THE VIABILITY OF RE-INVENTING KALINGALINGA TOWNSHIP INTO AN ENVIRONMENTALLY-FRIENDLY SPACE

By

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This dissertation of Chisha Chakulanda has been approved as fulfilling the requirements for the award of the Degree of Master of Science in Environment and Natural Resource Management by the University of Zambia.

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ABSTRACT

Cities worldwide are increasingly becoming vulnerable to hazards such as floods due to climate change. This study therefore sought to investigate the viability of re-inventing Kalingalinga into an environmentally-friendly township in relation to the identified climate variables of Sustainable Waste Management, green spaces and road transportation / infrastructure. The study adopted a mixed method sequential embedded design approach and conducted a cross sectional survey among eight key informants, 100 household owners and 50 commercial premise owners. Data collected through semi structured interviews was analyzed using thematic analysis while quantitative data from the Checklist were analyzed using a one sample T-Test. The study found that there are some low level sustainable waste management practices within the township, such as; 1) The existence of a recycling system though not formally structured as and this was evident through the presence of informal waste pickers.2) The households and commercial premises were engaged in some recycling and re-use practices, through the use of containers for storage purposes and the re-use of bottles for various forms of containment. However it was established that there were also some barriers to waste reduction by both the households and commercial premise owners, expressed as lack of knowledge on waste reduction practices. The viability of establishing green spaces was also apparent and this was expressed through the recognized benefits of green spaces as well as the willingness of the households and business premises to create green spaces, through apportioning some space for tree planting and maintaining some vegetation within their respective premises thus culminating into a large expanse of space covered by greening within the Township. The study also established that Kalingalinga Township ranked very low as an environmentally friendly space with regards to the investigated variables, however the viability of re-inventing it to be climate friendly is apparent through the inclusion and enforcement of climate friendly features in various development plans and programs by the planning authorities. The study was limited to a township within the city which provides an opportunity for further research at citywide level and also to investigate other components of climate factors such as energy and building infrastructure as this study only investigated three variables pertaining to waste management, green spaces and road transportation and infrastructure.

Key words: Environmentally friendly, Green Spaces, Sustainable Waste Management, Road Transportation/Infrastructure

DEDICATION

This work is dedicated to my late father Peter Bupe Chakulanda and my mother Mary Elizabeth Nyirenda who at an early age inculcated in me and emphasized the importance of reading and having an education. My husband Brian Banda and my children Towela-Jane and Malaika Banda who encouraged me and gave me the much needed time to focus and accomplish this level of education. I am so grateful for your patience and understanding, may The Lord God Almighty Bless You.

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LIST OF ACRONYMS AND ABBREVIATIONS

BRT	Bus Rapid Transit
CA	Conservation Agriculture
CO2 eq	Carbon Dioxide equivalent
GHG	Green House Gas
Gg	Giga Grams
ZEMA	Zambia Environmental Management Agency
MOGEE	Ministry of Green Economy and Environment
RDA	Road Development Agency
IPCC	Inter Governmental Panel on Climate Change
GDP	Gross Domestic Product
MRT	Mass Rapid Transit
LRT	Light Rail Transit,
FAO	Food and Agriculture Organization
CBD.	Central Business District
UN	United Nations
UGS	Urban Green Spaces
LUD	Lusaka Urban District
WB	World Bank
UNZA	University of Zambia
UTH	University Teaching Hospital
VCT	Voluntary, Counselling and Testing
LWSC	Lusaka Water Sewerage Company
CBE'S	Community Based Enterprises
NASREC	Natural Science Research Ethics Committee's
SPSS	Statistical Package for the Social Sciences

CHAPTER ONE: INTRODUCTION

1.1. Background to the study

Global climate change and the inevitable global warming is expected to have major impacts on the climate worldwide (IPCC, 2007). Cities will therefore be exposed to climate change from greenhouse gas induced radioactive forcing, and localised effects from urbanisation such as the urban heat island (McCarthy, 2010).

Urbanization, climate change and cities are intricately related as change in any one will affect the others. The world's population is quickly becoming urbanized. As of 1950, less than 30% of the world's population lived in cities. This number grew to 47% in the year 2000 (2.8 billion people), and it is expected to grow to 60% by the year 2025. The world's urban population is expected to increase by 84 % by 2050 taking 2009 as a base year (from the 3.4 billion in 2009 to 6.3 billion in 2050). All this means more and more people will be living in urban areas, as more and more people migrate to cities (Chan, 2017).

Uurbanisation has significant implications for climate change; air quality; water availability and quality; land use; and waste management. Provided that the right policies are put in place, the current wave of rapid urbanisation offers an unprecedented opportunity to create sustainable, liveable and dynamic cities. Cities are also particularly vulnerable to climate change and this is because extreme weather events can be especially disruptive to complex urban systems. For instance, vulnerability to storm surges and rising sea levels is set to increase rapidly over the coming decades and this will greatly impact the low-lying coastal areas. (OECD, 2014).

Cities must adapt to be sustainable in terms of their energy, food, water and other resource needs. This implies that they must control their ecological, water and carbon footprints in the face of climate change. Cities contribute to climate change via burning of fossil fuels, generating urban heat islands, deforestation and other activities. Generally, cities account for around 70 percent of global energy consumption and greenhouse gas emissions and are subject to climate change and its ill effects (Osborne, 2016). However, they can also help control climate change via reducing greenhouse gases, renewable energy, green designs, sustainable communities, eco-cities and other city measures. Building sustainable cities entail moving away from reliance on fossil fuels, but developing clean and more sustainable alternatives. In view of the above many cities worldwide are moving towards becoming climate friendly with

many European countries like Sweden, Denmark and the Netherlands leading the way (Chan, 2017).

Urban planning and urban design have a critical role to play in the global response to climate change. Actions that simultaneously reduce greenhouse gas emissions and build resilience to climate risks should be prioritized at all urban scales metropolitan region, city, district/neighborhood, block, and building. This needs to be done in ways that are responsive to and appropriate for local conditions. Climate change mitigation and adaptation strategies should form a core element in urban planning and design taking into account local conditions. Decisions on urban form have long-term (>50 years) consequences and affect the city's capacity to reduce greenhouse gas emissions and to respond to climate hazards. Investing in mitigation strategies that yield concurrent adaptive benefits should be prioritized (Rosenzweig etal, 2015).

Southern African cities, being densely populated, urban environments with expanding populations as compared to the rest of the countryside, are vulnerable to harsh weather, climate variability, extreme climate events and associated risks among other factors. Cities play a tripartite role when it comes to climate change as they are contributors to climate change through greenhouse gas emissions; bear the brunt of climate change; and can simultaneously be places of climate change (transformational) adaptation through innovation and solutions that can build resilience. Cities in southern Africa face a multiple stressor context with several development challenges including inadequate water provision, mismanagement, governance and infrastructure challenges and lack of financial resources. The city-space, is therefore characterized by complexity, and multiple, interconnected subsystems or ecosystems in which city planning and implementation should be considered using a climate-resilience development lens (Ndebele- Murisa, 2020).

Climate change projections indicate that southern African nations such as Zambia will experience temperature increases of between 1 and 2˚C by 2050 (UNDP, 2013). However, significant uncertainty persists with respect to future precipitation patterns, showing both the potential for a warmer-wetter and warmer drier climate (Hachigonta etal, 2013). Despite this uncertainty over the amount of precipitation that will fall, there does seem to be a consensus that extreme weather events more broadly, will increase in frequency (IPCC, 2014). In a 2010 analysis of the last four decades of climate, the Zambian Metrological Department (ZMD) established that frequency of extreme events has increased in Zambia. They also recognized

that there will be a change in the annual pattern of precipitation. It is expected that while rainfall events will tend to become less frequent, there will be more intense rainfall events, separated by a large number of dry days. This variable precipitation is likely to have significant impacts in Zambia and on Lusaka in particular. (FCFA, 2020).

Overall emissions results indicate Zambia was a net sink in 1994, 2000, 2005 and 2010. The sink capacity however, has been observed to be reducing over the years. The net sink reduced by 70.6 percent from -57,124.0 Giga grams (Gg) Carbon Dioxide Equivalent (CO2 eq.) to -16,815.2 Giga grams (Gg) Carbon Dioxide Equivalent (CO2 eq.) in 1994 and 2010 respectively. Further, the total Green House Gas (GHG) emissions increased from 85,805.1 Giga grams (Gg) Carbon Dioxide Equivalent (CO2 eq.) in 1994 to 120,507.7 Giga grams (Gg) Carbon Dioxide Equivalent (CO2 eq.) in 2010 representing a growth of 40.4 percent (GRZ, 2020).

The country has experienced a number of climate hazards over the past decades which include droughts, seasonal flash floods, extreme temperatures and dry spells. The frequency of occurrence including the intensity and magnitude of droughts and floods have increased and are adversely impacting on food and water security, infrastructure, energy, health and sustainable livelihoods of communities. Such a scenario therefore requires cities to be climate resilient so as to counteract the climate change impacts as well as to provide solutions in order to ensure climate change mitigation (GRZ, 2020).

For Lusaka City, a comprehensive development urban plan has been developed to guide the planning and development of the city from 2010 to 2030 with review periods after every five years. The plan encompasses the protection of the environment and green network development and also takes into account other sectors comprising of sustainable urban transportation and buildings (MLGH and JICA, 2009). Lusaka city is a hybrid of townships, suburbs commercial areas and unplanned settlements but of particular interest to this study is the township of Kalingalinga which is an improved settlement, therefore due to its strategic position within the city it provides potential as a model for eco-city transformation.

The purpose of this study is to create a model of a climate friendly and resilient township by incorporating components that would enable the township have minimal contributions to climate change through reduced Greenhouse gas emissions. Further the study aims to develop a model that is climate resilient which can be able to withstand climate induced hazards of extreme weather conditions which may result in floods or heat waves.

This chapter gives a global overview of cities, urbanisation and climate change, it then gives a regional account of cities and climate change with a focus on the vulnerability of cities in Southern Africa. The chapter thereafter narrows the discussion to focus on Climate Change in Zambia and particularly in the city of Lusaka whilst drawing attention to the identified characteristics of an Environmentally Friendly Township. Finally, this chapter also highlights the purpose of the study.

1.2. Problem Statement

Kalingalinga Township is a low cost residential area where environmentally friendly features and practices that do not support GHG emissions have not been included during the planning of the township as an improvement area, contrary to the requirements of an environmentally friendly township as prescribed by Chavan etal (2013), who indicates that environmentally friendly townships should include the following environmental indicators which are responsible for defining the environmental conditions of the township and these include; waste management, gardens and open spaces, use of passive technologies for energy generation and the reduction in pollution /no air pollution .These unfriendly environmental features that have been left out include poor waste management system which entails that Kalingalinga Township does not have an integrated solid waste management system comprised of reduce, reuse and recycle processes (Zulu,2019). Further no provisions have been made for waste separation at the source of waste generation and there are no waste recycling companies within the township that can recycle waste for other uses (Menikupra *et al,* 2012).

Kalingalinga Township suffers from a lack of incorporating open green spaces and/or urban afforestation activities through various greening mechanisms, this situation has further been compounded with the fact that the Township does not have existing large spaces required for the creation of green spaces such as park areas (Nero et al, 2017).

The transportation sector within the township has not taken into account the provision of bicycle, pedestrian and separate lanes for public busses as well as the implementation of a bus rapid transit system within the township. This is in contrast to the prescribed requirements of an environmentally friendly transport system as indicated in literature (MoI, 2011). In addition, most of the existing road network have not been constructed in a climate resilient manner and therefore do not have proper drainage systems to allow for efficient draining of surface and storm water and this contributes to heavy flooding in the township. A situation that is

compounded with the fact that Kalingalinga Township is located in a flood prone area hence the need to put up climate resilient infrastructure (Yasini, 2007). The occurrence of floods in the area adversely impacts on food, water security, sanitation, infrastructure, energy, health and sustainable livelihoods of communities (Mwape, 2009).

The failure to incorporate potential impacts of climate change in the upgrading of various aspects and services within Kalingalinga Township has rendered it vulnerable to climate induced hazards such as floods and extreme temperatures both hot and cold. This study will therefore endeavor to explore options to reducing the impact of Kalingalinga townships Carbon footprint due to the lack of incorporation of environmentally friendly features towards climate action hence resulting in the visible effects of flooding and extreme temperatures either hot or cold within the township

1.3. Aim

To assess features that can help Kalingalinga Township become environmentally friendly.

1.4. Objectives

i. To assess the extent to which Kalingalinga Township adheres to environmentally friendly standards in terms of roads, green spaces, transportation and waste management.
ii. To assess sustainable solid waste management practices in Kalingalinga Township.
iii. To investigate the viability of establishing green spaces in Kalingalinga Township.

1.5. Research Questions

i. To what extent does Kalingalinga Township in terms of roads/transportation system, green spaces and waste management adhere to environmentally friendly standards?
ii. What waste recycling systems are being utilized within Kalingalinga Township?
iii. How can the available waste recycling system be positioned to effectively contribute to a green environment in Kalingalinga?
iv. How can residents reduce on waste generation?
v. What are the barriers towards residents' engagement are in re-use of waste in Kalingalinga Township?
vi. What are the alternatives to creation of green spaces in Kalingalinga Township?
vii. How can green spaces in Kalingalinga Township be enhanced?

1.6. Significance of the Study

The relationship between climate change and cities is an important one. Cities are the hub of urbanization and modernity, housing large human populations due to the opportunities that they offer in the form of, improved standards of living, employment and technological advancements. The numerous activities taking place in the city cause them to become major contributors to greenhouse gas emissions, thereby exacerbating the effects of climate change.

This study will therefore provide relevant and practical information for urban mitigation strategies with a particular focus on the unplanned settlements such as Kalingalinga Township. This arises from the realization that unplanned settlements have a bigger carbon footprint hence targeting these areas will result in a larger impact for climate resilience. The knowledge and information produced may therefore be used by the planning authority as they re-orient the outlook of the township. Information from this study may also be replicated to other townships within the city thereby increasing the contribution of the city to climate change mitigation and adaptation.

Residents of Kalingalinga Township will be the primary beneficiaries of this study, this is from the knowledge and information that will be gathered and may be used to come up with effective strategies of planning an environmentally friendly township by the planning authorities who in this case are the Local Authority. The environmentally friendly township will be comprised of an integrated and sustainable waste management system, green areas as well as a sustainable transport system which will in evidently create a clean environment as well as social - economic benefits. For instance, a sustainable integrated solid waste management system can bring about job creation and entrepreneurship ventures for residents in the township. The Local authority being the district planning authority of Lusaka together with other organizations aligned with Environment and Climate issues such as Zambia Environmental Management Agency (ZEMA),Ministry of Green Economy and Environment and the Road Development Agency (RDA) also stands to benefit as this study provides information on how residents perceive climate issues and it also provides a template/guide on how improvement areas and even those unplanned settlements that are earmarked to be improved can be consciously planned with the incorporation of environmentally friendly factors towards climate action.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

Literature review is a fundamental part of the entire research process (Kumar 2005:30). It is an important aspect of research as it helps identify what is known and unknown about a particular area or subject and also identifies areas of controversy or debate that need further investigation (Bolderston, 2008). Bruce (1994:218) states that "the purpose of literature review is to provide the background to and justification for the research to be undertaken". Similarly, Creswell (2003:30), points out that reviewing literature helps one compare study's findings with those of others, therefore assisting the researchers build knowledge in their field of study.

2.2. Theoretical Framework: General System Theory

General system theory originated in the 1940s in the work of the biologist Ludwig von Bertalanffy who initially sought to find a new approach to the study of life or living systems. More broadly, Von Bertalanffy envisioned general system theory as a way to address the increasing complexity of the world's problems. General system theory emerged as an alternative to the dominant form of inquiry and way of thinking, reductionist analysis, which was criticized for being unable to address wholes, interdependence, and complexity. General system theory was presented as a new way of thinking that allows for the study of interconnections among systems and accounts for the nature of 'open systems' which interact with their environments (Montuori, 2011).

General system theory introduced key concepts such as *open and closed systems,* stressing the role and importance of context and environment, equifinality, or the way systems can reach the same goal through different paths, and isomorphism's or structural, behavioral, and developmental features that are shared across systems. General system theory positioned itself as transdisciplinary rather than interdisciplinary. Interdisciplinary refers to *inter*action between disciplines, whereas transdisciplinary refers to going beyond or across disciplines. General system theory would be the common language across diverse disciplines. Central to this language was the concept of 'system,' defined as a group of interacting, interdependent elements that form a complex whole. It also pointed toward a new world view that emphasizes such key concepts as every system's embeddedness in other, larger systems, and the dynamic, ever-changing processes of self-organization, growth, and adaptation. It is not surprising therefore that systems concepts have been central to the rise of ecology as a field of inquiry,

with such concepts as ecosystem. In creativity research the systems approach has also at times been referred to as an ecological approach, because of the emphasis on the larger ecosystem in which creativity emerges (Bertalanffy, 2003).

This theory therefore guides this study in that it is based on creating a climate friendly system for the township of Kalingalinga which will be composed of various components such as green spaces, transportation and waste management. The study recognizes that the problem of Kalingalinga Township not being climate friendly is part of a bigger picture which encompasses other interrelated factors such as the economic, social and institutional factors which hinder the township from becoming climate friendly. Therefore, in order to find solutions to this problem the components of the system should be looked at holistically and not in isolation of one another.

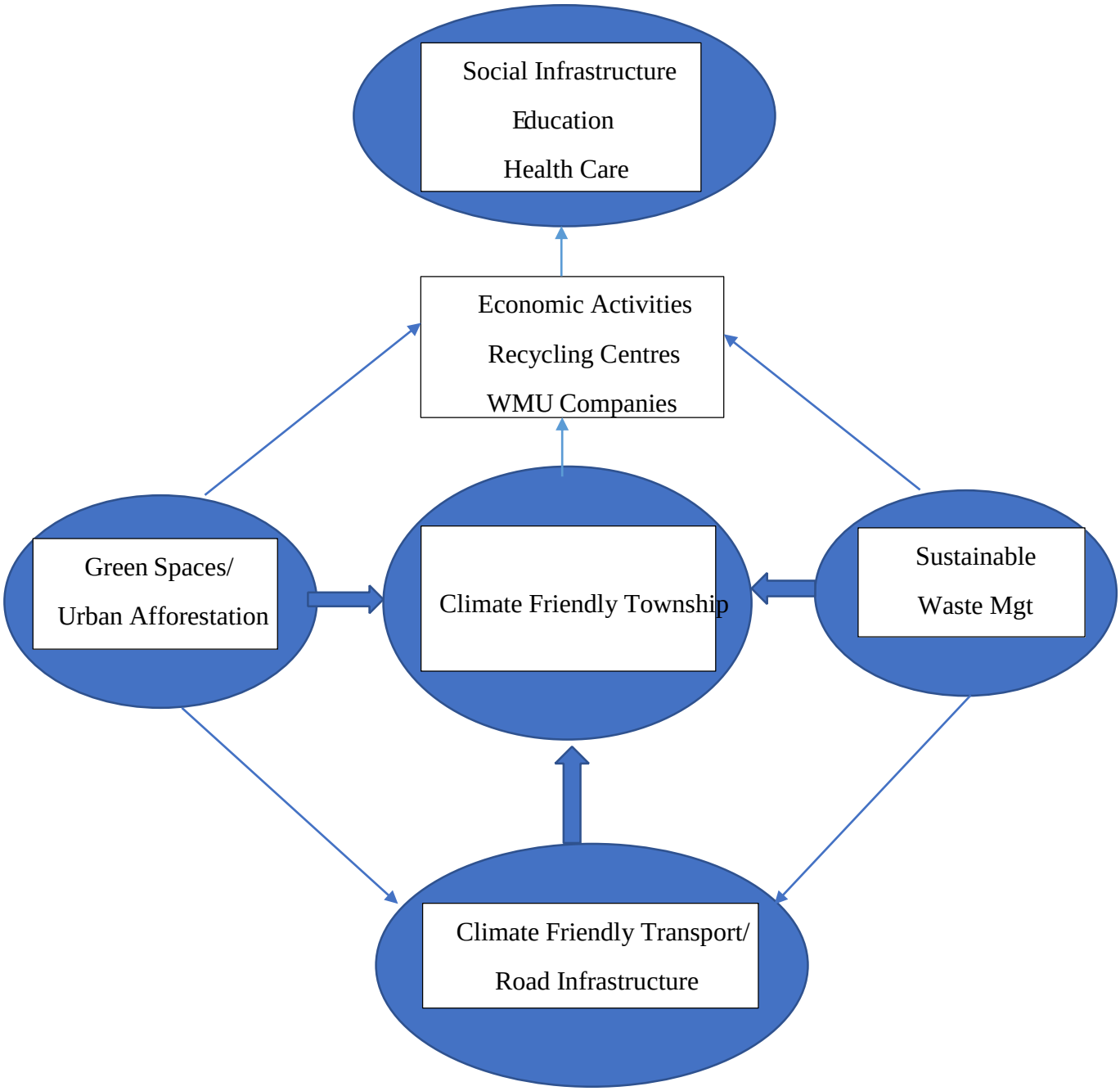

Figure 1: A system of a set of interconnected parts showing a green township

Source: Author (2021).

The figure above depicts an environmentally friendly township centered on the concept of sustainability which encompasses the Economic, Social and the Environmental Aspects interlinked in a holistic manner (Harris, 2003). Figure 1, highlights how the three components are connected using the lens of the systems theory where the Environmental factors (green

spaces, climate friendly transportation/infrastructure and sustainable solid waste management) should be incorporated in tandem with the economic and social factors. Where the inclusion of the environmental factors will benefit the economic and social Factors in the township in the following manner.

Economic Factors

Sustainable Waste Management Practices can result in the creation of employment through the establishment of business enterprises dealing in the Waste Value Chain for recovery and recycling of waste materials within the township (Papargyropoulou etal, 2015). The waste management companies within the township which are the Community Based Enterprises that have the responsibility of waste collection and disposal will also benefit from the sustainable waste management practices by also recovering recyclable waste from the collected waste and selling it to waste recycling companies. In addition, the CBE's will be able to reduce on the cost of disposing of the collected waste to the designated dumpsite as the practice of sustainable waste management entails a reduction in the waste produced by the community by re-using some of the products acquired such as bottles (Bacinschi etal,2010). According to the Natural Resources Defense Council (2014) waste collection and disposal in landfills creates one job per 1,000 tonnes of waste managed, the collection, processing, and manufacturing of products with recycled materials as feedstock creates six (6) to thirteen (13) or more jobs per 1,000 tonnes, depending on the material.

Green spaces are areas that have contiguous vegetated areas and spaces, such as artificially created city parks, stands with natural vegetation and land areas such as botanical gardens, as well as isolated street trees, street medians and private gardens. Green spaces also include school grounds and sports fields (Thaiutsa etal, 2008). The creation of the green spaces can be linked to the economic sector through the selling of vegetables, fruits and plants by the residents within the township for economic benefits. Furthermore, the creation of recreation facilities and play parks can also be used for economic benefits through the charge of access fees to use the facilities and in addition companies may be allowed to advertise their products at a fee at these sites (Juanee, 2015).

