PROJECT LIFE CYCLE COSTING AND SUSTAINABILITY OF PUBLIC HOUSING UPGRADING CONSTRUCTION PROJECT IN KIBERA SOWETO SLUM IN NAIROBI CITY COUNTY, KENYA

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DECLARATION

Declaration by candidate

The undersigned decree that this project has not been extracted from any other existing research work. I confirm that no part of this research project has been quoted from other reports and has not been referenced in this research.

Signature.…… Date……

Muriuki Vivian Wangigi

D53/PT/27840/2018

I confirm that the candidate has done this research project and submitted it for examination with my consent.

Signature ……... Date …….

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DEDICATION

I dedicate this research project to my beloved parents, Mr. & Mrs. Muriuki, for always making sure that I get access to quality education and for cultivating in me a spirit of hard work and a culture of responsibility.

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ABBREVIATION AND ACRONYMS

BIM	Building Information Model
EIA	Environmental Impact Assessment
ELCC	Environmental Life Cycle Costing Model
EOL	End of Life
HVAC	Heating, Ventilation and Air Conditioning
IBS	Industrialized Building Systems
ICT	Information Communication Technology
IEQ	Indoor Environment Quality
ISO	International Standard Organization
JKIA	Jomo Kenyatta International Airport
KENSUP	Kenya Slum Upgrading Programme
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
LEED	Leadership in Energy and Environmental Design
OECD	Organization for Economic co-operation and Development
PMBOK	Project Management Body of Knowledge
RC	Reinforced Concrete
SPSS	Statistical Package for Social Sciences
SSCM	Sustainable Supply Chain Management
UK	United Kingdom
UN	United Nation

UNEP	United Nations Environment Program
UNEP-FI	United Nation Environment Program Finance Initiative
UN-HABITAT	United Nation Commission on Human Settlement
US	United States
VE	Value Engineering

OPERATIONAL DEFINITION OF TERMS

End-of-life cost These are costs needed to cater to a building after it meets its purpose. The decision on whether to re-use determines the end-of-life cost of construction projects, re-cycle, reduce, decommission, or refurbish the total or sections of the project.

Initial cost These are the costs required for the capital of a scheme of a project that the clients and design team mainly consider. Initial cost caters to the construction, design, and land acquisition of construction projects.

Maintenance cost These are costs incurred for construction projects to sustainable construction projects in good condition after failures. Factors such as the building materials, age of the building, budget, and the expectations of the users in various construction projects influence the maintenance cost of construction projects.

Operational cost These are expenses incurred due to running the day-to-day activities during all the phases of a construction project. The fuel and electricity consumption, lease, insurance, and water and sewer connections determine such expenses.

Project Life Cycle costing The methodology used to estimate and analyze the total cost of a project when in operation, considering the initial cost, operation cost, maintenance cost, and the ultimate disposal of the asset at the end of its life, proper land use, materials, and water use are attained.

Public Housing Construction Project	These are projects that the government owns, finances the construction and controls all the operations.
Slums	These are the lowest-standard settlements that provide basic needs to a million people around the world.
Sustainability of projects	The sustainability of projects entails the developments that satisfy the current needs of a generation while ensuring the development will meet the needs of a future generation. It entails creating harmony between the interdependent dimensions: economic, environmental, and social

