the current Syria (Peck, 2002; Magill et al., 2011). During the middle ages, the roof gardens were found in houses of the Benedictine monks and the high-class people. Today, many people have adopted GRs in places of residence, commercial buildings, resorts, and hotels (Gutter & Rowe, 2006; Köhler, 2003). According to FLL (2002), the first interdisciplinary study providing guidelines

technical guidelines on green roof technology was published by the Landscape, Research, Development, and Construction Society in 1982. Currently, various urban set ups have defined and put forward various green (vegetated) roof laws which the urban developers must follow (Köhler & Keeley, 2005).

2.3 NATURE AND TYPE OF GRs

2.3.1 Adoption of green (vegetated) roofs and climatic conditions

GRs can be adopted in various geographical climates (Semaan & Pearce, 2016; Ascione et al., 2013). German has a rich history of GRs, but currently, many planners, urban experts, and policy makers from different climatic regions have gained interests in GRs (Köhler & Poll, 2010). Different nations with diverse climatic conditions have implemented GRs (Berardi et al., 2014; Berardi, 2016). GRs have been a solution to many urban problems such as the unexpected poor quality of urban air, severe incidents of weather, and excess urban heat within different climatic regions (Fioretti et al., 2010). An analysis of the effects of climate in New York City indicates that GRs could reduce the temperature of surface air in the city by 0.40C to 0.70C (Gaffin, 2009). GRs are used to reduce and manage urban floods especially in the urban areas that receive high rainfall. For instance, in 2004, the Chicago city council could not regulate rainwater drainage; they requested architects from the private sector to chip in with GRs (Rosenzweig, 2009).

GRs also moderate temperatures in the buildings where they are built (Gaffin, 2009; Niachou, 2009). The efficiency of heat insulation in GRs is important for the houses with no or little insulation. Cooling and heating rates in buildings with GRs are low irrespective of insulation materials used. Experiments done in Hong Kong by Peng & Jim, (2015) and in Singapore by Li

& Norford, (2016) indicate that green roofing is advantageous in hot Tropical Regions for they help in temperature regulations.

2.3.2 Structure of Green (Vegetated) Roofs

F. L. L, (2008) has given the main features of the structure of a green roof. A green (Vegetated) roof is made up of the following building materials and layers; Substrate layer or the Vegetation Layer- made of topsoil or any other growing medium that can make structural habitat for a green plant. This layer should have the capacity to hold water and provide nutrients to the plants (Bass & Baskaran 2003). Filter Layer made of geotextiles, polypropylene, or polyester materials. It allows movement of water but holds small particles that can block pores of the drainage membrane. Drainage Layer maintains the equilibrium of water and air within the GR structure. It also recreates natural growing conditions for water absorption in the green roof structure. It also allows excess water to flow and ensure proper aeration in the roots. Protection Layer of the GR is normally made up of polyester or polypropylene membrane geo membranes. It protects the layers at the bottom, especially the waterproofing layer. As indicated in the photo 1 below, Waterproofing Layer and Root Barrier Layers which are membranes protecting roots and water from penetrating to the structure or building under the green roof. Common materials used in the layer include reinforced mineral granules, fiber glass, bitumen, or PVC membranes (Cascone, 2019; Tolderlund & Drainage, 2010).

Photo 1 A Green Roof Model

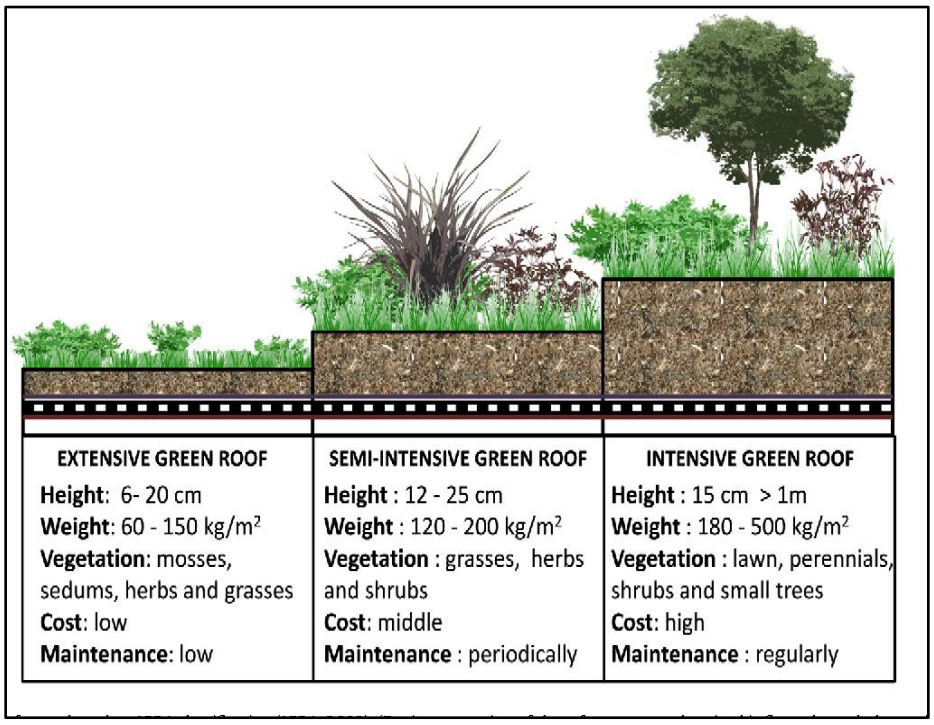
Source; Fieldwork, 2020

2.3.3 Categories of green (vegetated) roofs

There are three categories of green roofs; extensive, intensive, and semi-intensive GRs (Bianchini & Hewage 2012; Yang et al., 2008; Madre et al., 2013). Figure 2 (below) presents the three types of GRs and their characteristics. The type of GR to be adopted is determined by the conventional roof of the building on which the GR is to be installed on (Wong et al., 2003). The Semi-intensive green roofs (SGRs) usually support a variety of vegetation and thus needs a deeper soil layer (Bianchini & Hewage, 2012). For the extensive green roofs (EGRs), they have a shallow media depths and usually vegetated sedum or native grasses that are drought tolerant. The intensive green roofs (IGRs) have a larger media depth for the deeper root structures and plants like shrubs can survive. Owing to the high-water storage capability of the IGFs, there is no need for drought resistant vegetation plants. The cost, maintenance, labor, and the load holding capacity of the green

roofs do vary both in the IGRs and the EGRs. The extensive green roofs provide almost the same functions that the conventional green spaces do as opposed to the extensive and semi-extensive green roofs, (see figure 2) for pictorial representation.

Figure 2 Green (vegetated) roof categorization



Source; https://www.buildup.eu/en/learn/ask-the-experts/which-are-different-types-green-roofs

2.3.4 Common green (vegetated) roof vegetation

The vegetation used on different GRs vary greatly (Banting et al., 2005; Nagase & Dunnett, 2010; Nagase & Dunnett, 2011). The success of the GRs is determined by the choice of the plants selected. The chosen plants should fit the type of GR available. Furthermore, the plant preference to GR is affected by the type of climate in an area (Vanuytrecht et al., 2014). The GR plants must be managed and watered, but it is advisable to grow low maintenance and resilient vegetation that can survive on rain-fed water (Vijayaraghavan, 2016; Dunnett, 2006). According to Oberndorfer

et al., (2007), some plant species cannot survive on GRs because of the extreme temperatures, high light intensities, and high speeds of winds on the rooftops. Therefore, different plants will suit different GRs (Dunnett & Kingsbury, 2004). Drought resistant plants with fibrous roots and rapid growth are suitable for extensive GRs. Succulents can survive under incredibly low supply of water and can withstand harsh climatic conditions, making them appropriate plants for extensive GRs (Nurmi et al., 2013). The IGRs can have unlimited types of plants both deep and shallow rooted (Dunnett & Kingsbury, 2004).

2.4 PERCEPTIONS ON THE MAINTENANCE AND ADOPTION OF GRS (TECHNOLOGY, COSTS, MAINTENANCE, AND INSTALLATION)

2.4.1 Empirical studies done on GR perceptions

Few scholars have conducted studies to evaluate how urban dwellers perceive GRs (Cañero et al., 2013). Therefore, it is not out of time to look at how people living in the city of Nairobi view the aspect of GRs. Different people have different notions of GRs (Hossain et al., 2019). Urban residents in the private sector view GRs as a burden to them as it is accompanied by maintenance and installation costs (Wong et al., 2010). For instance, in Singapore, the cost of installing and maintaining GRs has gone down (Li et al., 2019). This has led to an increase in the adoption of GRs in both Singapore and Malaysia (Li et al., 2019; Rahman et al., 2015). Globally, researchers argue that green infrastructure like urban forests, community gardens, and city parks have a positive impact on the natural, economic, and social, facets of current cities (Wolch et al., 2014; Young, 2011). Some scholars argue that the concrete developments caused by cities' growth have reduced the worldwide green spaces in urban centers (Byomkesh et al., 2012; Li et al., 2019; Rahman et al., 2015). Based on the noted advantages of GRs, there is no doubt that an increase in

GRs will lead to increased greenery (Braaker et al., 2017). However, these advantages can only be achieved if the urban residents have the knowledge and are aware of GRs (Rahman et al., 2015).

Wong and Yuen (2005) noted that increased awareness has led to the adoption of GRs in high-rise buildings in Singapore. Highly educated residents in Malaysia understand GRs better and know their benefits and that has led to increased demand and adoption of the GRs (Rahman et al., 2015; Taib & Abdullah, 2012).

There has been a notion on GR adopters that Native type of vegetation is the best and would grow to greater heights. This perception was found to be very simplistic and unscientific by Butler et al., (2012) who studied the future of selected GRs in the USA and provided tangible evidence on the perception that native vegetation was not quite favorable and that would grow taller than other types of plants.

Globally, urban residents have varied thoughts on the barriers that challenge wide range adoption of GRs in the cities. A study by Everett and Lamond, (2019) on the attitudes and perceptions of GRs by the occupants of the CBD at Newcastle, the United Kingdom, attempted to compare and explore the opinions of the people occupying the CBD; both those with and without GRs. The study aimed to use the opinions of the respondents to identify the barriers on the adoption of GRs in the city if Newcastle. Everett and Lamond, (2019) found out that most of the GR owners, their attitude towards GRs was highly positive and those respondents never regretted adopting the GRs. Further, Everett and Lamond, (2019) noted that despite the higher costs of having GRs, the GR owners overlooked that and instead had a strong perspective on the benefits of having GRs. In contrast, the occupants of the Newcastle's CBD who had no GRs as revealed by the study of Everett and Lamond, (2019), were concerned about the cost of adopting GRs. The high cost was a great barrier to having a GR as revealed by the study. The study further found out that the residents

who had no GRs were not aware of the cost of having a GR, in fact they made assumptions that GRs were costly and also they did not understand how the high costs would be weighed by the benefits of GRs. The study also noted that due to lack of awareness and knowledge, the respondents were not able to know how the GRs would not be a risk to the rooftop. According Juric, (2016) who did a similar study but, in the USA, found out that the urban resident of Temecula city recognized the environmental, and socioeconomic benefits of GRs.

2.4.2 Green (Vegetated) cost-benefit & savings perceptions

The main purpose of GRs and their relationship with the building are key to the architectural goals of the building. The type of GR to be established is dictated by the purpose, aesthetic appeal, environmental concerns, and the load power of the building (Oberndorfer et al., 2007; Getter & Rowe, 2006). According to Dunnett & Nolan (2002), the vegetation in GRs needs to be maintained regularly by pruning, replanting, watering, fertilization, and weeding. The installation and maintenance costs of GRs are always high (Ascione et al., 2013; Teotónio et al., 2018; William et al., 2016). As the green roof industry grows, installation and maintenance costs are expected to go down. Running a GR in the private sector may not be cost-effective, but where social benefits are incorporated, business and multi-family green roofs are efficient (Blackhurst et al., 2010).

The maintenance and installation price of green roofs exceed that of the establishment of traditional roofs by approximately 30-60% (Worden et al., 2004). Therefore, it is significant to ensure that developers are aware of the anticipated advantages of GRs (Banting et al., 2005; Castleton et al., 2010). Quantification of the rewards of nature to the green roof can be done but assigning a monetary value to it is a challenge. These rewards include the aesthetic beauty of the green roof, and the well-being of the people occupying the structure (Ngan, 2004; Radić et al., 2019). In most cases, rewards that are not easy to evaluate numerically are considered useless. To increase the

accuracy in examining cost-benefits evaluations of GRs, scholars should establish techniques of measuring benefits associated with GRs (Liu et al., 2016).

2.5 EXISTING POLICIES, PLANNING GUIDELINES, REGULATIONS, AND LAWS THAT DISCOURAGE OR ENCOURAGE MAINTENANCE AND ADOPTION OF GRs

2.5.1 Empirical studies done on GR policies

The planning guidelines, strategies, laws, and policies related to GRs aim to optimize the overall advantages of GRs (Ngan, 2004; McGuire et al., 2013). Most of the urban areas in the world have policies related to the maintenance and adoption of their GRs (Carter & Fowler, 2008). According to Ngan (2014), for a long time in Canada, the installation of GRs was a voluntary exercise. In Germany, the increased adoption of GRs can be associated to the polices that championed for GRs by making the citizens aware of the pros of having GRs (Landskron, 1998; Shafique et al., 2018). In Tokyo, flat roofs must have GRs (Trépanier et al., 2009; Carter & Fowler, 2008), unfortunately most of the residents have been avoiding building flat roofs to avoid the extra cost of establishing GRs (Theodosiou, 2009). In her thesis, Miller, (2008) discussed different planning tools and innovative policies used by cities to encourage GRs adoption among the city dwellers while Forbes, (2010) evaluated the municipal planning that encourages the adoption of GRs.

2.5.2 Some examples of global GR laws & policies that facilitate adoption of GRs

The aim of the GR guidelines, according to Breuning and Yanders, (2008) is to set out the basic criteria and principles that generally apply to the planning, implementation, and maintenance of innovative urban green technologies. Green roof policies involve extra basic principles related to the construction and planning of properties. The policies pay special attention to the technical requirements of vegetation and construction (Mees et al., 2013). The global adoption of GRs

reveals different legal frameworks that change from one city to another; in some cities, it is compulsory while in others, it is a voluntary development exercise (Hendricks & Calkins, 2006; Mees et al., 2013). The tables 1 to 6 give the different mechanisms used by different cities in the world to promote and champion for the adoption of GRs. The tables (1-6) do not exhaust the mechanisms used globally to enhance adoption of GRs, but they give various examples used in developed cities from which the city of Nairobi can borrow from. Six categories of policies are separately discussed below (Liberalesso et al., 2020).

Storm water reduction charges: some urban centers, those who install GRs are rewarded with vouchers in the instead of having them pay for the sewages (Shafique et al., 2018; Grant, 2018).

Zoning incentives- some cities in the world give floor area ratio and density rewards to builders and adopters GRs (Duerksen, 2008; Liptan, 2003; Cutlip, 2006).

Refunds, tax abatements, and rebates- some cities offer reimbursements or tax incentives to people who implement green roofing (Spiegel-Feld & Sherman, 2017; James & Metternicht, 2013).

Grant and loan programs- some cities offer full or partial financing in the form of grants or loans to the citizens to establish GRs (Grant, 2018).

GR mandates- there are situations where green roofing is needed, for instance, when an existing structure undergoes key renovations or a new structure is being put up (Freund, 2018).

GR Sustainability mandates- in some cities, green roofing should comply with the environmental policies or general green building but does not demand green roofing explicitly (Cutlip, 2006).

The study is not aimed at criticizing, judging, or giving merits or demerits of any policy adopted in other cities but to shed light on how green roofing is being done globally and how the city of Nairobi city can localize it. These tables can be used as a guiding tool for city planners in Nairobi.

Table 1:Some of Worldwide GR Mandates

City and country	Name of legislation	Year Degreed.	Implementation requirements
Basel, Switzerland	Building and Construction Law	2002	Most of the modern rooftops and refurbished flats should have GRs.
Copenhagen, Denmark	GR Policy	2010	New buildings with less than 300 roof slopes should have GRs.
France (nationwide)	Biodiversity Act and Green Roof Statement	2015	Either GRs should be adopted by the buildings.
Munich, Germany	GR Ordinance	1997	All The roofs exceeding 100 km2, must have GRs.

Source: Researcher, 2020

Table 2: Some of the GR Sustainability Mandates

City and country	Name of legislation	Year Degreed	Implementation requirements
Chicago, USA.	Sustainable Development Policy	2004	Construction projects that seek financial assistance or unique exceptions to reach given levels should be granted based on the execution of the special measures in the surrounding, including GRs.
Denver, CO	Green Buildings Ordinance	2018	All buildings with 225,000f2 and above should have either solar panels or GRs.

Source: Researcher, 2020

Table 3; Enacted Refunds, Rebates &Tax Abatements on GRs

City and country	Title of legislation	Year decreed	Implementation requirements
Hamburg, Germany	GR Strategy	--	Owners of buildings can get up to 60%subsidies to cover the installation cost of GRs.
Palo Alto, CA	GR Rebate	2008	Gives $1.50/f2 for any installed GR. This amount cannot exceed $10,000 for commercial structures and $1,000 for residential structures.
Washington, DC	River Smart Rooftops Green Roofs Rebate Program	2006	The faculty of energy and environment in Washington gives rebates to those installing GRs voluntarily- $10/f2 if the GR lies within the collective sewer system and $15/f2 if it is in the civic storm sewer system.

Source: Researcher, 2020

Table 4; Incentives through zoning programs

City and country	Title of legislation	Year decreed	Implementation requirements
Chicago, IL	FAR Bonus	2015	An advantage of up to 2 FAR given for GRs. occupying more than half, or 2000 f2, of the total area of the roof.
Philadelphia, PA	FAR Bonus	--	The FAR advantage is given to housing GRs., and "green buildings," can be termed so according to GRs.

Source: Researcher, 2020

Table 5; Loans and Grants programs

City and country	Title of legislation	Year decreed	Implementation requirements
Basel, Switzerland	GR Installation Subsidies	1996–1997 2005–2006	Basel had long term long motivation programs; the two projects gave endowments to green rooftop establishments.
Chicago, IL	GR Grant Program	2005	The Department of Environment gives private and little business building proprietors $5,000 for green rooftop establishments
Cincinnati, OH	GR Loan Program	2011	Suggests low-intrigue credits for green rooftop plans and development for the existing and new structures.

Source: Researcher, 2020

Table 6: Reduction in Storm-water Charge

City and country	Title of legislation	Year decreed	Implementation requirements
Washington, DC	Storm-water Fee Discount Program	2013	A waiver of not less than 55% of the tempest water expense for ecological administration works on, structures, including GRs.
Portland, OR	Storm-water Discount Program	2006	Properties will win up to a 100 percent rebate on rising water administration costs when receiving stormwater, the board systems, for example, green roof
Minneapolis, MN	Storm-water Utility Fee Credit	2005	Structures who join storm-water procedures, including the development of green rooftops, acquire up to 50 percent credit against their storm-water administration instalments for hardware who improve the state of storm-water, and somewhere in the range of half and full credit for gear that tackles storm-water.

Source: Researcher, 2020

2.5.3 GRs and building standards

GR policies and regulations align with the building standards of a city (Ngan, 2004). GRs have exceptional benefits to the urbanites both in developed and developing cities. The economic effect of GRs can be understood better if people accept the variations in the codes and requirements existing in green roofing systems to integrate vegetation (Wark, & Wark, 2003). Germany has established detailed standards and specifications for the installation and maintenance of GRs (Philippi, 2005; Ngan, 2004). In the development policies and prerequisites for green roofs, assessment, and implementation of GRs has been effective (Reichmann, 2003; Wark, & Wark, 2003). The world is yet to agree on the global standard policies for the adoption and maintenance of GRs.