Creating climate friendly roads/transportation infrastructure is linked to the economic sector by way of providing available and accessible transportation through the use of bus rapid transit systems, bicycles and well laid walkways for the residents of the township to easily get to

their places of work and also to ferry their goods to the market places for the realization of economic activities (Valdemars and Atstaja, 2023).

Social Factors

The social sector in the township stands to benefit from the creation of the climate friendly township through the above identified variables of green spaces, sustainable waste management practices and climate friendly transportation and infrastructure. This will arise from the ripple effect arising from the economic activities from the identified environmental variables that have been mentioned (Gasper etal, 2011). This will therefore translate into having available resources to develop the social sector within the township, such as improved infrastructure and facilities for the health and education sectors as well as the improvement of recreation facilities. Further an increase in economic activities for the resident's entails that they have available resources to access the available social facilities within the township. Finally, the outlook of the township will be improved and will attract more people to visit the township thereby increasing the economic viability of the township (Gouldson, 2018). This therefore shows the creation of a climate friendly township operating as a system of a set of interconnected parts which brings value to the township.

2.3. The City and Climate Resilience

The definition, nature and character of 'the city' as any singular entity are highly variable and contested, it can be shown that the twentieth century witnessed a rapid process of urbanization, particularly in the industrialized countries of Europe, North America and Australasia, and more recently in Asia, so that, by 2010, over half of the world's population lived within some form of urban context that is broadly understood as a 'city'. By 2030, it is predicted that almost five (5) billion of the world's population of over eight (8) billion will live in cities, and this process of urbanization is likely to be most rapid in the least developed countries. Although large megacities will continue to grow rapidly, most urbanization is predicted to take place in smaller urban centers (UN-Habitat 2011: 2).

As sites of rapidly growing population, cities have come to be seen as part of the climate-change problem. On the one hand, cities are now seen as potential sites of climate vulnerability. On the other hand, cities are regarded as critical to the production of the GHG emissions that are creating the risks of climate change in the first place. The concentration of energy use within urban areas, in industry, transportation, and domestic and commercial buildings, means that cities are central to the ways in which GHG emissions, and particularly carbon dioxide, the most common GHG, are produced. According to the International Energy

Agency, projections indicate that over 80% of the projected increase in demand for energy will come from cities in non-OECD countries' (International Energy Agency 2009: 21); that is, the vast majority of future increases in energy demand will come from those least developed and developing countries outside the Organisation for Economic Co-operation and Development.

The word "Resilience is a new term comparatively gaining usage in policy debates as well as academic publications to refer to how the society suppresses its vulnerability to hazards caused by nature and humans. Resilience was further elaborated by Carpenter et al. (2001) to explain socioecological systems interaction which was supported by Twigg (2007) as the community's ability to adequately manage disturbances. Further the Intergovernmental Panel on Climate

Change (IPCC) defines resilience as 'the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity of self-organization, and the capacity to adapt to stress and change.' (IPCC, 2007). According to Almqvist, Barnett, and Wilkinson (2014), Moglia et al., (2018) and Pelling et al., (2018), for reduction in disaster risks and climate change adaptation globally, urban planning is a major factor to be considered. A resilient city is, therefore, an urban community capable of establishing and hasten an adaptable and equitable relationship between the civic elements and hard infrastructures which include built roads, buildings, energy facilities, waterways among others (Godschalk, 2003). In the case of urban climate adaptation, an approach based on resilience encourages practitioners to consider innovation and change to aid recovery from stresses and shocks that may or may not be predictable. Resilience building as a strategic approach has many advantages over conventional system management for complex social – ecological systems that are dynamic and facing high uncertainty (Walker et al, 2002).

The concept of urban resilience is increasingly used for the planning and development of public policies as well as the carrying out of activities coordinated by international agencies seeking the sustainable development of cities. The term resilience refers to the ability to cope with borderline situations and, at the same time, to adapt to changing circumstances. From the perspective of urban areas, this concept refers to the ability of cities to resist and overcome the various challenges they face. Some of these are extremely harmful, leading to the destruction of homes, killing people, and causing large financial damages. The poorest people are often the most affected by these problems. (Alvarez-Risco etal, 2020). Urban growth occurs mostly in emerging economies and developing countries, but a common feature of this

growth is that it is unplanned and informally carried out (OECD, 2017). Making the situation more challenging is the report that 1.4 million people move daily to urban areas, and that a growing number of people are subject to wars and climate impact.

Southern African cities, being densely populated, urban environments with expanding populations as compared to the rest of the countryside, are vulnerable to harsh weather, climate variability, extreme climate events and associated risks among other factors (Ziervogel, 2019). For instance, droughts often experienced in cities like Cape Town and Windhoek and currently across the southern African region because of low rainfall levels this past rainy season of 2018/2019 have become more frequent, intense and widespread (Sorensen,2017). While variations in inter annual rainfall have increased in the past half century these extreme events are projected to likely increase in the future

Cities in southern Africa face a multiple stressor context with several development challenges including inadequate water provision, mismanagement, governance and infrastructure challenges and lack of financial resources. At the same time, these and other cities function as ecosystems which are connected through processes that function at multi-scalar and high levels of complexity (Campbell, 2016). The city-space, is therefore characterized by complexity, and multiple, interconnected subsystems or ecosystems in which city planning and implementation should be considered using a climate-resilience development lens. Notably, the interaction of physical ecosystems with the built environment, social and financial systems, environment and climate is indeed complex, even more so in rapidly urbanizing African city regions where intricately, interconnected infrastructure, institutions and information form the urban ecosystem. Understandably, there is growing concern about the resilience of these urban areas, particularly in vulnerable and underdeveloped regions such as southern Africa, given the connectedness and fragility of the urban ecosystems and the need for transformative over an incremental adaptation and mitigation agenda even under 1.5˚C average global warming trends (Bai,2018)

The multi-stressor context, which is compounded by climate change and variability, means that these cities need to respond swiftly, flexibly and creatively to develop systematic, systemic, sustainable and resilient solutions to the climate crisis. The multi-stressor context requires numerous responses, which may consist of responses in physical planning such as ‘hardening up of infrastructure systems, including storm-drainage systems, water supply and treatment plants with protective physical improvements; protection or relocation of solid

waste management facilities, energy generation and distribution systems; and consolidation of hydro-geologically fragile areas' (Bigio,2003), and/or ecosystem- and community-based adaptation.

2.4. Characteristics of a climate-resilient township

Waste Management Waste management is the collection, transport, processing, recycling or disposal, and monitoring of waste materials. The term usually relates to materials produced by human activity, and is generally undertaken to reduce their effect on health, the environment or aesthetics. (Bacinshi, 2015). The climate benefits of good waste management practices result from avoided landfill emissions, reduced raw material extraction and manufacturing, recovered materials and energy replacing virgin materials and fossil-fuel energy sources, carbon bound in soil through compost application, and carbon storage due to recalcitrant materials in landfills. In particular, there is general global consensus that the climate benefits of waste avoidance and recycling far outweigh the benefits from any waste treatment technology, even where energy is recovered during the process. Although waste prevention is found at the top of the 'waste management hierarchy' it generally receives the least allocation of resources and effort. Resource managers in all cities should consider options such as reduce, re-use, recycle, and energy recovery in the waste management hierarchy. It can also be noted that in developing nations such as Zambia, the informal waste sector makes a significant but typically ignored contribution to resource recovery and GHG savings (UNEP, 2010).

Transportation. Transportation encompasses roads, highways, airports, railroads, public transit, ports, and bicycle trails, as well as the interaction of these systems with cities and communities. Transportation infrastructure and systems affect both Green House Gas (GHG) emissions and public health (Younger, 2008). Urban transport systems are major emitters of greenhouse gasses and are essential to develop resilience to climate impacts. At the same time cities need to move forward quickly to adopt a new paradigm that ensures access to clean safe and affordable mobility for all (Rosenzweig et.al. 2015). In order to deal with GHG emissions from the transport sector municipalities have sought to provide public transit systems, to promote low-carbon vehicle technologies and to encourage individuals to choose alternatives to the private vehicle. In terms of public transit, one approach that is growing in popularity is the Bus Rapid Transit (BRT) system, which involves guided bus ways or dedicated bus lanes, together with mechanisms to give buses priority in urban traffic (Bulkeley, 2016).

Vegetation and Green Spaces. Urban green spaces are public and private open spaces in urban areas, primarily covered by vegetation which are directly (e.g. active or passive recreation) or indirectly (e.g. positive influence on the urban environment) available for the users (Baycan-levent and Nijkamp, 2009). These green areas enhance ecosystem health and climate change resilience, contribute to biodiversity, and benefit human populations through the maintenance and enhancement of ecosystem services (Pauleit et al, 2011).

Urban green spaces are preserves of several ecosystem services which include direct mitigation of urban heat island effect by cooling through evapotranspiration and shading, improving air quality (by regulation of particulate matter, NOx, SO2, CO and O3), mitigating floods and runoff, recreation and cultural services provisioning, erosion control solid waste and sewage disposal, fuel and food provisioning, ground water supply acting as windbreaks, psychological and other health benefits and as sources of food. The capacity of Urban green spaces to provide ecosystem services is reinforced by their area extent in the city, composition, biodiversity, and efficiency in their management (Nero et.al, 2016). Therefore, vegetated surfaces are more effective in rainwater storage and decreasing runoff than built-up areas (Szaraz, 2014).

2.5. Case Studies of Eco-Friendly Cities.

2.5.1 Mexico City

Once a capital of the Aztec empire called Tenochtitlan, the area now occupied by Mexico City has been inhabited for centuries. After the 16th century Spanish conquest, Mexico City became the capital of New Spain. Now it is the most populous city in North America with over 22 million people in its greater metropolitan area. Mexico City stretches across 1,485 square kilometres and has the globe's 15th largest Gross Domestic Product (GDP). Challenges of growth are inevitable in a metropolis of this size.

The city is surrounded by mountains and is a large valley located on the high altitude site once covered by the waters of Lake Texcoco. Its geography historically has made it subject to flooding and wastewater management issues as well as freshwater supply challenges. Yet adaptation to change has always been a hallmark of Mexico City. The city developed a climate change plan aligned with the Paris Agreement and the goal of keeping temperature rise to below 1.5°C. By 2050 Mexico City expects to decarbonize, with an interim goal by 2025 of reducing carbon emissions by 31.4 million tonnes. The climate plan includes seven strategic areas: society and population, ecosystems, energy, as well as emissions, productive systems,

the private sector, and mobility. In 2018, Mexico's President Andrés Manuel López Obrador cancelled plans for a giant international airport project and instead embarked upon building one of the world's largest ecoparks, the Parque Ecológico Lago de Texcoco. Parque Ecológico will be situated where the original lake system that fed the city's early water needs is located. The goal with the Parque Ecológico is to rejuvenate drained lakes and restore swaths of Texcoco's wetlands while creating recreational spaces, an urban forest, and green infrastructure in one of the city's last undeveloped areas. Over 10 miles wide and covering 30,000 acres (12,000 hectares), the park grounds will include an urban forest to capture carbon and mitigate air pollution. Also to mitigate emissions, Mexico City has developed an extensive public transport system including the use of electric buses and a network of bike lanes. Regulation of diesel engines and a new system to improve efficiency of street lighting, wells, and pumping plants will also help reduce carbon emissions. In addition, Mexico City has pushed forward initiatives such as a ban of single-use plastic that went into effect in January 2021, which will help reduce the seven million tons of plastic the city accumulates annually.

The cities abundant, six-month rainy season was a natural plus for planning a sustainable water supply, and via the Cosecha de lluvia (Rainwater harvest) program the city is installing rooftop water collection and purifying systems. In 2021 over 500 neighbourhoods will be eligible for the program of either free or subsidized collection systems - over 20,000 homes have benefitted in the program's two-year history. Leak repair and grey-water usage are additional strategies the city is pursuing (WWF, 2021).

2.5.2 Stockholm Smart City

Stockholm is Sweden's most densely inhabited city, in fact about 20 % of the Swedish population lives in it. The city is situated along the east coast of Sweden, developing over fourteen islands that emerge where Lake Mälaren meets the Baltic Sea (Sanseverino, 2016).

Stockholm has put into practice in a few years a number of actions that will allow to reach the ambitious project to be fossil fuels free in 2050. Stockholm is a "green city" rich in parks and open spaces to cross and to spend time: 90 % of the population live less than 300 m far from a green area. This choice was further enhanced in the new city plan, which already from the nickname shows that it is a "Walkable" city. This allows an improvement in the quality of life by recreational activities, water purification and noise reduction as well as biodiversity and ecology support. Stockholm has already reduced CO2 emissions by 25 % compared to 1990. Currently they are less than 4 tons per capita, half the Swedish average. 69 % of households

have access to district heating, in which the share of renewable energy is close to 70 %. The biogas is produced in plants for the treatment of waste water through the digestion of organic sludge. In the eco-district of Hammarby, the waste water from a single house produces sufficient biogas to cover the gas demand for cooking use. Most biogas is currently used as fuel in cars and environmentally friendly bus. The collection of food waste for biogas production has increased from 4500 to 18000 tons between 2008 and 2012. The city has an excellent system for the treatment of waste and uses innovative production methods as an underground transport system of municipal solid waste which works by suction. 25 % of the 3 Smart Cities: Case Studies 67 waste produced by the Stockholm is recycled, 73.5 % is recovered for use (by incineration) district heating plant and 1.5 % is biologically treated (Stockholm City Council, 2010b).

The Stockholm City Council Master Plan of (2010) has a strong mobility infrastructure system which consists of subway, suburban trains and trams. Public transport is very efficient and is used by the majority of residents, on average 60% of commuters use public transport and during rush hours the same share reaches 80%. This results from the fact that transport capillary networks are integrated and, 90 % of the population live less than 300 m from a bus stop. All city buses are powered by bio-fuels and all subways and trains are powered by electricity produced from renewable sources. There are many cyclists of all ages, no scooters and, in the last 15 years, car use has significantly decreased. The city government is committed to building new infrastructures and to reduce the impact of transport.

2.5.3. Singapore City

An account of Singapore as a smart city has been outlined by Sanseverino etal (2016). Officially Republic of Singapore, is an island nation in South-East Asia, located on the southern tip of the Malay Peninsula which is connected by two major roads, located 152 km north from the equator imaginary line. To the north it is separated from Malaysia by the Straits of Jo-hor while to the south is separated from Indonesia's Riau from the Straits of Singapore.

Thanks to strong infrastructures, the city of Singapore is conquering the record for being one of the smartest cities of the world. From a recent analysis Singapore is considered the first in the world as regards the economic business. It already held the record as being the cleanest city and with less crime in Asia, it is now also the most environmentally friendly. The Conclusions of the Asian Green City Index61 have shown this. The assessment of this type of leadership is through environmental performance measures and considerations of 22 major

Asian cities by comparing eight different parameters: Carbon Dioxide (CO2) emissions, energy consumption, environmental friendliness of buildings, urban transport and mobility, water management and treatment, waste management, air quality and environmental governance.

The main actions for smart mobility include a network of 142 stations across the island and more to come, the Mass Rapid Transit, MRT, and Light Rail Transit, LRT, system is one of the most popular modes of transport in Singapore with a ridership of well over 2 million passengers each day. Purchase and use of cars. It is a considerable expense to buy and drive a car in Singapore because the government, through various measures, checks the number of vehicles travelling in the state, with the aim of keeping the environment as clean as possible and avoid traffic congestion. The heavy import taxes and other charges also for licensing pose, in fact, an obstacle to the desire of the people of Singapore to own a car.

2.5.4. Kigali

According to Bafana (2016) in Africa's cities of the future, Rwanda's moniker, "land of a thousand hills," not only attests to the country's unique geography but also suggests the trajectory of Kigali through its many crises to become a model sustainable city. Kigali is one of Africa's rising cities: it is clean and organized and, thanks to an ambitious national development plan, the city has become an ultra-modern metropolis that boasts recognizable social, economic and environmental successes.

Rwanda's national sustainability agenda includes plans to integrate urban and peri urban horticulture into Kigali's development master plan. With guidance from the United Nations Food and Agriculture Organisation (FAO), authorities are promoting the growing of fresh fruits and vegetables within the city to increase urban food security and boost farmers' incomes. They envision a cosmopolitan city with green gardens. The development of pedestrian and cycling corridors will be part of Kigali's public transit system, which will allow for cycling and walking, and will reduce car access to the Central Business District (CBD).

In 2015, Kigali was selected as one of six African cities out of 67 cities worldwide for the 100 Resilient Cities initiative of the Rockefeller Foundation. The initiative focuses on helping cities address urbanization, climate change and globalization challenges through infrastructure development that can cope with population growth.

The vision of Rwanda by 2040 is to have Kigali as a city of affordable homes. We also want a city of green transport, ensuring we reduce air pollution and congestion and conserve the city's environment," says the city engineer. For a city many already consider one of Africa's most beautiful, the future looks promising.

The study selected the above four cities as examples of cities that have either attained the status and /or are making serious efforts of being green, smart and clean cities, through the various interventions that are and have been implemented through the years arising from developmental plans, programs and policies. The study was also deliberate by selecting countries from the Developed nations as well as from cities in the developing countries. This was to demonstrate that the creation of environmentally friendly cities can be achieved by all countries by prioritizing the sustainability agenda. The cities above have showcased the integration of sustainable solid waste management practices through the three 'R's of reduce, reuse and recycling processes, the reduction of Carbon Emissions through the use and promotion of sustainable transportation such as cycling, walking, BRT systems and the creation of green spaces such as Eco parks. These are consistent with the environmentally friendly variables being investigated by the study. Arising from the above case studies the study in review has noted that the countries understudy are deliberate about their plans with regards the sustainability of their respective cities which may not be the case for the country/city where the study area for this research is found.

2.6. Options to Enhance Climate Resilience

2.6.1. Transportation System

Urban transport planning systems play a critical role in fostering healthy and sustainable cities. By 2050, 66% of the world's population will live in cities requiring a serious consideration of the role of transport and its impact on the liveability of people and planet (Stoett et al., 2019).

There is significant air pollution in most cities from transportation, with various impacts (Dons et al., 2019). In most jurisdictions, motor vehicles are the most widely used mode of transport, and more than 90% of transportation energy use is in the form of fossil fuels. An important aspect of planning by countries to combat environmental pollution, especially in transportation, is to ensure issues affecting poor populations are addressed. More broadly, it is pointed out that two targets of the United Nations Sustainable Development Goals for 2015–2030, which were approved by the United Nations (UN) in 2015, are directly transportation-related: Target 3.6: By 2020, halve the number of global deaths and injuries from road traffic

accidents and Target 11.2: By 2030, provide access to safe, affordable, accessible, and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations—women, children, persons with disabilities, and older persons.

Bike-share schemes have benefits that differ by city. In many cases, the user (including those residing in the city and internal and external tourists) values the experience of using bicycles, as they provide another transportation experience. The use of bikes can also be very beneficial in relation to travel times, especially in cities where vehicular traffic is a serious problem. This problem is exacerbated at specific times like weekday rush hours (6–8 am and 4–7 pm), and in those cases the bicycle can be a significantly beneficial alternative for certain distances and routes. To ensure sustainable transport in the city, there must be easy pedestrian access, and ramps for the movement of people with disabilities with relatively easy access. Another relevant aspect of sustainable transportation is that sustainable cities often have offer bicycles to ride around the city, as well as good interconnections between buses, taxis, and bikes (Alvarez-Risco, 2020).

In terms of public transit, one approach that is growing in popularity is the BRT system, which involves guided bus ways or dedicated bus lanes, together with mechanisms to give buses priority in urban traffic. In their survey of C40 cities, Arup (2011b: 32) which is an urban development company found that such systems have been introduced in thirteen cities, with a further eight planning their introduction, with all six C40 members in Latin America having introduced or planning such a system. The emergence of such systems in Latin America can be traced to the pioneering experience of Curitiba and Bogotá and the process of knowledge sharing that has taken place through the C40 and other networks, as well as the provision of international financial support for the development of BRT systems within Latin American cities. Such initiatives often depend upon a partnership of municipalities and the (often privately owned) providers of public transport services, as well as access to sufficient capital to establish what are often costly schemes (Bulkeley,2013).

2.6.2. Solid Waste Management.

Municipal solid waste management is inextricably linked to increasing urbanization, development, and climate change. The municipal authority's ability to improve solid waste management also provides large opportunities to mitigate climate change and generate co-benefits, such as improved public health and local environmental conservation.

Globally, solid waste generation was about 1.3 billion tons in 2010. Due to population growth and rising standards of living worldwide, waste generation is likely to increase significantly by 2100. A large majority of this increase will come from cities in low- and middle-income countries, where per capita waste generation is expected to grow.

Reducing greenhouse gas emissions in the waste sector can improve public health; improve quality of life; and reduce local pollution in the air, water, and land while providing livelihood opportunities to the urban poor. Cities should exploit the low-hanging fruit for achieving emissions reduction goals by using existing technologies to reduce methane emissions from landfills. In low and middle-income countries, the best opportunities involve increasing the rates of waste collection, building and maintaining sanitary landfills, recovering materials and energy by increasing recycling rates, and adopting waste-to-energy technologies. Resource managers in all cities should consider options such as reduce, re-use, recycle, and energy recovery in the waste management hierarchy (Rosenzweig, 2015).

2.6.3. Green Spaces

Urban Green Spaces (UGS) constitute a low-cost local strategy that can easily be adopted and practiced in most human settlements at a limited scale and with limited institutional support. Although often obliterated by human demographic growth as a consequence of poor planning, it is clear from the literature that UGS of various forms remain a major part of the urban landscape of many cities in developing countries (Lindley etal, 2015). Urban green spaces, in addition to their numerous co-benefits, collapse slowly, are more resource-efficient and more resilient to stress induced by both urbanization and climate change processes (EU, 2015).

Defined as the relics of vegetation (i.e., parks, tree lots, cemeteries, home gardens, lawns, grass and farmlands), bare ground, and waterbodies sandwiched by grey infrastructure (buildings, roads and paved surfaces) in cities (Breuste etal,2013). UGS can sequester carbon in trees, vegetation, soil, and water. Through photosynthesis, plants absorb CO2 from the atmosphere, transmit it to the soil in the form of living (roots) and dead organic matter (humus) and release it back to the atmosphere during respiration. Human management of UGS can alter these source/sink processes with the climate and hence the ecosystem services they provide (Francis, 2013)

Besides influencing local and regional climates, carbon cycle, and energy budgets, UGS are preserves of several ecosystem services. These include direct mitigation of urban heat island effect by cooling through evapotranspiration and shading, improving air quality (regulation

particulate matter, NOx, SO2, CO and O3) mitigating floods and runoff, recreation and cultural services provisioning, erosion control solid waste and sewage disposal, fuel and food provisioning, ground water supply acting as windbreaks, psychological and other health benefits and as sources of food. The capacity of UGS to provide ecosystem services is reinforced by their area extent in the city, composition and biodiversity, and efficiency in their management. (Nero etal, 2017).