ABSTRACT

Public housing construction projects in Nairobi City County have faced a lot of challenges hence not achieving sustainability. The Public construction projects have failed to incorporate economic, environmental, and social factors leading to the growing gap between demand and supply of houses which has, in turn, contributed to the continued failure of housing in the country. The Kibera Soweto housing project has faced challenges attributed to a lack of incorporation of the social and economic life of the slum dwellers into the projet. The research mainly focused on determining the relationship between project life cycle costing on the sustainability of public housing construction projects in Nairobi City County, Kenya. The specific objectives were to identify the relationship between the initial cost, maintenance cost, operation cost, and end-life cost of projects and the sustainability of public housing construction projects in Nairobi City County. The research used weiber's least cost theory, the Four Capital Model theory, and the theory of constraint to support this study. The research focused on Kibera –Soweto East public housing construction projects implemented under the Kenya Slum Upgrading Project. The research incorporated both descriptive and explanatory research designs. The research targeted the Kibera Soweto Upgrading Housing Project. Hence the sampling frame comprised of State Department of Housing and Urban Development (Project Implementation Unit), United Nations Human Settlements Programme (UN-HABITAT), Settlement Executive Committee, Muungano wa Wanavijiji, Pamoja Trust, and Soweto High Rise Housing Cooperative. The sample size of the study was 73 respondents picked randomly. Pilot testing was conducted by distributing questionnaires to informants from the aforementioned institutions to determine the validity and reliability of the questionnaires. The research sought expert opinion to determine the validity of the research. Additionally, the research used a test-retest method to assess the reliability of the instruments which was found to be 0.872, which is reliable. Research permits were obtained from NACOSTI for authorization to conduct the study. Data was collected from the informants, and the response rate was 75%. Mean, standard deviations, deviations, and frequencies are descriptive statistics applied to analyze the primary data collected. Diagnostic tests were conducted, and data was found to be fit for analysis. A correlational analysis was conducted and found that the variables have a significant relationship. The research analyzed the data to derive descriptive and inferential statistics. The findings established that initial costs affected the sustainability of public housing construction projects. From the findings, it was evident that both maintenance costs and end life costs affected the sustainability of the Kibera public housing project. Finally, research established that operation cost was used to explain public housing construction projects in Nairobi County. The research concludes that there is a significant relationship between the initial cost and the sustainability of public housing construction projects. Additionally, the research identified maintenance cost and end life cost to have a significant positive relationship with the sustainability of public housing construction projects. The research recommended a thorough consideration of the operation cost, initial cost, end life cost and maintenance cost when dealing with the sustainability of public housing projects.

CHAPTER ONE: INTRODUCTION

1.1 Background to the study

Most countries and international bodies have tried to incorporate proper housing into their policies to ensure every citizen has access. The majority of the set standards stipulate that every citizen should easily access adequate housing that meets a reasonable sanitation standard. However, the rampant population growth around the world has made this goal difficult to achieve. More than 54 percent of the world's population resides in urban areas, increasing the recorded 43 percent recorded in 1990 (UN-Habitat, 2016). According to UN-Habitat (2017) research,1.6 billion people around the world are reported to be inadequately housed. Sustainable house construction projects remain a problem, not only in Kenya but also in some developing countries in the world. This problem has escalated due to the increase in urban population, high construction and finance cost, and the ever-increasing prices of urban land cost (Kieti, Rukwaro, & Olima, 2020).

Since housing is a basic right, the government has taken the initiative to alleviate the housing problem. However, this has come with little success, especially in developing countries. Most countries have attributed the unsustainability of public housing construction projects to the lack of an effective housing finance system. Additionally, most public housing construction projects in developing countries have been designed according to low standards and do not meet residents' needs. Furthermore, the projects are located in areas with poor infrastructure and lack social amenities (Musa, Yusof, Samsudin, & Halil, 2016). Public housing construction projects have been found to fail since they did not take into consideration environmental, social, and economic factors. In South Africa, public housing construction projects are unsustainable due to the poor mortgage and housing finance systems. This has contributed to the illegal sale of houses, the continued

construction of shacks, and a huge population on the house waiting list (Ganiyu, 2015). Internationally different countries have taken it upon themselves to join different bodies promoting sustainability. In 2016, to ensure a proper transformation to a sustainable, low-emission, and climate-resilient economy, OECD instituted a Centre on Green Finance and Development (Shan, Hwang, & Zhu, 2017). The Centre acts as a platform to ensure that financial sectors strive to attain sustainable development (Bon-Gang, 2018). Also, the centre provides a policy for knowledge exchange among the different players in sustainable construction (Worall, Colenbrander, Palmer, Mushi, & Kida, 2017)

The United Nations has contributed to sustainable development by establishing UNEP as its environmental conscience. Since its formation. UNEP strives to find solutions that ensure equality for economic prosperity and environmental protection. In 1991, the UN formed a partnership with 200 leading global banks forming UNEP-FI. UNEP-FI engages financial institutions on the complicated connection between ensuring that the environment is protected, sustainable development, and economic prosperity. Other than the partnership, UNEP-FI has engaged the private sector in investing in sustainability and giving particular importance to sustainable construction (Shan, Hwang, & Zhu, 2017).