2.6 STRATEGIES AND PRACTICES THAT CAN BE PURSUED IN THE PROMOTION OF GREEN (VEGETATED) ROOFS ADOPTION AND MAINTENANCE

2.6.1 Empirical studies on how GRs adoptions can be promoted

The adoption of GRs is faced with a myriad of barriers. To overcome that, there is need to encourage urban residents using various mechanisms. Studies have been carried out to see how the adoption of GRs could be promoted to increase the number of GRs in various cities. In 2019, Burszta-Adamiak & Fiałkiewicz did a review of incentives that could be used to promote adoption of GRs in the cities of Europe. They found out that the cities that had incentives introduced to the adopters of GRs had seen more realization of GRs (see table 1-6 for some examples) as compared to the cities that had no incentives to motivate the urban people are wished to have GRs. Further, Burszta-Adamiak & Fiałkiewicz, (2019) found out that city authorities had mechanisms that would see them implement various forms of incentives to the urban residents. A similar study was done

by Keeley, (2004) who studied the incentives (see table 1-6) that Europe had used to promote the massive adoption of GRs in their cities. Keeley, (2004) found out that there were various programs enacted by the governments that provided subsidies to the adopters of GRs. Additionally, Keeley, (2004) noted that the several authorities had worked out various reasonable tax reliefs and restructured their GR fees that made it comfortable for various developers to adopt GRs. The study also found out that the European cities had strong GR policy tools that supported and promoted the adoption of the GRs.

In Taiwan, Shiah, (2011) did a study that aimed at designing various strategies which city municipalities could use to upscale the rate GR adoption in their cities. Shaih, (2011) used the examples of existing strategies from other successful municipalities to develop a strategic framework that can be used to promote GRs. Another similar study was done by Chen et al., (2019) who critically looked at the factors that discouraged adoption of GRs in various cities in China. Chen et al., (2019) found out that the costs of both in GR adoption and management were extremely high and that discouraged urban people from adopting GRs. Also, the cost to have the GR designs was quite expensive and that further demotivated urban developers from installing GRs. Additionally, Chen et al., (2019) noted that the urban China lacked incentives that would motivate city developers to adopt GRs. The lack of incentives has also been noted by studies done in by Keeley, (2004) and Burszta-Adamiak & Fiałkiewicz, (2019).

The recommendations made by Chen et al., (2019) to the authorities included the provision of favorable policies on GRs that the city developers would reduce on the costs; on design, adoption and in management of the GRs. In Nigeria, Ezema, et al., (2015) studied the opportunities that come with GRs and the obstacles to the implementation of GRs in Lagos. Ezema et al., (2015) noted that GRs had the potential to increase UGS for the rapidly urbanizing City of Lagos. The

findings of Ezema et al., (2015) on high cost of adopting and managing GRs as vital reason why city developers do not take into consideration GRs into their properties aligns with those of Shiah, (2011), Chen et al., (2019), Keeley, (2004) and Burszta-Adamiak & Fiałkiewicz, (2019). Lack of government support and unavailability of incentives, lack of awareness and knowledge of GRs were found by Ezema et al., (2015) as additional obstacles and drawbacks to the fast adoption of GRs in city of Lagos.

2.6.2 Further Discussions on Obstacles to GR adoption that call for incentives

Despite the increased awareness and knowledge on the importance of GRs, little is documented on the GR adoption barriers (Hendricks & Calkins, 2006). There are, however, several hurdles that should be addressed (Ngan, 2004) that have discouraged both developed and undeveloped cities from embracing GRs globally (Chan et al., 2018). Despite the global endorsement of GRs in the building sector to solve urban environmental issues, the adoption of GRs is still faced by obstacles (Chan et al., 2018). A detailed study is important in identifying and discussing the obstacles to implement GRs (; Chen et al., 2019; Zhang et al. 2012).

The cost of adopting GRs per square decrease with the increase in the size of the GR (Nurmi et al., 2016). The assessment of GRs cost-benefit needs to be done project-by-project. The implications of the whole life cycle should also be considered in the cost of the project. A roof covered with gravel needs repair or replacement after 25 years, while the membrane of a GR can take 40-50 years without repair (Krupka, 2001; Nurmi et al., 2016). In GRs, repair work includes identifying leakages, monitoring degraded medium, spreading, and collecting the cuttings, and weeding. Developers and owners of buildings are encouraged by cost-benefit assessments to install GRs. Green roof repairs result from faulty workmanship, design, or poor maintenance of the GR. Developers and owners should be careful at all stages of adoption and maintenance of GRs. The

layers of GRs require highly technical knowledge to make them different from normal roofs (Ismail et al., 2012). With advanced technology, instruments have been developed to detect leakages using electro-impulse (Edwards et al., 2014).

2.7 THEORETICAL FRAMEWORK

This paper is based on four theories related to GR adoption and maintenance as part of UGS: The Garden City Theory, The Eco City Theory, Unified Theory of Urban Living and Diffusion of Innovations Theory.

2.7.1 Garden City Theory (GCT)

In 1898, Ebenezer Howard (Sir) coined the garden city concept (Howard, 1946) to solve various urbanization challenges the cities in London were facing. In his publication, Howard called the situation of the then urbanizing London as 'Unhealthy Cities' and then thought of bringing into context the idea of 'health Cities' through the GCT through which he aimed at having an ordered urban area with good quality environment. Overtime, continuous heated criticisms, and series of debates have happened regarding the GCT. Despite several urban plans and projects incorporating this theory in their practices globally, there is no city up to date that has truly captured into realization the GCT (Zhao, 2012; Gang, 2006). Mostly, the GCT is perceived as a task of having rural characteristics to the urban set ups. It was envisioned that the city could have 'rural space' into the city such as there is interactions of agricultural activities, transport, urban housing, and manufacturing activities.

2.7.1.1 Relevance of the Garden City Theory to this study

Due to urbanization, the contemporary urban areas especially in less developed economies are experiencing unhealthy chaos as put forward by Howard, (1946). Nairobi needs restructuring

especially in terms of UGS. The rapidly urbanizing city of Nairobi has led to loss of UGS which has rendered the urban residents into multiple urban challenges including climate change, urban heat. The GCT, being founded on the pillar of quality environment, this study found it perfectly accurate to guide it. The reduced UGS should be talked using innovative mechanisms such as the adoption of GRs in the city of Nairobi City. GRs could be used to bring back the quality environment as advocated by Howard, (1946). In terms as agriculture in the cities as proposed by Howard, (1946) GRs have been found to be potential grounds to do urban agriculture (Oberndorfer, et al., 2007; Whittinghill & Rowe, 2012)

2.7.2 The Eco City Theory (ECT)

Richard Register, the founder of Eco city Builders, came up with the idea of Eco-City in 1975 (Zhou, 2013; Wong & Yuen, 2011). ECT advocates that the urban designs and plans should include an ecological perspective in their activities. The proponents of ECT sees the need for urban areas to coexist in balance with the environment whereby the cities have to be treated as ecosystems with a continuous flow of activities and resources and which need to be managed so as to maintain good quality of Urban environment (MAJiao-guo, 2004). The eco-city has to be designed, while keeping in mind the ecological, social and economic needs with aim of reducing urban problems such as air pollution, urban heats, loss of UGS, reduced energy urban consumption etc. for a liveable urban environment to be created (Zhou et al., 2015; Zhou, 2013).

2.7.2.1 Relevance of the Eco City Theory to This Study

Urbanization has led to diversified patterns of consumption that differs greatly from the pre-industrial era. Contemporary cities are characterized by high levels of consumption and production because the modern-day urban needs are complex than last century cities which has led to a series of urban environmental problems that need to be addressed. The eco city theory gives suggestions

on how to have urbanization, yet in harmony with environment. GRs are part of the UGS that can be used to promote the Eco city ideology.

GRs are used as habitats for various urban biodiversity which the eco city advocates for. Adoption of the GRs in the city of Nairobi is mostly based on the objectives and purpose and most often the decisions are made by the owners of the building. For commercial buildings with GRs, workers at the top floor would enjoy natural breakouts similarly to those on the ground floor. In addition to that, the employers wished to have a place for their clients and employees where they could relax, chit chat with each other, brainstorm and share ideas and for psychological benefits. Mesimäki et al., (2019) who investigated the possibility of small GRs on offering experiential and recreational benefits in Helsinki, Finland confirmed the use GRs just as the Eco city aims to have same benefits.

2.7.3 A Unified Theory of Urban Living (UTUL)

This theory was developed by Prof. Geoffrey West (Bettencourt & West, 2010). He notes that the various urban challenges such as the ill health of the Urban areas, urban pollution, poor urban energies, negative impacts on urban environment, climate and global warming and urban diseases as all originating from the city. Further, Prof. West points out that innovativeness and creativity originates from the urban areas and this leads to creation of wealth and progress economic prosperity. He sees the urban set ups as large organism that depends on people's knowledge and goods. For Prof West, the contemporary rapid growth of urban areas and massive economic progress in the cities has led to consequences that are undesirable to the city where man is supposed to tackle such challenges with his knowledge and innovativeness. He recommends that urban policies whether in developing or developed cities should be cautiously designed to have a predicative and integrative city.

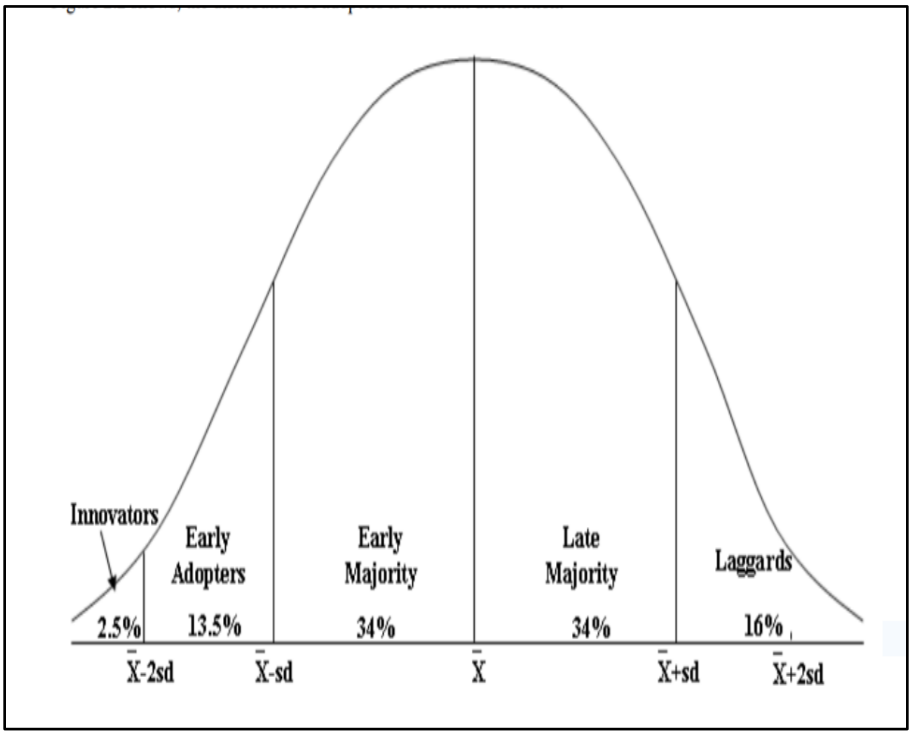
2.7.3.1 Relevance of Unified Theory of Urban living to the study

GRs are innovative green strategies that the urban residents have come up with to solve the declining urban green spaces. Urban challenges that such as climate changes, urban floods, air pollution, urban heat Islands that GRs can tackle are the undesirable consequences that Prof. West (Bettencourt & West, 2010) noted as ills that emanate from the urban areas. Most buildings within the city of Nairobi lack places for recreational purposes (Mbatia, 2016) which calls for innovative way to have such facilities. As suggested by this theory, cities are the cradle of innovation and creativity and thus GRs are the solution provided to the city of Nairobi. Advantages of the urban green infrastructure are contrasted against known implementation challenges thus presenting a focus for innovation and research to support the establishment of urban green infrastructure and maximize benefits. There have been length discussions on the use of GRs to ensure air quality control and noise insulation (Rowe, 2011; Van Renterghem & Botteldooren, 2011).

2.7.4 Diffusion of Innovations Theory (DIT)

This theory was established by Rodgers in 1962 (Udayan 2018; Minishi-Majanja & Kiplang'at, 2005; Smerecnik & Andersen, 2011; Dearing & Cox, 2018). According to Rodger (1995), innovation is an object, practice, or an ideal that a unit of adoption or an individual perceives new. Individuals adopt ideas differently, and new ideas can be adopted if they seem to benefit the existing ones (Rodgers, 2000). Innovators from European countries like Germany were the first individuals to adopt GRs (Magill et al., 2011). The idea of GRs then moved to other nations in the world where the adoption is being done at varying rates (Jim, 2017). In Africa, the GRs idea is still new at 16%, Asia is at 34%, North America 13.5%, and the whole of America at 34% (see figure 3)

Figure 3; Adopter categorization based on innovativeness



Source; Rogers, (2003)

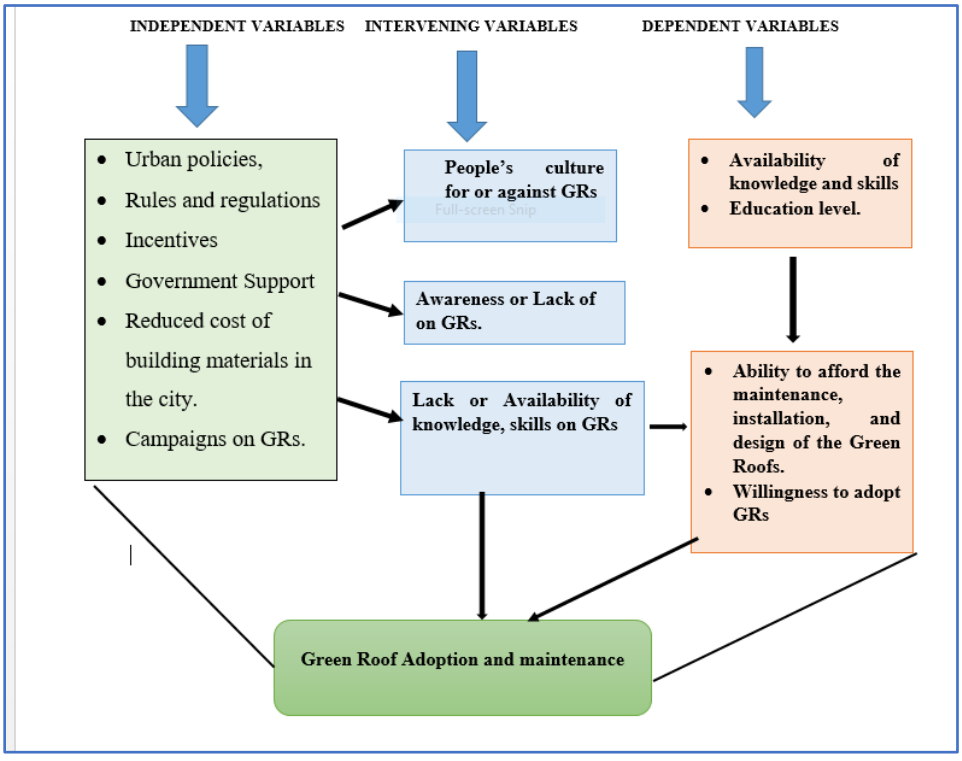
2.7.4.1 Relevance of the Diffusion of Innovations Theory to the Study

GRs are very new to the developing cities. The idea of GRs can be traced back to the European cities. The modern GRs originate from roof gardens (Magill et al. 2011, Oberndorfer et al., 2007). The Semiramis' hanging gardens were the first roof gardens found in current Syria (Peck, 2002). Modern vegetative roof technology first emerged in German in the 20th century. This technology aimed at introducing vegetation of rooftops to curb the adverse effects of solar radiation on the roofs (Magill et al., 2011). According to Köhler (2003), these GRs were also used fire retardant structures. Currently, there are different complicated styles of GRs made of different materials,

but they have similar functions. During the middle ages, the roof gardens were found in houses of the Benedictine monks and the high-class people. Today, many people have been adopted GRs in places of residence, commercial buildings, resorts, and hotels (Gutter & Rowe, 2006). Between the 1600s and 1800, Norwegian rooftops were covered with soil then grass planted to increase stability. Some American settlers in Great Palins borrowed this idea to make some of the early GRs (Osbundson, 1999). This idea has diffused to the rest of the world at different rates (see figure 3). The absorption of the idea differs greatly from on region to another. The city of Nairobi, being a developing urban area, the idea is not well taken and thus the city is at the laggard's stage as shown in figure 3.

2.8 THE CONCEPTUAL FRAMEWORK

Figure 4; Conceptual Framework



Source: Researcher, 2020

In this research, the conceptual framework (figure 4) links three variables; the dependent, independent, and intervening variables. Adopting GRs is the dependent variable. It is indicated by the availability of knowledge and skills, maintenance, installation, and design. Independent variables include urban policies, rules and regulations, incentives, and installation and maintenance cost of adopting GRs in city of Nairobi. The main intervening variables include knowledge, skills, culture, and awareness of GRs. Adopting GRs depend on the developer's willingness, policies for or against the technology, installation cost, and design of the structure. However, lack of legal documents, social-cultural factors, inadequate knowledge, and skills on green roofs, little or no economic returns, and installation and maintenance cost discourage the adoption of GRs

2.9 RESEARCH GAPS

Various research findings indicate that perhaps the implementation of GRs depends on multiple factors, including legal support, municipality subsidies and incentives. Furthermore, the available literature indicates that GRs in developed cities are extensively implemented. Also, GR adoption faces implementation setbacks not just in developing cities, but also in other developed cities that lack public support and goodwill. Various GR studies have been done worldwide; Zhang et al., (2012) took a gander at the hindrances to the execution of extensive green roofs of frameworks in Hong Kong. Ismail et al. (2012) evaluated the deterrents to the reception of green roofs in Malaysia. Brudermann & Sangkakool, (2017) investigated the vegetative rooftop selection choice elements in European Union; Ezema et al., (2015) looked possibilities for and obstructions to green material in Lagos. Furthermore, the assessed writing uncovered that a large portion of the examinations done on green rooftops around the world have zeroed in on the advantageous functions of green rooftops with more consulates on the metropolitan biodiversity protection of

vegetative roofs. For instance, an investigation done by Köhler and Ksiazek-Mikenas in 2018 in German, attempted to clarify examples of different aspects of life in different green roofs.

A research by the Kadas and Gedge in June 2004 inspected green roof plans to have uncommon types of invertebrates, including honeybees, and bugs in Canada. Studies in Kenya, none has contemplated GRs as an entirety. Past studies have evaluated the possibilities, effects, and employments of green buildings in Nairobi; (Okemwa, 2017; Kariuki et al., 2014; Masu et al., 2012; Muli, 2013; Momanyi, 2018). None of these past studies have looked at the adoption and maintenance of GRs and their related potentials with the city of Nairobi.

3 CHAPTER THREE: METHODOLOGY

3.1 INTRODUCTION

The main objective of this study was to investigate the adoption and maintenance of GRs as part of the UGS. To answer the objectives of this study, this section discusses and presents the research methodological approach that was used. This section outlines the research design used, the criteria used to select the case studies, the data collection methods and the techniques used to analyze the collected data. The chapter opens with a detailed description of the case study distribution area and goes further to discuss the UGS, the future of UGS and the threats that the existing UGS are facing in the city of Nairobi. To realize the intense of the theorical framework (see the previous chapter) of this study, this chapter bring pout the relevance of the used theories through the case studies.