Lusaka's Comprehensive Urban Development Plan according to the Ministry of Local Government and Housing (2009) outlines the development agenda of the city in various sectors, some of which are outlined below in line with the objectives of this research. Urban transportation network should be developed as essential infrastructure to attract economic/industrial investments and realize the orderly urban land use. Namely the challenges of the transportation sector are to provide smooth access to job opportunities and other urban activities especially for low-income communities, by improving the main roads and public transport system. The future road network will consist of three ring roads, 12 radial roads, and seven other major roads. Renovation of bus system for the modal shift from car to public transport will be necessary in 2030. Priority projects and programs to be implemented in the short term are proposed to include inner ring road development, Lusaka South-Multi Facility Economic Zone access road development, and city roads decongestion by improvement of minor roads, intersections, and missing link connection as well as comprehensive traffic management.

The comprehensive development plan on transportation sets out priorities on increasing and improving the road network within the city. Such a situation will therefore result in the increased number of vehicles on the roads and this will result into increased Carbon emissions which will lead to the problem of climate change to be exacerbated. The plan does not mention the inclusion of climate friendly road infrastructure such as bicycle/pedestrian lanes, which could allow for road users to consider alternative modes of transport for their mobility as opposed for recreation purposes only.

As Lusaka still has potential natural resources such as available land, water resources in the form of streams, dams and underground water resources as well as some forests which are rapidly diminishing due to rapid urbanization (ZEMA,2017).A strategic approach is required to achieve effective urban environment protection, as it was also known as the "garden city Lusaka". In this context, strategies for urban environment protection and green network

development are; to provide urban environment protection and green management program in order to formulate strategic interventions for environmental protection, the establishment of sustainable urban design in order to protect the destruction of natural reserve forest and damage of natural habitats and biodiversity, to formulate a "green belt zone" maintaining mainly agriculture land and other natural green spaces, functioning as buffer for urban sprawl and environmental and recreational network, to formulate spatial network for urban green environment (river green, street green, open space, and suburban agriculture belt) and recreational activities (parks and walkways or cycling lanes) and to empower local communities' activities in a participatory manner for the environment improvement, especially for waste management and energy (charcoal) issues (MLGH and JICA,2009).

The Comprehensive urban development plan has outlined ambitious strategies for urban environmental protection and green network development which are also part of the plan to regain the lost status of a garden city. However, the plan does not take into account that the city does not have readily available open spaces which could easily be converted into green spaces. Therefore, there is need for a model of a plan on how urban strategies could include households to secure a small portion within the vicinity of their households to plant trees and maintain a small patch of grass. This would therefore result into a cumulative large green space that would be able to contribute to the effect of urban heat islands and mitigate urban runoff.

Consistent with the strategic plan, Lusaka City Council intends to address the problems of environmental management through adequate solid waste management practices, which include the redesigning and rehabilitation of the engineered landfill incineration of medical waste and other non-recyclable waste, increased number of waste subscriptions data base and billing system. This is in addition to encouraging the public to practice sustainable urban gardening and recycling waste from households, commercial and institutional premises (LCC, 2017)

The plan does not therefore provide for the integration of the 3r's of solid waste management to ensure adequate sustainability. This is due to the fact that no mechanisms or activities such as recycling centers, provision of waste separation at source as well as deliberate programs to sensitize residents on the need to avoid over consumptive behavior patterns which result in large quantities of waste to be generated have been provided.

2.7. Research Gap

The literature review conducted revealed limited available data on the subject of options for transforming unplanned settlements into climate resilient ones. Lata (2019) conducted a study on the evaluation of eco-sustainability standards of Purbachal Township in Bangladesh. The claim over the township is that it had been planned to be eco sustainable and therefore the study aimed to assess and analyze the eco sustainability status of the township based on checklists, parameters and indicators. Further Yu (2014) highlights in his study the attempt to explore the low carbon eco city initiatives in China by critically analyzing the problems which impact upon such an environmentally friendly development model. Aigbayboa etal (2020) study on improving resilience of cities through smart city drivers in developing countries using the case study of South Africa examines the various factors which influence the ability of cities to develop resilience through smart city drivers. Factors influencing resilience were identified as;

Education, according to Wijsman and Feagan (2019), planning a resilience city requires knowledge system which is aimed at "understanding resilience within the locality and specific systems; embrace values such as a plurality of perspectives, collective problem framing, and societal agenda setting; and recognizes the need to pay analytical attention to those practices that keep certain patterns of thinking in place".

Food Security, according to Béné et al (2016) states that advancing development and resilience plays a major role in nutrition and food security as a "mobilising metaphor". The ever-growing climate change effect coupled with urbanisation is contributing majorly to South African cities' food security concerns this is outlined by The Munincipalities of South Africa (2016).

Public Safety urban safety and crime prevention "emphasizes the role of residents – or communities – in developing and implementing safety policies. Public safety begins when there is acceptance of the fact that inadequacy of local governance, urban development, and social patterns gives room for violence and crime occurrence (UN-Habitat III, 2015).

Threat to Disease - Even though cities around the world are aiming at transforming to healthy regions, processes and programs that will assist in reducing communicable and non-communicable diseases risks, remain a major concern. In South Africa various ways have been identified in order to reduce the threat to diseases and these include the following; encourage cycling and walking within the city rather than driving vehicles or using other

means of transportation to enable them to do exercises and workout (Municipalities of South Africa, 2016). Improvement in hygiene facilities will bring a decrease in the risk of transmissible diseases. Therefore, making clean water available will help in the formation of a healthier city (NPC, 2012).

Climate Change - Faster warming is associated with the climate systems of urban areas compared to rural areas. These rural areas have water bodies, less built-up areas and vegetation which helps regulate the temperature (Chan, 2017). Climate change was therefore considered to be amongst the leading influencing factors, thus indicating that climate change plays a significant role when considering the resilience of cities.

Finally, in Zambia many studies carried out on climate change have focused on the sustainability of sectors such as; agriculture, where a study was conducted by Mangaba (2018) on the impact of Climate Change on Sustainable Agriculture and Food Security in a bid to identify and analyze the effects of climate change on agricultural productivity and food security as well as to suggest measures that can be embraced in a bid to mitigate the detrimental effects of climate change.

Other studies reviewed on Climate Change and Agriculture include; Advancing Local Ecological Knowledge-Based Practices for Climate Change Adaptation, Resilience-Building, and Sustainability in Agriculture: A Case Study of Central and Southern Zambia where the study analyzes past and present climate change-related impacts on agriculture and identifies effective Local Ecological Knowledge adaptive mechanisms utilized by the local smallholder farmers in central and southern Zambia. The article further concludes that the integration of effective Local Ecological Knowledge with scientific knowledge and the ultimate incorporation of key aspects of Local Ecological Knowledge into developmental and climate change policies can be one of the most effective ways for a sustainable and adaptive agriculture sector in the face of climate change(Sakapaji,2021).

Further still, other studies include those done by Arslan etal (2014) who conducted a study on Assessing the Adaptation Implications in Zambia, which examined a set of potentially climate smart agricultural practices, including reduced tillage, crop rotation and legume intercropping, combined with the use of improved seeds and inorganic fertilizer, for their effects on maize yields in Zambia.

A study conducted by Umar (2021) on Adapting to Climate Change Through Conservation Agriculture: A Gendered Analysis of Eastern Zambia explored the use of Conservation

Agriculture (CA) as a climate adaptation strategy among smallholder farmers in Eastern Zambia. The study therefore concludes that there is room for CA to serve as a climate smart agricultural system for both men and women smallholder farmers in Eastern Zambia.

Finally Moonga and Chileshe (2020) also conducted a study where they reviewed literature on the mainstreaming of environmentally friendly practices such as greening initiatives in the Hospitality and Tourism Industry through the development of a sustainability curricula for hospitality and tourism training institutions.

In view of the above, the researcher found no study in Zambia that explored methods of re-inventing townships from unfriendly environmental practices to ecofriendly ones. This presents a gap which this research can fill by exploring options on the comprehensive components of a climate friendly township which is relevant to environmental planners.

CHAPTER THREE: DESCRIPTION OF THE STUDY AREA

3.1. Introduction

This chapter of the research focuses on describing the study area (Kalingalinga Township). It describes in details its location, demographics and environmental factors. It also describes the socioeconomic activities undertaken in the study area and finally it includes a map of the study area indicating the main features and areas sampled.

3.2. Overview

Kalingalinga settlement is an improvement area. It was legalized on 1st April, 1986 under the 1972 Government Policy towards upgrading of squatter settlements (Carole et.al., 1981). After legalization, the council tried to establish a systematic grid layout of houses and roads in most parts of the area (Yasini, 2007). Initially the settlement was omitted from the Lusaka Urban District (LUD)/World Bank (WB) upgrading programme in 1985 but it later benefited from the LUD and the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) project which took place in 1991 (LCC, 2008; Mulenga, 2003). The upgrading scheme included: the provision of a school, clinic, market and community center; installation of water standpipes to groups of families; roads; street lighting; house improvement loans through community revolving funds; core house materials loan programme through community revolving funds; secure land titles; and promotion of informal economic activities and income generation through micro-loans which presently employs about 80 per cent of the population in this location (Mulenga, 2003; LCC 2008). The scheme also included the re-alignment of dwellings, and efforts to lower population-density and allow for street-widening, (Simatele, 2010).

3.3. Location

The Settlement is situated east of Lusaka city (Figure 3.2) along Alick Nkhata Road. It is surrounded by the following areas: The University of Zambia (UNZA), Great East Road Campus to the north; The City Airport to the south, across Alick Nkhata Road; Helen Kaunda to the east and Mass Media Complex to the west. Its total surface area is about 682,389.5 square meter of flat land. Kalingalinga Settlement can be accessed by motor

vehicle through Alick Nkhata Road from Kabulonga Round About and Kamloops Road from the Great East Road. It also has several inner roads that cuts cross the settlement. The inner-roads are gravel and poor condition (Yasini, 2007).

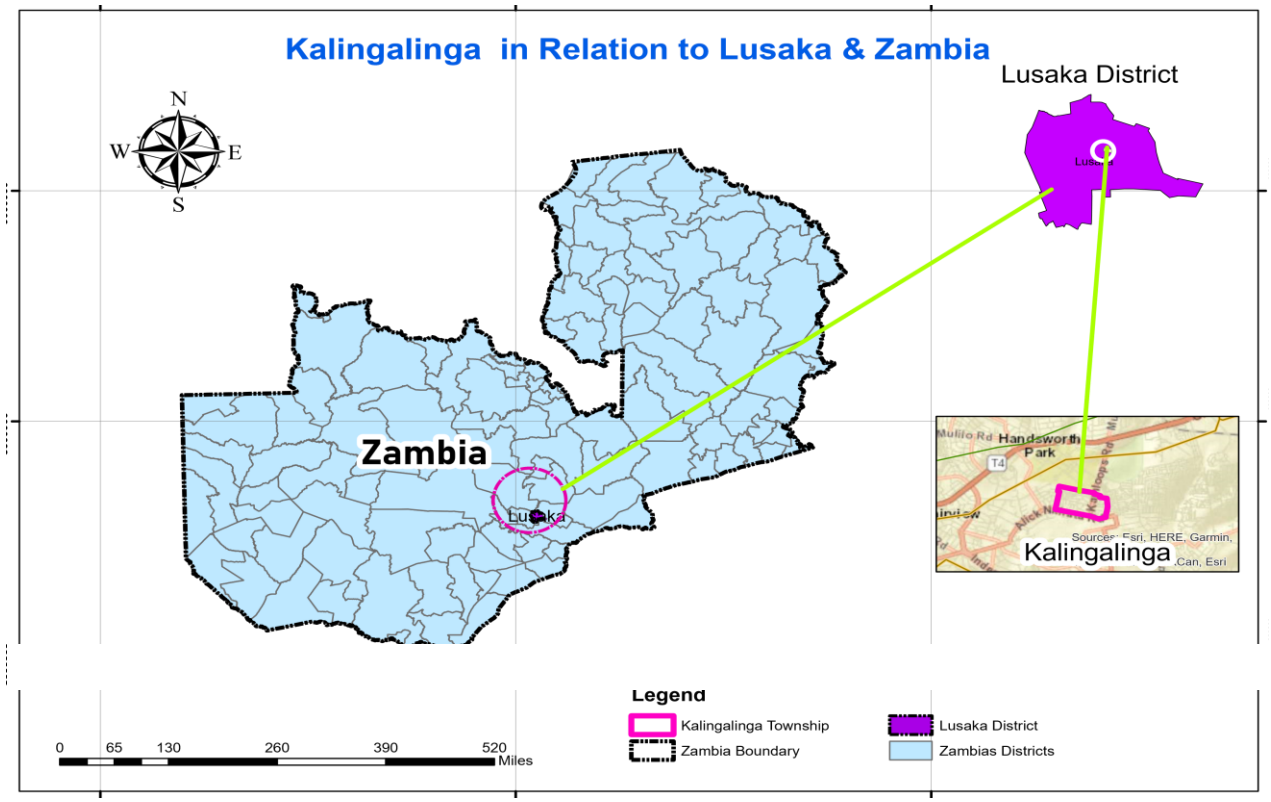

Figure 2: Location of Kalingalinga Township in Lusaka District of Zambia
Source: Author (2021)

3.4. Demographics

The total population of Kalingalinga Settlement stands at 44,154 with 22,120 males and 22,034 females and the number of households is estimated at 8,714 (CSO, 2011). The population of the area is growing fast due to high birth rates and immigrations but overspill and extension areas have not yet been identified. The housing infrastructure lack proper layout plans. They are a mixture of shacks and well-built houses. The former are poorly constructed with mud bricks and old iron or asbestos sheets. The walls are just slightly above the door level. The latter are nicely constructed using concrete blocks with nice roofs. At best they equal or betters the conventional build houses like those found in Chilenje or Kabwata (Yasini, 2007).

3.5. Socio-Economic Status

Kalingalinga Township has one of the highest number of people in formal employment as compared to other settlements in Lusaka. They range from police officers, soldiers, medical officers, teachers to general office workers. The main reason is that the settlement is located near administrative and education centers such as the Judiciary, Government Ministries and Departments, Cabinet Office, University Teaching Hospital (UTH), Embassies, Hotels and the University of Zambia (UNZA). It is also due to better social infrastructure and facilities as compared to other settlements within the vicinity. The settlement also has a high number of people in informal employment. These people survive through vending, selling vegetables in the markets and selling sand along the roadside. They also survive through carpentry, tailoring, tinsmith, metal work, piece works, and making blocks, crushing stones and brewing illicit beer. Others work as maids, garden boys, security guards, drivers and prostitutes (Yasini, 2007).

Kalingalinga settlement has one basic school, a police station, churches, a community hall, a hospice and a clinic. The clinic provides the service such as maternity, mortuary, maternal child health care, laboratory service, Voluntary, Counselling and Testing (VCT) and outpatient. The settlement has several playgrounds used for football, netball and community activities. Kalingalinga has a number of commercial and retail facilities. These include taverns, bars and bottle stores, nightclubs, butcheries and shops. It also has a commercial bank and two service stations. Lusaka Water Sewerage Company (LWSC) is the licensed service provider supplying water to Kalingalinga. The water is supplied through indoor connections, individual yard taps and public taps which are in a poor condition. Though water supply is erratic at times, the situation is far much better than most unplanned settlements. Residents also fetch water from shallow wells which are in a poor condition and tend to dry up in the dry season. The quality of the water at the wells is considered to be poor and therefore hardly used for drinking and cooking (Yasini, 2007).

3.6. Environment

Kalingalinga Settlement is vulnerable to floods because it is located on a flood prone area and lacks proper drainage system. After heavy rainfall, the area experiences flush floods causing damage to housing and road infrastructure. The floods also form stagnant pools of water which become breeding ground for mosquitoes and other disease carrying bacteria. Kalingalinga

Township is faced with a problem of uncollected garbage: heaps of uncollected garbage are visible in many places like markets, roads and in the drainages. The garbage problem has persisted despite the settlement having a formal waste management system, this is due to the fact that though

Community Based Enterprises (CBE'S) have been created, registered and are recognized by the Local Authority as entities tasked to collect waste within the locality, these CBE's do not offer an integrated Solid Waste Management service which comprises of the three R's of reduce, reuse and recycle. Uncollected garbage has an effect both on the health of the residents because it produces an offensive smell when decomposing and it attracts flies and rodents that transmit diseases. The garbage also has an effect on the environment through the leakage of pollutants to the soil and water sources (Yasini, 2007).

Kalingalinga Township was chosen strategically as a model for this study due to the fact that it is an informal settlement also known as an improvement area which is characterized by a population whose majority are in the low income bracket. Populations found in the higher density areas such as Kalingalinga are therefore usually the worst affected when floods, droughts and disease arise as a result of extreme weather events. A situation which arises from the fact that these populations live in areas which are environmentally fragile coupled with the fact that they do not have the economic resources to invest in infrastructure that can withstand the environmental vulnerabilities of the areas they occupy (UN-Habitat,2007).

CHAPTER FOUR: METHODOLOGY

4.1. Introduction

Methodology is the "general approach a researcher takes in conducting a research project (Leedy and Ormrod, 2001: 14). It is that procedural framework within which the research is conducted (Remenyi et al., 1998), involving data collection and the analysis of the assumptions in a particular study. This chapter describes the methodology for the study. It is organised according to the following subsections; the philosophical orientation, research strategy, research design, sample design, data collection and analysis. The chapter ends with a review of ethical considerations.

4.2. Philosophical Orientation

There are a number of philosophical paradigms used in social sciences and educational research among them positivism, interpretivism, post-positivism and pragmatism. These philosophical paradigms are assumptions, beliefs, values, ontology and epistemology that are crucial to methodology (Kincheloe and Berry 2004). Therefore, they underpin the methodological choice, research strategy, data collection techniques as well as analytical procedures (Saunders, 2009).

Jackson (2013) asserts that 'without the formulation of the philosophical background, researchers may remain innocently unaware of the deeper meaning and commitments of how they conduct their research. These philosophical paradigms are mainly focused around ontological and epistemological assumptions.

Ontology is the study of being (Crotty, 1998). Ontological assumptions are concerned with what constitutes reality, in other words what is. Researchers need to take a position regarding their perceptions of how things really are and how things really work. According to Creswell (2014) these philosophical orientations are also referred to as general worldviews about the world and the nature of research that a researcher brings to a study. Worldviews arise based on discipline orientations, students' advisor's/mentors inclinations, and past research experiences. The types of beliefs held by individual researchers based on these factors will often lead to embracing a qualitative, quantitative, or mixed methods approach in their research. There are four main worldviews that are widely discussed in the literature and these include; post-positivism, constructivism, transformative, and pragmatism.

For the purpose of this research the researcher has assumed the ontological position of pragmatism, this is arising from the fact that this philosophical underpinning is not committed

to anyone system of philosophy and reality and uses all pluralistic approaches to derive knowledge about the problem. This is evident in the study as it constitutes objectives that entail data will be drawn from both the quantitative and qualitative research approaches thereby resulting in a mixed methods approach. This is unlike the case for objectivism and constructivism, which are philosophical underpinnings that are inclined to the quantitative and qualitative research approaches respectively. In view of this and in order to provide the best understanding of the problem and to come up with climate resilient options for a township the research will combine both the qualitative and quantitative research methods in order to have a comprehensive understanding of the problem. (Creswell, 2014).

According to Bryman (2012) an epistemological issue concerns the question of what is (or should be) regarded as acceptable knowledge in a discipline. Epistemological considerations loom large in considerations of research strategy. To a large extent, these revolve around the desirability of employing a natural science model (and in particular positivism) versus interpretivism. In assuming an epistemological position, the study will combine both the positivist and interpretivist positions. Positivism entails the impartial discovery of absolute knowledge about an objective reality. The researcher and the researched are independent entities, meaning solely resides in objects, not in the conscience of the researcher, and it is the aim of the researcher to obtain this meaning (Crotty 1998). The interpretive epistemology is one of subjectivism which is based on real world phenomena. The world does not exist independently of our knowledge of it (Grix, 2004).

Further, interpretive methodology is directed at understanding phenomenon from an individual's perspective, investigating interaction among individuals as well as the historical and cultural contexts which people inhabit (Creswell, 2009). This study therefore assumes both epistemological positions of positivism and interpretivisim as can be evidenced where the study will generate knowledge on the set objective of assessing the extent by which the township adheres to climate friendly standards by following the processes of natural sciences to collect data deductively by means of testing the hypothesis and will also employ quantitative data collection tools. This will allow for statistical data to be generated which can then be generalised for the township, At the same time the study will collect data inductively in order to generate meanings and interpretations from the participant's point of view and this will be in regard to set objectives on assessing options for reducing GHG emissions from solid waste and the viability of creating green spaces.

4.3. Research Strategy

A research strategy is simply a general direction to the conduct of social research (Bryman, 2012). A mixed method strategy involves combining or integration of qualitative and quantitative research and data in a research study, the basis of using this approach arises from the fact that qualitative data tends to be open-ended without predetermined responses while quantitative data usually includes closed-ended responses such as found on questionnaires or psychological instruments. Hence, the mixed method strategy provides the researcher with the ability to conduct a single study that answers questions about both the complex nature of phenomena from a participant point of view and the relationship between measurable variables (Williams, 2007).

Combining qualitative and quantitative data in a research study enhances the strength or credibility of a research by off-setting the weaknesses of each respective approach as it narrows down the bias and weaknesses of each approach. In addition, one database could help explain the other database and one database can also explore different types of questions than the other database, such as the quantitative approach will answer the what whilst the qualitative approach will answer the how in the study. Various form of the mixed method approach exists but for the purpose of this study the mixed method sequential embedded research design will be employed. This design involves as well either the convergent or sequential use of data, but the core idea is that either quantitative or qualitative data is embedded within a larger design (e.g. an experiment) and the data sources play a supporting role in the overall design. In this study the quantitative design will constitute the larger component of the research with the qualitative data providing a supporting role. This is due to the fact that the quantitative design provides the basis upon which the study is established and then the qualitative part will be used to provide meanings and interpretations arising from the experiment. This will therefore allow for a comprehensive understanding to the research. (Creswell, 2014)

The quantitative data will be composed of data obtained from assessing the extent of the variables of the climate friendly standards in the township comprised of transportation and road networks, green spaces and solid waste management in order to answer the ‘what’ in the study. Whereas the qualitative data will be composed of data arising from the research questions on options for reducing GHG emissions from solid waste management and the viability of establishing green spaces in the township.

4.4. Research Design

A research design is the structure that guides the implementation of a research method and the analysis of successive data (Bryman, 2004). It is a master plan which specifies the methods and procedures for collecting and analysing data (Zikmund, 1988). A research design is simply an action plan that guides research from the questions to the conclusions and includes steps for collecting, analysing, and interpreting evidence according to pre-established propositions and application of set criteria for interpreting the findings (Yin, 2003). Thus it is important as it facilitates the smooth sailing of the various research operations, thereby making research as well organized as possible in achieving its aims.

This study employed a cross sectional survey research design. A cross-sectional design entails the collection of data on more than one case (usually quite a lot more than one) and at a single point in time in order to collect a body of quantitative or quantifiable data in connection with two or more variables (usually many more than two), which are then examined to detect patterns of association. It should also be noted, however, that qualitative research often entails a form of cross-sectional design. A fairly typical form of such research is when the researcher employs unstructured interviewing or semi-structured interviewing with a number of people (Bryman, 2012). The key feature of this research design is that it takes a representative sample from the population to generalise the findings for the study population (Omair, 2015). Cross-sectional studies can be used in both descriptive and analytical studies. Thus it will be used for this study as it involves the use of semi structured interview guides in the collection of data from the sampled population which is comprised of households, commercial premise owners as well as the key informants. Further the cross sectional survey research design encompasses both the descriptive aspects from the qualitative data and the analytical from the quantitative data and this is consistent with this study which employs both qualitative and quantitative data. Finally, the cross-sectional study will allow relationships to be established between eco-friendly standards in a township and climate resilience.