In Kenya, the government has worked towards attaining sustainable public construction projects by incorporating standard building design and mass production of housing units, using locally available materials to cut construction costs, and adopting innovative building technologies and materials. However, achieving sustainability still proves a problem due to the high capital intensive venture and funds, shortage of land for development, high construction cost, and the fact that Kenyans have not adapted to alternative building materials and technologies. Finally, the county

does not have a standard policy framework that defines the standards of sustainable housing projects (Kieti, Rukwaro, & Olima, 2020).

Sustainability is essential in public housing construction projects since it maximizes human comfort, adapts design for change, cuts construction costs, and reduces maintenance expenses. Additionally, the concept maximizes efficient planning and ensures that the natural values are fully protected during all the stages of the project (Hossein, Farah, & Leila, 2012) Project life cycle costing is an essential tool in achieving sustainability since it reduces the project risks, acts as a decision tool, and ensure that the projects get the value for money (Manewa, Siriwardena, & Wijekoon, 2021).

1.1.1 Sustainability of projects

The sustainability of projects is undeniably the most significant problem presented to humankind in the 21st century (Moxon, 2012). Currently, sustainability entails three interdependent dimensions: economic, environmental, and social (Opuku & Fortune, 2013). When dealing with the sustainability of projects, project managers are required to create harmony in social, environmental, and economic interests and ensure short and long-term returns.

Additionally, project managers should ensure the proper incorporation of values and ethics, advocate for transparency and accountability, ensure the participation of stakeholders, reduction in risks, and elimination of waste, resource consumption, and procurement of projects (Cuevas & Nicoleta, 2021). Memon (2013) postulates that for a project to be sustainable, it must possess economic sustainability by considering the cost of resources and the financing mechanism required during the project's life cycle. ISO 212929 (2015) explains that when taking up construction

projects, the property value of the structures and the capacity of the community to purchase a particular building must be considered to attain economic sustainability.

According to Chugan (2013), sustainability is the attainment of the environmental sustainability of a project. This can be done by paying attention to the balance between ecological aspects and consumption of unrenewable resources and ensuring natural resources are handled well and passed onto the future generation. Markelj (2014) discusses that environmental sustainability is a key factor for sustainability to exist. Markrelj (2014) postulates that projects have to take into account; pollution and waste from construction projects, consumption of energy and water, use of natural materials, and sustainable land use during the construction period. Further, ISO 212929 (2015) explains that using non-renewable raw materials can reduce the existence of the same non-renewable resources. ISO 212929 (2015) recommends that the use of freshwater during construction affects the sustainability of construction projects and urges the protection of natural resources and the ecosystem.

Kuzman (2014) opines that social sustainability should be considered to ensure that clients are served to their satisfaction and that there is proper work cohesion between the stakeholders involved. Additionally, social sustainability will be achieved by encompassing factors, such as the functionality of the building, the well-being of the user, and the technical characteristics of the building. ISO 212929-1 (2015) has set standards, such as indoor conditions, air quality, thermal conditions, acoustic, and visual conditions, as a gauge to attain social sustainability. Furthermore, the user's comfort is ensured by ensuring that factors, such as temperature, noise, and light present, are implemented to the user's satisfaction. In the study, the sustainability of projects is evaluated

in terms of environmental, social, and economic aspects, which are the three pillars of sustainability (Wen-der & Shao-tsai, 2018).

1.1.2 Project Life cycle costing

Project life cycle costing first emerged in the U.S. Department of Defense, Washington, D.C., to aid installations and logistics. Later on, other central states decreed the implementation of project life cycle costing during the planning, design, and construction of all public buildings (Dhillion, 2010). Additionally, India has adopted LCC to compete in the world market and improve its domestic weapons programs. This is due to the high initial cost of acquiring assets, turning out to be lower than the operating and maintaining cost (Singh & Matai, 2013).