3.2 AN OVERVIEW OF THE CASE STUDY DISTRIBUTION AREA

This study was conducted in the city of Nairobi. The GR case studies were unequally distributed throughout the city of Nairobi and thus the specific areas on which the GRs ware located forms the case study distribution area. The city of Nairobi, Kenya's capital, is located at the central part of Kenya (Foeken & Mwangi, 2000; Owuor & Mbatia, 2008; Omwenga,2010; Mbatia, 2016). Further, the city of Nairobi is in the southern parts of Kenya’s agricultural mainland at an approximate 1° 19’ degrees south of the equator (Mbatia, 2016). Additionally, the city of Nairobi is 480 kilometers away from the Indian Ocean, and at an approximate latitude 1°17’ South and longitude 36° 48’ east of the meridian (Mbatia, 2016). The altitude of city of Nairobi ranges between 1,500 Meters above Sea Level (MASL) in the East and 1,900 MASL in the west. The climate of the city of Nairobi is generally a temperate tropical climate, with hot and dry hours of

the day, and cool mornings and evening which become cold most of the daytime on the months of May to August.

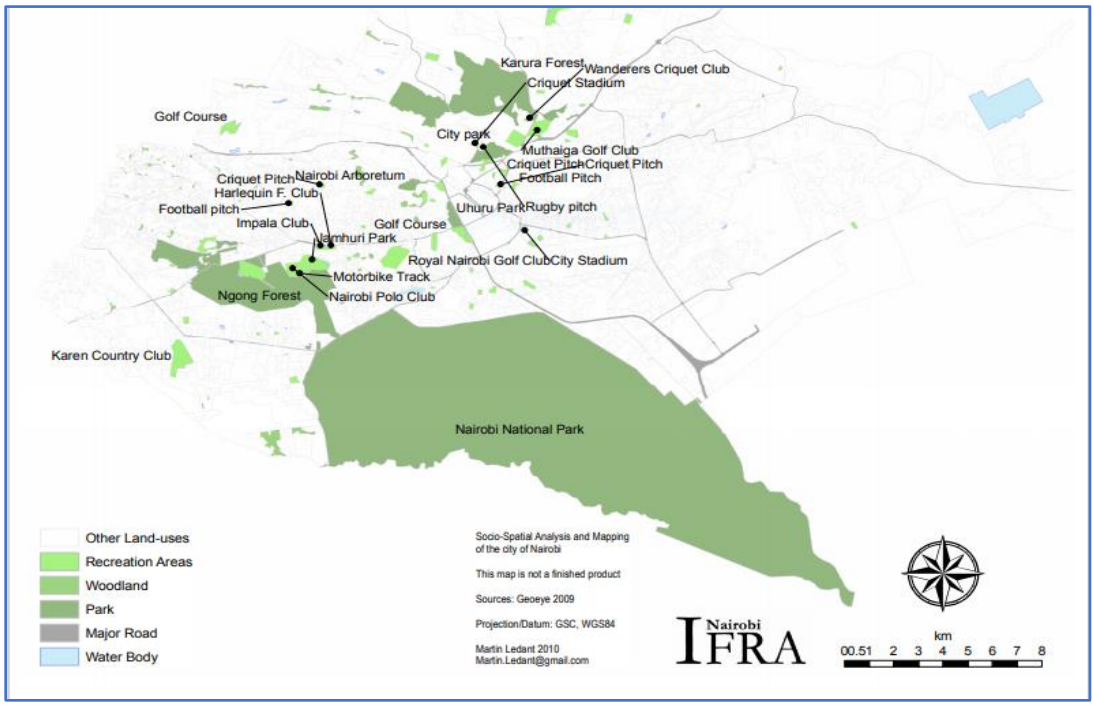
3.2.1 Topography and Climate

Under the Köppen climate classification, the city of Nairobi has a subtropical highland climate (Desert, et al., undated; Gaita, et al., 2016). At 1,795 metres (5,889 ft) above sea level, evenings may be cool, especially in the June/July season, when the temperature can drop to 9 °C (Githugunyi, 2014). The warmest and sunniest times of the year is from March to December especially when the average temperatures average mid-twenties at daytime. The mean maximum temperature for this period is 24 °C (75 °F). The city of Nairobi has two distinct rainy seasons with moderate rainfall. The cloudiest part of the year is just after the first rainy season, when, until September, conditions are usually overcast with drizzle. As the city of Nairobi is situated close to the equator, the differences, there is minimal difference between the dry and wet seasons. The timing of sunrise and sunset varies little throughout the year for the same reason.

3.2.2 Urban Green Spaces in The City of Nairobi (UGS)

According to Mbatia, (2016); M'Ikiugu et al., (2012), the city of Nairobi has various natural urban green space reserves that are not evenly distributed across the city. Map 1 below shows the uneven spatial distribution of the open spaces in the city of Nairobi. Most of UGS are in the western part of the city. The Nairobi county council has devoted about 21 percent (147 sq. km) of the city to the natural green space reserves (Ledant, 2011; Mbatia, 2016). The Nairobi National park is the main natural UGS that consists of a wildlife game reserve and a forest (see Map). Karura and Ngong forest are also natural UGS that have a variety of flora and fauna (Mbatia, 2016).

Map 1; Nairobi UGS Spatial Distribution



Source; (Ledant, 2011; Mbatia, 2016)

Map 1 shows the spatial distribution of UGS across the city of Nairobi. According to Shah & Ayiemba, (2019) the above mentioned UGS contain a variety of biodiversity. The rapidly urbanizing City of Nairobi threatens the urban native (Makworo & Mireri 2011; Mutuga, 2009; Güneralp et al., 2017). The urbanized land of the Nairobi's territory accounts for only 48%. The built area of Nairobi which includes commercial, residential, industrial activities, and institutional land uses is approximately less than half of Nairobi's total land area (Ledant, 2011; Mbatia, 2016). The remaining half of the Nairobi's Land is covered by open spaces either privately or publicly owned. Apart from the Nairobi National Park (NNP) which is the largest open space in Nairobi (Ledant, 2011; Mbatia, 2016) which is located in the savanna region of the city of Nairobi most of the other naturally occurring green spaces are found on the western side of Nairobi where the upper middle class live (Mbatia, 2016).

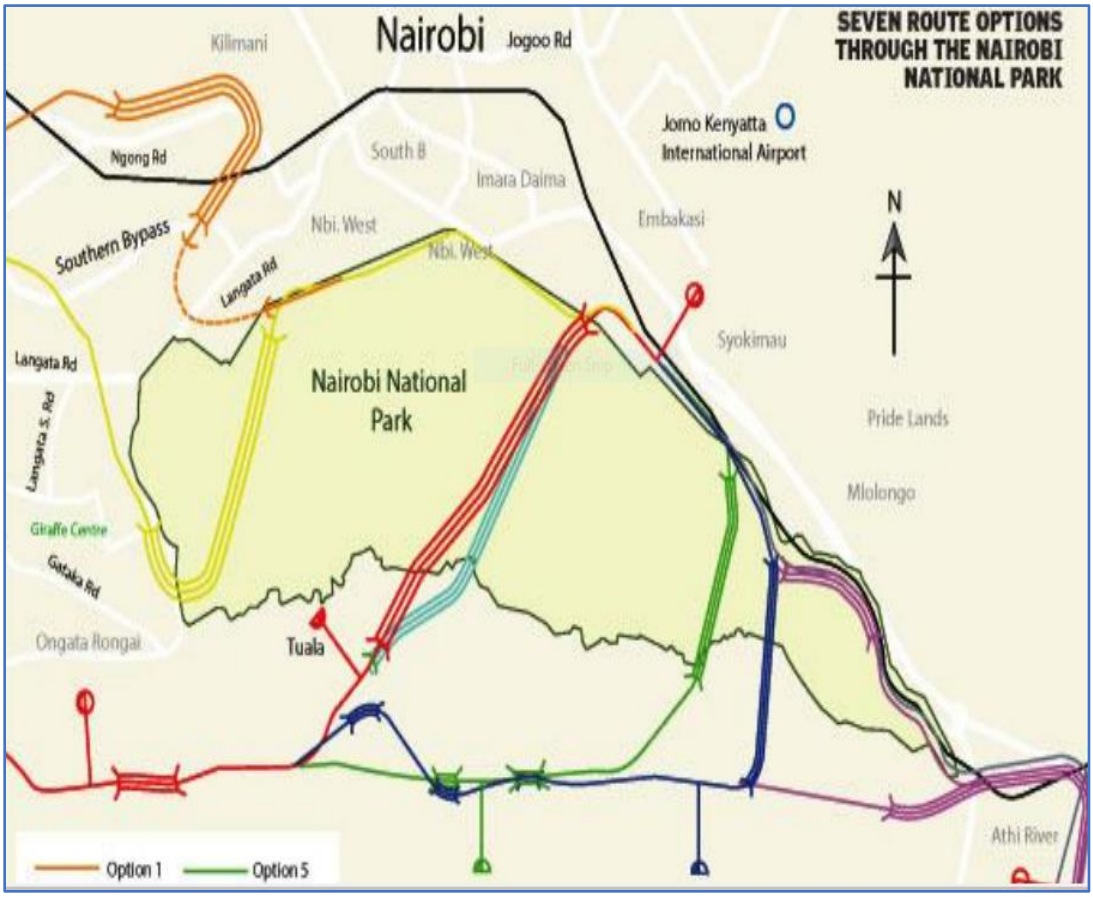
3.2.2.1 CITYWIDE THREATS TO UGS IN CITY OF NAIROBI

Between the years 1990 and 2016, the city of Nairobi lost over 22 percent of its UGS (Makworo & Mireri, 2011; Mbatia, 2016). The rapid rate of urbanization is pressuring the UGS in Nairobi City. Main factors facilitating this include the real estate development, government mega projects, unlawful interferences, and infrastructural growth. Due to the nature of these important natural areas within the capital, Nairobi Capital is commonly regarded as the 'Green City under the Sun' (Owuor & Mbatia, 2008). These UGS (see figure 5) are recently under pressure of construction (Mbatia, 2016).

3.2.2.1.1 The Railway Construction through the Nairobi National Park

Government projects are causing much destruction to the open space within the city of Nairobi. (Mensah, 2014). This can even be seen from the establishment of the Standard Gauge Railway (SGR) that runs through the Nairobi National Park, one of the largest open spaces in the city of Naiorbi (Ambani, 2017; Gitari, 2019). It is expected that Nairobi will end up losing more open spaces due to urbanization. Map 2 shows the proposed SGR railway liner passing through the NNP. The planned routes (Map 2) from Nairobi South Railway Station-Naivasha Industrial Park-Enoosupukia, Narok to the Standard Gauge Railway Scheme are marked by the red line. This an evidence that UGS in Nairobi are under a great threat and thus the introduction of GRs is a revolutionary green technique which can be utilized to minimize potential reductions of UGS.

Map 2; The Alignment of Most Suitable Route Option for the SGR-2A



http://www.nema.go.ke.

3.2.2.1.2 Nairobi Inland Container Depot Access

Road Construction shows the construction activities taking place within the Nairobi National Park. These are the threats that face the future of the UGS. The government major projects are a bigger threat to the future of the UGS in the city of Nairobi (Mbatia, 2016). It is anticipated that an access roadway of 4.153 km that occupies several parts of the Nairobi National Park would run from the Southern Bypass near Wilson Airport. The roadway (Image 1) on the eastern side alters the borders of the Nairobi National Park and meets the Southern Bypass near Wilson Airport. The access road is built to allow use of roughly 4,153 meters in length and 21 meters in width of the

territory of the NNP. These challenges call for creative solutions and it is real that there is a vulnerability to the Nairobi's UGS. Well-standardized green roofs can assist in the restoration of green spaces.

Photo 2: Access Road Through NNP

Source; https://www.the-star.co.ke/counties/nairobi/2020-03-12-road-works-underway-through-nairobi-national-park/

3.2.2.1.3 Jomo Kenyatta International Airport (JKIA)-Westlands Expressway

As noted by Ambani, (2017) and Gitari, (2019) the government projects are threatening the open spaces both the large UGS and the smaller UGS. After the SGR passing through the NNP, the government of Kenya, through the Kenya Roads Authority, have designed road that is intended to cut up to 23 meters from the Uhuru Park as indicated by map 3. The attempts by the Kenyan government to construct the road has severely encountered opposition from the urban residents

and radical environmentalists who believe in the spirit of the famous Late Prof. Wngari Mathai and the green belt movement. Map 3 below shows the proposed KeNHA Project that would have 23 meters hived off from the Uhuru Park.

Photo 3 The proposed KeNHA Project that would have 23 meters hived off from the Uhuru Park

Source; KeNHA

3.2.2.2 NEIGHBORHOOD LEVEL THREATS TO URBAN GREENSPACES IN NAIROBI

(Mbatia, 2016) observes that apart from city wide threats to urban greenspaces mentioned above, several neighborhood challenges to preserving and allocating urban green spaces in Nairobi exist. These include: (1) Corruption and land grabbing whereby many open/ green spaces for public use have been illegally occupied or allocated to well-connected individuals with impunity; (2) Extension of settlement area and encroachment of green space components such as housing

projects which have encroached into urban forests and riverine areas with impunity; (3) Inadequate /Poor Green Space Planning Policies whereby green space provision is merely alluded to rather than made a mandatory component of urban development; (4) Lack of development control and/or implementation of existing policies to guide open space preservation and manage urban development; (5) Market failures in open space allocation whereby developers to build up on every available space to make as much profit as possible at the expense of leaving at least some open spaces for community use and (6) Uneven Distribution of Greenspaces that stems from the colonial urban policies which reserved and protected large nature reserves and parks in the former European colonial areas (present upper and middle class neighborhoods) largely ignoring the African areas which are currently occupied by the low - lower middle income residents of the city.

3.2.3 The Future of Nairobi's UGS

Modern-day urban plans and urbanization are the key determinants of the future of the city of Nairobi. Additionally, this contemporary government plans and projects that are to be implemented before vision 20130 are and would determine the shape and display of city of Nairobi. hence the future of the city of Nairobi is in the hands of the today's city managers, the Nairobi city county government, the National government of Kenya and the residents of the city as well. Mbatia, (2016) noted that the Kenyan Vision 2030 was a roadmap to the future shape and development of Nairobi, which Linehan, (2007) also supports. The Kenya's vision 2030 seeks to achieve good quality life for the citizens, but how will this good quality life be achieved with declining UGS around the city? According to Omwenga, (2010) and Mbatia (2016), the Nairobi Metropolitan Vision 2030 was formed to assist in achievement of the Kenya's Vision 2030. This was aimed at establishing a greater city of Nairobi region. The city of Nairobi's expansion city via urban sprawl is an indication that UGS will be consumed by the horizontal urbanization. The

adoption of GRs in Nairobi is based against these lacunae of urban future needs. As noted by Mbatia, (2016) the Nairobi Metropolitan Strategy aims to balance Nairobi's urbanization with Nature. This possibility of balancing urbanization and nature is questionable with the current rapid urbanization of the city.

3.3 RESEARCH DESIGN; MULTIPLE CASE STUDY (MCS)

Yin (1989) argued that a research design helps to logically deal and analyze a problem. Therefore, it was important to establish a well-designed procedure for the whole research to succeed in understanding the maintenance and adoption of GRs as part of the UGS in the city of Nairobi. An empirical inquiry that involved investigating real-life context phenomenon was also applied in understanding how the few GRs case studies in the city of Nairobi were adopted, installed and how they managed. This research aimed at answering the questions HOW and WHY which could only be answered after a comprehensive study and inquiry of the current existing GRs. The Case Study Research design was chosen for this study. This is because, through case study design, one can analyze and do an in-depth of a situation. When the researcher has intentions of going beyond the rigidity of quantitative studies whereby YES or NO answers are the case, this study chose a qualitative research techniques so as to be able to avoid rigid and mechanical responses during Case study analysis. Mbatia, (2016) observes that qualitative studies help in getting the descriptions and explanations of the phenomena under study which could not be possible in quantitative studies due to the complexities of the quantitative research methods. For this study, the YES and NO responses were not enough to give to the information about GRs as more explanations and descriptions on maintenance and adoption of GRs were needed. Relying on case studies absolutely fitted this research paper. According to Njogu (2016), case study research design can unveil more focused, valuable insights of a phenomenon that may not be known or shallowly

understood. The MCS technique was used for multiple GRs exist in the city of Nairobi. MCS design perfectly fitted the six accessible, known, and available GRs in the city of Nairobi.

3.3.1 Criteria for selection of the case studies

Nairobi city is densely built up (Huchzermeyer, 2007; Igunza, 2014). This necessitated filtering and narrowing down of the areas and buildings to a researchable number. The number of GRs in Nairobi is small, this study targeted only the accessible, available, known GRs in Nairobi for in-depth studies. Intentionally, the research chose the buildings with artificially maintained and installed GRs (vegetated roofs) to assist in narrowing down to the six case studies selected and the only that fitted to the stipulated meaning of GRs for the study. Naturally, growing vegetation on rooftops were not included. Despite the pot vegetation and the free-standing vegetation providing similar benefits just as GRs do, they were not considered in the selection of GRs for in-depth analysis. The table 7, shows the six regions and the reasons as to why the regions were selected.

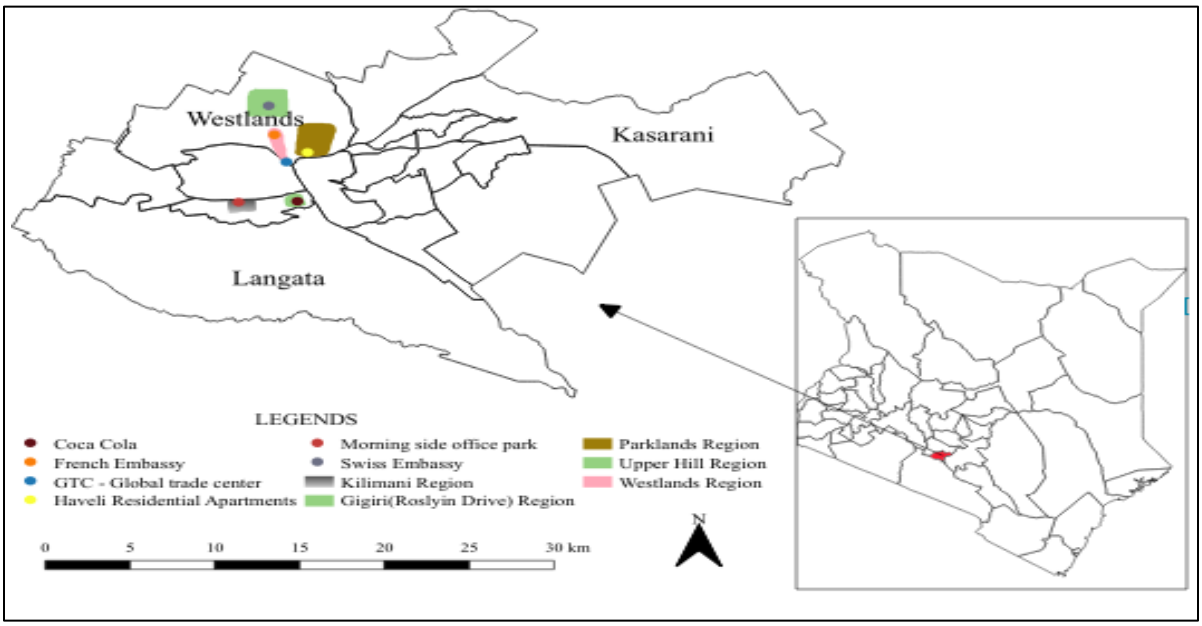
Table 7; The criteria used to identify the locality of the green (vegetated) roofs.