4.5. Sampling Techniques

A sample is a segment of the population that is selected for investigation in a research. It is a subset of the population. There are two types of sampling methods that can be utilized in research and these are probability and non-probability sampling methods. Probability sampling entails that each member of the population has an equal chance of being selected in the investigation whilst nonprobability sampling entails that not every member of the population has an equal chance of taking part in the study. In this study a combination of both

sampling methods will be utilized which is consistent with this study being mixed method (Bryman, 2012).

4.5.1. Purposive Sampling

Key informants in the study were sampled using purposive sampling. According to Paharoo (1997:232) purposive sampling is "a sampling method where the researcher deliberately chooses who to include in the study based on their ability to provide necessary data". For the purpose of this study, purposive sampling was carried out in order to get information related to the extent of climate friendly standards of the township and these included the transportation and road network system, sustainable solid waste management systems as well as the green spaces. A total of eight (08) key informants were purposively sampled and broken down as follows; from the transportation sector i.e. The Road Development Agency, one (1), Lusaka City Council two (2), Zambia Environmental Management Agency two (2), the Community Based Enterprises in charge of collecting waste in the area two (2) as well as the Ministry of Environment and Green Economy one (1). The engagement of more than one key informant that were interviewed during the structured observation was in order to help remove the element of biasness which may have arisen if the researcher conducted the observation independently.

4.5.2. Systematic Sampling

Systematic sampling is a sampling procedure in which you select units directly from the sampling frame that is, without resorting to a table of random numbers. This sampling method will be used in order to ensure an even distribution of the collection of subjects. This study will employ the use of this sampling technique in line with collecting quantitative data on the set objectives for reducing GHG emissions arising from Solid Waste and the viability of creating green spaces. In order to achieve this a sample size of 100 households was determined with the aid of the Rao soft sample size computer software calculator which was set at a confidence level of 95% and a margin error of 5%.The selected households will take part in the survey where every, one (1) household in 87 will be selected based on the sampling fraction, expressed as sample size/total household population where the total population will be derived based on the given statistics from Central Statistics Office (Bryman,2012).

4.5.3. Simple Random Sampling

The simple random sample is the most basic form of probability sample. With random sampling, each unit of the population has an equal probability of inclusion in the sample. This technique will be used to sample the business premises within the township as they comprise a significant component within Kalingalinga township and their activities may also impact on climate change therefore there is need to conduct a survey on the objectives pertaining to the reduction of GHG emissions arising from Solid Waste and the viability of creating green spaces from their perspective. A total sample size comprising of 50 business premises will be selected using a comprehensive sampling frame and computer software will be used to randomly generate and assign numbers for the business premises.

4.6. Data Collection Methods

Data collection is a method of gathering information following an established systematic procedure in order to address critical research questions (Mubanga, 2018). It is key for any research project as it establishes a basis for decision making. There are basically two main sources of data; however, this study used primary data. Primary data collection is first hand collection of data from subjects a researcher is interested in studying. It was used because it yields original and unbiased information from the population and it is the most reliable form of data (Krueger and Casey, 2000).Secondary data which is the other source of data, is the previously sourced, arranged and analyzed data which is readily available for researchers to research their research, secondary data is typically gathered from various sources, though occasionally, it is also gathered from within the same organization. For this study secondary data was obtained from books, journal articles and reports and it was used to make reference on the climate variables/indicators for an environmentally friendly township (Tama, 2024).

Semi-structured Interview typically refers to a context in which the interviewer has a series of questions that are in the general form of an interview schedule but is able to vary the sequence of questions. The questions are frequently somewhat more general in their frame of reference from that typically found in a structured interview schedule. Also, the interviewer usually has some latitude to ask further questions in response to what are seen as significant replies (Bryman, 2012). Semi-structured interviews will therefore be used on households, commercial properties and Community Based Enterprises to ascertain the objective on options for reducing Green House Gas Emissions through sustainable solid waste management

practices as well as to investigate the objective of the viability of creation of green spaces to reduce temperatures within the township.

The study will collect quantitative data through the use of a well-developed checklist in a method known as structured observation, often also called systematic observation. This is a technique in which the researcher employs explicitly formulated rules for the observation and recording of behaviour and or phenomenon. The rules inform observers about what they should look for and how they should record behaviour. (Bryman, 2012). For this study the researcher will develop a comprehensive checklist as the tool for conducting the structured observation, complete with all the identified standards of an echo friendly township in terms of a transportation system, sustainable solid waste management system and green spaces. A 5 point likert scale then be will be used to rate the research variables in reference to the checklist with a score being given for prevailing climate friendly standards in the township and another score being given for what is environmentally acceptable, in order to create two sets of scores per respondent per given variable. The lowest score will be indicated by one and the highest indicated by five, for instance, if a key informant gives a score of five in terms of solid waste management system, it simply means that the solid waste management system meets all the parameters to qualify it as an eco-friendly system. Whilst a low rating of one is an indication that the system in terms of meeting eco-standards is very low. This will also be true for the scores that will be given for the set environmentally acceptable climate standards on the other hand.

4.7. Data Analysis Techniques

Data analysis can be defined as the process of organizing and examining the information gathered from the field in order to interpret or explain what it means and make sense out of it (Spicer, 2004). It is basically concerned with reducing the large quantity of information that the researcher has gathered to make judgment of it. Data collected from the field is raw and has no meaning on its own. Therefore, the essence of data analysis is to help the researcher interpret the gathered information and decide whether or not the objectives have been met. For this study, field data will be analysed using both qualitative and quantitative techniques (Bryman, 2012).

Qualitative information obtained from semi-structured interviews will be analysed using thematic analysis. Thematic analysis involves converting textual material from interview transcripts into categories like themes (Bryman, 2012). It will involve checking for patterns

in the data collected, putting it into themes and thereafter present it in graphs. Coding is the process of organizing the data by bracketing chunks (or text or image segments) and writing a word representing a category in the margins (Rossman and Rallis, 2012). It involves taking text data gathered during data collection, segmenting sentences (or paragraphs) or images into categories, and labelling those categories with a term. For the purpose of this study this will involve coding the collected data according to the predetermined themes determined from the objectives. These predetermined themes will therefore include activities on waste recycling, methods through which waste recycling can contribute to reduced GHG emissions as well as ways in which residents can reduce on waste generation. Other predetermined themes will include barriers of waste re-use by residents as well as alternatives to the creation of green spaces. This process of coding will be carried out through the use of QSR NVivo which is a qualitative data computer software. The identified themes will then be analysed and shaped into a general description as well as to form connections between the themes (Creswell, 2014).

Quantitative Data will be analysed using the one sample two tailed t-test, this will be in relation to assessing the extent of Kalingalinga Township being climate friendly this is in regards to the identified climate variables of transportation/infrastructure, green spaces and sustainable waste management. The one sample *T-t*est compares the mean of a single column of numbers against a hypothetical mean, this hypothetical mean can be based upon a specific standard or other external prediction. The test is done for continuous data and the data should be a random sample from a normal population. (Lakshminarasimhan, 2023)

For the purpose of this study the one sample T-Test will be used to test the given hypothesis which states that the inclusion of climate friendly features in the form of transportation/infrastructure, green spaces and sustainable waste management will enable the township to be environmentally friendly to a certain extent. This will be carried out by comparing the T- calculated value with the T-Critical Value derived from the degrees of freedom and significance level set at 0.05. This is in order to accept or reject the null hypothesis, which states that there is no difference in the township being climate friendly even with the inclusion of climate friendly features such as roads/transportation, green spaces and sustainable waste management. Depending on the findings obtained the study will propose climate friendly interventions. (Salkind, 2016).

For the purpose of this study the Statistical Package for the Social Sciences (SPSS) statistical tool will be used to conduct the quantitative data analysis. In addition, the p-value which is a

standard method that is used to measure the significance of the empirical analyses will be set at 0.05 ($P \leq$
0.05) (Fenton et al., 2012).

4.8. Validity and Reliability

Reliability is concerned with the question of whether the results of a study are repeatable. The term is commonly used in relation to the question of whether the measures that are devised for concepts in the social sciences (such as poverty, racial prejudice, deskilling, religious orthodoxy) are consistent. Reliability is particularly at issue in connection with quantitative research. The quantitative researcher is likely to be concerned with the question of whether a measure is stable or not. (Bryman, 2012).

For the purpose of this study the five point Likert scale which is a standard measure in research commonly used in questionnaires—from simple surveys to academic research—to collect opinion data will be employed. The five point Likert scale increases response rates and response quality in addition to being less confusing and reduces the respondent's frustration levels, it also enables respondents to accurately express their views. The reliability of the findings for the research will therefore be based on the fact that the five point Likert scale set at a range from very high to very low will be used to collect the quantitative data on opinions for a climate friendly township with regards to a sustainable waste management system, green spaces as well as a transportation and road infrastructure system. Furthermore, a number of studies have suggested that five point scales increase response rates and response quality in addition to being less confusing and reducing respondents' "frustration level" (Devlin et al., 1993). Further other studies explain that the 5-point scale is common and thus readily comprehensible to respondents, enabling them to accurately express their views (Marton-Williams, 1986).

Validity is one of the strengths of qualitative research and is based on determining whether the findings are accurate from the standpoint of the researcher, the participant, or the readers of an account (Creswell & Miller, 2000). For the purpose of this research, to ensure validity of results the research will endeavour to provide rich, thick, detailed descriptions of the identified themes of transportation and road infrastructure, green spaces and sustainable waste management in relation to the findings so that anyone interested in transferability will have a solid framework for comparison (Merriam, 1988).

4.9. Ethical Considerations.

Ethical issues in research command increased attention today. The ethical considerations that need to be anticipated are extensive, and they are reflected through the research process. These issues apply to qualitative, quantitative, and mixed methods research and to all stages of research. Accordingly, it is helpful to address them as they relate to different phases of inquiry. Attention needs to be directed toward ethical issues prior to conducting the study; beginning a study; during data collection and data analysis; and in reporting, sharing, and storing the data. Prior to conducting the study, this study will seek the University of Zambia's Natural Science Research Ethics Committee's (NASREC) approval to conduct the research. Further, local permission from the local authority which in this case is Lusaka City Council will be sought before gaining access to study sites and participants. As the study commences the researcher will ensure not to put pressure on participants when signing research consent forms and will endeavour to be sensitive to the needs of vulnerable populations such as children and the elderly. During data collection the study will ensure that all participants receive the same type of treatment and will avoid in engaging in tactics of coercing participants to take part in the research by promising them rewards in financial, material or any other form thus resulting in deception to the participants. The study will further ensure that during data analysis both positive and negative results are disclosed whilst respecting the privacy and anonymity of participants. Finally, the researcher will also ensure not to disclose any information that would result in participants to be harmed and the communication and sharing of the report will be carried out in a clear, straightforward and appropriate language (Creswell, 2014).

CHAPTER FIVE: PRESENTATION OF RESULTS AND DISCUSSION

5.1. Introduction

This chapter focused on the presentation of results from the respondents. The results presentation has been organized according to four sections. Section 5.2 outlines the demographic characteristics of the respondents from both households and commercial premises. Section 5.3 presents the options for reducing GHG emissions from solid waste from households and commercial premises. Section 5.4 outlines the benefits and viability of establishing green spaces/urban afforestation in the township while section 5.5 outlines the extent to which Kalingalinga Township adheres to environmentally friendly standards in terms of roads, green spaces, transportation and waste management.

5.2. Demographic characteristics of the sample

The study targeted households and commercial premises in Kalingalinga Township, with a sampled population of 100 households and 50 commercial premises. From the 100 respondents interviewed from the households, there were more males (51 %) than females (49%). With regards the age of the respondents interviewed at household level, it was noted that most of the households consist of young people (38%) representing the age group of 21 – 30 with the older population, those above the age of 60 years old at (5%). Thus indicating that the population in Kalingalinga Township is youthful and this gives hope for new interventions to be tried, tested and appreciated by the households. In terms of educational status, the majority of households had attained secondary school education status (43%) those who had attained tertiary education (35%) were next in line whilst those who had only attained primary education were the least (22%). This provides a good platform for education and awareness campaigns as most households are literate and access information. However, for employment status most households are in informal employment (59%) with those in formal employment (33%).This suggests that households are engaged in some form of small businesses in order to earn an income which means that most households may not have disposable income that would enable them to carry out activities such as the purchase of plants for greening purposes, as shown in Table 1.

Table 1: Demographic Characteristics of the respondent sample

Age	**Percentage**		**Gender**	**Percentage**
21 - 30	38		Male	51.0
31 - 40	31		Female	49.0
41 - 50	14		**Marital Status**	**Percentage**
51 - 60	12		Married	59
≥ 60	5		Single	21
Education Status	**Percentage**		Widow	10
Primary	22		Widower	10
Secondary	43			
Tertiary	35			
Employment Status	**Percentage**			
Formal	33			
Informal	59			
Tertiary	35			
Retired	8			

Source: Field Data 2021.

From a total of 50 business owners interviewed, 64% were male and 36% were female. In terms of age. The business owners in Kalingalinga Township can be considered to be mostly youthful as seen by 54% representing the age group of 21-30, followed by 28% (31-40) with only 2% representing those above 51 years old. When it came to education, the township was characterized with business owners who had mostly attained secondary education (52%)with those who had attained primary education at (16%).This denotes that most of the business owners have gone through the education system up to grade twelve and can therefore understand issues and make informed decisions as shown in Table 2.

Table 2: Demographic Characteristics of the sample of business owners

Age	**Percentage**		**Gender**	**Percentage**
≤20	6.0		Male	64.0
21- 30	54.0		Female	36.0
31 - 40	28.0		**Marital Status**	**Percentage**
41 – 50	10.0		Married	64
≥51	2.0		Single	28
Education status	**Percentage**		Widow	2
Primary	16		Widower	6
Secondary	52			
Tertiary	32			
Employment status	**Percentage**			
Formal	32			
Informal	66			
Retired	2			

Source: Field Data 2021.

Most of the businesses operating in Kalingalinga where retail shops (29.8%), while other businesses included service providers (12.8%) such as Veterinary Services, Business Centres and Security Companies whilst others included restaurants (3.2%), butcheries (2.1%), bars (2.1%), as well as carpentry and welding (2.1%). Wholesale shops (1 %) had the least presence in Kalingalinga as shown in Figure 3.

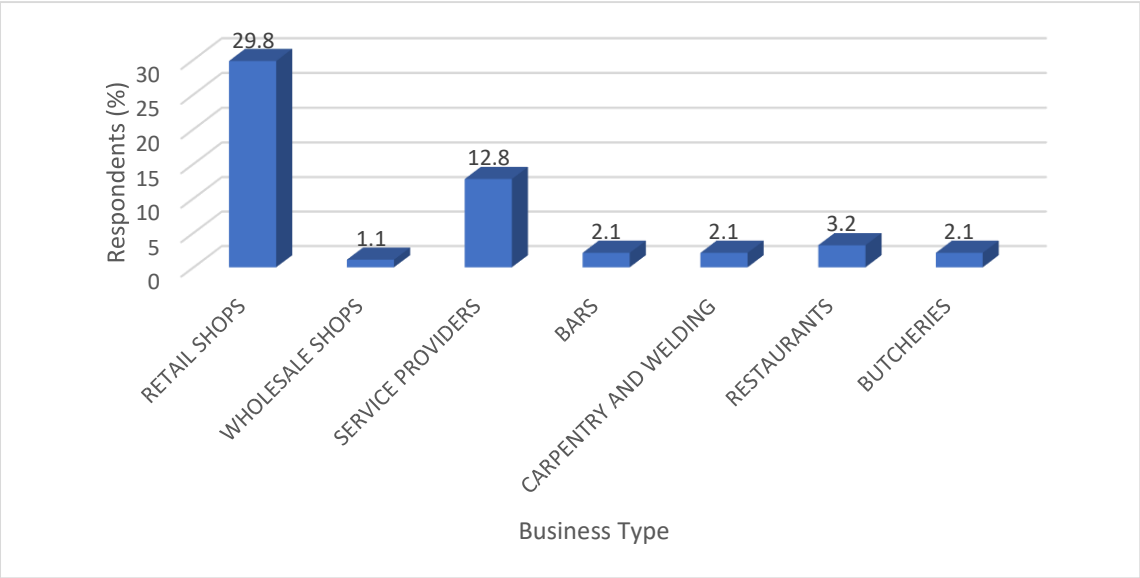

Figure 3: Common Businesses found in Kalingalinga Township

Source: Field Data 2021.

5.3. Solid waste management from households and commercial premises in Kalingalinga Township

The study sought to establish the existence of recycling systems within the township as part of the waste management system. Majority (87%) of the respondents interviewed from households indicated that there is a significant presence of informal waste pickers within the township, while only 6% said there were no informal waste pickers in the area. Seven (7%) did not know anything pertaining to informal waste pickers in Kalingalinga Township as shown in Figure 4.

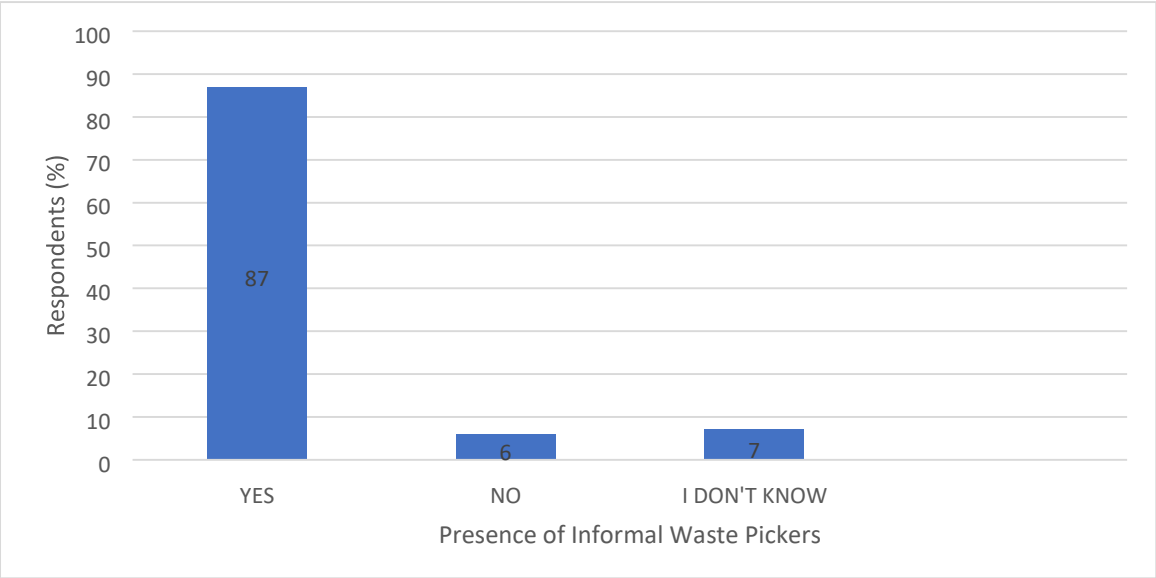

Figure 4: Presence of informal waste pickers in the Township as evidenced by households.
Source: Field Data 2021.

The informal waste pickers collect waste for recycling purposes and it was established that much of this waste (44.8%) is taken to businessmen and women engaged in the waste recycling business whilst only (9.60%) of the households indicated that the waste is taken to recycling centers as shown in Figure 5.

The presence of informal waste pickers in the township was part of a waste recycling system.

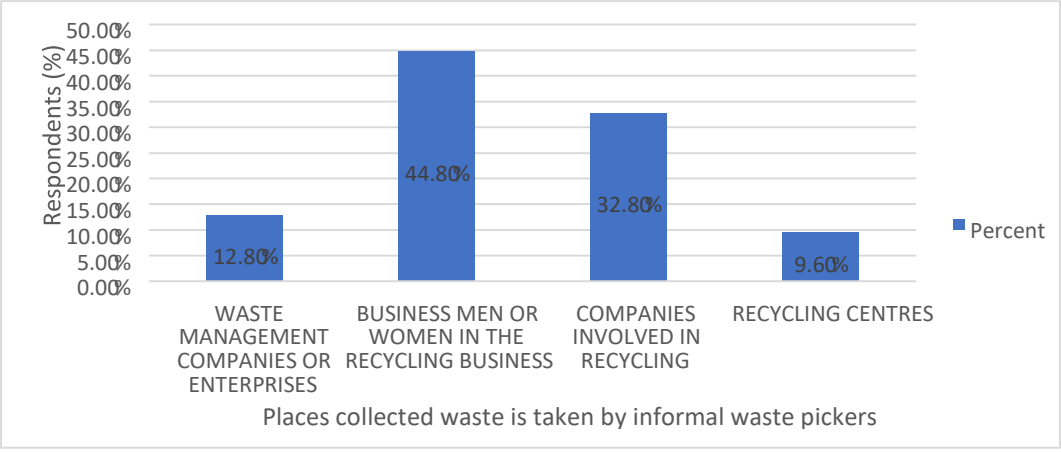

Figure 5: Areas where waste collected from households is taken by informal waste pickers in Kalingalinga Township.

Source: Field Data 2021.

Some respondents from commercial premises indicated that there is a significant presence of informal waste pickers in the township (70 %, while 24% did not believe the township had informal waste pickers and 6%, did not have any information with regards to informal waste pickers in the township as shown in Figure 6. The overwhelming response from the commercial premise owners concerning the presence of informal waste pickers corroborates with the information given by the households thus confirming that the informal waste pickers in the township are part of a recycling system.

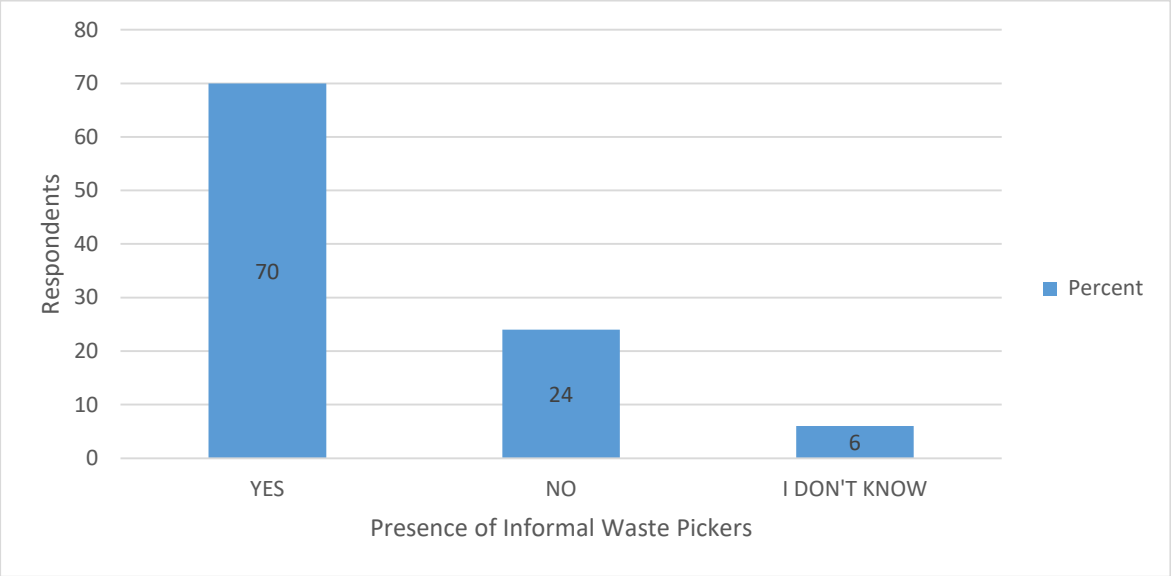

Figure 6: Business Owners perceptions of the presence of informal waste pickers in Kalingalinga Township.
Source: Field Data 2021.