Project Life Cycle Costing compares alternative design strategies at the beginning of each project (Architectural Research Centers Consortium, 2015). This is carried out by looking at the initial maintenance and operational costs over time (Gundes, 2016). Heralova (2017) explains that project life cycle costing is conducted during the economic evaluation of various phases of construction for all the costs involved. Janipha (2019) further defines project LCC as a tool that ensures that sustainable development is achieved and used to estimate initial, financing, construction, operation, maintenance, refurbishment, demolition, and salvage costs life span of a building. According to the state of Alaska (2018), the project LCC is a summation of all costs incurred during the building's life, inclusive of the end life of the building.

International Standards describe life costing as a method applied when forecasting and analyzing the cost performance of any building. It will enable the project team to know whether the project has met the client's requirements for satisfaction. Project Life Cycle Costing looks at the initial operation, maintenance, and end-of-life costs. It assesses various tenders and recognizes the

difference between their tender prices and maintenance and operation costs (Buildings and constructed assets, 2017).In recent times, the global economy and pressure from the market and the acquisition of projects no longer depend on the initial procurement rather than life cycle costs. Past experiences have made it easier to depict that the ownership cost can differ from 10 to 100 times the original acquisition cost (Dhillion, 2010)

Section 401 of Executive Order 13123 has created options for government agencies in the USA to use life cycle costs to make an investment decision and lower the government cost and water and energy consumption. However, many government decision-makers are unaware that the law and executive order require LCC use. Besides, the European Commission has advocated for life cycle costing, which constitutes internal costs for public procurement to support sustainable growth. Internal costs are a summation of the cost incurred during the initial operating, maintenance, and end-of-life stages that guide the acquisition of better products (Sigma, 2016)

The initial capital cost can be divided into three subcategories: acquisition, purchase, and installation/commissioning costs (Muhammad & Benjamin, 2014). The initial capital costs in a construction project encompass the expenses incurred in the establishment of the facility. Such expenses incurred include the cost of acquisition of land, planning and feasibility studies, architectural and engineering designs, labor wage rates, and site conditions. Additionally, construction, field supervision of the building, and construction financing are considered part of the initial capital cost. Project managers consider construction cost as the largest component of capital cost. However, other costs are not insignificant; land acquisition in high-density urban areas tends to capture a high percentage of the capital cost. Construction financing can also have a higher magnitude depending on the size of the project (Mohamad, 2016).

Operating cost involves energy, consumables, or any other resources needed to use the product (Mohamad, 2016). Most of the operation costs are related to the building and custodial services. However, operating costs not directly associated with the building operation are excluded from the LCC. For example, costs, such as costs of office materials, are excluded since they are costs that have nothing to do with the operation of the building (Mearig & Morris, 2018).

Maintenance costs mainly involve labor and material expenses incurred to maintain buildings in suitable use conditions. Some military systems estimate maintenance costs to be about 70% of the life cycle cost. It mostly involves budget preparations, equipment replacement decisions, productivity improvement, and comparing competing maintenance methods (Dhillion, 2010).In addition, it involves tasks that are scheduled and intended to keep the inhabitable building conditions.

On the other hand, repair costs involve unanticipated expenses that draw out the life span of a building system without having to replace it. For instance, repairing a broken window will not require replacing the whole window but only the broken pane (Mearig & Morris, 2018). Some of the factors that are taken into consideration when determining maintenance cost include expectations of the user, building age, building material, building regulations, and budget constraints (Salleh, Annuar, Yakin, Ismail, & Talib, 2016)

End life costs involve the cost needed to maintain the end-of-life activities to cater for either demolition or renovation of the structure. It will also deal with transporting the construction demolition waste to the designated final disposal site (Bragança, Vieira, & Andrade, 2014). Once a building system has reached the end of its economic life, it can be replaced, hence replacing cost (Fai Pun & Nurse, 2010). Replacement costs are foreseen costs for crucial building elements

required for the uninterrupted operation of a building. Replacement costs can be extracted from construction cost literature, contractors' quotes, historical data, or cost consultants. (Mearig & Morris, 2018) It enables project managers to decide between decommissioning, demolition, re-using, re-cycling, or reducing the project's various components.