Region	Reason for selection
Gigiri (Rosylin Drive)	It is a high-income residential zone. The Swiss Embassy located here
The Kilimani/Ngong	It is a rapidly growing business hub with a mixture of economic classes. It is also a residential and commercial suburb Morning side office park is located here.
Parklands	A residential zone with mixture of activities and different socio-economic classes and a multicultural zone where The Haveli Towers is located
Westlands	It is a mixed socio-economic zone and where the Global trade center (GTC) and the French Embassy in Nairobi-Along Peponi Road are located.
The Upper Hill Region	It is a commercial zone providing a different picture contrary to the residential zones. The region has the green roofed Former Coca-Cola Building

Source: Researcher, 2020

Map below gives a detailed spatial distribution of the selected GRs for this study. The buildings selected were; the Haveli Resdential apartments in Parklnads, The Morning Side office Park along Kilamani/ Ngong Road, The French Embassy along Peponi Road in Westlands, Rosylin drive in Gigiri area, The Switzerland Embassy building, the old Coca-Cola Building in Upper Hill.

Map 3; Case study distribution within the city of Nairobi



Source: Author (Modified from IEBC data 2017)

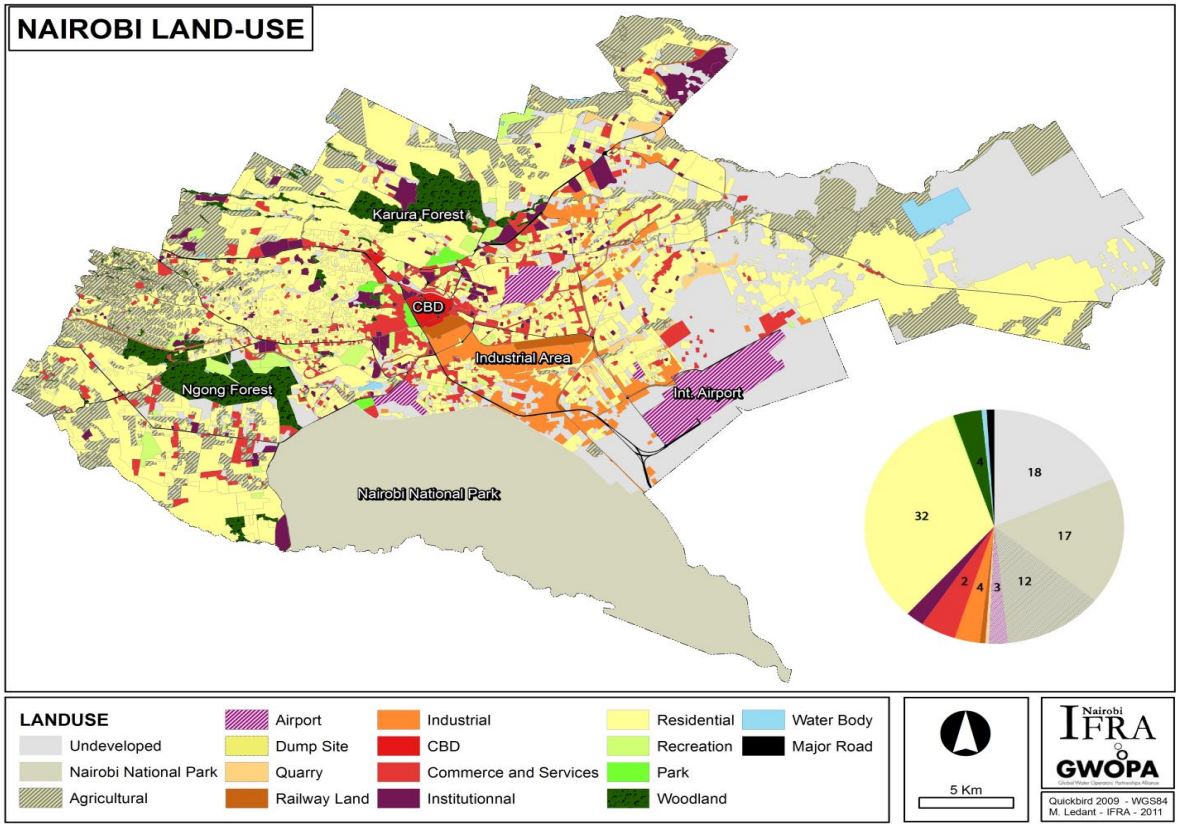
3.3.2 Land Use of Selected Case Studies

Land use in Nairobi has significantly changed over time (Mundia &Aniya, 2005; Mbatia, 2016; Ledant, 2011) and these various land use changes of the city of Nairobi are shown in Map 5. For instance, from 1976 to 2000, the built-up urban areas raised by 47 sq. km. This represents more than 300% increase. The expansion of urban areas has been accompanied by urban sprawl and destruction of urban forests and usage of the open spaces (Mundia & Murayama, 2010; Mbatia, 2016). The selection of the GR case studies was also guided by the Zones guide and the city of

Nairobi Development Ordinance. Parklands from where Haveli Towers sampling point was located, is part of zone three and can have residential and commercial flats. In addition, zone 3 of Nairobi city includes residential flats, commercial offices, in parts of Westlands and Museum Hill and Westlands CBD.

From this zone, the French embassy and GTC were sampled. According to the Council, (2004), the zone was not supposed to have over four high rise buildings, it is therefore calling for policy review. Although the policy is under review, the Council, (2004) allows on residential developments in zone 4 where Morningside office park is located. Zone 13 has The Swiss Embassy in Gigiri where the Council, (2004) allows well planned low-density residential.

Map 4; Various land use activities across the city of Nairobi



Source (Ledant, 2011; Mbatia, 2016)

The map above gives a detailed display of the various land use in city of Nairobi. The residential uses of the of the city of Nairobi's land is the highest. This is attributed to the high population that the city of city of Nairobi has experienced for the past two decades. The implication of this is that the open spaces are being used to develop buildings to accommodate the raising urban population of the city. The infrastructural development which includes the major roads and railways is seen to be consuming various urban open spaces within the city of Nairobi.

Changes in land uses are determined by site location characteristics, economic development, and population. Over this period spatial expansion directions have also changed. For instance, between 1976-1988 and 1988-2000, Nairobi experienced expansion to the north-east and western parts, respectively. Road network in Nairobi has also been linked with influencing the shape of urban development – expansion is tilted towards the and along the major roads. Physical factors influencing expansion of Nairobi include topography, geology, and soils. Nairobi City has a master plan that was made to order in 1948 and reviewed in 1978 that shows the plans for urban expansion in future.

3.4 DATA COLLECTION METHODS AND ANALYSIS

3.4.1 Data Collection Methods

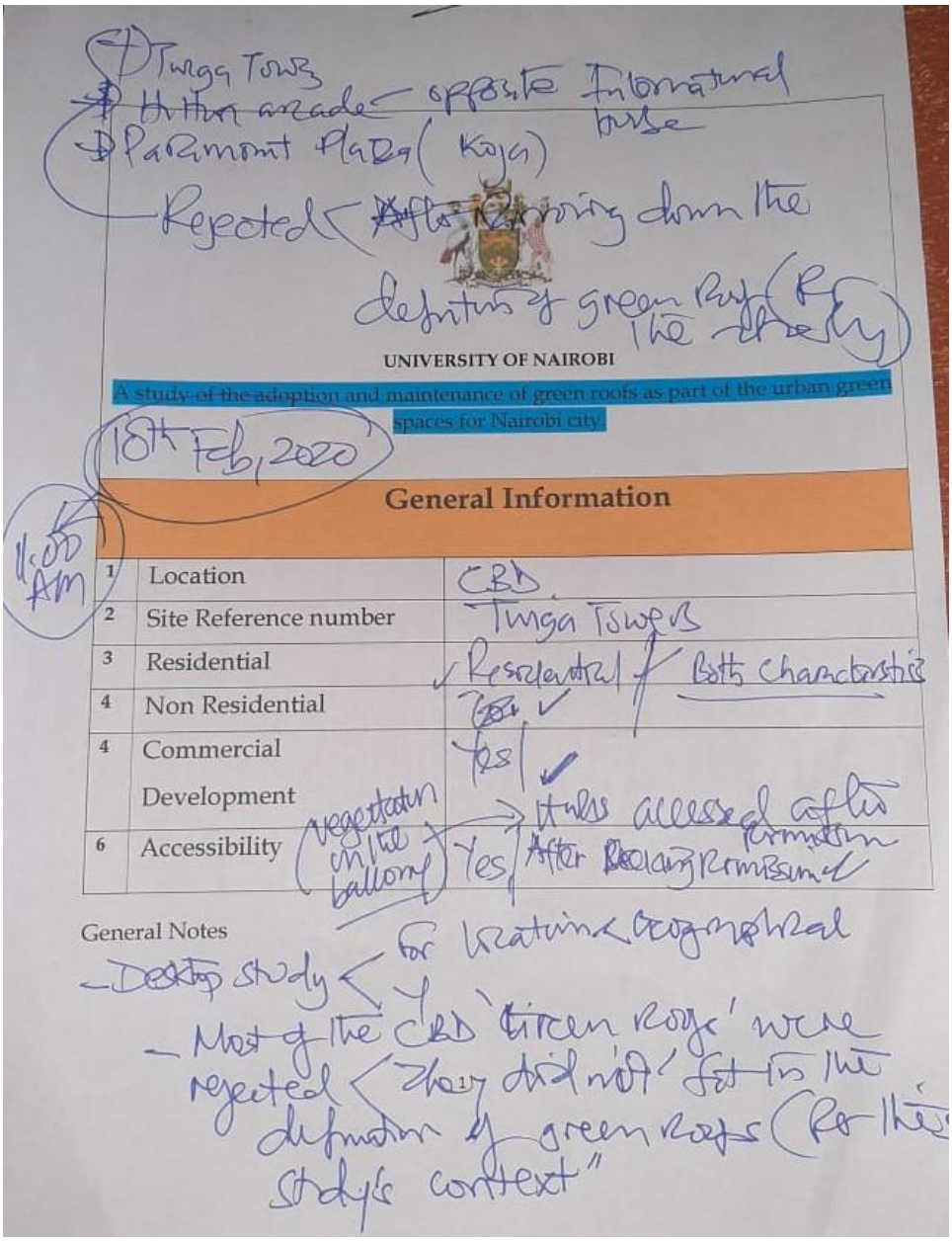
Given that the research had six sampling points, a large amount of data was collected. Thus, the study was keen with the types of data collected, and data handling methods to make the analysis of the data easier. This research was guided by three principles of collecting data; creating database for the case study, use several sources of evidence and retaining a record for evidence. There were attempts to use the same data collection methods to gather the same type of information at all levels of analysis. The study collected as much data as possible. However, this was not possible as

different case studies differed in terms of characteristics. All the same, the study relied on the mainstream data collection methods for qualitative studies, with several source for the all the green roofs in the six case studies. These data collection methods included desk study, observations, interviews, policy reviews, participant participation, rapid user surveys, social media discussions, and rapid site assessments. These techniques are discussed in subsections as follows.

3.4.1.1 Rapid Site Assessment (RSA)

There was need to rapid site assessments because there are few known green roofs in Nairobi. This helped in ensuring that the available green roofs are fit to be used as green roofs for the context of this study. The research used structured rapid observations in Nairobi. The random data obtained was the keyed in in a designed checklist (Image 3) that was designed to assist in capturing pre-data for the study. The checklists included the green roofs' general information like; the GPS coordinate of the green roof, topology, physical setting of the GR, and the information contained in the GR. Image 2 shows the a filled RSA and the comments made to disqualify the earlier agreed upon 'Green (vegetated) roofs.

Figure 5 Filled Rapid Site Assessment form



UNIVERSITY OF NAIROBI

A study of the adoption and maintenance of green roofs as part of the urban green spaces for Nairobi city

18th Feb, 2020

11:00 AM

General Information

1	Location	CBD
2	Site Reference number	Twiga Towers
3	Residential	Residential / Both characteristics
4	Non Residential	Yes
4	Commercial Development	Yes
6	Accessibility	Yes, After Permission

General Notes

- Desktop study for locating geographical
- Most of the CBD 'Green Roofs' were rejected (they did not fit in the definition of green roofs (for this study's context"

Source; Pre-fieldwork, 2020

A desktop research was done to fill the missing information on the RSA form. The study identified different construction companies, landscapers, and architects that designed, built, and maintain vegetated roofs in Nairobi. Different types of buildings -gated communities, residential or

commercial were established through desktop study. To access some site, the permissions were granted by the security officers or the gatemen at the entrance points. The rapid assessment took place between 7th February to 12th February 2020 before the Covid-19 pandemic hit Kenya. The site assessment guide was essential as it collected both secondary and raw data.

3.4.1.2 Observation

The informal fieldwork for study began early 2019. Causal walk through Upper Hill, Parklands and Ngara within the Nairobi CBD was done to check for the availability of GRs in Nairobi. This was challenged by the fact that a GRs cannot be seen from the ground level; one can particularly see the crate plants and pots on structures in balconies. These types of urban vegetative strategies can be misused for GRs. For instance, this study was almost settling on urban greeneries on the roofs and balconies like; the International House along Mama Ngina Street, the Hilton Arcade next to Kencom, the Twiga Towers next to Moi Avenue Primary, and the paramount Plaza next to Globe Roundabout.

3.4.1.3 Desktop Study (DS)

Desktop studies were done to review the information related to the available GRs. The desktop study was interested with the patterns, trends, historic data, and the documents related to the green roofs. This helped in contacts identification and the identification of GRs geographical distribution in Nairobi. Based on this information, key information about the GRs that was not addressed by previous research was obtained.

3.4.1.4 Policy Document Review (PDR)

Policy document review was guided by RSA (Image 2). Legal documents (table 8) that could affect the maintenance and adoption of GRs in Nairobi were identified, government acts, annual plans,

management plans, sessional papers, regulations, strategic plans, legislations, policies, and urban green spaces guidelines where applicable. The table 8 is detailed summary of the reviewed documents.

Table 8; A summary of the reviewed documents

Document	Information Sought in Line with adopting and maintaining GRs
Climate Change Act, 2016	County Governments of Kenya are needed to establish climate change initiatives. These 'initiatives' are not defined herein. This research brings in GRs as a micro-level climate-fighting action that fits into the 'initiatives' intended in Nairobi City County.
Conservation of biological diversity and benefit sharing regulations, 2006	The regulation backs increase of forests in Kenya. The rapid urbanization is reducing the spaces left idle to increase forests. This confirms that there is need for GRs to increase vegetation cover in urban areas.
NEMA's fourth Strategic Plan 2019-2024	This plan promotes adoption of eco-houses. Houses with vegetated roofs can serve as eco-houses. This move by NEMA is in line with this research as the GRs will help in achieving eco-houses.
Nairobi Integrated Urban Development Master Plan	This is aimed at ensuring sustainable, inclusive, resilient, and secure urban development. Development of new industrial parks was planned will endanger the few existing urban green spaces. Adopting green roofs in Nairobi is in time as it will help in restoring green spaces in Nairobi.
The Sessional Paper No. 3 of 2016 on National Housing Policy	This policy is aimed at stopping the worsening housing conditions and reduce shortage of houses. Unfortunately, the policy is focused on provision of houses but has ignored the urban ecosystem- an action that will reduce open green spaces. GRs can intervene and provide more green spaces in Nairobi.
National Urban Development Policy (NUDP)	It is focused on enhancement of environments in urban areas and mitigation of climate change. The policy advocates for increment of urban green spaces. GRs remain the best alternative for the reducing urban green spaces in Nairobi.
The Urban Areas and Cities Act, 2011	This act direct governance and management of cities and urban areas. This act can establish the guidelines for maintenance and adoption of GRs in Nairobi.
The National Construction Authority Regulations, 2014	NCA has the responsibility to manage the construction industry to achieve a sustainable construction sector. GRs are part of NCA regulations' visionary objectives. NCA approves construction of buildings and green roofs make part of building design.

Source: Researcher, 2020

3.4.1.5 In-depth Interviews

Interviews for this research paper were conducted for non-state and state actors. The interviewed state actors were from Nairobi City County, Department of Urban Planning, and the National Environment Management Authority (NEMA). On the other hand, non-state actors interviewed included NGOs, vegetated roof owners in Nairobi, and professional bodies. In this case, two NGOs were interviewed; Kenya Green Building Society (KGBS) and Kenya Alliance of Resident Associations (KARA). The study applied both unstructured and structured interviews to collect data. Interviewing state actors necessitated formal interviews with booking of appointment done in advance and interviews done at the specified time. Some officers were interviewed informally for example, the Chief Research NEMA. The interview questions contained words from stories about GRs, personal meaning, understanding, and experiences. Research changed slightly and evolved as the interviews were in process.

3.4.1.5.1 Government Bodies (State Actor) interviewed.

3.4.1.5.1.1 National Environment Management Authority (NEMA) Interviews

In this case the acting Director General NEMA was interviewed to get the legal perspective concerning adoption and maintenance of green roofs. The unstructured interview took place on 7th January 2020 at the NEMA head office after a successful booking of appointment with director's secretary. The head of Environmental Impact Section was also interviewed at the office of EIA.

3.4.1.5.1.2 Nairobi City County interviews

The research then focused on the county government of Nairobi where deputy directors of urban planning department were interviewed on 7th January 2020 at the City Hall. Later, the Principal

of development control section was interviewed. These interviews provided general information about Nairobi's urban development based on patterns, trends, figures, and facts.

3.4.1.5.2 Professional Bodies Interviewed

3.4.1.5.2.1 Triad Architects & Planners Interviews (TAP)

TAP have been in the lead line of the profession of architecture not only in Kenya but also in the East Africa region for over fifty years. TAP was involved the designing the green roof of the Coca Cola in Upper Hill. Two architects who were involved in the designing of the Coca-Cola building green roof were interviewed. This interview took place in their office in Triad House, 83, Muthaiga Road.

3.4.1.5.2.2 Pharos Architects Limited interviews

This is an architectural practicing firm consisting of experienced technicians, project managers, designers, and architects. They designed and installed the French Embassy green roof, along Peponi Road. The head architect, Andrew Gremley was interviewed at his office along E Church Road in Westslands on 9th March 2020.

3.4.1.5.2.3 Lariak Landscapes Limited interviews (LLL)

This is a Kenyan firm offering Landscape Architecture and Environmental Planning services. This firm installed the green roof of the Morningside office park and maintained it for six months. An authorized landscaper from the firm was interviewed at the firm's office in Westlands.

3.4.1.5.2.4 Italbuild Imports Limited interviews

This is a private organization concerned with road works, water works and building works. It also imports specialized waterproofing and roofing solutions. This company was involved in the designing process of the Swiss Embassy Green roof. They designed and installed waterproof

membrane of the Haveli Towers and the Swiss Embassy green roofs. The senior manager of the company was interviewed at his Karen office.

3.4.1.5.3 Green Roof Owners' Interviews

3.4.1.5.3.1 New Swiss Embassy in Nairobi, Kenya interviews

Several interviews were done about the green roof of the New Swiss Embassy building which is in a green area where trees are especially important. The Logistics Project Manager at the Swiss Confederation Federal Office for Buildings and was interviewed through phone call and emails (from Switzerland) on 20th February 2020. The person maintaining the green roof was also interviewed. Lastly the Head and Deputy Head of Facilities Officers respectively were interviewed.