Much of the waste picked in Kalingalinga is taken to individual recyclers (42.9%) while 34.7% is taken to companies involved in recycling as shown in Figure 7. However, as indicated by the key informant interviews, much of the waste from the informal waste pickers were disposed of indiscriminately with no regard to the township's cleanliness. There was no waste recycling center in Kalingalinga only waste aggregation centers were present in the township.

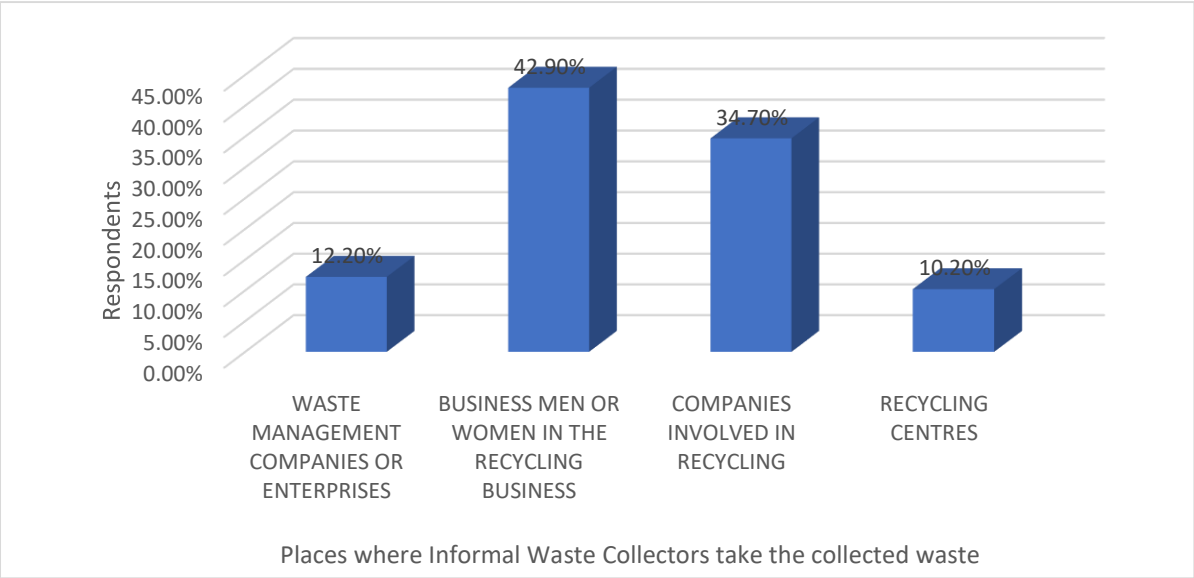

Figure 7: Places where Informal Waste Pickers take the Waste Collected in Kalingalinga. Source: Field Data 2021.

Figure 8: Informal Waste Pickers Delivering Waste at an Aggregation Site Source: Field Data 2021.

Figure 9: Material Recovery Facility Operated by Business Men/Women in the Township.
Source:Field Data 2021.

5.3.1. Waste Recycling by Households and Business Premises

The study sought to ascertain whether respondents at households and commercial premises practiced any form of waste recycling and if they did, what type of waste recycling they were practicing. The majority of householders were engaged in some form of waste recycling at household level represented by 81% and only 19% were not carrying out waste recycling as shown in Figure 10, confirming that the majority of households were involved in waste recycling.

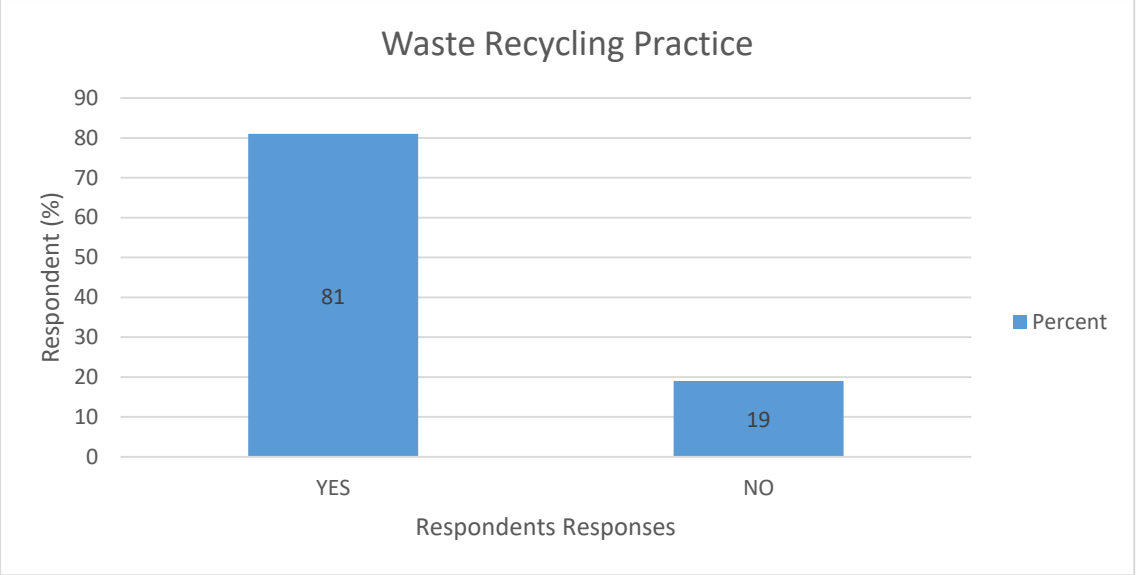

Figure 10: Households carrying out waste recycling practices
Source: Field Data 2021.

From the households that had indicated that they were involved in waste recycling the most prevalent practice was indicated by the use of storage containers (plastic/glass bottles) 36.50%, cleaning materials 21.20%, shopping bags 13.80%, creative uses such as for decorative purposes 11.10%, gardening purposes 10.10% and bin liners at 7.40% as shown in Figure 12.

However even though most of the households were recycling their plastic/glass bottles, this practice was only carried out periodically due to the fact that these households usually only buy commodities packaged in plastic/glass bottles periodically as most of their commodities are bought in small quantities and on a daily basis as need arises. This implies that most of these households still dispose of plastic and paper regularly as these are the packages used for these small commodities that households buy on a day to day basis. Further, it was also noted that most households are not engaged in recycling of the food waste that is generated and this is due to the fact that food waste was generally regarded as a source of nuisances such as attracting flies, cockroaches, rats as well as stray dogs searching for food on the premises. Also because of the lack of space within their premises, most households did not see the need to recycle food waste for composting purposes.

When it comes to the recycling of plastic bags as shopping bags, the practice is that, households usually only recycle the plastic bags which they obtain when they buy a large amount of items either from big supermarkets such as Shoprite or the large local markets such

as Soweto Market periodically. Otherwise other smaller plastic bags obtained from the local markets and grocery shops in the area are usually disposed of after items are emptied and these are the plastic bags that are commonly found lying around the township as well as in the drainages.

Figure 11: Indiscriminate disposal of waste in the drainage
Source: Field data 2021.

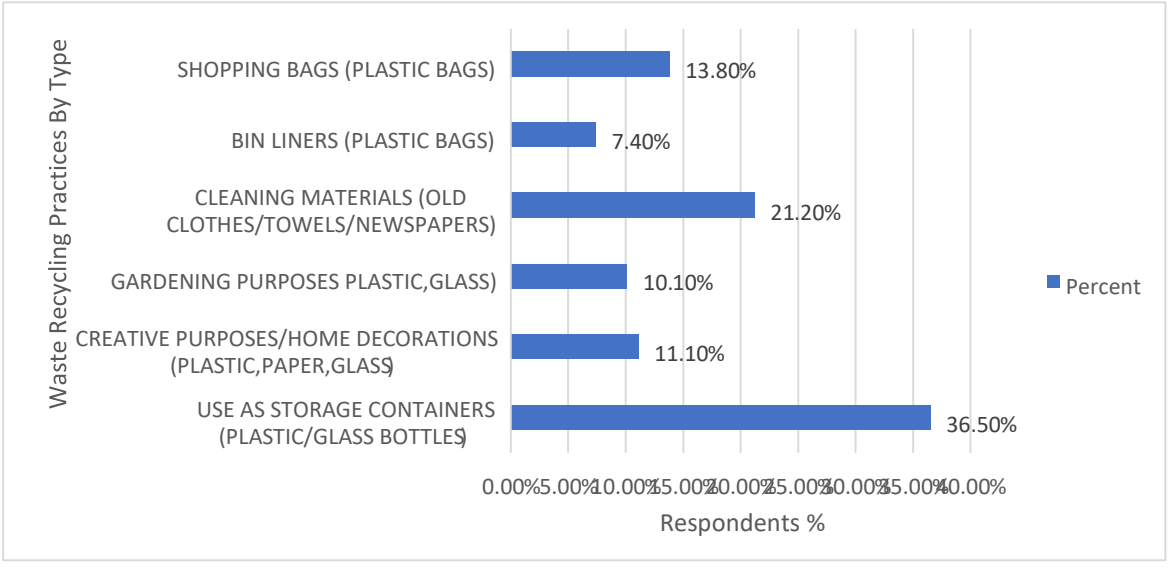

Figure 12: Identified waste recycling practices by households.
Source: Field Data 2021.

Respondents from commercial premises were also interviewed on whether they practiced waste recycling at their various businesses as well as the specific types of waste recycling that they were engaged in. Majority of businesses were indeed involved in waste recycling with 60% confirming their engagement in the practice of waste recycling and 36% indicating that they were not involved in waste recycling whilst only 4% did not know anything as indicated in Figure 13. This therefore, affirms that the commercial premises were carrying out some waste recycling activities.

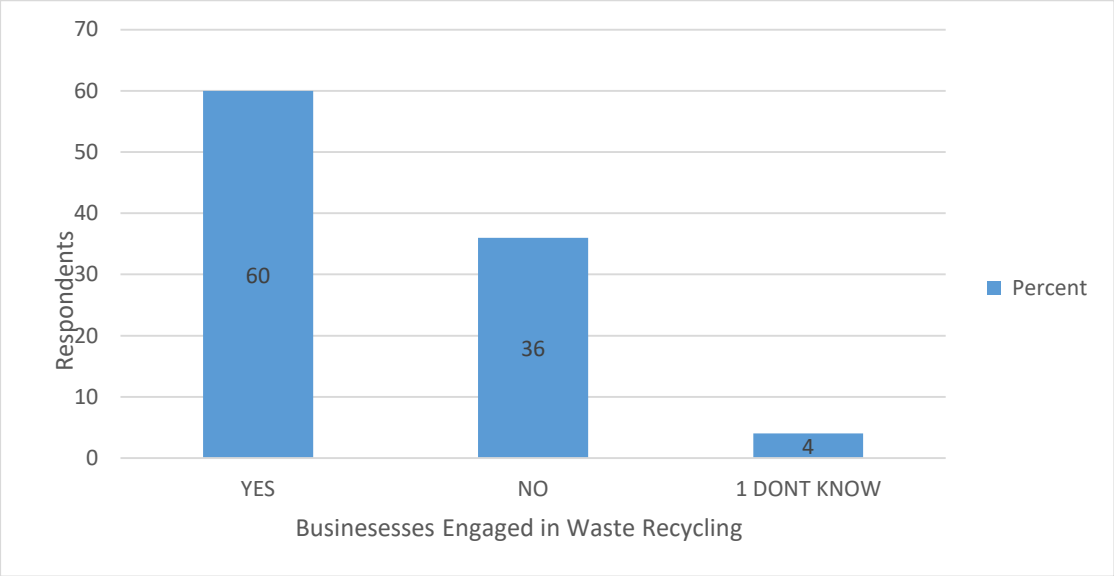

Figure 13: Businesses engaged in Waste Recycling
Source: Field Data 2021.

Further out of those commercial premises who agreed that they were involved in waste recycling, the following are the specific types of waste recycling that they engaged in, storage containers in the form of plastic and or glass bottles at 26.80 %, plastic, paper, glass and bottle tops for creative purposes at 21.40 %, plastic bags as bin liners at 23.20%, shopping bags at 14.30% , recycling plastic bags, old clothes/towels, newspapers as cleaning materials at 12.50% and plastic, glass and sacks for gardening purposes was the least at 1.80% .This therefore shows the most common waste recycling practice for businesses is that of plastic/glass bottles as storage containers whilst the least recycling practice was the use of sacks for gardening as is shown in Figure 14.

Although businesses interviewed indicated that they were conducting some form of waste recycling within their premises, it was also observed that most businesses did not recycle the

cardboard boxes they generated from their premises but instead disposed of them by burning them or placing them on the garbage heap for disposal to the dumpsite. It was also noted that the food waste (organic waste) generated by most businesses was not recycled except for the restaurants who were able to recycle the food waste for the preparation of traditional drinks such as munkoyo and chibwantu. This represents a similarity in the specific ways of recycling employed by both households and commercial premises, where it was evident that the recycling storage containers for other uses was the most common practice employed.

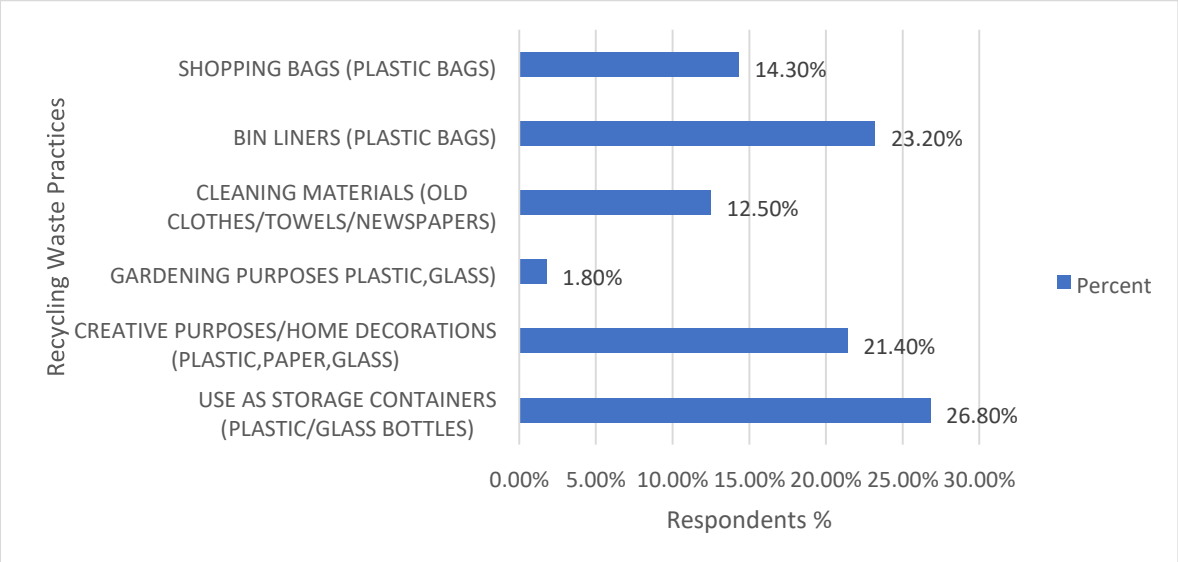

Figure 14: Ways of Recycling Waste by Commercial Premises
Source: Field Data 2021.

Though it was indicated that the most prevalent practice of recycling by both households and businesses was through the use of plastic/glass bottles for storage purposes, it was noted that both households and businesses are only interested in specific types of containers such as the 2.5 - 5 litre plastic containers which can be used for buying cooking oil and storage of water for the households. Thus other plastic and glass bottles are not recycled and are disposed of indiscriminately within the community, or are thrown in the garbage for disposal to the dumpsite. This scenario is also a similar practice for the businesses, which also only conducted recycling of the plastic/glass bottles for a limited time before the containers were thrown in the garbage for disposal to the dumpsite. This, therefore means that the practice of recycling from both households and business owners is only carried out to a certain extent and on a temporal basis.

5.3.2. Waste Recycling Systems and Reduction in GHG Emissions.

A total of seven (07) strategic key informants were interviewed through a semi structured interview guide to give expert knowledge on how the waste recycling system in Kalingalinga can be positioned in order to effectively contribute to reduced GHG emissions from. Table 3 summarizes the positioning of waste recycling systems in the Township.

Table 3: Potential for the Reduction of GHG Emissions from Solid Waste Management

Key Informants	Responses
Number - 1	Residents of Kalingalinga township can be motivated to engage in waste separation at source by • Demonstrations on how waste can be a business • Awareness and education • Incentivizing waste management.
Number - 7	Residents of Kalingalinga Township can be motivated to engage in waste separation at source by: • Stakeholder engagement • Buy-in and sensitization on tv, radio and other media outlets • Incentivizing the process • Use of waste champions
Number -5	Residents of Kalingalinga can be motivated to engage in waste separation at source through; • providing incentives
Number - 3	Residents of Kalingalinga can be motivated to engage in waste separation at source by: • Sensitizing them on the negative impacts to the environment • Engaging with recyclers to buy the sorted waste from the residents

Number - 4	The residents of Kalingalinga township can be motivated to engage in waste separation at source by: • Providing additional bin liners or sacks for separation. • Offering incentives such as awarding households necessities such as soap with hand washing.
Number -8	He said that the residents of Kalingalinga township can be motivated to engage in waste separation by; • Sensitizing them on the fact that residents can make money from waste engaging in waste separation and selling items such as plastic bottles, single use plastics to companies.
Number -6	Residents of Kalingalinga can be motivated to engage in waste separation at source by providing incentives through; • Provision of waste bins for separation • Giving them some sort of award • Coming up with some waste separation projects.

Source: Field data 2021

5.3.3. Reduction of Waste Generation by Residents

In an effort to identify how residents could reduce their waste generation. The study sought to first establish the level of knowledge that household owners and commercial business owners had when it comes to waste reduction and it was indicated that the majority of households interviewed (88%) had knowledge on waste reduction whilst 11% and only 1%, respectively, said that they had no knowledge and did not know anything as shown in figure 15.

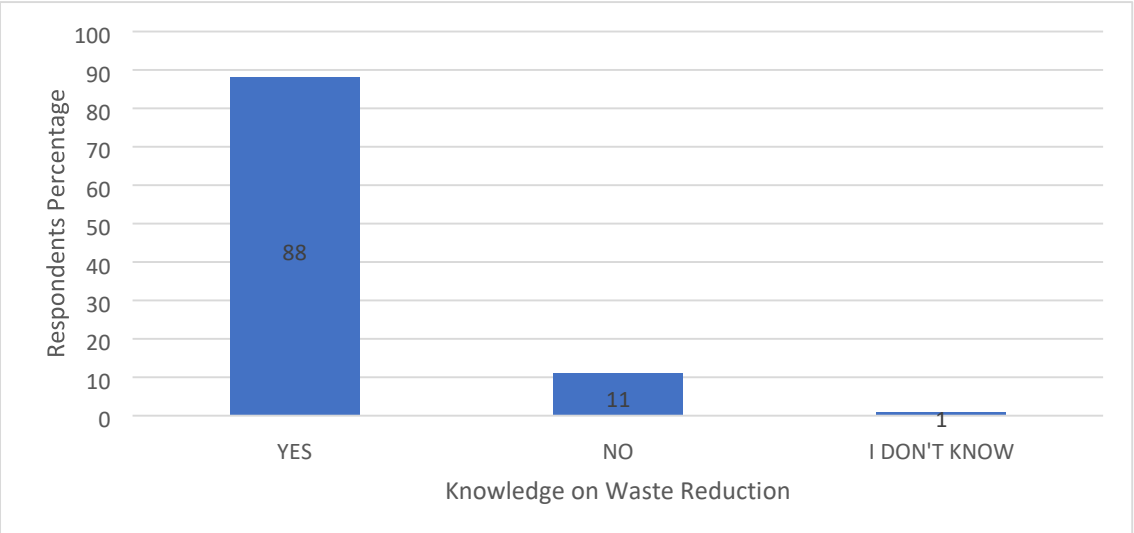

Figure 15: Knowledge on Waste Reduction by Households
Source: Field Data 2021.

In the case of commercial business owners, the majority indicated that they had knowledge on waste reduction (72%) with only 18 and 10% respectively stating either a definite no or that they did not know anything on waste reduction as shown in Figure 16. Therefore, both household owners and business owners had knowledge on waste reduction.

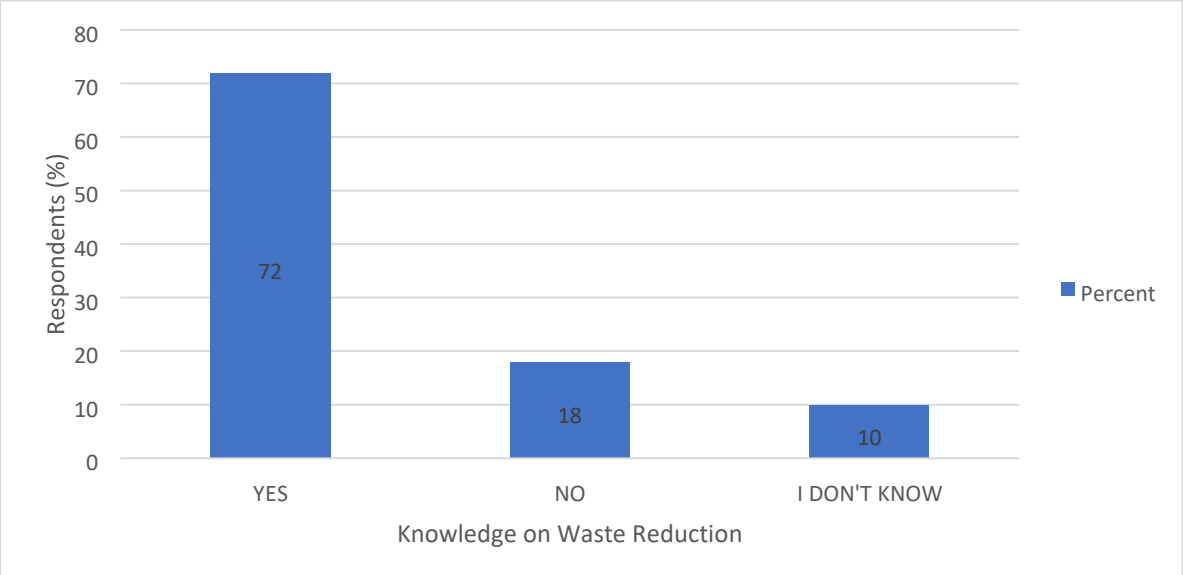

Figure 16: Knowledge on Waste Reduction by Commercial Premises.
Source: Field Data 2021.