In Kenya, project life cycle costing was implemented in WASH programs in schools to aid policymakers in budgeting for schools and ensuring the sustainability of the WASH programs (Alexander, Mwaki, Adhiambo, Muga, & Freeman, 2016) The Constitution of Kenya 2010 alongside the Kenya Vision 2030 have assigned sustainable development and steady growth as fundamental principles. In addition, the constitution acknowledges a conducive and healthy environment as a crucial human right. The Constitution has also gone ahead and accommodated the provision of natural resources and environmental conservation, management, utilization, and sustainable exploration (Kenya, 2015).

1.1.3 Public Housing Construction Projects in Nairobi City County.

The government has been working to provide public housing in Nairobi to control the rampant urban population growth but has proven to be pathetically slow. This is because the majority of the projects have proven to be economically and socially irrelevant, further encouraging the rampant increase of informal settlements (Mungai, 2012). The government of Kenya started a major informal resettlement plan in Kibera-Soweto East, intending to build new houses to replace the dilapidated homes in urban areas (Baffoe & Mutisya, 2015). However, the government has only been able to actualize the Kibera Soweto East Housing Project which has not met the sustainable criteria(Cronin & Guthirie, 2012).

The Kibera Soweto slum upgrading project was unsustainable since economic, social, and environmental aspects were not considered. However, the project was considered to lack sustainability because community participation was flawed. Most of the targeted communities were not fully engaged and hence caused design challenges that hindered successful implementation. Additionally, the lack of community participation led the intended beneficiaries to look for tenants who could afford to live in these houses. Moreover, most of the programs' funding is donor sourced, with the Kenyan government having little direct investment, resulting in a lack of sustainability. Due to the deficiency of space for economic activities on-site, sections of land set aside for recreation purposes and gardens in the residential areas were replaced with kiosks not to lose their incomes (Fernadez & Bernard, 2012).KENSUP was initially set to mitigate local flooding because of the improved housing and drainage in the new houses. However, no strategies are set to slow down or infiltrate surface flood water (Shreya et al., 2017).

In 2017, the government of Kenya unveiled affordable housing projects under the big four project. Under this program, the government aimed to provide 500,000 houses by 2022 but is yet to achieve this. In Nairobi county, the government had set out to develop Park Road Ngara Estate, Jeevanjee Estate, Makongeni Estate, Shauri Moyo, Starehe, Kibera, Mariguini, and Kiambiu. Park Road Ngara stands to be the only housing project completed among the planned projects. Some of the housing projects' challenges include environmental, economic, and social aspects. This has been attributed to the lack of social participation, lack of finance and incentives, poor infrastructure, and inadequate knowledge of environmentally friendly materials. Due to this, the housing problem in Nairobi is yet to be solved (Kieti, Rukwaro, & Olima, 2020).

1.2 Statement of the problem

The government has put a lot of effort into ensuring the sustainability of the public housing construction project in Kibera. However, they are underlying factors that bar these efforts (Cronin & Guthirie, 2012). Kamaruddin (2022) identified the inability to implement social aspects in housing construction projects as a contributor to the failure of the projects. Nzau (2020) observed that environmental constraints have projects under contributed to the failure of the project. This is due to the unsuitable topography of the project leading to inhabitable living conditions.

An analysis of the previous studies indicates that the project did not consider proper relocation of the dwellers hence leading to the disruption of the economic and social life of the slum dwellers. Once the slum dwellers moved away they were not able to revive their economic lives since they did not have a stable source of income. Second, once the houses were allocated, half of the allocated people either sold the units or rented them out. This was greatly attributed to the high monthly instalments and rent charged for the purchase of the houses. The project mainly focused on the physical aspect leaving out the economic aspect which contributed to its failure, Additionally, economic aspects have hampered the success of the project (Colins, 2020). Cytonn (2019) identified the main factors hindering the sustainability of public housing in Nairobi: the inflated costs of land, the high construction and infrastructure cost, and inadequate access to financing.