3.4.1.5.3.2 The Morningside Office Park interviews

The Morningside Office Park is profitable building with a green roof and is strategically sandwiched between Kilimani Road and Ngong Road. The head of property management and the person in charge of taking care of the GR respectively were interviewed. A neighboring household was also interviewed to get the viewpoint on their thoughts on the green roof.

3.4.1.5.3.3 The French Embassy Green roof interviews

The French Embassy GR interviews were done through phone calls and emails due the Covid-19 pandemic. Further information based on the French Embassy GR was obtained from the Pharos Architects Limited who were involved in the designing and installation of the GR.

3.4.1.5.3.4 Global Trade Center interviews (GTC) interviews

Three interviews were conducted for GTC where the GTC's Marketing Director, Resident Engineer, and TRIAD Architects & Planners were interviewed. They unpackaged the whole concept of the GTC's green roof and the economic and social perspective of green roofs.

3.4.1.5.3.5 The Coca-Cola Green roof interviews

For the GR in the Coca-Cola building, two interviews were carried out. The TRIAD Architects & Planners who were involved in the designing and installation of the GR were interviewed. The attempts to interview a South African company that designed and installed together with the TRIAD Architects & Planners failed. Reaching a key person to interview from Coca-Cola building was not easy because during the time of interview, the property was on sale and the Coca-Cola officers had relocated to Lavington. The interview was done over a phone call with the former Coca-Cola manager of Government Relations and Public Affairs was involved in the adoption of the green roof.

3.4.1.5.3.6 Haveli Towers Green roof interviews

The Innovative Planning and Design Consultants (IPDC) designed and installed the green roof of Haveli Towers. For this building, two interviews were conducted where the designers of the green roof (Italbuild Imports limited) at their office in Karen. The second interview involved an IPDC representative who oversaw the process of adopting and installation of Haveli Towers green roofs.

3.5 DATA ANALYSIS AND INTERPRETATION

Data collection and data analysis for this qualitative study was not as easy task as many researchers may think (Agee, 2009; Crang, 1997; Jacelon & O'Dell, 2005). In most case, researchers underestimate the amount of time and commitment to make an in-depth and an all-inclusive

analysis of data that gives clear explanation of the results (Du Plooy-Cilliers & Cronje, 2014; Agee, 2009). Analysis of the collected data was based on four denominators of qualitative analysis techniques: substantiation, interpretation, organization, and reduction. Recorded conversations and interviews were translated and transcribed to clean and reduce them to relevant and specific text. Naturalism transcription was applied on all utterances captured like non-standard accents, omitted words, interview noise, and pauses. After reduction of the information, it was organized for interpretation and making the content substantive. Better quality control of the qualitative data collected was ensured through constant checking. This research gathered three categories of qualitative data: structured texts from secondary sources, unstructured texts, and audio and video recordings.

3.5.1 Qualitative Data Analysis (QDA)

In most cases, analysis and collection of qualitative data is done simultaneously (Morse, 2010). The research being virtuously qualitative, it is allied to Chpwdhury, (2015), who argued that in Qualitative Data Analysis (QDA), the researchers move the gathered data in a way that can be understood, interpreted and explained to fit in the topic under study. Some qualitative researchers point out the notion that QDA needs non-scientific forms of data processing and interpretation- it threatens reliability and robustness of qualitative research (Chowdhury, 2015). Data collected for this study was qualitative and includes symbols, observations, words, pictures and not numbers. Therefore, the data was subjected to qualitative methods of data analysis.

3.5.2 Qualitative Content Analysis (QCA)

This is one of the different qualitative techniques used to analyze and interpret qualitative data (to Elo et al., 2014; Vaismoradi et al., 2013). According to Myers, (2019); Yanow, (2003), QCA is normally based on interpretive philosophy with the assumption that the reality of a phenomenon

can only be accessed through constructions like shared instrument and meanings, consciousness, and language. QCA was applied in the study to examine symbolic and meaningful content of the qualitative data collected.

3.5.2.1 Coding Of QCA

The collected data was first preserved in an analyzable form before the qualitative content analysis started (Dhillon, 2016). The data obtained from emails, media and desktop studies was already in written forms thus transcription was not necessary. However, field discussions and interviews were recorded and required transcription before content analysis started. Coding involved identifying the meaningful sections of the collected data and assigning codes to them. Assigning codes involves using a short phrase and a word that symbolically assigns an essence-capturing attribute to the collected qualitative data (Saldaña, 2015).

In this case, coding was done by means of highlighting segments of the text data collected. Afterwards, shorthand labels were used to describe to content of the highlighted phrases and sentences. Different highlighting colors corresponded with the codes. Coding helped the researcher to condense essential points that may be repeated in the interview. The excerpts below was taken from some of the interviews carried out and they it shows where some of the various themes that were used to generate codes for data analysis came from.

'this plant can even go for a whole month without water. At times one can think that the plant is dead, but when the rains come, the plant resurrects and grows again. These leaves have a lot of water that makes it still wet for long. I think it uses that water when hibernating in the soil. This plant is less expensive in terms of water usage…..''……

Codes generated from the excerpt
Drought resistant vegetation
Tolerant plant
Maintenance cost
Perception of people towards plants

Source: Field work, 2020

These Codes kept on increasing in numbers as the data analysis proceeded and a total of 43 codes were reached on. To make conclusions, the codes and themes that repeated themselves were counted and generalizations made from them. Some of the codes that recurred included, Vegetation uses, high cost, lack of government policies, lack of knowledge on the GRs.

3.5.2.2 Ensuring validity of the coded information

Coding is an important step as the research moves from raw data to the findings, as it maintains coherence between the results and the objectives. Coding ensured that the research was based on the research questions and the questions were answered. The initial research questions may change through the process but (Charmaz, 2014) argued that the researcher should reconcile the answer(s) and question (s) in such situations. This ensured validity of codes assigned to the collected data.

3.5.3 Narrative Analysis

According to Anderson & Kirkpatrick, (2016), a narrative is a transcribed experience. All the interviews conducted for the study had the aspect of a narrative. There was reflecting and progress sorting on interviews and observations. This gave room for enhancement of the interviews and observations and presented the two as a revised shape where conclusions could be arrived. The main purpose of analyzing the narratives was to re-structure the observations made in various contexts and the stories given by the respondents to keep them in the setting of this research.

3.5.4 Interpretive Phenomenological Analysis (IPA)

In the mid-1990s IPA was used as characteristic research technique in psychology (Murray & Holmes, 2014; Shinebourne, 2011). IPA was made to comprehend a subject's experiences (for instance an individual) based on a main life situation, experience, and event (Quinn, & Clare, 2008). Shinebourne's (2011) phenomenological attitude provided this research with rich source of ideas on examination and comprehension experiences of respondents with the Kenyan GRs. The research applied the IPA in the analysis while focusing on only the experiencer (subject-centered). This was mainly applied when interviewing the owners of the GRs as IPA should only be used with small sample sizes (Brocki & Wearden, 2006; Shinebourne 2011).

3.6 ETHICAL CONSIDERATIONS

The privacy of study participants by the provision of appropriate ethical standards is critical in all scientific studies. In a qualitative research, owing to the in-depth nature of the analysis process, ethical considerations have a resonance. While interviewing for this study, several respondents especially the neighbors to the GFs preferred that they should be unidentified and objected to be photographed, recorded, and filmed. Action was taken to prevent the rights and reputation of the relevant parties. The interviews were undertaken only after clear description of the goals and anticipated results of the study had been provided to the respondents. No concessions were made to fix the social, environmental, or economic problems faced by the respondents in the subject area. However, generalized feedback, to best of knowledge, was offered in response to several questions posed during interviewing. Finally, only interested individuals who had been approached were surveyed. No manipulation was used to persuade someone to be interviewed.

4 CHAPTER FOUR: RESULTS AND DISCUSSION

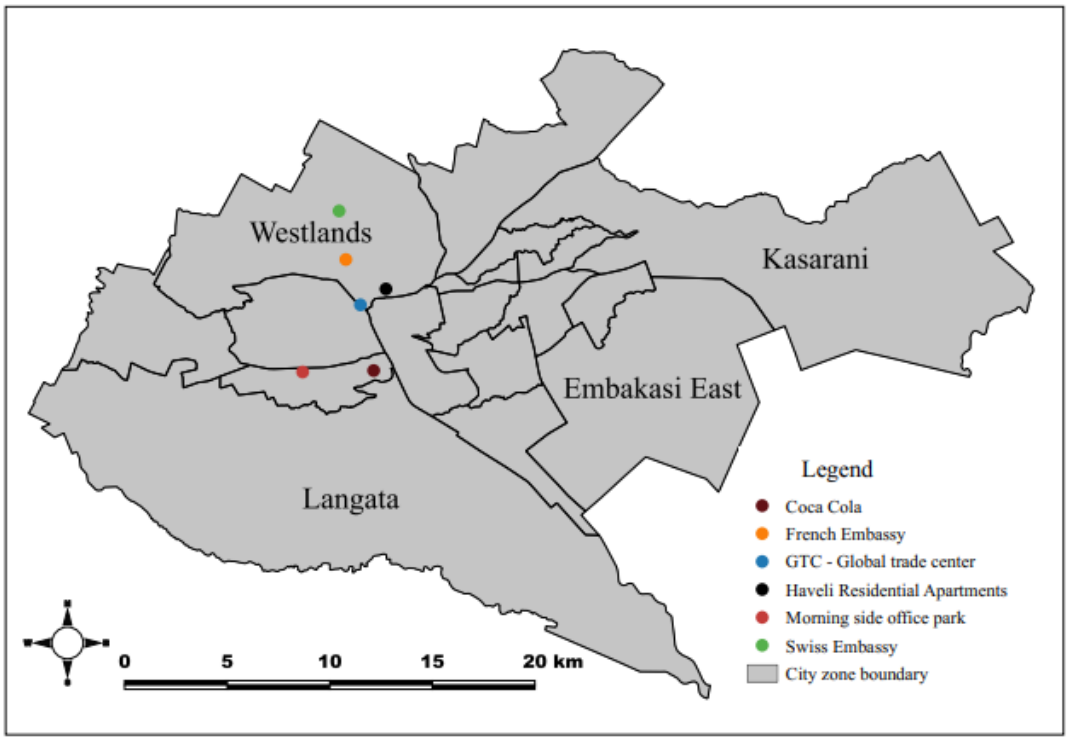
4.1 INTRODUCTION

This section provides the research findings and a synthesis of the discussions about the selected GRs in City of Nairobi. The collected data was analyzed qualitatively as per the research methodology. The findings are presented here thematically according to the study objectives.

4.2 DISTRIBUTION, NATURE AND TYPE OF GRs IN THE CITY OF NAIROBI

4.2.1 General Location and Distribution of Green Vegetated Green Roofs in Nairobi

Map 5 Geographic distribution of then GRs in Nairobi.



Source: Modified from IEBC Data.

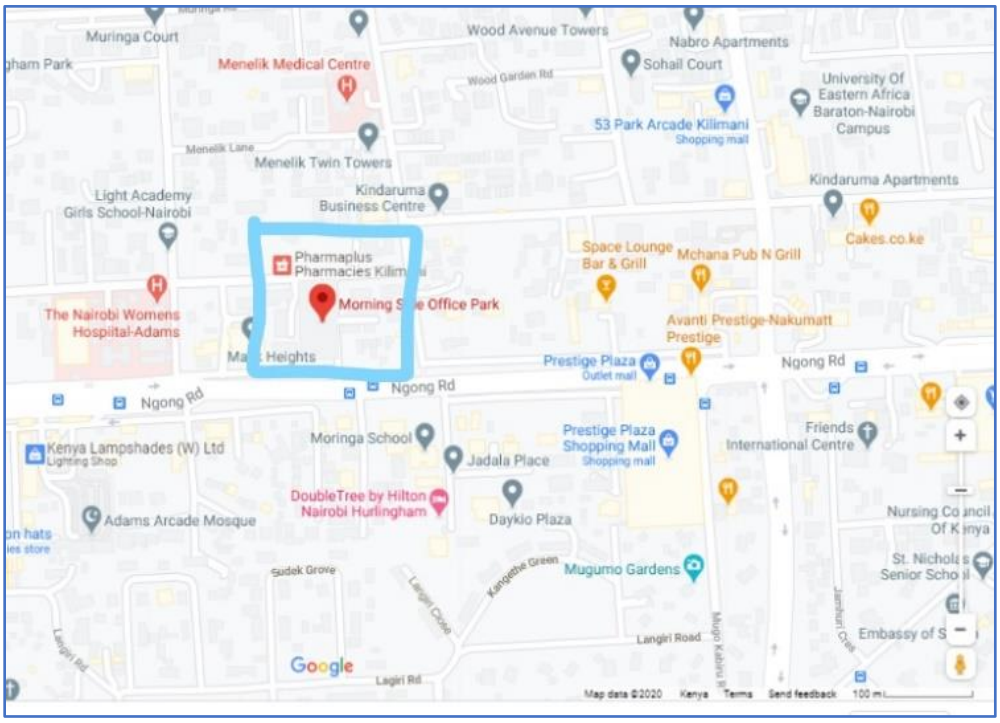
Map 5 above gives the geographical locations of the identified GRs selected for the study. As can be seen from the map, all the six GRs identified were located in the upper income areas of the city (Westlands), also known as the European residential areas during the colonial times (Mbatia 2016; Owuor and Mbatia, 2008). This indicates that GRs are unequally distributed spatially in the city of Nairobi and only affluent residents appear to be able to have installed green roofs.

4.2.2 Specific Location, Nature and Types of Vegetated green roofs in the \City of Nairobi

4.2.2.1 Morning Side Green Vegetated Roof

4.2.2.1.1 Location of MoP Vegetated roof

Map 6: The location of MOP Green (vegetated) roof



Source; Edited from google maps

The map above shows the exact location of the MoP building, which is found along Ngong Road and strategically situated between Kilimani Road and Ngong Road. The building is a commercial cum residence building that has one of the oldest GRs in the city of Nairobi.

4.2.2.1.2 Nature, Type and Functions of MoP GR

MOP green roof has a mixture of vegetation, the green roof is covered in grass, some flowers, shrubs, and small tree varieties that can withstand the sun and winds at the top of the building. The building is locally owned (see table 9). The scent of flowers and green vegetation (see Photo 4) gives people a good feel and allows employees to get back to work refreshed after spending time on the vegetated rooftop. Williams et al., (2019) appraised the psychological advantages of GRs to urbanites. The rooftop vegetation had flowers and therefore it serves an aesthetic function in addition to the psychological benefits.

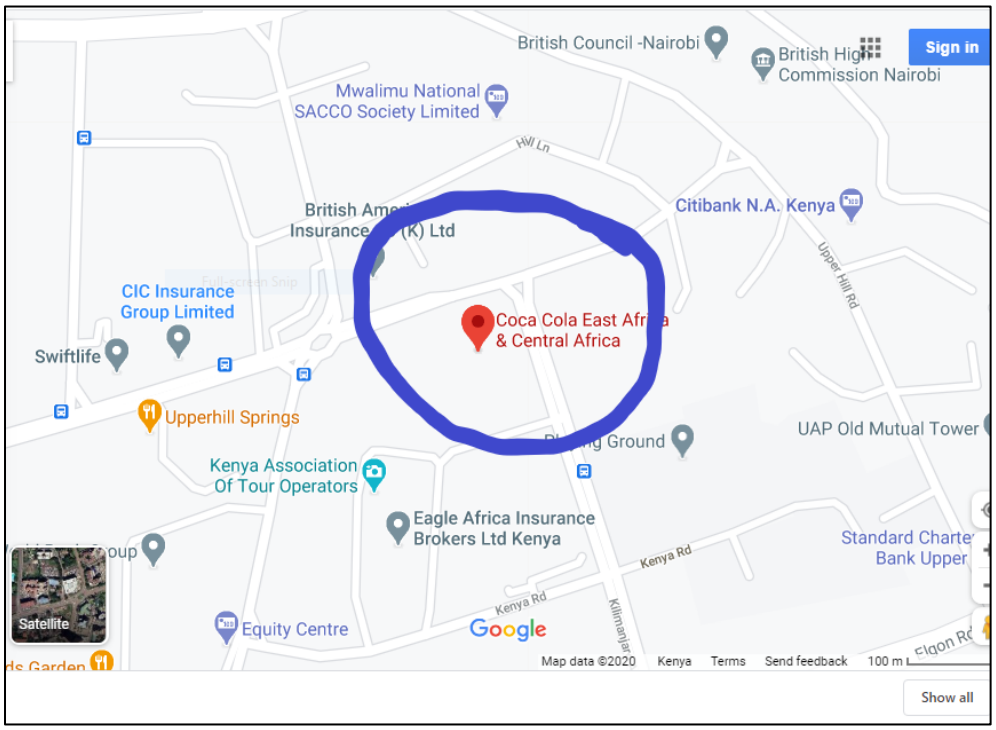
Photo 4 Various types of vegetation at MOP Green roof.

Source; Fieldwork, 2020

4.2.2.2 Coca-Cola Vegetated Roof

4.2.2.2.1 Location of Coca-Cola GR

Map 7; location of Coca-Cola GR.



Source: Edited from google maps

Located in the Upper Hill area of the city of Nairobi, the former Coca-Cola company limited had its regional East & Central Africa Office Headquarters within a 4 Kms from the Nairobi City Centre. GAPP Architects and Urban Planners of South Africa worked with Triad Architect in putting together the Coca-Cola GR in Upper Hill.

4.2.2.2.2 Nature, Type and Function of Coca-Cola GR

Initially, Coca-Cola's vegetated roof was planned according to the owner's intention and with objectives of coming up with work breakouts. Workers at the top floor would enjoy natural breakouts similarly to those on the ground floor. The main vegetation on the Coca-Cola green roof

is mainly the Kikuyu grass. At the peripheries of the vegetated roof, several shrubs do exist. Lee et al., (2015) from their research on the role of micro-breaks in restoring focus, suggests that people spend more time watching environment often enhance their concentration and enhance their mood for minutes to hours

Photo 5; Gikuyu grass on a section of the Coca-Cola vegetated roof

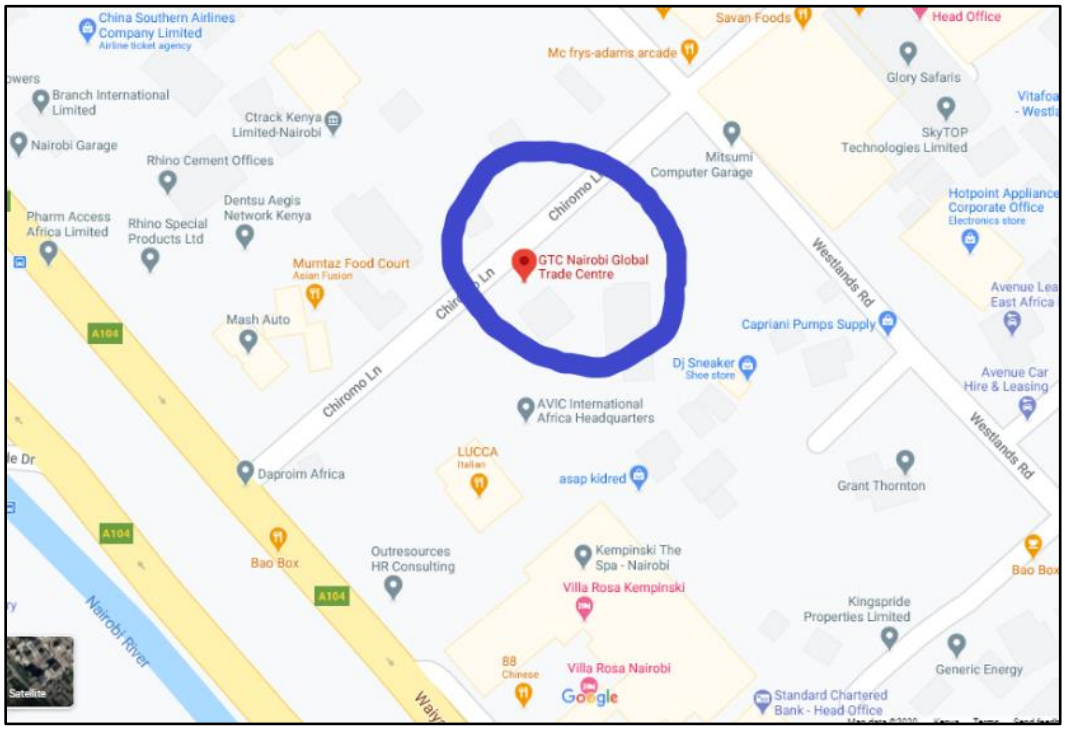
Source: Fieldwork, 2020

The photo above shows Kikuyu grass at the Coca-Cola's GR. This kind of grass forms a carpet like landscape and that is why it was chosen for this specific vegetated roof. Additionally, the shallow roots of the Kikuyu grass make it suitable since the roots cannot reach the geotextile membrane, the delicate section of the vegetated roof. Coca-Cola building has several "green" components, such solar panels, collection of rainwater, renewable power and a green roof garden, that functions as a recreational facilities and ensures that through the rooftop there is low heat gain in a large part of the building.