From the respondents interviewed from households, the practices used to carry out waste reduction were also interrogated from where it was established that 35.9% reuse bottles and

other containment, 18.9% reuse shopping bags,18.0% donate used clothes, 7.8% carry out composting of organic waste,6.8% purchase only required items such as making a budget, 6.3% conduct their shopping from the local markets, 2.9% use the leftover foodstuffs such as a local dish known as nshima to make local traditional drinks known as *munkoyo* or *chibwantu*, 2.4% burn their paper and plastic waste in order to reduce on the accumulation and the remaining 1% indicated that they pay the subscription fees for waste collection services so as to ensure that they reduce the waste from accumulating at their premises as shown in Figure 17.

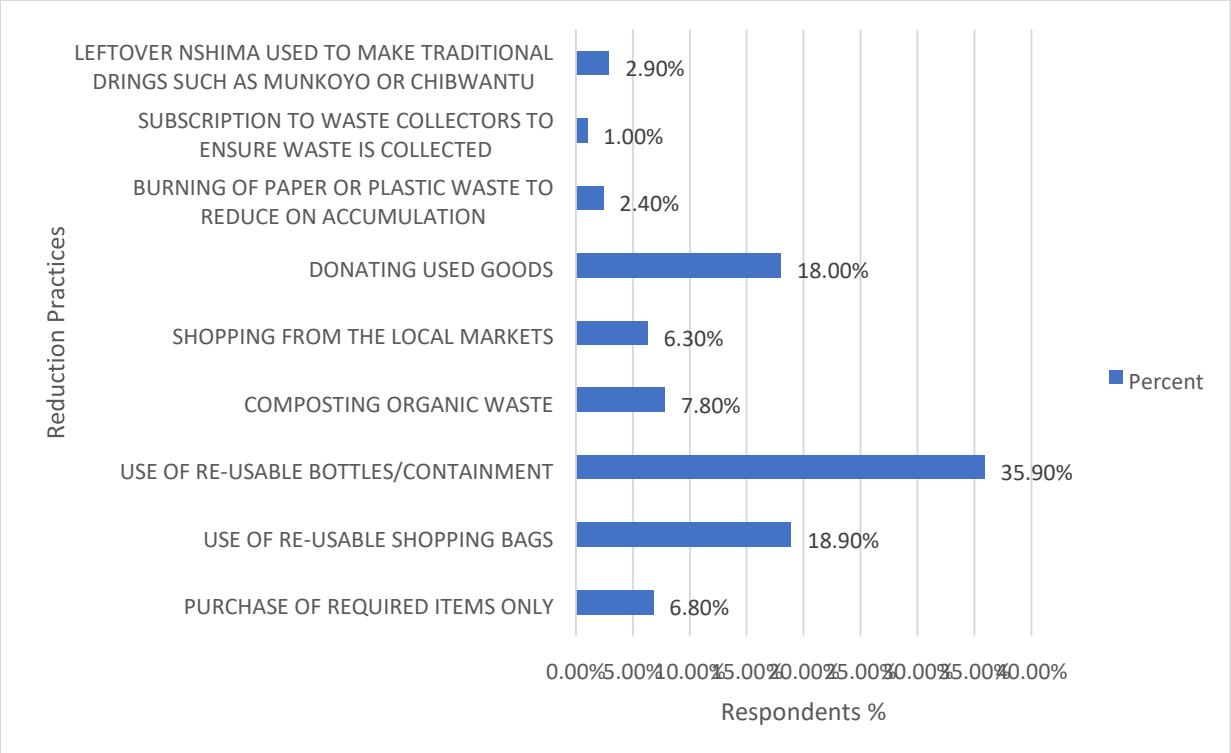

Figure 17: Waste Reduction Practices by Households
Source: Field Data 2021

Respondents interviewed from the commercial premises that had knowledge on waste reduction were involved in various ways to ensure waste reduction practices. The most common practice was the use of re-usable bottles for containment at 28.20 %, followed by the purchase of items that are required at a particular time at 22.50 %, re-usable shopping bags at 14.10%, donating used goods to family members as well as members of the community in need at 11.30 %, composting of organic waste at 9.90 %, reduce the use of paper by going

digital at 4.20 %, subscription to waste management services at 4.20 %, shopping from the local markets at 2.80 %, burning of waste at 1.40 % and using leftover foodstuffs such as nshima to make traditional drinks such as munkoyo also at 1.40% in the case of restaurants as shown in Figure 18.

Having identified the waste reduction practices as indicated by households and business owners, it is noted that the contribution of some of these practices to environmental sustainability, such as in the case of the purchase of required items only, this practice counteracts the behavioural tendency of overconsumption habits which if left unchecked leads to an increased generation of waste being deposited in the environment. Which in turn exacerbates the problem of indiscriminate disposal of waste as well as causing large amounts of waste to be deposited at the designated Chunga Dumpsite. Such a situation leads to the production of large amounts of methane gas, which is a highly potent Green House Gas (GHG) from the decomposing organic material.

In addition, the large amounts of waste generated by households and commercial premises may cause a burden on the waste management system for storage and collection of waste and this may allow for the households and commercial premise owners to find alternative ways of disposing off of their waste such as burning or indiscriminately disposing of this waste in the environment, thereby causing adverse effects to the environment which may ultimately lead to climate change effects. This is also true when the waste reduction method of reusable bottles for containment is not practiced.

In the case of composting organic waste as a method for waste reduction, it is an environmentally sustainable method in that it reduces on the production of GHG such as methane, which would otherwise be produced if the organic waste material is left lying indiscriminately. Shopping from the local markets is also another sustainable method that can be employed as a waste reduction method. This is because when residents shop from the nearby local markets they are reducing on what is termed as food miles. Food miles is a phenomenon where food is transported to the local markets from far off places, hence the distance covered by vehicles to reach the local markets causes a significant contribution to the issue of climate change due to the release of carbon dioxide into the atmosphere arising from the combustion of the fuel to move the trucks transporting the food.

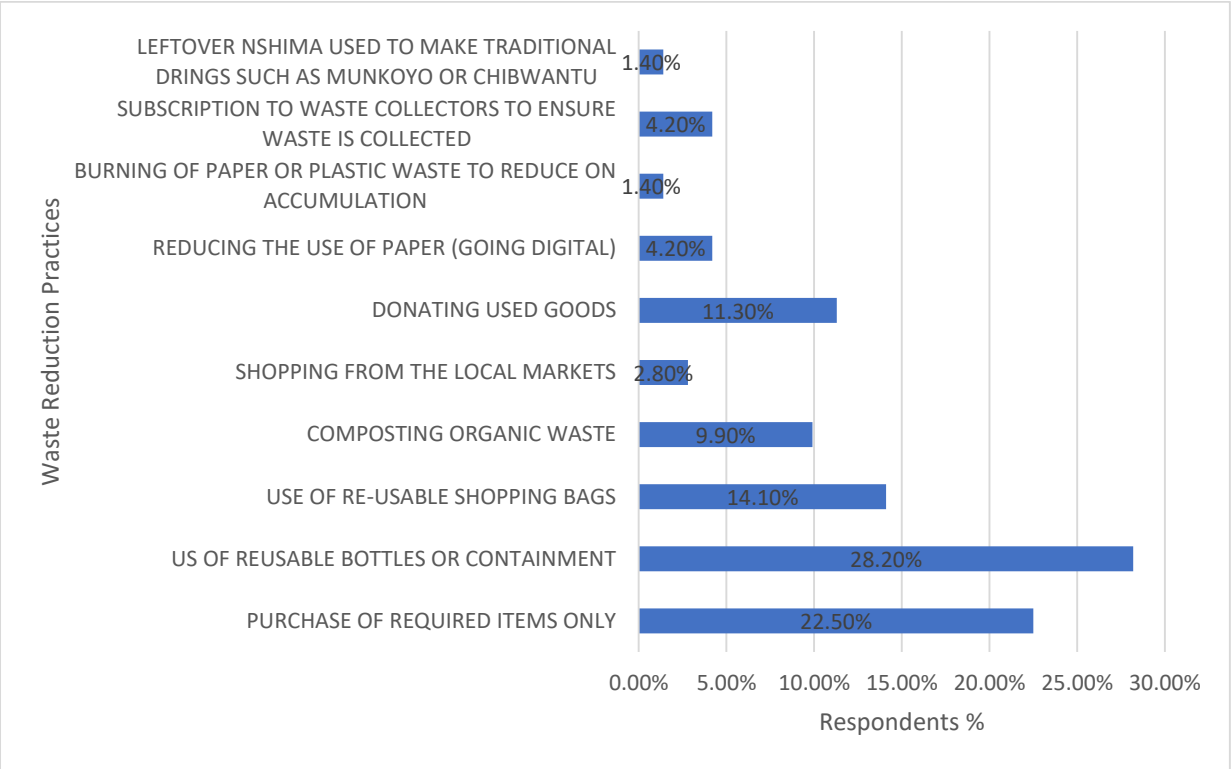

Figure 18: Ways for Waste Reduction by Commercial Premises
Source: Field Data 2021.

Both household owners and commercial business owners were engaged in the reuse of bottles for containment, as the major method employed to ensure their waste reduction but a significant difference was noted where commercial business owners also employed the practice of purchasing required goods only as a means to ensure waste reduction whilst household owners employed the way of reusable shopping bags significantly as a means to ensure waste reduction.

The key informants interviewed indicated that the practice of reducing the generation of waste at household and commercial level is a positive and sustainable measure towards climate action as it helps to reduce GHG emissions which can otherwise be released from the large amounts of waste deposited at the dumpsite as well as from the burning of waste by households and business owners.

Key informant (1) said,

"Waste reduction can be achieved through practices such as garden composting, change in consumption patterns and the use of re-usable shopping bags."

On the other hand, key informant (7) indicated that,

"*Reduction of waste right from the household and commercial places as well as integrated supply-chains for waste management & reuse could be employed in ensuring waste reduction".*

Key Informant (5) said,

"Waste reduction can be achieved through recycling waste and purchase of eco-friendly products e.g. reusable shopping bags".

Key Informant (4) said,

"Waste reduction can be achieved through Making of fertilizer/composting from garbage and using the garbage for crafts or decorative purposes".

Having interrogated the practices to ensure the reduction of GHG emissions for sustainable waste management, the study sought to determine the barriers that hindered residents in engaging in reuse of the waste they generated in the township. Respondents from the interviewed households indicted that they had challenges in the reuse of waste as evident from 47% agreeing in the affirmative, 51% said they didn't and the remaining 2% said they did not know anything pertaining to the challenges.

The specific types of challenges that householders face in re-use of waste were indicated by 63.50% saying that they lack knowledge on re-use, 26.90% said due to the high poverty levels sustainable waste management practices was not a priority for them, 5.80% said they did not want to keep the waste for reuse at their premises due to the fact that the waste makes the surroundings of the household look dirty and can become a breeding ground for cockroaches whist 3.80% said that they did not have enough space at their premises to keep the organic waste as shown in Figure 19.

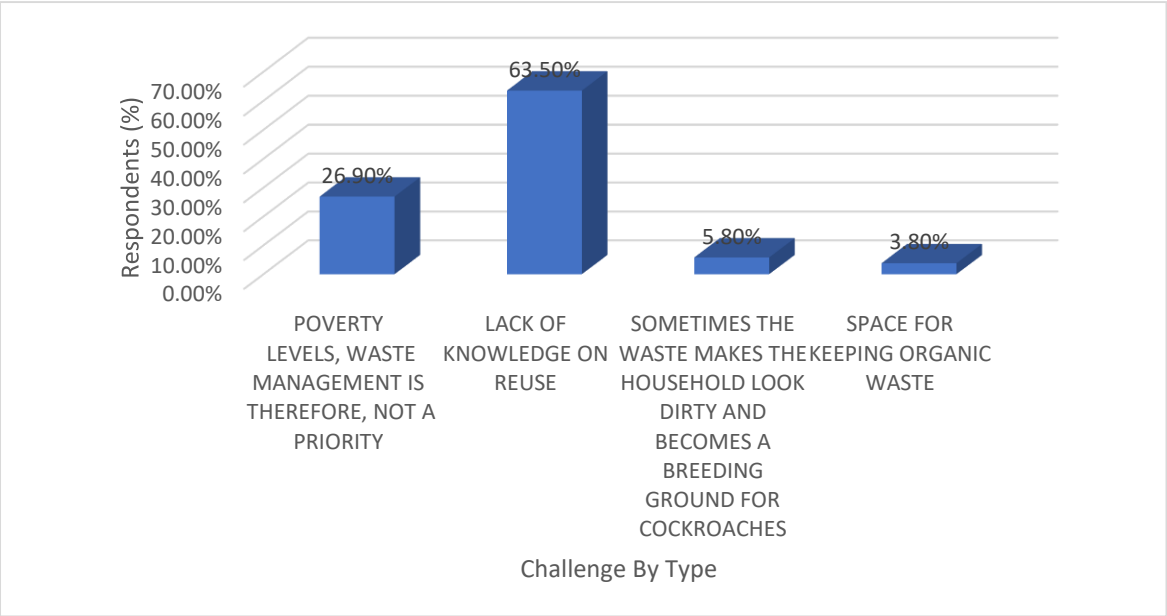

Figure 19: Types of Challenges in Re-use of Waste by Households
Source: Field Data 2021.

The different types of challenges experienced by commercial premise owners in the re-use of waste was indicated by the major challenge of having inadequate knowledge on how to carry out activities pertaining to re-use and this was expressed by 88.90 percent followed by the fact that due to high poverty levels, the issue of sustainable waste management was not a priority particularly the aspect of re-using waste, expressed by 7.40 percent and finally they also indicated that they did not have enough space at their premises to store the accumulated organic waste expressed by 3.70 percent as presented in figure 20.The challenges experienced by both household and business owners are similar and are therefore shared challenges.

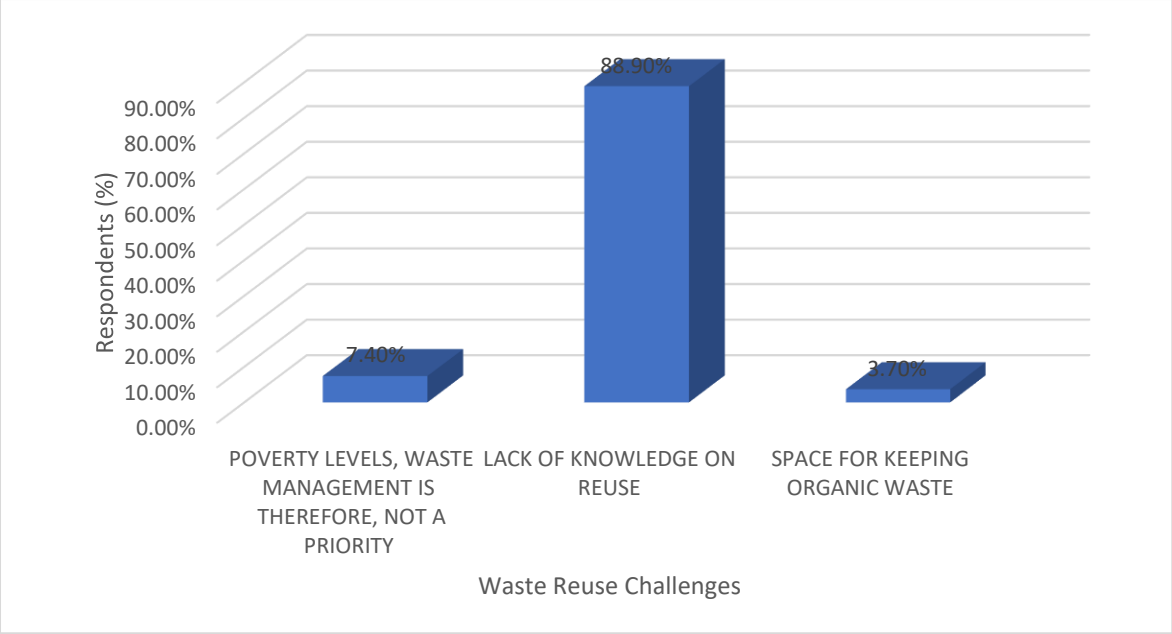

Figure 20: Types of Challenges Encountered by Commercial Premises in Re-use of Waste.
Source: Field data 2021.

5.4. The viability of establishing green spaces in Kalingalinga Township.

The study primarily sought to first understand and establish whether householders and commercial premise owners understood the importance and benefits that accrue from green spaces in a designated area. Respondents interviewed from households and commercial premises indicated that most household owners definitely had knowledge on the importance of green spaces (95%) with only five (5) % indicating that they had no knowledge of the importance of green spaces. For commercial premise owners, the majority 62% also had knowledge of the importance of green spaces with only 2%and another 2% respectively either expressing no knowledge or having no idea completely on the importance of green spaces.

The respondents interviewed from households further indicated the benefits of having these green spaces, where the greatest benefit perceived was that of fresh air, 39 %,24.60% indicated a beautiful environment,23.0 % indicated a cool environment (mitigation of the urban heat island) whilst only 7.5 and 5.9% respectively attributed the benefits of the green spaces to carbon sequestration and minimizing of floods which represents a direct relation to climate change impacts as shown in Figure 21.

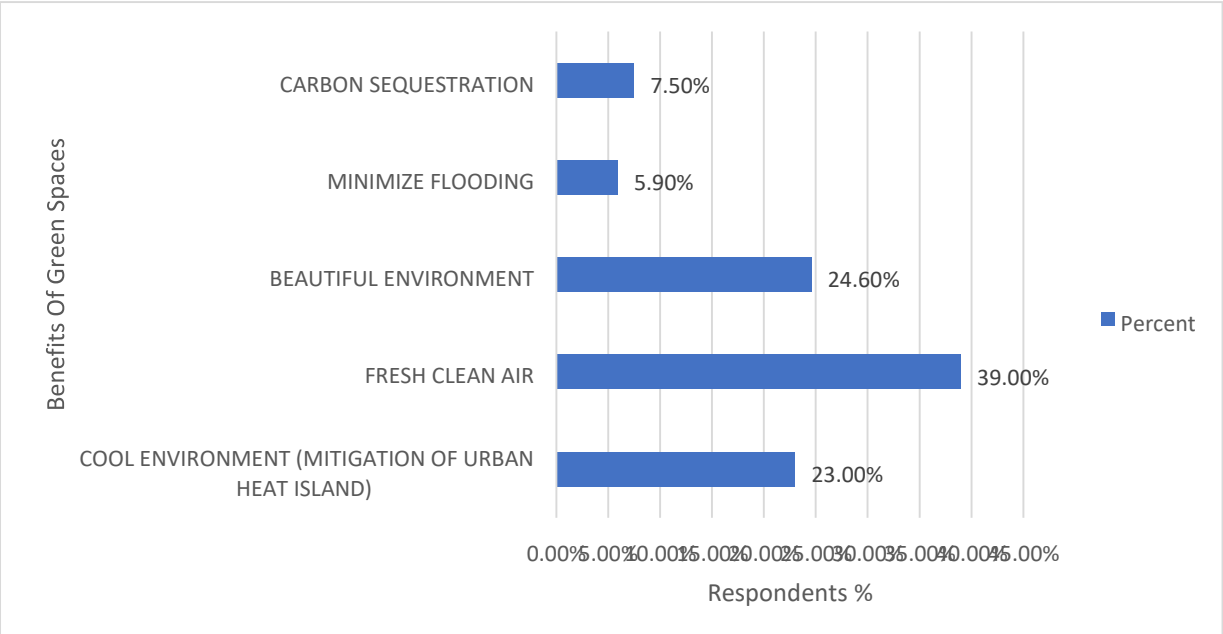

Figure 21: Benefits of Green Spaces by Households
Source: Field Data 2021.

For commercial premise owners, the benefits of green spaces were indicated and recognized respectively as follows; 33.7 % as fresh air,22.5 % as a beautiful environment,18.0 % for carbon sequestration,15.7% for a cool environment and 10.1% attributed the benefits to minimizing of floods as shown in Figure 22.

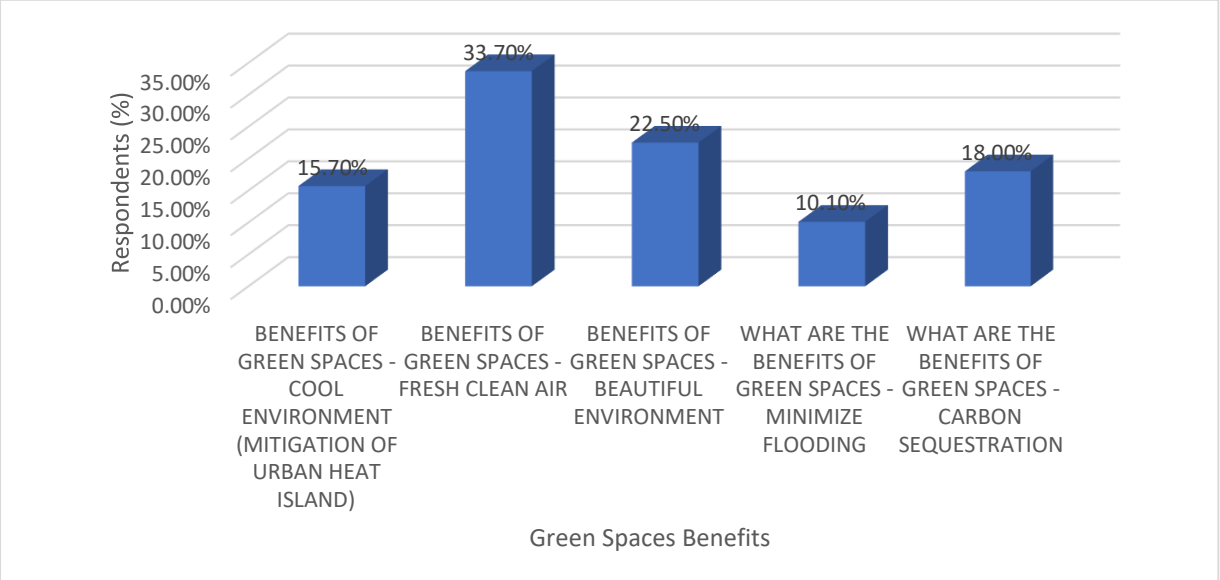

Figure 22: Benefits of Green Spaces by Business Owners
Source: Field Data 2021.

The key informants interviewed also agreed on the benefits that green spaces provide to an area by mentioning a number of them, such as Carbon sinks which are a sponge mechanism that help in the control of floods, Green spaces also help to regulate the temperature in an area and also provide areas for recreation activities.

To determine the viability of creating green spaces in the township, the study sought to find out whether household and commercial premise owners would want to see the creation of green spaces in the township. Most of the households (96%) indicated in the affirmative, 3.0 % said no and only 1% indicated that they did not know. For the commercial premise owners, the scenario was similar to the households with the majority (96%) indicating they would want to see the creation of green spaces, with 2% saying no and 2% saying I don't know.