Scholars from different disciplines are paying attention to how they ensure the sustainability of public construction projects. According to Pattono (2018), project life cycle costing plays an essential role in achieving economic-environmental sustainability by creating a long-term perspective of all actions performed at every stage of the building life cycle. Also, research was conducted to depict if LCC can assess the energy efficiency of a structure and furnish information

that considers lowering the operating costs of sustainable materials and fittings used in a building. The study argues that LCC allows investors, users, and developers to realize more about highly sustainable buildings (Emeksi, 2018). When applying a project life cycle cost perspective, organizations assess the environmental, economic, and social impact of projects they want to implement. Developers can consider the consequences of investing, transportation use, and the end-life of needed inputs. Based on this kind of assessment, organizations will develop strategies that will involve stakeholders in sustainable actions (Schneiderova, 2019).

Different studies have been conducted on the sustainability of public housing projects. However, few of them create a balance between the three pillars of sustainability and the project life cycle cost. Mungai (2012) looked at housing development and sustainability challenges in the low-income housing market. The study concluded that the process of acquiring land, costly transaction costs, archaic methods of planning, codes, and regulations guiding the building industry, and the lack of stakeholder involvement act as barriers to achieving economic sustainability for public housing construction projects. Alabi (2017) investigated on effect of building material costs on housing delivery towards sustainability. Alabi (2017) postulated that variations in the construction and maintenance costs tend to increase the cost of building materials for house sustainability. Reddy (2016) researched the analysis of the cost of sustainable construction projects and found that green buildings relate to lower operation costs, lower energy, waste, and water cost, and lower maintenance cost. However, the study was limited to environmental aspects of sustainability.

1.3 Objectives of the study

1.3.1 General objectives

The general objective was to investigate the relationship between project life cycle costing and the sustainability of the public construction upgrading project in Kibera Soweto Slum, Nairobi.

1.3.2 Specific Study objectives

i. To investigate the relationship between the initial cost and sustainability of public housing upgrading construction project in Kibera Soweto Slums in Nairobi City County, Nairobi.
ii. To determine the relationship between operation cost and sustainability of public housing upgrading construction project in Kibera Soweto Slums in Nairobi City County, Nairobi.
iii. To examine the relationship between maintenance cost and sustainability of the public housing upgrading construction in Kibera Soweto Slums in Nairobi City County, Nairobi.
iv. To establish the relationship between end life cost and sustainability of the public housing upgrading construction project in Kibera Soweto Slums in Nairobi City County, Nairobi.

1.3 Research Questions

The following research questions guided the research:

i. How does knowledge of the initial cost of projects relate to the sustainability of the public housing upgrading construction project in Kibera Soweto Slums in Nairobi City County, Nairobi ?
ii. How does awareness of the operation cost of projects appertain to the sustainability of the public housing upgrading construction project in Kibera Soweto Slums in Nairobi City County, Nairobi?
iii. How does an appraisal of the maintenance cost of projects pertain to the sustainability of the public housing upgrading construction project in Kibera Soweto Slums in Nairobi City County, Nairobi?

iv. How does awareness of the end life cost of projects apply to the sustainability of the public housing upgrading construction project in Kibera Soweto Slums in Nairobi City County, Nairobi?

1.4 Significance of study

The study will greatly impact many stakeholders to understand all three dimensions of sustainability better. This will enable developers and clients to take into consideration the need for sustainable construction and settle for alternatives that will benefit the economy, environment, and social aspects.

Project managers may be able to clarify the results when deciding which alternatives to use, considering costing and benefit analysis. Additionally, they may be able to predict the abilities of projects in their early stages. Project managers may encourage procurement based on project value rather than the cheapest price; cheap procurement will create a false economy. Finally, they may learn to take factors, including political responsibility, business regulations, housing, and transport, so as improve strategic decision-making and efficiency.

Based on the research findings, quantity surveyors may understand the tremendous role in promoting sustainability in the construction industry. They may provide cost advice on the best sustainable option; hence, the client will be making an informed decision. The findings from this study may encourage performing life cycle costing on the various alternatives and hence project value of the project to their clients. They may no longer need to rely on engineers to know sustainable materials.

The professional construction team may see the need for using valuable rating tools. The tools may offer guidance and emphasis on better ways to benefit the clients and the environment. The tools may end up proving that sustainability is cheap in the long run and get rid of the misconception that sustainability is expensive. The team may push for legislation of industry rating systems, which will pressure stakeholders to approve sustainable designs in their projects.