4.2.2.3 Global Trade Centre (GTC) vegetated roof

4.2.2.3.1 Location of GTC Green Roof in Nairobi

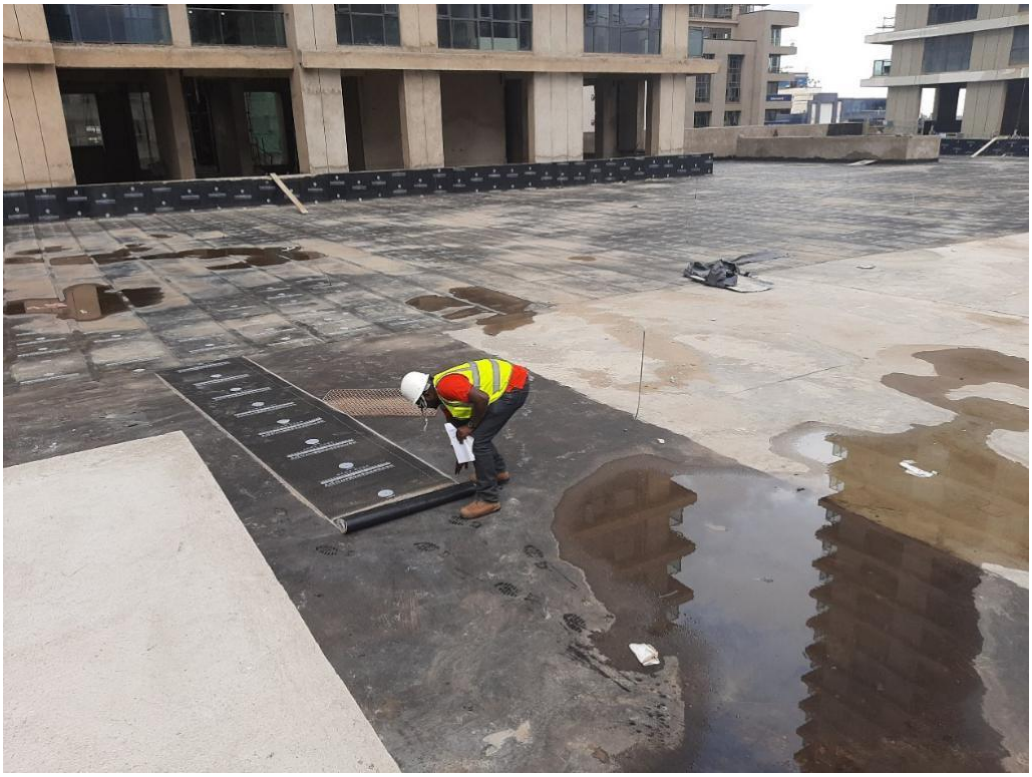
Map 8; Location of the GTC



Source: Edited from google maps

GTC is located in between Chiromo Road and Westlands Road along Nairobi-Nakuru Highway. The Triad Architects were the designers of the GR which is to be the largest GR in East Africa. At the time of the study, the mixed-use structure by the Aviation Industry Corporation of China (AVIC- International) was being constructed. The GTC green roof would also form an extensive green roof perhaps the only in East Africa. By time of this study installation of the vegetated roof was going on.

Photo 6; on-going green roof installation of the GTC vegetated roof



Source; fieldwork, 2020

The photo above shows the upcoming GTC vegetated roof. The Triad Architects designed the upcoming vegetated roof at GTC which is expected to be the largest in East Africa according to the respondents.

4.2.2.3.2 Nature, Type and Purpose of GTC GR

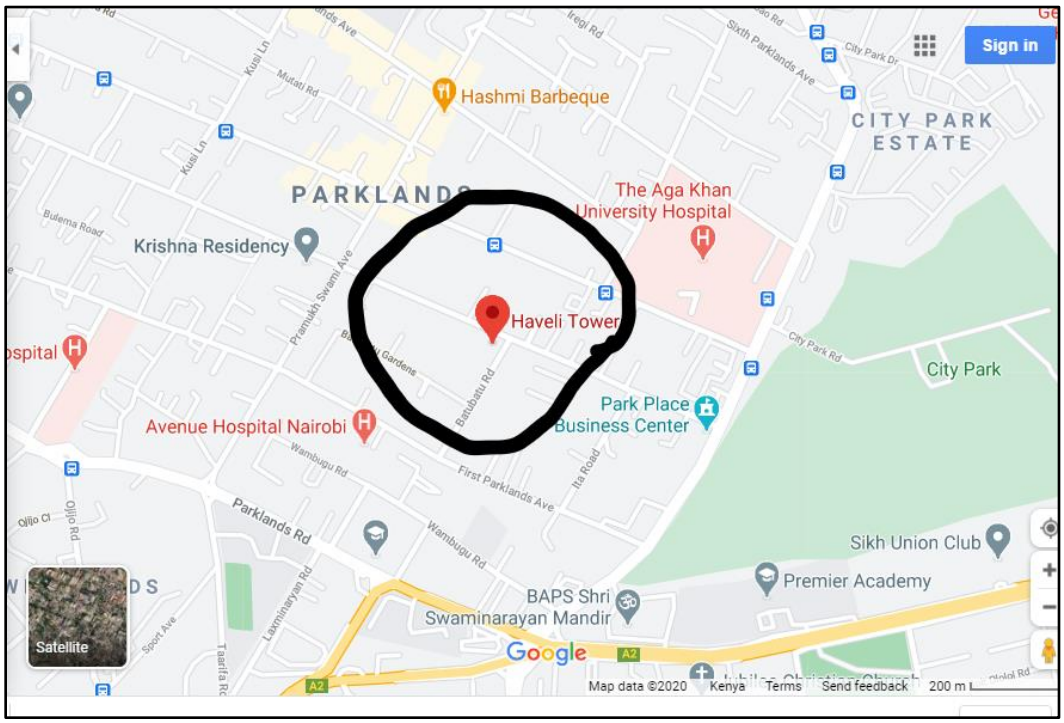
Various reasons were behind the adoption of the green roof at the GTC, the respondent informed the study that the urban modern architect needed to be "fully equipped" which meant that someone would shop, drive through the green roof, stay and enjoy the environmental benefits associated with the roof. The green roof would be used for various activities like jogging, hosting social events (parties, weddings, bars & restaurant activities) and this was one of the reasons for adoption of the green roof on the GTC. The reasons to use the green roof as mechanism for break out is in

line with the reasons that the Coca-Cola green roof was established as earlier discussed in the Coca-Cola vegetated roof.

4.2.2.4 The Haveli Tower (HT) GR

4.2.2.4.1 Location of the Haveli Towers Green Roof in Nairobi

Map 9; Location of Haveli Towers GR



Source: Edited from google maps

HT, a 10 storey apartment is in the heart of Parklands, in the city of Nairobi, sandwiched between major landmarks such as the aga khan hospital, avenue hospital and city park forest.

4.2.2.4.2 Nature, Type and Purpose of Haveli GR

The Haveli building was designed by the Innovative Planning and Design Consultants (IPDC). The name Haveli is borrowed from the ancient architecture of haveli buildings. The design is in line with the Rajasthan architecture.

Photo 7 Aerial view of the Haveli Towers Green roof

Source: Fieldwork, 2020

According to IPDC, HT is attributed to the historical buildings in India that bear the same name. The GR was installed designed by the Innovative Planning & Design Consultants (IPDC). The Italbuild Imports designed and provided the water roofing materials of the GR while the Parbat Siyani Construction Limited did the construction of the GR. The GR has both some shrubs and grass. The Kikuyu grass was chosen for the GR as shown in image photo above.

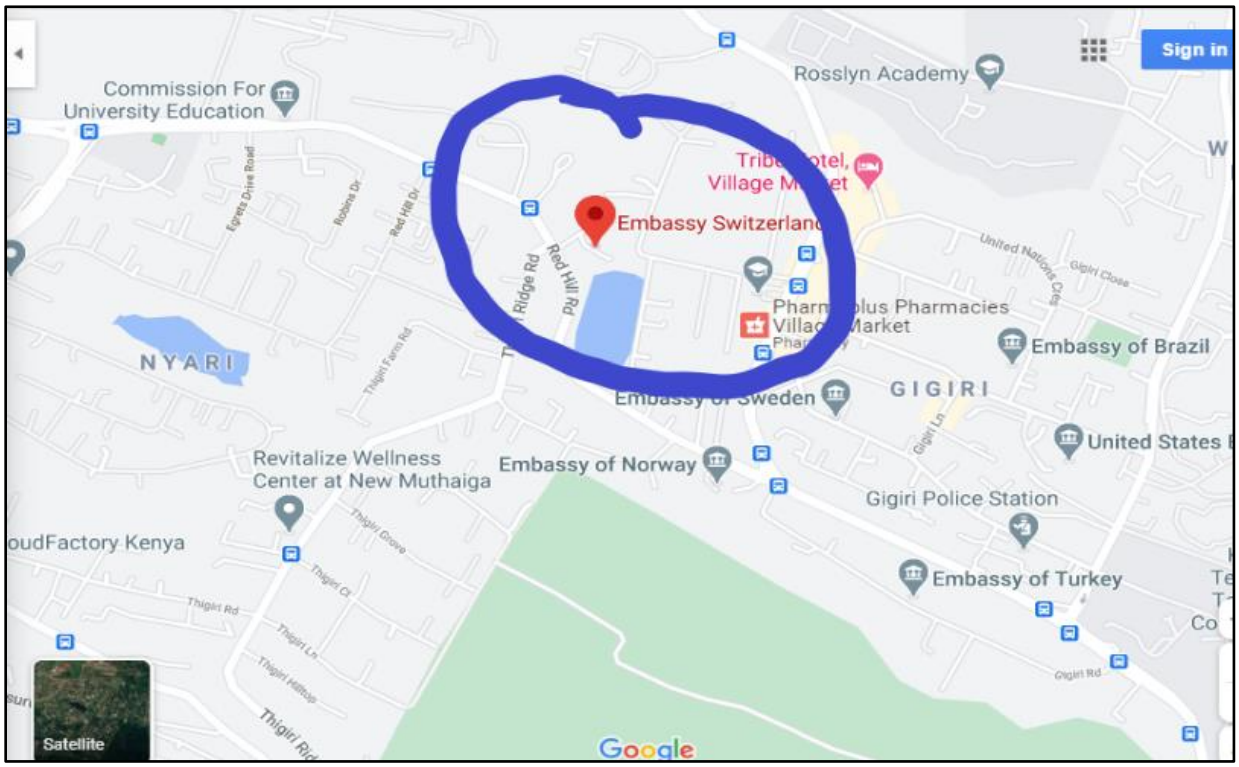
Photo 8 Kikuyu grass on the Haveli GR

Source; Fieldwork, 2020

4.2.2.5 Embassy of Switzerland (EoS) GR

4.2.2.5.1 Location of EoS GVR

Map 10: EoS location



Source: Edited from google maps

Located at Rosslyn Green Path, off Red Hill Road on L.R No. 7788/92 Gigiri, Nairobi, the green vegetated roof of the Embassy of Switzerland is situated approximately 25 kilometers from the CBD of Nairobi (see map 8).

4.2.2.5.2 Nature, Type and Purpose of the EoS GR

The GR has Aptenia cordifolia (Image 5) a drought resistant plant. The Swiss GR serves as a beautification center for the facility. Access to the GR is limited to researchers and individuals participating in the maintenance of the green roof, technical staff, and any authorized individuals.

In terms of climate change, the EoS was built to align with the United Nations in the fight against war on climate change. The Swiss Embassy uses the green roof to cool the building's temperatures, as indicated by the respondents, by Vila et al., (2012) that The green roofs reduce the heat fluctuation and keep the air temperature in the lower room cooler in summer and warmer in winter. In addition, the building was designed to align with the Strategic Plan for Biodiversity of the United Nations, established in 2010.

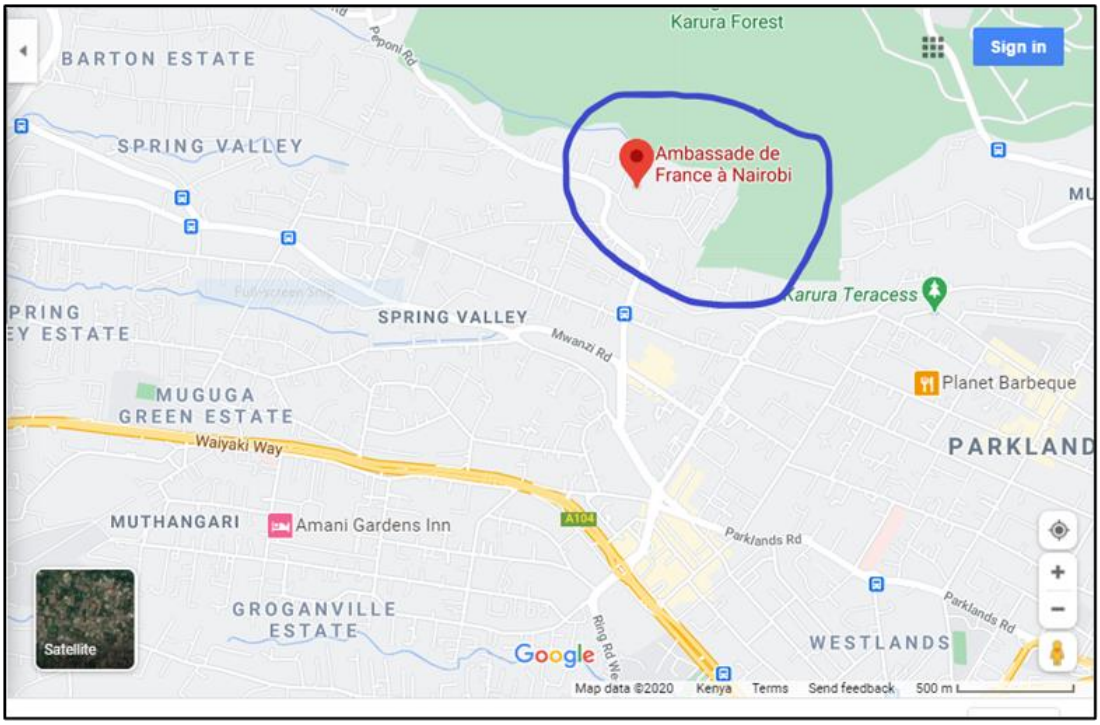
Photo 9 Aptenia cordifolia

Source; Fieldwork, 2020

4.2.2.6 The French GR

4.2.2.6.1 Location of the French Embassy GR

Map 11; Location of the French embassy



The French Embassy is situated at an area around Peponi Road in Westlands. Its unique location that provides convenient and quick access to the various services in the area such as; shopping centers, banks, eateries, entertainment spots and residential homesteads which are isolated from the Westlands overcrowding. The building design is based on the French culture,

4.2.2.6.2 Nature, Type and Purpose of FE GR

The idea of French green roof was designed b by Terreneuve 10, rue Vicq d'Azir in Paris France & Pharos Architects Nairobi. The embassy espoused and installed the green roof in 2017. The French green roof settled for both "sedum" and "crassulaceae", plants that do not need any upkeep or regular watering. Sedum is a succulent that belongs to the Crassulaceae family. The green roof

is also an indication of devotion to the efforts of the French government has had in biodiversity conservation both locally and internationally. Sedum when used as a vegetation for the green room require little attention. Sedum on the French green roof is adapted to and found in dry and or cold arid areas. The vegetation on the French green roof is highly resilient to disease hence no or minimal incidents of diseases or pest attacks in the green roof plants on the French embassy.

Photo 10; French Embassy vegetated roof

Source: Pharos Architects Limited

In 2015, France established an environmental regulation that called for new constructions to be put up in commercial areas should be partially covered with either vegetation or solar panels. The French, according to the respondents was in a row with the Paris Agreement of 2015 whose goal is to reduce global warming from 2 to 1.5 degree Celsius which is above the pre -industrial levels through developments that are sustainable and climate-resilient as illuminated by Hulme (2016)

and (UNFCCC, 2015). The green roof is also an indication of devotion to the efforts of the French government has had in biodiversity conservation both locally and internationally.

4.2.3 Summary on Location, Nature, Type and Purpose of Green Roofs in Nairobi.

Table 9 gives a detailed summary of the findings in terms of case study location, type of building ownership, the type of vegetation on the adopted GRs and the spatial distribution of the GRs within the city of Nairobi.

Table 9; A summary of the distribution, ownership, and Nature of GRs in the city of Nairobi

Case Study	Building Function & Location	Green Roof Purpose	Type of Vegetation And Type of green roof
Swiss Embassy	Commercial (Gigiri area)	Environmental,	Aptenia cordifolia
French Embassy	Commercial (Westlands)	Environmental	“sedum" and "crassulaceae", plants
Haveli Towers	Residential (Parklands)	Environmental	Mainly Kikuyu Grass &Various Shrubs
Coca-Cola Building	Commercial (Upper Hill)	Aesthetic	Kikuyu grass
Morning Side office park	Commercial (Ngong-Kilimani)	Social, Aesthetic	Grass, shrubs, flower plants.
Global Trade Centre (GTC)	Commercial cum residential (Westlands	Social, Environmental Aesthetic	To be agreed on

Source; Researcher, 2020

4.3 RESIDENTS' PERCEPTION THE ON THE MAINTENANCE AND ADOPTION OF GRS

For this study, Nairobi Residents referred to the neighboring households who were interviewed. It should be noted that the interviewed households included representatives from homesteads and not passers by or hawkers. A point to note is that it was a big challenge to get anyone to interview in these neighbourhoods. It was found out that most of the neighbors had no ideas of the green roofs around them. For example, the neighbors (not more than 1000Meters) from Morningside office park had never heard about green vegetated roofs. In every case study, two neighbors who were purposively selected were interviewed to understand their thoughts on the vegetated roofs in terms of cost for installation, maintenance, and the whole concept of green roof technology.