With regards the preference in the types of green spaces that households would want to see created,42.8 % indicated public parks,38 % playgrounds,12.7 % roof gardens and 6.60 % said public squares as seen in Figure 23. Whereas the commercial premise owners indicated that 48.4% would want public parks, 29.7% play grounds, 12.5% public squares and only 9.4% indicated roof gardens as can be seen in Figure 24. Public parks for both households and commercial premise owners were the most preferred form of green spaces.

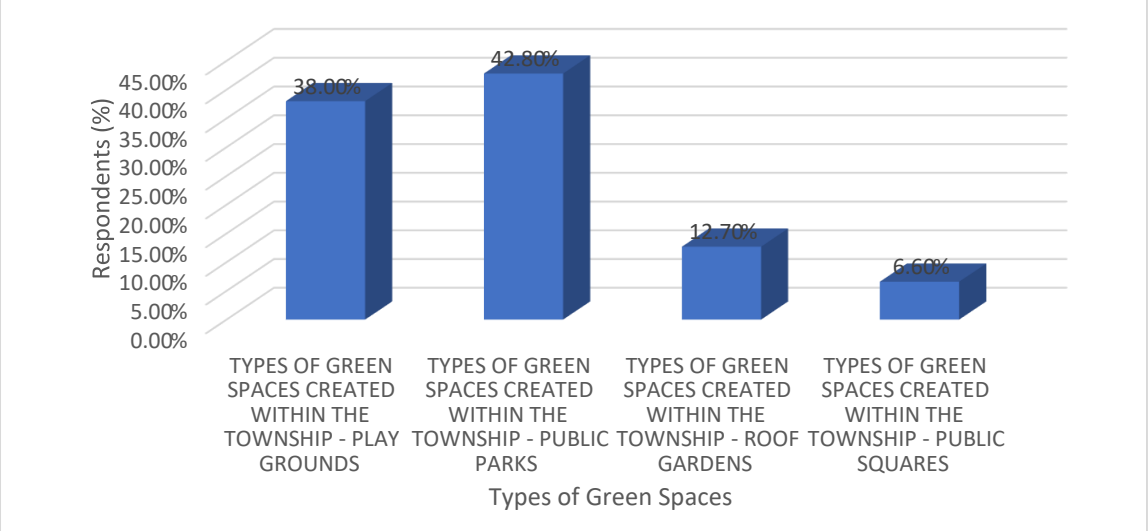

Figure 23: Types of Green Spaces that Households want to see created in Kalingalinga. Source: Field Data 2021.

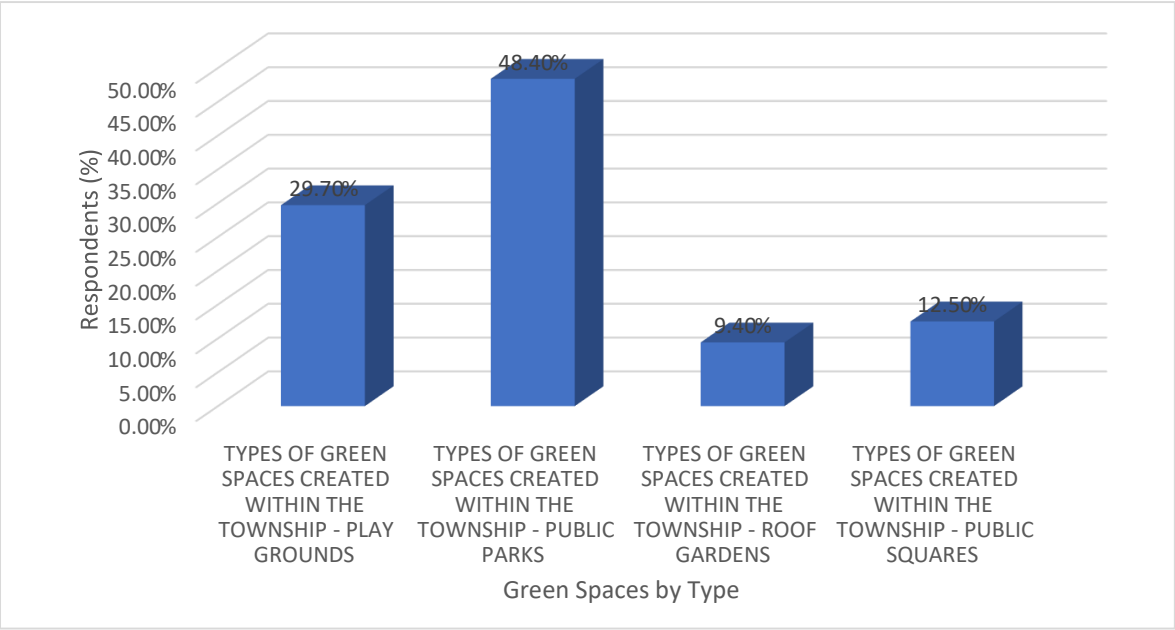

Figure 24: Types of Green Spaces Business Owners would want to see created in Kalingalinga
Source: Field Data, 2021.

The study went further to interview respondents from the households and commercial premises on their willingness to create green spaces at their premises and it was indicated that most household owners (95%) were willing to create green spaces, with only 4% saying no and 1% saying I don't know, as shown in Figure 25.

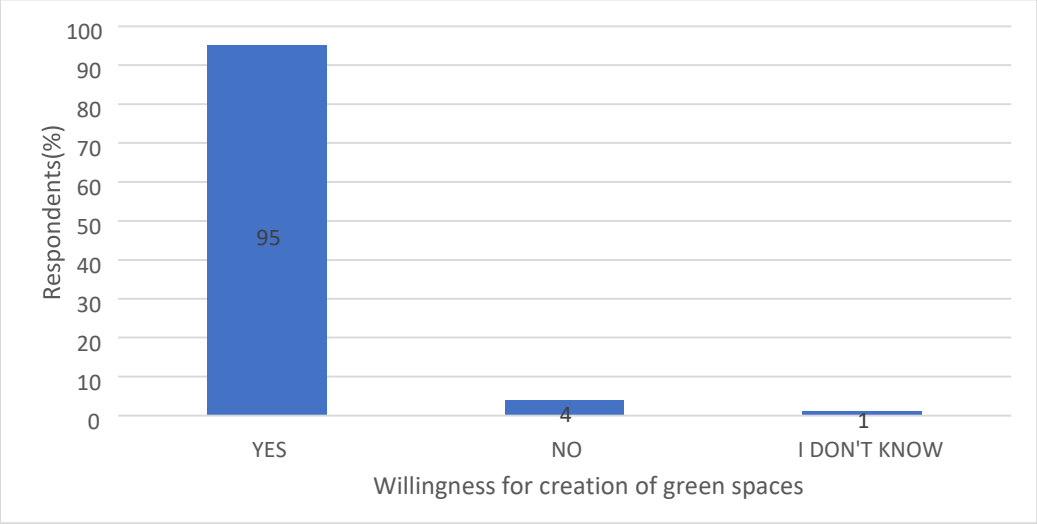

Figure 25: Willingness to Create Green Spaces by the households.
Source: Field Data 2021.

This was similar to the commercial premises where the majority of owners (86%) were willing and only 6 % saying no and 8% indicating I don't know as presented in Figure 26 thus showing an overwhelming sense of willingness by both household and business owners to create green spaces within the confines of their premises.

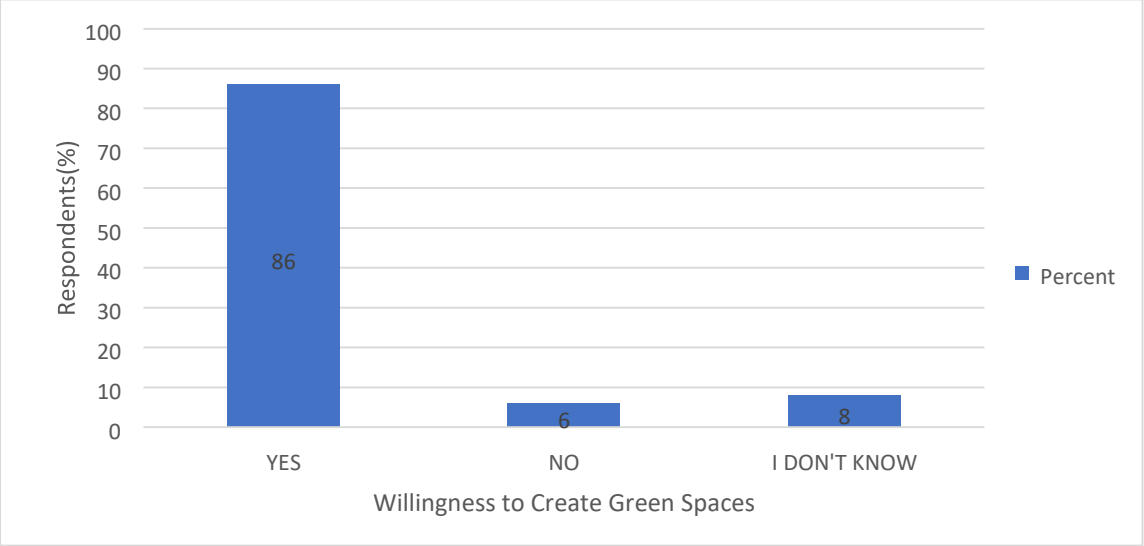

Figure 26: Willingness by Business Owners to Create Green Spaces
Source: Field Data 2021.

Respondents both from households and commercial premises indicated they would consider apportioning as a green space (either for grass or tree planting) as a measure of promoting climate action. Households indicated a maximum area of 800 m^2, which translates to a combined contribution of green space to be apportioned by the households, this is in view of the fact that individual households were willing to contribute even a 1*1 m^2 up to a 5*6 m^2 of space depending on the available space within their premises. This is in addition to planting a mean of approximately four (4) trees. In the same regard commercial premise owners indicated they would apportion a maximum area of 105 m^2, which also translates to a combined contribution from each business premise towards green spaces. Additionally, the business premises indicated that they would consider planting a mean of four (4) trees in total. This is a reflection of how much space both the households and commercial premises can afford to spare as the majority have limited plot sizes but both cadres acknowledged that they do not require a large space of land for either planting grass or trees as shown in Table 4.

Table 4: Descriptive Statistics on Size of Plot to be Apportioned for Green Space by Householders and Commercial Premise Owners.

Category Type	Size of Current Residential Plot To Be Apportioned As A Green Space (Grass Or Tree Planting			How Many Trees Would You Consider Planting On Your Current Plot In Kalingalinga?			
	Min	Max	Mean	Std	Min	Max	Mean	Std
Households	0	800 m^2	31.08	93.76	0	25	4	4.25
Commercial Premises	0	105 m^2	22.42	32.91	0	15	4	3.67

Source: Field Data 2021.

To support the viability of the creation of green spaces, key informants interviewed also indicated that there are various policies that enable and support the creation of green spaces.

Key informant,"1" indicated that The Urban and Regional Planning Act No.3 of 2015 which though not explicitly clearly indicating green space but by implication section 3 (1) and sub section (c) on the principles and standards for urban and regional planning notes the consideration that planning procedures shall incorporate environmental standards and requirements specified in any law relating to the environment and natural resources.

On the other hand, open space can imply to be covered under "amenities" defined in the law.

Key informant "5" indicated, the Environmental Management Act 2011 which encourages the maintenance of greenery through conditions that are attached to licenses or decision letters to project proposals. In addition, reference is made to other laws or stakeholders that maybe affected by projects.

Having interrogated the willingness of householders and commercial premise owners to create green spaces the study sought to investigate the barriers/hindrances that households and commercial premises in the township encounter in the creation of green spaces and the following reasons were established, 65.5 %said small plots, 11.2 % lack of information, 9.5% inadequate water supply, 6.0 % low income levels,2.6 % rented house,1.7 % had no time

because they were busy conducting their business whilst another 1.7 % said the soil at their premises was not conducive for growing plants and the remaining 0.9% indicated they had no interest due to lack of monetary benefits and the other 0.9% said the presence of free range chickens were a hindrance as seen in Figure 27.

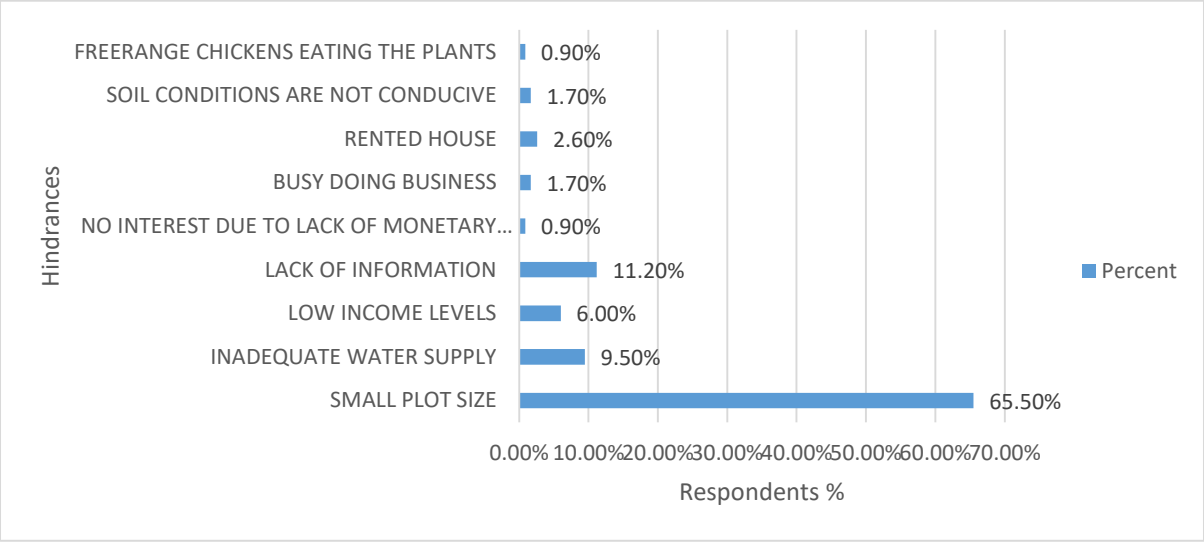

Figure 27: Hindrances to the Creation of Green Spaces by Households.
Source: Field Data 2021.

Respondents interviewed from the commercial premises also indicated that the major hindrance they faced in the creation of green spaces was 65.0% small plot,18.3 % inadequate water supply,8.3 % lack of information whilst only 3.3 % said they had no time as they were busy running their business and the other 3.3% said that if they planted trees, the trees would cover the signage for the business as shown in Figure 28, further key informants also acknowledged the challenge of inadequate open spaces for the creation of green spaces.

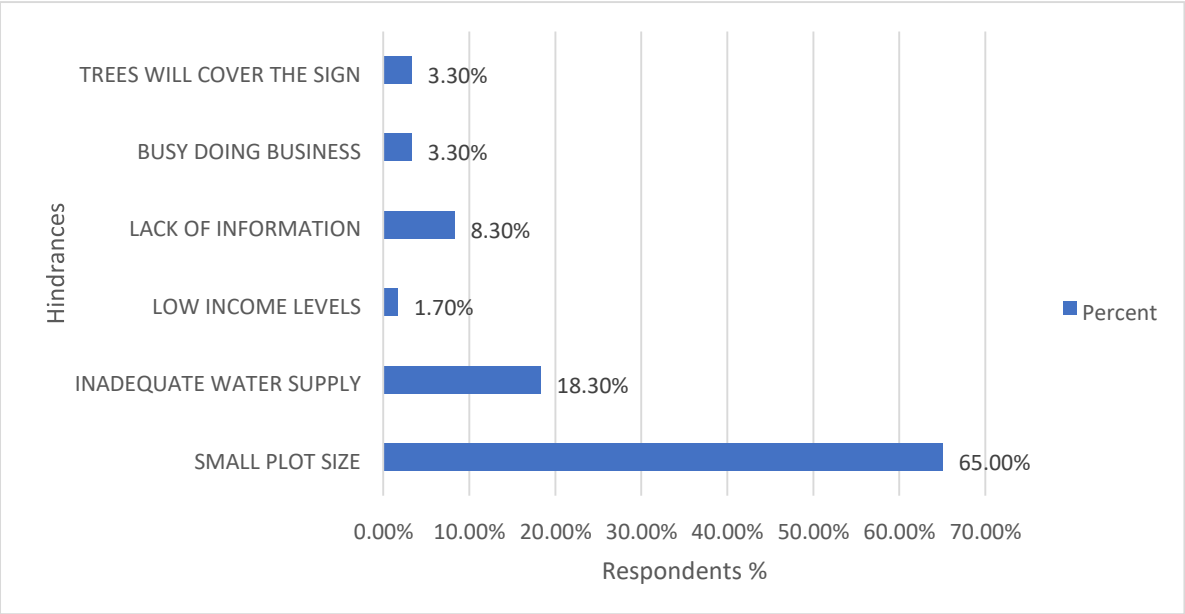

Figure 28: Hindrances faced by Commercial Premises in creating Green Spaces. Source: Field Data 2021.

The study sought to determine how households and commercial premises would create green spaces as an alternative to the absence of green spaces in the public open areas within the township. According to the households, 44.10% plan on doing this by planting trees, 36.80 % through urban gardening, 18.40 % said by maintaining a lawn and 0.70 % indicated the use of sacks, pot plants and other discarded materials such as old tyres, damaged basins and buckets as other means to create green spaces, as shown in Figure 29.

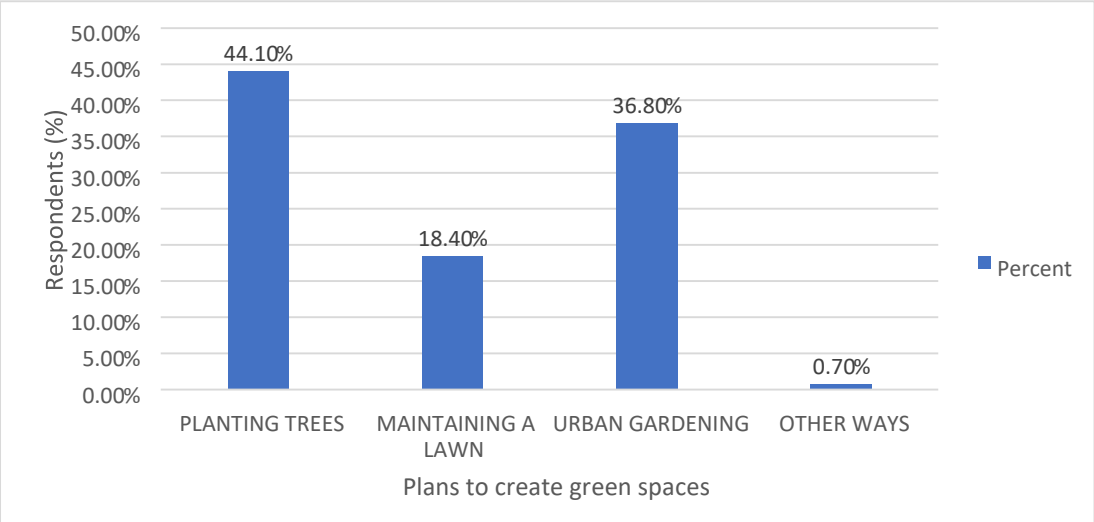

Figure 29: Options for Creating Green Spaces by Households in Kalingalinga Source: Field Data 2021.

Commercial premise owners indicated how they would create the green spaces by planting trees (48.3%), maintaining a lawn (26.7%), urban gardening (13.3%) and utilisation of pot plants to plant flowers and green plants (11.7%) as shown in Figure 30.

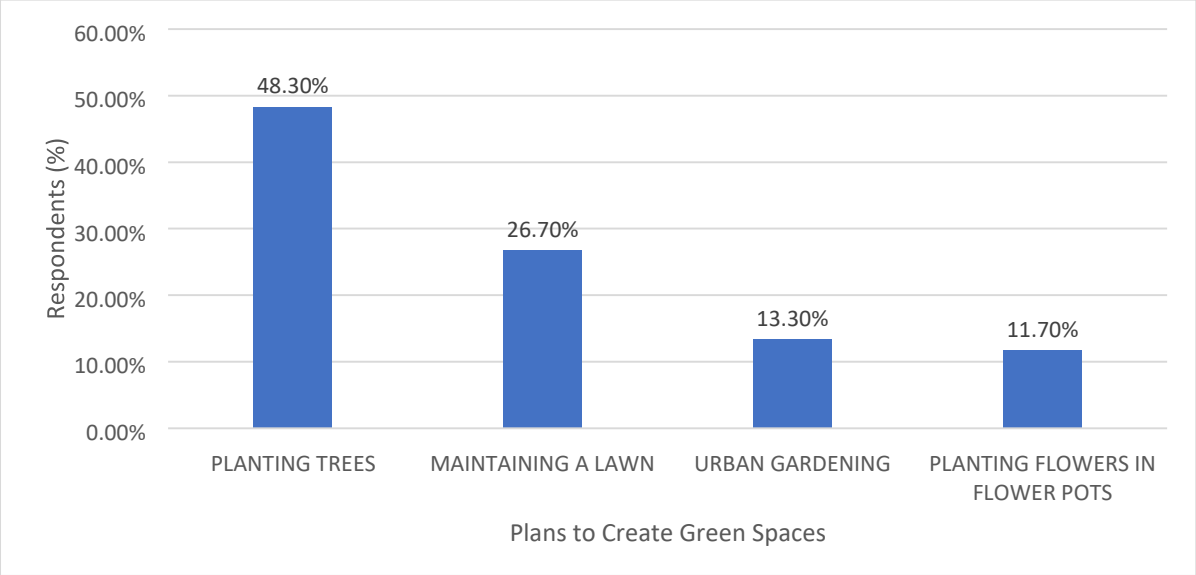

Figure 30: Options for Creating Green Spaces by Commercial Premises.
Source: Field Data 2021.

Table 5: Various ways to enhance Green Spaces in Kalingalinga Township

Key Informants	How green spaces can be enhanced
Key Informant (1)	1. Winning community support or participation through awareness 2. Need for multi sectoral plan to enhance collaboration with other stakeholders 3. The need to plan and prioritize ideal green spaces 4. Consider school afforestation 5. Roadside greenery and vegetation barriers along streets.
Key Informant (2)	1. through the use of sacks and discarded tyres

	2. Lusaka City Council leasing out land to private individuals for the creation of green spaces 3. Identification of open spaces for the creation of green spaces
Key Informant (6)	1. The creation of these green spaces can easily be implemented by the Local Authority. 2. Through community sensitization and engagement residents can be encouraged to participate in creating green spaces, as not much effort or finances are required. 3. Local Enforcement and Implementation
Key Informant (5)	1. Encouraging growing of trees within the living areas and around yards.
Key Informant (3)	1. Through planning documents and made reference to Kanyama as an example, where in Kanyama a document has been made called Resilience Action Framework for Kanyama (draft). 2. Carrying out complete urban renewal projects.
Key Informant (4)	1. Corporate Social Responsibility whereby local organizations work with corporate institutions in the creation of green spaces. 2. Schools should have clubs centered around the creation of green spaces in the community.