According to the research findings, the government may be encouraged to use LCC in many projects to reduce energy consumption and related costs. LCC may be used to perform an energy audit of different premises. The government is encouraging a reduction in the usage of energy due to the rising cost of oil and the finite availability of such fossil fuels. With the help of LCC, an energy audit may be carried out on repeat and at frequent intervals to monitor changes in the variables that may have any financial implications.

1.5 Scope of Study

The research concentrated on Kibera Soweto East, Kenya, since it is part of the housing and is still experiencing poor shelter, joblessness, tenure insecurity, diseases, and evictions. The study was restricted to Kibera Soweto Slum Upgrading Project under the Kenya Slum Upgrading Programme (KENSUP), which began in 2004. Additionally, the study concentrated on the State Department of Housing and Urban Development under the National Housing Programme, which is mandated with program designs, overall program coordination, financial management, procurement, monitoring and evaluation, and reporting on the slum upgrading program (Cronin & Guthirie, 2012)

Conceptually, the study focused on initial cost, maintenance cost, operation cost, and end life pillars that ensure sustainability in a project is achieved and how life cycle costing is applied to

control sustainable construction. The study was restricted to weiber's least cost theory, the theory of constraint, and the four capital model theory that supported the variables.

1.6 Limitations of the study

During data collection, respondents were somewhat reluctant since the information in question was rather sensitive, hence hesitant to share information. This is because of fear that information could be used to subdue or mar a reputation with the public. Finally, the researcher acquired an introductory letter from the respective academic institute to assure maximum confidentially, and the data collected is purely for research purposes.

1.8 Organization of Study

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The research entails five different sections, as outlined below

Chapter one, Introduction, entails the context of the study. It covers the background to the study, Project life cycle costing, and sustainable construction projects in Nairobi, outlines the study's problem statement and presents the research objectives and research question. Further, the section outlines the scope of the study, significance, and limitations of the study.

Chapter two, Literature Review, covers theories that support the objectives of the study and the dependent variable, an in-depth study of past scholarly works aligned to the research objectives, questions, and the dependent variable. The section also involves a conceptual frame showing the independent and dependent variables.

Chapter three, Research Methodology, gives a detailed explanation of the research design, target population, sample size and sampling design, and tools, methods, and procedures that were used to collect and analyze data.

Chapter four presents and analyses the responses from the administered questionnaires.

Chapter five gives a presentation on the conclusions arrived at and recommendations given by the research for policy implementation. Additionally, a summary and suggestions for further studies has been included in this section.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The section entails theories that support the study as per research questions, objectives, and the dependent variables. Scholarly work on research objectives and the dependent variable that has been conducted over the last years has been adequately covered in this section. Additionally, the chapter includes a conceptual framework indicating the correlation between the dependent and

independent variables. Lastly, the chapter identifies the research gap and how recent research will fill the gap.

2.2 Theoretical Review

2.2.1 Weber Least Cost Theory

Alfred Weber formulated the Weber Least Cost Theory in 1909, which was later translated to English in 1929. The theory was formulated to address the industry's movement from one location to another. Weber found that the cost of ground, buildings, machines, labor, and transportation caused this change. Therefore, Weber suggested that the site condition of the industry would greatly help in the minimization of costs by reducing transportation, cost labor cost, and encouraging agglomeration. Additionally, Weber (1909) argued that the location of the site contributes to congestion costs, pollution, high levels of traffic as well as an increase in social costs due to crimes.

According to Weber (1909), when labor is expensive, the project will incur low profits making the project unsustainable. Weber's least cost of theory explains that the site chosen must consider moving the raw materials to the site and ensuring a balancing act of the possible location is achieved. Additionally, the theory is based on assumptions such as equal demand in the region and equal opportunities to purchase the product from all regions. Moreover, the theory explains that agglomeration pools services, resulting in lower costs.