4.3.1 Profile of residents interviewed

Since the GRs were in the gated communities of the upper middle- and high-income residents of Nairobi, it was not easy to get a diverse group of people to interview. The types of respondents interviewed came from residential, commercial, and commercial cum residential. In Upper Hill, the respondents were businesspersons from the commercial buildings surrounding the Coca-Cola green roof. This was the same case in Westland's, Parklands and Gigiri for the neighbors of GTC, French Embassy, Haveli Towers and Embassy of Switzerland green roofs, respectively. Other respondents interviewed were from the residential households in Kilimani- Ngong road for the MoP building, which has residential-cum commercial neighbors

Nevertheless, at least twelve households were interviewed after a long time of trying to reach out. Two households represented by an adult family member were interviewed. Residential and Commercial residents from the three main Kenyan racial groups that is native Kenyans, Asian Kenyans, and Europeans, were accessed as respondents for the interviews.

Table 10 The level of education and Nationality of the respondents

Green roof Location	Green Roof	Nationality of the respondent (Neighboring Household	Level of Education
Gigiri	Swiss Embassy	European	Formal Education (FE)
Kilimani-Ngong Road	Morning Side office Park	Kenyan	FE
Parklands	Haveli Towers	Asian	FE
Upper Hill	Coca-cola	Kenyan	FE
Westlands	GTC & French Embassy	Kenyan and European	FE

Source: Field Work, 2020

4.3.2 Awareness of Green Roofs among residents interviewed

Additionally, most of the respondents interviewed from the neighboring households were not aware of the existing GRs around them. This can be attributed to the nature of the gated community where residents in the area live in isolation and independence from the rest of their neighbors.

However, the Europeans (most likely expatriates) interviewed in the areas were aware of green roofs and could relate with them as they mentioned they were common in their home countries. Additionally, they showed interest in acquiring GRs in future for their buildings. The Asians and Kenyans in the neighborhood were reluctant on the whole idea of adopting green roofs. They lacked knowledge on how buildings could be having gardens on their rooftops and wondered how such could be possible. Interestingly, these respondents had formal education.

4.3.3 Perceptions on adopting and maintaining vegetated roofs

The respondents who understood the concept of vegetated roofs thought that the cost of adoption and maintenance of the GRs would be too high. The GR technology was new to most of the

neighbors. The respondents thought that it was expensive both to have a vegetated roof and to have maintained. The lack of awareness and knowledge on the existing vegetated roofs on the respondents' neighborhood was seen to be associated with lack of government efforts to enlighten the public on such innovative green strategies. The respondents suggested that the government and other city managers should do a national awareness creation to the public to educate them on the green roof technology and give them incentives on those who wish to adopt GRs. Some of the respondents had an opinion of the vegetated roofs should be adopted at developers' choice. The residents can be encouraged by the government but in the end be left to make the choice on whether to adopt or not. The table below gives a detailed summary of the thoughts in terms of cost, knowledge and suggestions s given during the interviews.

Table 11; A Summary of respondent' thoughts on cost, knowledge of neighboring GRs and how they can be promoted.

Region	Nature of the Household	Respondents' thoughts on Cost of adopting & Maintenance of GRs.	Respondents' Knowledge on the existing green roof within their neighborhood.	Respondents' thoughts on how GRs adoption can be promoted.
Upper Hill	Commercial Household	High Cost	Not aware	Through Government support, awareness, and incentives.
Westlands (GTC)	Commercial Household	High Cost	Not aware	Through Government support, awareness, and incentives.
Westlands (French Embassy)	Residential Household	High Cost	Not aware	Through Government support, awareness, and incentives.

Gigiri	Residential Household	High Cost	Aware of GRs but not the one on their neighborhood.	Through Government support, awareness, and incentives.
Kilimani-Ngong Road.	Residential cum Commercial	High Cost	Not Aware	Voluntary basis and own choice.
Parklands	Residential Household	High Cost	Not Aware	Through Government support, awareness, and incentives.

Source: Field Work, 2020

4.3.4 Challenges faced during and after installation of the GRs

Installation of the green roof meant extra expenses to the developers. As explained by the directors of the building management, they had to attend several meetings to come to terms with the new budget of installation which was high as per the budget. The cost of adopting green roofs is high because of installing and maintaining charges as seen in the findings by Chen et al., (2019); Mahdiyar et al., (2018); Zhabg et al., (2012; Mahdiyar et al., (2020); Williams et al., (2010). More cost was incurred in sourcing for landscapers who would design for the type of vegetation to be planted on the rooftop. The prerequisite demands for plants with shorter roots and the expenses of getting skilled gardeners, since the green roof needs absolute care e.g. not use of sharp tools that might damage the water proofing membrane of the green roofs. Even though the cost was high, this did not stop the adoption of the new green roof since the client had future benefits at focus. Apart from the cost, the other challenge as of the study respondent is related to water collection at the rooftop with the unpredicted rains even though the management of the building has made it easier to channel the water to the ground. Maintaining a green roof is a delicate task that requires utmost attention. The person managing the GR must use work tools which are not sharp enough to damage the water layer of the GR. This makes it more costly, as trained workers should be

employed to manage the GR. The photo below shows the Coca-Cola green maintenance process whereby soil must be replaced periodically.

Photo 11: Coca-Cola GR maintenance

Source: Fieldwork, 2020

4.4 EXISTING POLICIES, PLANNING GUIDELINES, REGULATIONS, AND LAWS THAT DISCOURAGE OR ENCOURAGE MAINTENANCE AND ADOPTION OF GRs IN THE CITY OF NAIROBI

An extensive document review was done to see whether there exists urban guidelines, laws, or urban policies in the city of Nairobi that promote or discourage the adoption of GRs around the city. The documents are listed in the table below.

Table 12 A summary of the reviewed documents

Document	Information Sought in Line with adopting and maintaining GRs
Climate Change Act, 2016	County Governments of Kenya are needed to establish climate change initiatives. These 'initiatives' are not defined herein. This research brings in GRs as a micro-level climate-fighting action that fits into the 'initiatives' intended in Nairobi City County.
Conservation of biological diversity and benefit sharing regulations, 2006	The regulation backs increase of forests in Kenya. The rapid urbanization is reducing the spaces left idle to increase forests. This confirms that there is need for GRs to increase vegetation cover in urban areas.
NEMA's fourth Strategic Plan 2019-2024	This plan promotes adoption of eco-houses. Houses with vegetated roofs can serve as eco-houses. This move by NEMA is in line with this research as the GRs will help in achieving eco-houses.
Nairobi Integrated Urban Development Master Plan	This is aimed at ensuring sustainable, inclusive, resilient, and secure urban development. Development of new industrial parks was planned will endanger the few existing urban green spaces. Adopting green roofs in Nairobi is in time as it will help in restoring green spaces in Nairobi.
The Sessional Paper No. 3 of 2016 on National Housing Policy	This policy is aimed at stopping the worsening housing conditions and reduce shortage of houses. Unfortunately, the policy is focused on provision of houses but has ignored the urban ecosystem- an action that will reduce open green spaces. GRs can intervene and provide more green spaces in Nairobi.
National Urban Development Policy (NUDP)	It is focused on enhancement of environments in urban areas and mitigation of climate change. The policy advocates for increment of urban green spaces. GRs remain the best alternative for the reducing urban green spaces in Nairobi.
The Urban Areas and Cities Act, 2011	This act direct governance and management of cities and urban areas. This act can establish the guidelines for maintenance and adoption of GRs in Nairobi.
The National Construction Authority Regulations, 2014	NCA has the responsibility to manage the construction industry to achieve a sustainable construction sector. GRs are part of NCA regulations' visionary objectives. NCA approves construction of buildings and green roofs make part of building design.

Source: Researcher, 2020

4.4.1 Policies that encourage or vaguely encourage

The following policies were found to vaguely encourage the adoption of vegetated roof in the city of Nairobi.

1. The NEMA's fourth Strategic Plan 2019-2024; This plan promotes eco-house adoption across Kenya. The plan is specific on the adoption GRs, but since eco-houses are part of the green innovative strategies, the document was found to be vaguely supporting and encouraging the adoption of GRs in the city of Nairobi. The role of eco-houses in mitigating urban environmental challenges converges with the potentials of GRs in tackling urban disasters. At NEMA, the interview revealed that, despite the lack of knowledge on the idea of GRs, NEMA was concerned with developing a strategy that promoted eco-houses.
2. The National Construction Authority Regulations, 2014; the mission of the NCA is to achieve sustainable development. Through the regulations of the NCA, green roofs are approved. Innovative urban designs which NCA prioritizes, encourages GRs adoption
3. Conservation of biological diversity and benefit sharing regulations, 2006; The regulation backs increase of forests in Kenya. The rapid urbanization is reducing the spaces left idle to increase forests. This confirms that there is need for GRs to increase vegetation cover in urban areas and this regulation somehow and vaguely encourage the adoption of GRs.
4. Climate Change Act, 2016; The County Governments of Kenya are needed to establish climate change initiatives. These 'initiatives' are not defined herein. This research brings in GRs as a micro-level climate-fighting action that fits into the 'initiatives' intended in Nairobi City County. The document leaves it open for the counties to use any initiative as an intervention to the climate change mitigation.

4.4.2 Policies that discourage or vaguely discourage

Nairobi Integrated Urban Development Master Plan; This is aimed at ensuring sustainable, inclusive, resilient, and secure urban development. One of its key is focus on urban renewal, which includes beautification of the landscape like tree and grass planting on the unbuilt open spaces of Nairobi, with no mention of buildings or on making use of the concrete spaces in the city for greenery. This vaguely discourages the adoption of the vegetative roofs in the city of Nairobi in the sense that it does not suggest alternative options.

4.4.3 Policies that are neutral or indifferent

The following documents were found to neither discourage nor encourage the adoption of GRs in the city of Nairobi.

1. The Urban Areas and Cities Act, 2011; This act direct governance and management of cities and urban areas. This act can establish the guidelines for maintenance and adoption of GRs in the city of Nairobi.
2. The Sessional Paper No. 3 of 2016; This policy is aimed at stopping the worsening housing conditions and reduce shortage of houses. Unfortunately, the policy is focused on provision of houses but has ignored the urban ecosystem- an action that will reduce open green spaces. GRs can intervene and provide more green spaces in the city of Nairobi.
3. National Urban Development Policy (NUDP); It is focused on enhancement of environments in urban areas and mitigation of climate change. The policy advocates for increment of urban green spaces. GRs remain the best alternative for the reducing urban green spaces in the city of Nairobi.

4.4.4 Summary of existing polices

Review of these policy documents corroborated the interviews held with state actors, who noted that there is no set down legal framework that encourages or prohibits the adoption of GRs in the city of Nairobi. Additionally, both the state and non-state actors gave similar opinions on the need to come with a legal framework to guide on the adoption of GRs. Also, due to the technicality of maintaining the GRs, the respondents suggested that a guide on how to manage GRs should be provided by the relevant government bodies.

Overall, the respondents were concerned about the lack of legal framework on GRs in the city of Nairobi. Unanimously, the respondents suggested that GRs in city of Nairobi need to be guided by government policies. The Italbuild imports Limited was quite specific on the reduction of taxes on the importation of GR materials. The respondent suggested that the government, by reducing taxes those importing GR materials would reduce on the costs also to the buyers once the materials are imported which would encourage people to have GRs in the city Nairobi.

Table 13 Comments on the GRs legal framework from the adopted GRs respondents.

Adopted Green Roof (GR)	Respondents on the adoption and Maintenance of the GRs	Comments on the GR legal framework
Swiss Embassy GR	Project Manager Ital-Builds Imports Limited	Kenya need GR policies A law should be passed to promote adoption of GRs in Nairobi. Laws to reduce taxes on the importation of GR materials.
French Embassy GR	Pharos Architects	There is need for laws and standardization of GRs (In t6erms of Cost and materials)
GTC GR	Triad Architects Resident Engineer	Need for GR policies
Coca-Cola GR.	Triad Architects	Need for GR policies
Haveli Towers GR	Innovative Panning and Design Consultants (IPDC)	Need for GR policies

Morning Side office Park	Lariak Landscaper Limited	Need for GR policies, law and Guidelines.

Source: Field Work, 2020.

Six GRs which exist in the city of Nairobi have been adopted without following any existing guide or law. Additionally, the same GRs were being managed without any legal manual or guide from the government and urban authorities. As noted from the interviews, the government approvals of the buildings were inclusive of the vegetated roofs. It was the choice of the developer to decide on how to have the roof gardens. The maintenance of the studied GRs is not based on any law and the owners must follow their own means of managing the GRs. The documents reviewed revealed a three-dimension perspective; some policies vaguely encourage the adoption of vegetated roofs for the city of Nairobi, while some policies vaguely discourage adoption of the GRs, and other polices were found to be neutral about the idea of GRs.

4.5 STRATEGIES AND PRACTICES THAT CAN BE PURSUED IN THE PROMOTION OF GRs ADOPTION AND MAINTENANCE IN THE CITY OF NAIROBI

Most of the respondents suggested that GRs should be included in the legal procedures of obtaining permits for buildings in the City of Nairobi. Although others had a view that GRs should start as voluntary initiative by the urban developers. Respondents at the commercial bindings cautioned that the economic value of the GRs should be evaluated before the government and other city mangers imposing the adoption to the urban developers. Respondents revealed that, if the idea of GRs is widely championed, most of the residents would be aware of the benefits and probably consider adopting them. The GR owners indicated that, the cost of having a GR was an additional expense to them. To maintain the beauty of the GR, the roof must be maintained frequently which cost money. Kikuyu grass can form a nice table like level which can only be achieved by frequent grazing or cutting to form a dense tuff. For instance, the Haveli and Coca-Cola GRs have Kikuyu

grass as the main vegetation which for it to perform well, there is need for consistent supply of nitrogen (N) and phosphorous (P). On pests, Kikuyu grass is usually affected by African black beetle larvae, army worms and sod web worms and this makes a must to be maintained regularly. Various strategies can be used to promote the adoption and maintenance of GRs in the city of Nairobi. Some of the global strategies that can be borrowed include.

4.5.1 Global/ international strategies and policies or incentives that can be borrowed/adopted

1. Storm water reduction charges: some urban centers, those who install GRs are rewarded with vouchers in instead of having them pay for the sewage charges
2. Refunds, tax abatements, and rebates- some cities offer reimbursements or tax incentives to people who implement green roofing
3. Grant and loan programs- some cities offer full or partial financing in the form of grants or loans to the citizens to establish GRs
4. GR mandates- there are situations where green roofing is needed, for instance, when an existing structure undergoes key renovations or a new structure is being put up

4.5.2 Existing local practices that can be supported and encouraged

As mentioned earlier, all the six GRs were found to have been adopted without government support or any form of incentive from the city managers. Based on fieldwork carried out in this research, some of the local strategies that can be used to promote GR adoption include:

1. A mass public awareness to be done to the public on the benefits of GRs.
2. Reduce cost of construction permits for the developers intending to have GRs

3. The government of Kenya can make it a rule for those city developers to have an additional condition on the EIA License to a portion of the rooftop for GR
4. State recognition of people with GR and reward them to encourage others to adopt such green innovativeness.

Table 14: Field Work Based Suggestions for strategies that can be used to promote GRs adoption

Respondent	State actor/ Non-State Actor	Suggested strategies to promote adoption of GRs in Nairobi City.
Ital Build Imports Limited	Non-State Actor; Professional Body	Government to Impose adoption of GRs Make it compulsory to have GRs for all new buildings in the city of Nairobi.
Triad Architects and Planners	Non-State Actor; Professional Body	Government to educate the public on GRs. Government policies that support GRs to be enacted and promoted though incentives. A mass public awareness to be done to the public on the benefits of GRs. Reduce cost of construction permits for the developers intending to have GRs.
NEMA	State Actor.	Creation of awareness. The government can make a rule for those city developers to have an additional condition on the EIA License to a portion of the rooftop for GR. Incentives and reduced cost on the permits to those intending to have GRs can promote and encourage them.
Kenya Alliance of Resident Associations (KARA).	Non-State Actor	Creation of awareness. Voluntary initiative
Nairobi City County; Urban Planning Department	State actor	Incentives to be given to those intending to have GRs. State recognition of such green innovativeness. Awareness creation.
Kenya Green Building Society (KGBS)	Non-State Actor	Creation of awareness Reduce taxes on those importing Green Roofing materials. Urban policies supporting GRs to be brought up.

Source: Field Work, 2020.

Table 15; Field work-based suggestions for strategies that can be used to promote GRs adoption.

Region	Nature of the Household	Respondents' Knowledge on the existing green roof within their neighborhood.	Respondents' Suggested strategies to promote adoption of GRs in Nairobi City.
Upper Hill	Commercial Household	Not aware	Through Government support, awareness, and incentives.
Westlands (GTC)	Commercial Household	Not aware	Through Government support, awareness, and incentives.
Westlands (French Embassy)	Residential Household	Not aware	Through Government support, awareness, and incentives.
Gigiri	Residential Household	Aware of GRs but not the one on their neighborhood.	Through Government support, awareness, and incentives.
Kilimani-Ngong Road.	Residential cum Commercial	Not Aware	Voluntary basis and own choice.
Parklands	Residential Household	Not Aware	Through Government support, awareness, and incentives.

Source: Field Work, 2020.

5 CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter summarizes the research paper and draws conclusions for the findings of the research. It also gives recommendations based on the implications of the research findings. The research aimed at investigating the maintenance and adoption of GRs part of UGS for the city of Nairobi.

5.2 SUMMARY OF THE FINDINGS

5.2.1 Distribution, nature, and type of GRs in Nairobi

The study found out that GRs are unequally distributed, and all the ones that were existing and could be accessed for the study were in the upper-middle class residential cum commercial areas in Nairobi. Despite being in the high-end areas, respondents from these areas still found the cost of maintaining and installing GRs to be high, based on the green roof being installed. This is a possible reason why the few GRs are found in city's high-income regions but for commercial buildings owned by corporates, rather than individuals.

Table 16 A Summary on the Nature, Distribution and Types of GRs in Nairobi

Case Study	Location	Social-economic characteristics	Nature of GR	Size Covering the rooftop	Age (Between 0-10 years)
Swiss Embassy	Gigiri area	High Class (Upper)	Semi Intensive GR	Approximately Above 75%	Less than 10 Years
French Embassy	Westlands, Peoponi Road	High Class (Upper)	Semi-Intensive GR	Approximately Above 75%	Less than 5 Years

Coca-Cola	Upper Hill	Upper Class Business Hub	Extensive GR	Approximately Above 50%	Less than 10 Years
Haveli Towers	Parklands	High Class (Upper)	Semi-Intensive GR	Approximately Above 75%	Less than 10 Years
Morning side office park	Kilimani-Ngong Road	High Class (Upper)	Extensive GR	Approximately Above 50%	Less than 10 Years
GTC	Westlands	Upper Class Business Hub	Intensive GR	Approximately Above 75%	Less than one year

Source: Fieldwork, 2020

All the GRs have existed for less than 10 years which confirms that GRs are a recent phenomenon in the city of Nairobi with the youngest being GTC which is the only Intensive GR in Kenya as per the findings of the study. Based on fieldwork, three functions of the GRs were found to be common: environmental, aesthetic, and social. The main functions of the GRs appeared to be aesthetic. Additionally, most of the GRs were found to have Kikuyu grass, a common grass mostly used in greening and beautification of urban landscapes in most parts of Kenya.

5.2.2 Nairobi residents' perceptions on the maintenance and adoption of GRs

Both the adoption and maintenance of GRs were perceived to be expensive. Therefore, cost limitations seem to be one of the main issues that would discourage people from having GRs. Lack of awareness and understanding of GRs also appeared to be a limitation because several of respondents lacked knowledge on the existing GRs within their neighborhood. GRs were noted to a very recent phenomenon and that most of the residents of the city of Nairobi are not aware of as noted in table 11. The study found out that many of the neighbors knew nothing about green roofs in their neighborhood. For instance, the neighbors, from Morningside office park (within 100m

radius), for example, had never heard about GRs. Existing policies, planning guidelines, regulations, and laws that discourage or encourage maintenance and adoption of GRs in Nairobi

None of the reviewed policy documents gave specific guidelines on the adoption and maintenance of GRs. The policy documents were found to be vaguely encouraging, discouraging or neutral on the adoption and maintenance of GRs. Below is a summary of the reviewed documents where GRs can fit and which can provide a foundation for the adoption and maintenance of GRs in city of Nairobi.