Source: Field data 2021

5.5. Extent to which Kalingalinga Township adheres to Environmentally Friendly Standards.

Key Informants from the various identified sectors as well as respondents from the households and commercial premises conducted structured observation of the township with regards the identified variables of roads/transportation infrastructure, green spaces and waste management.Afterwhich, they were asked to give an overall ranking for the township using a Likert scale of 1-5 on their perception of Kalingalinga Township Being Climate Friendly in consideration with the outlined details of the given climate variables for this study, as derived from Literature (Bulkeley,2016) and as seen in *Appendix 'B'*. On the Likert scale, 1 represented very low extent, 2 represented low extent, 3 represented moderate extent, 4 represented high extent and 5 represented very high extent.

A one sample T-Test was used to determine whether Kalingalinga Township can be referred to as being climate friendly arising from the rankings given by the respondents. A test statistic of 4 representing high extent was used to compare the respondent rating of the extent to which Kalingalinga abides to the principles of climate friendliness. Results revealed a T-value of (-5.656) which is significantly lower than the mean value of ranking (1.63). Thus signifying that the township ranks low as a climate friendly township form the perspective of the respondents interviewed. This is also confirmed by the p-value (0.001) obtained, that is lower than P = 0.05 significant test value signifying a significant difference between the test statistic (4) and the mean ranking (1.63), signifying that Kalingalinga is not perceived as a climate friendly township by key actors in the environmental field as well as the households and business owners in the township as shown in Table 7.

Table 6: Descriptive One - Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
CLIMATE FRIENDLY RANKING	8	1.63	1.188	.420

Source: Field Data 2021

Table 7: One Sample T - Test for Kalingalinga Township Climate Friendly Rankings by Respondents.

One-Sample Test						
	Test Value = 4					
	t	df	Sig. (2tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
CLIMATE FRIENDLY RANKING	-5.656	7	.001	-2.375	-3.37	-1.38

Source: Field data 2021

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

This study examined the extent to which Kalingalinga Township adheres to environmentally friendly standards in terms of roads, green spaces, transportation and waste management. It went further to assess the options for reducing GHG emissions from solid waste from households and commercial premises, as well as the barriers that contribute to residents' failure to practice sustainable waste management. Finally, the study investigated the benefits and viability of establishing green spaces/urban afforestation in the township. The study indicates that the Townships adherence to the identified, environmentally friendly standards in form of road transportation/infrastructure, green spaces and sustainable waste management practices is very low. This situation can be attributed to the fact that there is some form of low level sustainable waste management practices (recycling and reuse mechanisms) being carried out by the households and commercial premises, however these are not carried out in a structured manner, which overall causes the township not to be environmentally friendly. The absence of these environmentally friendly factors in the township pre disposes the township not to be environmentally-friendly and in turn causes the township to be vulnerable to climate induced hazards such as floods, heat waves, diseases and food insecurity.

The study assessed Sustainable Solid Waste Management in terms of recycling and reducing systems of waste by the households and commercial premises. Therefore, there is some form of waste recycling system within the township which is demonstrated through the presence of informal waste pickers who collect recyclable materials such as plastic bottles and take them to business men and women engaged in the waste recycling business. Furthermore, households and commercial premises practice waste recycling but not too a large extent. This is done through the usage of used and empty containers for storage purposes. On the aspect of waste reduction both the households and commercial premises who had knowledge on waste reduction practiced waste reduction to a certain extent. Whereby the majority of households and commercial premises reduced their waste through the re-use of bottles for containment of goods but the business owners also reduced their waste through the purchase of items and goods that were required for the business.

The barriers to sustainable solid waste management were therefore identified as; lack in knowledge on re-use, high poverty levels which had a turn over effect on sustainable solid waste management by causing it not to be a prioritized by the residents of Kalingalinga. Furthermore the storage of organic waste for the purpose of composting was seen as causing the surroundings of the household premises to look dirty thereby creating a breeding ground for cockroaches and other pests. The viability of establishing green spaces and afforestation in Kalingalinga is apparent. This has been established through the willingness and desire of both households and commercial premise owners to see the creation of green spaces in the township through the creation of green spaces within and around their premises of planting at least one tree and or maintaining a lawn. The viability of establishing green spaces is also premised on the fact that household owners and commercial premise owners recognize the benefits of having green spaces which include Carbon Sequestration.

6.2. Recommendations

In order to examine the viability of Kalingalinga Township becoming climate friendly in terms of the investigated variables of road transportation and infrastructure, green spaces and sustainable waste management. The study recommends that:

1. Planning authorities such as the Local Authority and other relevant stakeholders such as the Road Development Agency should ensure that climate friendly infrastructure and systems such as road infrastructure/transport, green spaces and sustainable waste management are included in the development plans (Integrated Development Plans) for upgrading of these improvement areas such as Kalingalinga Township. Which should also be followed up with an implementation plan.
2. The informal waste pickers within the township are part of an informal waste recycling system which comprises of business men and women who have some form of aggregation sites dotted around the township. The study therefore recommends that the government and other Non-Governmental Organizations both local and international empower the local business men and women with funds to set up Material Recovery Facilities within the township which will also create formal jobs for the informal waste pickers. Local Authorities should provide waste receptacles which will enable separation of waste at source by both households and Commercial Premises.
3. At household and commercial premises level it was noted that though there is some form of waste recycling being carried out by the households and businesses, it is only

being carried out for some type of waste and only on a temporary basis. It is therefore recommended that widespread education and sensitization by the relevant stakeholders should be continually carried out, highlighting the importance and benefits of recycling and how the households and business premises can be involved. This should be accompanied by streamlining messages of sustainable waste management in the school curriculum.

4. In addition, the Local Authority should also educate the householders and businesses on the economic benefits from practicing sustainable waste management through waste separation at source for the purpose of recycling. This is through the selling of recyclable materials to those involved in the recycling industry.
5. The process of waste recycling can also be incentivized by awarding households and business premises with some form of awards for engaging in waste recycling/separation at source. Prizes may not be in monetary form but may include hygiene products such as soap and detergents.
6. When it comes to waste reduction, households and business premises are engaging in some form of waste reduction practices but with limited knowledge. Therefore, there is need for widespread information and education on practices for re-using materials
7. Local Authorities should attach economic benefits such as the creation of linkages for households and business premises to be able to sell the valuable recovered waste to recycling facilities or waste management facilities, as well as facilitating the acquisition of financial resources through empowerment schemes such as loans and grants. This is in order to encourage sustainable waste management practices by making it viable for the households and business premises.
8. One of the key informants highlighted that, through the development of planning documents to guide climate action and reference was made to Kanyama, where a document has been developed called Resilience Action Framework for Kanyama (draft).In addition through carrying out urban renewal projects, Planning Authorities may therefore increase/redesign the plot sizes as they upgrade the informal settlements.
9. Planning Authorities Local Authorities could formulate Bylaws which will compel households and business premises to plant a tree or maintain some form of green space within their premises.
10. The planning authorities may repossess or buy off properties within the township in order to incorporate green spaces within the township as a long term measure.

11. Lease out existing public green spaces such as the play grounds in the township to private operators to maintain and operate these green spaces.

6.3. Recommendations for Future Research

The planning for the creation of an environmentally friendly township/space forms an integral component of climate change action. This is arising from the fact that an environmentally friendly township is comprised of features that minimise the contribution to Green House Gas Emissions (GHG). This research illustrates how the inclusion of environmentally friendly features such as sustainable solid waste management practices, green spaces and climate friendly transportation /road infrastructure in improved settlement area in Kalingalinga can help in mitigating climate hazards such as floods and extreme temperatures as well as contributing to climate mitigation and adaptation efforts.

As such it provides the status of Kalingalinga Township as an environmentally friendly space in relation to the identified variables of climate change. It also shows some of the sustainable solid waste management practices being carried out and how they can be enhanced. Finally it shows the viability of creating green spaces through the recognised benefits by the residents which is in turn expressed through their willingness to apportion some space within their respective premises for the creation of green spaces. The research sufficiently the intended objectives, however, they would be a great benefit from further research in eco-transformation of cities

Below are recommendations for future research;

1. Research on the viability of creating environmentally friendly spaces to be up scaled to city level.
2. Research on environmentally friendly features/variables to be broadened to include; green buildings, sustainable energy practices and efficient water resource use

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APPENDICES

APPENDIX A: STRUCTURED INTERVIEWS FOR HOUSEHOLDS /BUSINESS RESPONDENTS

THE UNIVERSITY OF ZAMBIA SCHOOL OF NATURAL SCIENCE DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

Introduction

Hi my name is ----------

I am a student at the University of Zambia pursuing a Master's of Science in Environment and Natural Resource Management. I am conducting a study entitled: Options for Re-Inventing Kalingalinga into A Climate Friendly Township. This study is significant to the planning and reorienting of townships within the city towards climate action, as it provides for urban mitigation strategies which are designed for the unplanned settlements which are presumed to have a larger carbon footprint and thereby contributing more to the climate change problem. You are therefore invited to participate in the study. The information collected will be used for academic purpose only and the researcher will keep such information strictly confidential. Thank you for participating in this study.

SECTION A: PERSONAL INFORMATION

Please tick where appropriate.

1. Gender

[ ] Male [ ] Female

2. Age: ……

3. Nationality……

4. Type of Business Premises……

5. Household head/ Business Owner

….…….

SECTION B - KNOWLEDGE ON CLIMATE CHANGE

1. Do you have knowledge about climate change?
   ( ) Yes ( ) No ( ) I don't know

2. Do you know the effects of climate change?
   ( ) Yes ( ) No ( ) I don't know.

3. Do you know that engaging in poor practices on the environment can result in negative climate change effects?
   ( ) Yes ( ) No ( ) I don't know

   If yes what are some of the poor practices that you know?

   Indiscriminate disposal of waste in drainages [ ]

   Absence of bicycle/pedestrian lanes to the road network [ ]

   Increased use of public and private motorized transport (second hand vehicle [ ]

   Lack of recycling waste [ ]

   Inability to re-use waste [ ]

   Burning of waste [ ]

   Lack of creation of green spaces [ ]

SECTION C: OPTIONS FOR REDUCING GREEN HOUSE GAS EMISSIONS FROM SOLID WASTE IN KALINGALINGA TOWNSHIP.

Waste Recycling

4. Are there any informal waste pickers in the township?

   ( ) Yes ( ) No ( ) I don't know ( )

5. If yes where do, they take the waste they collect?
   Waste Management Companies/Enterprises [ ]
   Business men/women in the recycling business [ ]
   Companies involved in recycling [ ]
   Recycling Centers [ ]

6. Do you practice waste recycling at your household/business?

   ( ) Yes ( ) No ( ) I don't know

7. If the answer is yes, how do you recycle your waste?

   Use as storage containers (Plastic /glass bottles) [ ]

   Creative Purposes/Home decorations (plastic, paper, glass) [ ]

   Gardening purposes (plastic, glass) [ ]

   Cleaning materials (old clothes/towels/newspapers) [ ]

   Bin liners (plastic bags) [ ]

Shopping bags (Plastic bags) [ ]

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8. Do you have knowledge on how to reduce your waste?

( ) Yes ( ) No ( ) I don't know

9. If Yes, what ways do you ensure waste reduction

Purchase of required items only [ ]

Use of re-usable bottles/containment [ ]

Use of reusable shopping bags [ ]

Composting organic waste [ ]

Shopping from the local markets [ ]

Donating used goods [ ]

Reduce the use of paper (going digital) [ ]

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……

10. Do you have challenges in re- use of waste generated in your home/business?

( ) Yes ( ) No ( ) I don't know

11. If yes, what are these challenges?

Poverty levels –waste management is not a priority [ ]

Lack of knowledge on reuse [ ]

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SECTION C: CONTRIBUTION OF GREEN SPACES AS A CLIMATE ACTION IN KALINGALINGA TOWNSHIP.

12. Do you have knowledge on the importance of green spaces in the township?

( ) Yes ( ) No ( ) I don't know

13. If yes, what are the benefits of green spaces?

Cool environment (Mitigation of Urban Heat Island)	[ ]
Fresh clean air	[ ]
Beautiful environment	[ ]
Minimize flooding	[ ]
Carbon Sequestration	[ ]

14. Do you know of any green spaces in Kalingalinga?

( ) Yes ( ) No ( ) I don't know

15. What types of green spaces do you know?

Green Vegetation along sidewalks	[ ]
Urban Gardens	[ ]
Play Grounds	[ ]
Public Parks	[ ]
Roof Gardens	[ ]
Public Squares	[ ]

16. Do you want to see green spaces being created in public places within the township?

( ) Yes ( ) No ( ) I don't know

17. If yes, what type of green spaces would you want to be created within the township

Play Grounds	[ ]
Public Parks	[ ]
Roof Gardens	[ ]
Public Squares	[ ]

18. Would you be willing to create green spaces at your household/commercial level?

( ) Yes ( ) No ( ) I don't know

19. If yes, how do you plan to create the green spaces?

Planting trees	[ ]
Maintaining a lawn	[ ]
Urban gardening	[ ]

Any Other Ways……

20. As a measure of promoting climate action, what size of your current residential plot would you consider apportioning as a green space (either for grass or tree planting)?

    ……
    ……
    ……
    ……
    ……

21. How many trees would you consider planting on your current plot in Kalingalinga?
22. What hindrances do you face in creation of green spaces (planting grass and trees) on your plot?

Small Plot size	[ ]
Inadequate water supply	[ ]
Low income levels	[ ]
Lack of information	[ ]

Any Other Ways……

Thank you for your participation!

APPENDIX B: SEMI-STRUCTURED INTERVIEWS FOR KEY INFORMANTS

THE UNIVERSITY OF ZAMBIA SCHOOL OF NATURAL SCIENCE DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

Introduction

Hi my name is ----------

I am a student at the University of Zambia pursuing a Master's of Science in Environment and Natural Resource Management. I am conducting a study entitled: Options for Re-Inventing Kalingalinga into A Climate Friendly Township. This study is significant to the planning and reorienting of townships within the city towards climate action, as it provides for urban mitigation strategies which are designed for the unplanned settlements which are presumed to have a larger carbon footprint and thereby contributing more to the climate change problem. You are therefore invited to participate in the study. The information collected will be used for academic purpose only and the researcher will keep such information strictly confidential. Thank you for participating in this study.

SECTION A: PERSONAL INFORMATION

Name of Organization…….

Name of Department……

Position in the Organisation……

SECTION B: EXTENT OF ADHERENCE TO CLIMATE FRIENDLY STANDARDS IN KALINGALINGA TOWNSHIP.

1. Do you think the township has been planned/upgraded in a climate friendly manner? Explain your answer.

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2. What climate indicators do you think were included in the upgrading/planning for Kalingalinga Township and which ones weren't?

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3. On a scale of 1 to 10, to what extent do you think Kalingalinga township ranks as a climate smart township? Explain your rating.

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4. What impact do you think the current state of Kalingalinga green spaces, transportation system, and waste management have on the local climates?

Variable	How their current state in Kalingalinga impact on local climates	Rate of impact (Very High, High, Moderate, Low, None)
Green spaces		
Waste management		
Transport system		
Others		

5. What interventions would you suggest be done in Kalingalinga to make the township climate friendly?

Variable	Current problems	Proposed interventions
Green spaces		
Waste management		
Transport system		
Others		

6. How would you rate the climate indicators within the township in terms of the identified characteristics against the accepted environmental standards as presented in the policy and strategic plans?
7. Rate each climate variable using the following scale, placing the rating number in the Blank boxes. Very high [5] High [4] Medium [3] Low [2] Very low [1]

Green Spaces	**Kalingalinga Township**	**Range of acceptable environmental Standard**
Green Vegetation along sidewalks		
Urban Gardens		
Play Grounds		
Public Parks		
Roof Gardens		
Public Squares		

Transportation/Road Infrastructure	**Kalingalinga Township**	**Range of acceptable environmental Standards**
Public Transport System i.e. affordable, accessible, comfortable, reliable, regular		
Bus Rapid Transit System (BRT) – Road infrastructure provided with dedicated bus lanes		
Road infrastructure sidewalks constructed of water permeable surfaces i.e. pavers(bricks) loosely laid stones, concrete pavement blocks with enlarged joints or granular road cover without binding material		
Continuous Bicycle lane network		
Bicycle storage facilities		
Provision of bicycle racks		
Bicycle rental systems in the township		
Continuous Pedestrian lanes connected to each other		
Installation of traffic lights at intersections for a pedestrian friendly way		
Elevated pedestrian walkways		
Car sharing systems		

Carpooling systems		
Climate friendly driving instructions (ecological driving)		

Sustainable Waste Management System	**Kalingalinga Township**	**Range of acceptable environmental Standards**
Waste separation at source		
Waste recycling centers		
Knowledge on re-use		

SECTION B: OPTIONS FOR REDUCING GREEN HOUSE GAS EMISSIONS FROM SOLID WASTE IN KALINGALINGA TOWNSHIP.

Waste Recycling

1. Are there any waste recycling centers in Kalingalinga Township? (Probe for an explanation).

   ( ) Yes ( ) No ( ) I don't know

2. What provisions have been made at household/commercial level to ensure waste is collected and taken to the recycling centers.

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3. How can residents of Kalingalinga be motivated to engage in waste separation at source?

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4. Are there any informal waste pickers in the township?

5. ( ) Yes ( )No ( ) I don't know ( )

6. If yes where do, they take the waste they collect?

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7. Do residents of Kalingalinga recycle their waste at household/commercial level

( ) Yes ( ) No ( ) I don't know

8. If yes, what waste recycling activities are being commonly practiced?

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9. How does the practice of waste recycling affect GHG emissions?

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Waste Reduction/Reuse

10. What methods can be used to reduce waste generation?

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11. What are the impacts of waste reduction on climate change?

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SECTION C: CONTRIBUTION OF GREEN SPACES AS A CLIMATE ACTION IN KALINGALINGA TOWNSHIP.

12. What are the benefits of having green spaces in the township in relation to climate change?

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13. What types of green spaces are found in Kalingalinga?

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14. What type of green spaces can potentially be created within the township

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15. What impact do you think green spaces have as a climate restoration tool?

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16. Do you know of any policy documents in place which support the creation of green spaces as a measure for climate action?

( ) Yes ( ) No ( ) I don't know

17. If yes can you mention them and what they indicate about the creation of green spaces?

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18. Are there any deliberate plans to establish green spaces in unplanned settlements such as Kalingalinga Township?

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19. From your own perspective is it feasible to create green spaces or urban afforestation in Kalingalinga Township? Explain your answer.

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20. What challenges are there in creating green spaces/urban afforestation in Kalingalinga Township?

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21. How can green spaces be created in Kalingalinga Township?

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Thank you for your Participation!!

APPENDIX FIVE: UNZA STUDY ETHICAL APPROVAL

THE UNIVERSITY OF ZAMBIA
DIRECTORATE OF RESEARCH AND GRADUATE STUDIES

Great East Road Campus | P.O. Box 32379 | Lusaka10101 | Tel: +260-211-290 258/291 777
Fax: (+260)-211-290 258/253 952 | E-**mail**: director.drgs@unza.zm | Website: www.unza.zm

APPROVAL OF STUDY

10th March, 2022

REF NO. NASREC-2022-FEB-003

Chisha Chakulanda
The University of Zambia
School of Natural Sciences
P.O. Box 32379
LUSAKA

Dear Ms. Chakulanda,

RE: "OPTIONS FOR RE-INVENTING KALINGALINGA INTO A CLIMATE FRIENDLY TOWNSHIP"

Reference is made to your protocol dated as captioned above. NASREC resolved to approve this study and your participation as Principal Investigator for a period of one year.

Review Type	**Ordinary Review**	**Approval No. NASREC-2022-FEB-003**
Approval and Expiry Date	Approval Date: 10th March, 2022	Expiry Date: 9th March, 2023
Protocol Version and Date	Version - Nil.	9th March, 2023
Information Sheet, Consent Forms and Dates	• English.	To be provided
Consent form ID and Date	Version - Nil	To be provided
Recruitment Materials	Nil	Nil
Other Study Documents	Questionnaire.	

Specific conditions will apply to this approval. As Principal Investigator it is your responsibility to ensure that the contents of this letter are adhered to. If these are not adhered to, the approval may be suspended. Should the study be suspended, study sponsors and other regulatory authorities will be informed.

Conditions of Approval

- No participant may be involved in any study procedure prior to the study approval or after the expiration date.
- All unanticipated or Serious Adverse Events (SAEs) must be reported to NASREC within 5 days.
- All protocol modifications must be approved by NASREC prior to implementation unless they are intended to reduce risk (but must still be reported for approval). Modifications will include any change of investigator/s or site address.
- All protocol deviations must be reported to NASREC within 5 working days.
- All recruitment materials must be approved by NASREC prior to being used.
- Principal investigators are responsible for initiating Continuing Review proceedings. NASREC will only approve a study for a period of 12 months.
- It is the responsibility of the PI to renew his/her ethics approval through a renewal application to NASREC.
- Where the PI desires to extend the study after expiry of the study period, documents for study extension must be received by NASREC at least 30 days before the expiry date. This is for the purpose of facilitating the review process. Documents received within 30 days after expiry will be labelled "late submissions" and will incur a penaltyfee of K500.00. No study shall be renewed whose documents are submitted for renewal 30 days after expiry of the certificate.
- Every 6 (six) months a progress report form supplied by The University of Zambia Natural and Applied Sciences Research Ethics Committee as an IRB must be filled in and submitted to us. There is a penalty of K500.00 for failure to submit the report.
- When closing a project, the PI is responsible for notifying, in writing or using the Research Ethics and Management Online (REMO),both NASREC
- and the National Health Research Authority (NHRA) when ethics certification is no longer required for a project.
- In order to close an approved study, a Closing Report must be submitted in writing or through the REMO system. A Closing Report should be filed when data collection has ended and the study team will no longer be using human participants or animals or secondary data or have any direct or indirect contact with the research participants or animals for the study.
- Filing a closing report (rather than just letting your approval lapse) is important as it assists NASREC in efficiently tracking and reporting on projects. Note that some funding agencies and sponsors require a notice of closure from the IRB which had approved the study and can only be generated after the Closing Report has been filed.
- A reprint of this letter shall be done at a fee.
- All protocol modifications must be approved by NASREC by way of an application for an amendment prior to implementation unless they are intended to reduce risk (but must still be reported for approval). Modifications will include any change of investigator/s or site address

or methodology and methods. Many modifications entail minimal risk adjustments to a protocol and/or consent form and can be made on an Expedited basis (via the IRB Chair). Some examples are: format changes, correcting spelling errors, adding key personnel, minor changes to questionnaires, recruiting and changes, and so forth. Other, more substantive changes, especially those that may alter the risk-benefit ratio, may require Full Board review. In all cases, except where noted above regarding subject safety, any changes to any protocol document or procedure must first be approved by NASREC before they can be implemented.

Should you have any questions regarding anything indicated in this letter, please do not hesitate to get in touch with us at the above indicated address.

On behalf of NASREC, we would like to wish you all the success as you carry out your study.

Yours faithfully,

Dr. E. M. Mwanaumo

CHAIRPERSON
THE UNIVERSITY OF ZAMBIA NATURAL AND APPLIED SCIENCES RESEARCH ETHICS COMMITTEE - IRB

cc: Director, Directorate of Research and Graduate Studies
Assistant Director (Research), Directorate of Research and Graduate Studies
Assistant Registrar (Research), Directorate of Research and Graduate Studies