Table 17; Summary of the documents and gaps the GRs can fit in.

Document	Gaps on which from the document that GRs can fit in.
Climate Change Act, 2016	County governments in Kenya mandated to come up with climat e Interventions. GRs as the Interventions.
Conservation of biological diversity and benefit sharin g regulations, 2006	Advocates for forest increment in Kenya. The rapid urbanizatio n of Nairobi leaves no or limited 'idle' open spaces that can be us ed for forest cover increment activities. GRs can be used to increase urban 'Forests'
NEMA's fourth Strategic Pl an 2019-2024	The NEMA's fourth strategic plan aims at promoting the adoptio n of eco-houses.
Nairobi Integrated Urban D evelopment Master Plan	To ensure secure, resilient, inclusive, and sustainable urban deve lopment. GRs complements Eco-Houses.
The Sessional Paper No. 3 o f 2016 on National Housing Policy	This policy focus on house provision while ignoring on Urban e cosystem. GRs chips to solve that.
National Urban Developme nt Policy (NUDP)	This policy framework was envisaged advocate the immediate n eeds of all people residing in urban areas. These needs include increment of the urban green spaces.

The Urban Areas and Cities Act, 2011	How to manage and govern cities and urban areas. The Act can help in providing a framework on adoption and maintenance of GRs.
The National Construction Authority Regulations, 2014	The NCA is responsible for managing the construction industry and guiding its growth with a focus to achieve a sustainable construction sector.

Source: Researcher, 2020

5.2.3 Strategies and practices that can be pursued in the promotion of GRs adoption and maintenance in the city of Nairobi

Most of the respondents both at state and non-state levels revealed lack of awareness and knowledge on existence of GRs in Kenya. Majority of the interviewees proposed that the government of Kenya should invest in creating adequate awareness on GRs. The government of Kenya was urged by respondents to come up with a legal framework to guide on the adoption and maintenance of the GRs, and have a standardized procedure that would reduce costs on have a uniformity on the type of materials to be used for GRs in Nairobi. Importation of green roofing materials was suggested by the respondents to have taxes on the materials reduced by the government to make it cheaper to sell the materials to the developers. The table below shows the proposed ways of promoting the adoption of GRs and who is supposed to implement the suggested move by the respondents.

Table 18: proposed ways of promoting the adoption of GRs

Respondent	State actor/ Non-State Actor	How to encourage and promote GRs adoption in Nairobi.	Targeted Facilitator
Ital Build Imports Limited	Non-State Actor; Professional Body	Government to Impose adoption of GRs Make it compulsory to have GRs for all new buildings in the city of Nairobi. \ Reduced Tax to the GR material importers	The Government of Kenya (GOK) County government of Nairobi

Triad Architects and Planners	Non-State Actor; Professional Body	Government to educate the public on GRs. Government policies that support GRs to be enacted and promoted though incentives. A mass public awareness to be done to the public on the benefits of GRs. Reduce cost of construction permits for the developers intending to have GRs.	The Government of Kenya (GOK) County government of Nairobi
NEMA	State Actor.	Creation of awareness. The government can make a rule for those city developers to have an additional condition on the EIA License to a portion of the rooftop for GR. Incentives and reduced cost on the permits to those intending to have GRs can promote and encourage them.	The Government of Kenya (GOK)
Kenya Alliance of Resident Associations (KARA).	Non-State Actor	Creation of awareness. Voluntary initiative	The Government of Kenya (GOK) Non-Governmental Organizations
Nairobi City County; Urban Planning Department	State actor	Incentives to be given to those intending to have GRs. State recognition of such green innovativeness. Awareness creation.	The Government of Kenya (GOK) County government of Nairobi
Kenya Green Building Society (KGBS)	Non-State Actor	Creation of awareness Reduce taxes on those importing Green Roofing materials. Urban policies supporting GRs to be brought up.	The Government of Kenya (GOK) County government of Nairobi Non-Governmental Organizations

Source: Researcher, 2020

5.3 CONCLUSIONS

Like many other cities in the developing world, the rapid urban growth and development of Nairobi is responsible for the decline and fragmentation of urban green spaces. However, as can be deduced

from literature reviewed in this study, the incorporation of green roofs into urban buildings has been found to be one of the innovative solutions to enhancing and promoting urban green spaces in several cities around the world.. Nevertheless, this study concludes that green roofs remain uncommon in Nairobi city, thereby, necessitating the need to promote their adoption geared towards restoring open spaces in the wake of concrete development. It is interesting to note that the few adopted green roofs are largely not known to the people within their neighborhood. Besides, the few who were aware got their knowledge of GRs mostly from social media. Thus, there is an urgent need to first create awareness and encourage it as part of the modern building requirements. The study also confirms that Nairobi city has no guidelines, policies, and standards that can be used to promote maintain and adopt green roofs. The few green roofs in Nairobi are adopted, installed, and maintained without intervention, support or knowledge of the national government or county government of Nairobi.

Explicit policies and effective planning need to be put in place if Nairobi is going to achieve substantial green roofs. Regarding policies, the respondents expressed diverse opinions. Some respondents, for instance, were of the view that policies ought to be formulated and implemented putting into consideration all suitable levels to achieve urban greeneries in Nairobi while targeting long-, medium-, and short-term implementation of green roofs. Finally, the research concludes that there is mismatch in pitying the environmental, economic, and social value of green roofs against the maintenance and adoption costs. The various quantifiable benefits of GRs were found to insufficiently compensate high cost of implementing the GRs. This was considered a reason behind a disincentive towards the adoption of GRs. Thus, the government ought to provide the right incentives for the adoption of GRs.

5.4 RECOMMENDATIONS

5.4.1 Recommendations from Field work

Absence of policies, planning guidelines, regulations, and laws that discourage or encourage maintenance and adoption of green roofs in Nairobi is evident. Triad architects, for instance, disclosed having installed two green roofs in Nairobi City without any legal specifications pointing to the absence of a legal framework targeting green roofs. Global green roof adoption experience reveals varied legal frameworks which differ across cities with some providing for voluntary adoption while others institute compulsory adoption (Hendricks & Calkins, 2006; Mees, et al., 2013). This study, therefore, recommends formulation and implementation of policies and regulations within Nairobi City geared towards mandating the adoption of green roofs. The observation at Pharos Architects and Italbuild Imports Limited supported mandatory adoption of vegetated roofs in Nairobi backs up this recommendation. In their view, green roofs adoption ought to not be optional. Thus, laws should be passed to pave way for the enforcement of green roof adoption by new developers within the city.

Respondents drawn from Swiss Embassy, French Embassy and GTC held a different view, vouching for the provision of incentives to adopt green roofs by the government. This perspective agrees with that of Zhang et al., (2012) in a study on the barriers to the adoption of extensive green roofs in Hong Kong. Zhang et al., (2012) concluded that lack of motivations from the government decelerated the adoption of green roofs. Even then, additional research is required to fully quantify the benefits of green roofs with particular focus on private developers for ease of policy formulation.

5.4.2 Recommendations from Literature Review

The global adoption of green roofs reveals diverse city-specific legal frameworks with elements of either voluntary or compulsory adoption (Hendricks & Calkins, 2006; Mees, et al., 2013). A review of the literature revealed that Baltimore city offers an incentive of $2 per square foot to developers who adopt green roof installation. This study recommends that Nairobi City employs a similar incentive while using Baltimore city as a benchmark.

Moreover, in enhancing the restoration of urban green spaces, this study recommends the following as established by the literature:

1. Development of green roofs adoption mandates in cities and towns, especially on emerging ones.
2. Imposition of urban sustainability mandates such that citizens are offered green roof laws without necessarily forcing them to adopt. These mandates also provide for training and educating the citizens on the importance of green roofs.
3. Restructuring the tax system in cities such that subsidies and tax waivers are availed to individuals adopting green roofs. This serves as an incentive to have green roofs.
4. Provision of financial grants and loans by city management to property developers adopting green roofs.

5.4.3 Recommendations for Future Research

This was a qualitative study that looked at adoption and maintenance of GRs for the City of Nairobi. A further study is needed especially on the quantification of the potentials that GRs have to the city of Nairobi. Further, a research is needed to test the cost benefit analysis of GRs in the case of Nairobi. Finally, all the GRs identified for this study happened to all be in the high-end

parts of the city, revealing disparities in their affordability and consequently adoption. Thus, there is need to see how the low-end parts of the city can innovate and also adopt GRs.

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7 APPENDICES

7.1 APPENDIX 1: GUIDE FOR GREEN (VEGETATIVE) ROOF OWNERS

I'm John K. Shadrack, a post graduate student; MA Urban Geography at UoN and undertaking a research on, 'The adoption and maintenance of GRs as part of the UGS for Nairobi city' this is part of the research project, fulfilling the requirements of the course. If you could provide me with some quality time to have a quick conversation about your understanding of green roofs, I will be honored.

Part one: Background information of the building.

1. Building's Name…….
2. Geographical Location ……
3. Ownership of the building (Foreign/ local) …….
4. Use of the building; Commercial or Residential …….
5. Availability of Green roof (GR); Size, usage, and age
   General Objective
6. Reasons for the vegetative rooftop?
7. Type of Vegetation on the GR and why?
8. Cost of the GR; Installation and maintenance.
9. Type of the GR?
10. What encouraged the GR's adoption?
11. Barriers to the adoption of the GR? And how they were tackled.
12. Type of government approvals required.
13. Benefits of the GR; Socially, Economically and Environmentally?
14. Do your neighbors know about this GR and how do they think of it?
15. What activities are carried on the GR?
16. How is the rainwater handled?

Distribution, Nature, and type of GRs in the city Nairobi.

17. What makes it possible to have GRs in this area?
18. What is encourages the adoption of GRs in this area?
19. What hinders large scale adoption of GRs in the city of Nairobi?
20. Why is distribution of GRs not uniform in the city?
21. Any other GRs that you know in this area?

Policies, planning guidelines, regulations, and laws that discourage or encourage maintenance and adoption of green roofs in the city of Nairobi.

22. What authorization was needed to have the GR?
23. What policy guide was followed to have the GR?
24. Any inspections on the GR done by Government officials?
25. What should be done by the government to promote GRs?
26. Should GRs be encouraged or not by the government?

Strategies and practices that can be pursued in the promotion of GRs adoption and maintenance in The City of Nairobi.

27. Any incentives by the government for having a GR?
28. How can the government make the citizens aware of the GRs?
29. How can the barriers to the GR's adoption be tackled by the government?
30. How can the GRs be promoted in the City of Nairobi?
31. Thank you so much for your time.

7.2 APPENDIX 2: INTERVIEW GUIDE FOR NEIGHBOURS TO THE GRS

I'm John K. Shadrack, a post graduate student; MA Urban Geography at UoN and undertaking a research on, 'The adoption and maintenance of GRs as part of the UGS for Nairobi city' this is part of the research project, fulfilling the requirements of the course. If you could provide me with some quality time to have a quick conversation about your understanding of green roofs, I will be honoured.

The aim of this conversion is to have your thoughts in terms of Cost and the GR technology.

How the Urban Residents perceive the maintenance and adoption of green roofs (technology, costs, maintenance, and installation).

- What do you think as the future of UGS in the City of Nairobi?
- What is the solution to the diminishing UGS in the City of Nairobi?
- Have you heard about GRs (How did you learn about them?)
- Are you aware of any GRs within your neighborhood?
- What are your thoughts on Cost of having a GR?
- How can GRs be promoted in the City of Nairobi?
- Do you think GRs are well known in Nairobi?
- How would it be made possible for all residents of the city Nairobi to be aware of GRs?
- What benefits do you think GRs have?

Thank you so much for your time.

7.3 APPENDIX 3: INTERVIEW GUIDE FOR THE STATE ACTORS

Interview questions for key informants NEMA, Nairobi City County)

Part One: Background information of Government body

Name of the Government Body	Person being Interviewed (e.g. Director General	Date of the Interview	Start time	End time	Interviewer (Name)

Based on the General Objective

1. Presently, Nairobi as city is growing amazingly fast with many developments coming up all over (Buildings, Roads etc.). Do you think we should expect more growth in the future?
2. What have been some of the environmental effects of these urban developments? Given the currents trends and patterns, what do you think is the future of the Nairobi's conventional Green spaces?
3. In the context of Nairobi, do you think urban Green spaces can have a role to play in tackling Environmental disasters that come with urbanization? If yes, which disasters and how? (please give examples)
4. What do you think could be the remedy to the reducing the declining rates of urban green spaces and open spaces in Nairobi ….?
5. Are there any innovative strategies for increasing the amount of greenery in Nairobi?
6. Are there any specific urban policies, guidelines or laws geared towards protecting open spaces or green spaces as urban growth takes place?
7. Should we advocate for expansion of green spaces and more conservation of the already existing ones? If yes, how….? What is the government or your department doing in this regard?
8. Have you ever heard of concepts such as Green roofs in urban areas? If yes, where? Do you think such green infrastructures are applicable in the Kenyan or Nairobi context? If yes, where? If not, why?
9. Where in Nairobi do you think we have green roofs and why; what determines the distribution of green roofs in Nairobi City according to you …?
10. What type of green roofs do you think exist in Kenya?
11. Do you think it is possible to have guidelines, policies and laws to lead the concept of green roofs and green walls? How can this be done?
12. Are you aware of the Historic Passing of The Climate Mobilization Act in New York City – Green Roofs Required on New Buildings?
13. As a government body what is you take on the green roofs and green walls? Should they be encouraged or discouraged? If yes, how?

How the urban residents perceive the maintenance and adoption of green roofs (technology, costs, maintenance and installation).

1. Are there any GRs in Nairobi? If yes, where? Are they of significant sizes?
2. What is your Take on the GRs?

3. Any positive effects of the adoption of the GR?
4. What are the Cost implications of GRs?

Policies, planning guidelines, regulations, and laws that discourage or encourage maintenance and adoption of green roofs in City of Nairobi.

1. Is there any law, regulation or guideline that is existing that guides developers in the city in the adoption and maintenance of greenery/ green spaces/open spaces in Nairobi?
2. How do green roofs fit in these existing laws and regulations on greenery?
3. Do we need a specific legal framework, regulation and guidelines on the adoption and maintain ace of green roofs in Nairobi? Who then should guide on this?
4. What do you think would be the main obstacle to the adoption of laws requiring adoption of green roofs in Nairobi City...?
5. Are you aware of The SDGs on the effort towards Climate Action and The Sustainable cities and communities? To what extent do you think this goal is achievable in the Nairobi city context? Please explain your answer.

Strategies and practices that can be pursued in the promotion of GRs adoption and maintenance in The City of Nairobi.

1. What are the current practices and strategies existing in Nairobi for increasing the amount of greenery in Nairobi?
2. Do you think this kind of innovative greenery ideas such as GRs would get supported by the Nairobi County government?
3. Should there be more encouragements to developers by the County government of Nairobi towards this kind of urban greenery?
4. What do you think can be done by NEMA to promote adoption of green roofs in Nairobi?
5. Do you think that the public is aware of the green roofs? What could be done to make the public aware of such greenery strategies and help them be part of the 'movement'?
6. Do you think it should be made optional or mandatory for new developments in the city to have the green roofs (Partially or wholly) Implementation in the city?
7. Are there any incentives like tax breaks or relief from paying land rates that could be given to developers to adopt greenery strategies such as green roofs?
8. Are there any strategies and/or innovative practices for increasing the number of green roofs in Nairobi, being undertaken by your department/ organization/institution? If yes, please explain more and give us any informational materials on the same.

7.4 APPENDIX 4: INTERVIEW GUIDE FOR NON-STATE ACTORS

Request for Information on The Swiss Green roof Regarding My Master of Arts in Urban Geography Research Topic Entitled; 'A Study of The Adoption and Maintenance of Green Roofs as Part of The Urban Green Spaces for Nairobi City."

I am John Kimote Shadrack, a Post Graduate Student at the University of Nairobi pursuing a Master of Arts degree in Urban Geography. Due to the ongoing Covid-19 pandemic, I am requesting, kindly for a phone call interview or email response to my 10-15 Minute interview with a Representative of The DMJ ARCHITECTS pertaining the green roof New Swiss Embassy in Nairobi, Kenya. From my site visit to the embassy on 19th Feb 2020 and an interview with Jodok Brunner through a phone call, I was advised that DMJ ARCHITECTS were the local based firm that brought the green roof into the Nairobi Context. I have designed an interview guide which you can kindly respond online and I will get it and be incredibly grateful.

Here is the link for my Interview.

https://docs.google.com/forms/d/e/1FAIpQLSfn5QqSYOI49CL0JqyVzgjOM9CFQ4imEoFyE2v9s5sWtJW8ZQ/viewform?usp=sf_link

This study aims to understand the adoption of green roofs and how they are maintained in the Kenyan context. I have received the necessary research permit from the National Council for Science and Technology (NACOSTI) as attached.

Please note that the study is only for academic purposes. It shall not involve any harm or discomfort to the respondents and no personal information will be collected. After I have finished the study, I shall submit the required copies of my study report to your office. My goal is to finish the interviews for the study completely by the End of May 2020. I will be available to share our findings and have suggestions of research or activities that may help in the study. Looking forward to your favourable consideration.

Sincerely,

John Kimote Shadrack

Candidate, Master of Arts in Urban Geography,

Department of Geography and Environmental Studies

University of Nairobi, Kenya

P.O. Box 30197, GPO, Nairobi, Kenya

Phone; +254-720624580

Email; johnshadrack@students.uonbi.ac.ke

7.5 APPENDIX 5: LIST OF THE RESPONDENTS

Case Study	Structured/unstructured In-depth interview	Respondent Non-State Actors	On Site/ off site
GTC	Both	The Triad Architects (Two Rep) The Resident Engineer The Principal Engineer The Sales Manager	Both
The Swiss Embassy	Both	Project Manager (Construction) Human Resource Manager (Admin) The operations Manager Deputy Manager The gardener ItalBuild Imports Limited	Both
Haveli Towers	Structured In-depth Interview	The Architect; Innovative Planning and Design Consultants. (IPDC) Ital Build Imports Limited	Off site
Coca-Cola	Structured In-depth Interview	The Architects (Triad Architects) Two Architects Landscaper Former Relations Manager	Offsite
French Embassy	Structured In-depth Interview	French Embassy Representative The Pharos Architects (The architects and Planner	Offsite
Morning Side Office Park	Structured In-depth Interview	Lariak Landscapers (A representative) Head of Property Management Gardener	Both

7.6 APPENDIX 6: RESEARCH PERMIT

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **198298**

Date of Issue: **18/December/2019**

RESEARCH LICENSE

This is to Certify that Mr.. John Shadrack of University of Nairobi, has been licensed to conduct research in Nairobi on the topic: An assessment of the adoption and maintenance of green roofs and green walls as part of the urban green spaces for Nairobi city. for the period ending : 18/December/2020.

License No: **NACOSTI/P/19/3213**

198298

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

7.7 APPENDIX 7: UNFILLED RAPID ASSESSMENT TOOL

UNIVERSITY OF NAIROBI

A study of the adoption and maintenance of green roofs as part of the urban green spaces for City of Nairobi

General Information		
1	Location	
2	Site Reference number	
3	Residential	
4	Non-Residential	
4	Commercial Development	
6	Accessibility	