However, the theory faced criticism since consumers are not fixed to a particular area. Additionally, the theory has only considered the initial cost leaving out other social, economic, and political factors. The theory has been based on having perfect competition in an ideal

condition, whereas achieving this may be unsustainable. Weber Least Cost theory is applied in this research since it supports how the initial cost of a project can affect the sustainability of a project by controlling the cost of labor, site conditions, cost of raw materials, and the construction cost of a project. Labor rates for construction workers vary from place to place and can contribute to 10-20%, depending on the location of the site. Additionally, the longer the distance between a construction project and the available resources, the higher the cost of the project (Thulasimaaran, Jayawickrama, & Melagoda, 2019). Adapting to this theory, construction projects will highly reduce the initial construction cost by minimizing raw materials, labor, and transportation costs.

2.2.2 Theory of Constraints

Eli Goldratt developed the theory of constraint in the mid-1980s as an overall theory of running an organization. Goldratt's theory of constraint states that every system has at least one constraint that limits an organization from achieving its performance and goals. The theory of constraints works towards removing constraints in a project. Additionally, identifying such constraints in an organization provides opportunities for improvement. For example, if one constraint is not dealt with on time, other constraints tend to sprout up. Forecasting of the restrains allows proper resource allocation and planning. However, the approach is challenging to sustain since it demands a lot of changes in an organization. In general, the theory of constraint is meant to reduce the operating cost, and while these costs are reduced, adverse effects may be experienced. Some of these negative effects are taking management's concentration from increasing the throughput and reducing the customer's satisfaction. Additionally, identifying the constraint may not be effective if another hidden restriction causes the problem. The constraints in a project can be categorized

into economic constraints, legal, environmental, technical, and social constraints (Maithilee & Rithe1, 2020).

The theory is that constraint has been used in construction projects to deal with cost overruns and technical and managerial issues between the parties involved during the operation process (Sha'ar, Assaf, Bambang, Babsail, & Fattah, 2017).In the theory of constraint, operating costs refer to money going out of an organization in terms of utilities, salaries, and wages (Goldratt, 1984). Therefore, the theory aids this research since it reduces the operation cost of a project or organization by monitoring the various operations and resources needed by ensuring a low inventory. Additionally, the theory of constraint ensures that decisions are made to reduce operational costs by avoiding pitfalls and connecting all the functional boundaries in an organization. As a result, the operation cost will be reduced since labor costs will be lower and resources will be ordered when needed; hence there will be less waste.

2.2.3 Four Capital Model Theory

The research used the four capital model theory to discuss the notion of sustainability for an in-depth understanding. Capital ensures a continuous flow of goods and services, which are an aid to human beings' existence. Elkin (1992) formulated a four capital model theory that linked manufactured, human, social, and natural capital to the generation of human well-being. Manufactured capital aid in processing other goods and services rather than being finished. These are machines, buildings, and tools. Natural capital entails natural resources, including timber, water, and energy, that are not easily valued monetarily.

Elkin (1997) describes human capital as the health and the potential for production for individual people, which improves the chances of economic expansion through productive personnel. Social

capital pertains to social values, principles, and networks that people employ to decipher obstacles and create social linkage. Meeting various human requirements and improving standards of living may be described as evolving from the flows conveyed by the capital stocks. To attain sustainability of projects, the capital stocks should be maintained or increased over time. The four capital model is built based on principles that none of the capitals is complementary. Investing in one will not compensate or substitute the loss made in another capital.

This means that neglecting physical capital will bring about adverse effects on natural capital. The deterioration of natural capital causes a decline in the productivity of human capital, which adversely affects social capital. Poor social capital translates to distorted investments and low-quality physical capital. Hence a need to invest in all of them to create a balanced investment program. This research applies the theory since it supports sustainability in construction projects. Sustainability entails offering the same opportunities to the future generation as those offered to the current generation. Therefore sustainability depends on the quality and quantity of four capital: human capital, manufactured, social and natural capital (Ahmad, Neuweg, & Stern, 2018)

2.3 Empirical review

2.3.1 Initial Cost and Sustainable Public Housing Construction Projects

Braganca (2014) conducted a study on the early-stage design decisions and how to achieve sustainable buildings at lower costs in Portugal. The study aimed to investigate at which phase should the design of the project be developed that emphasizes the severity and its ability to contribute to sustainability and performance of a project and the project life cycle cost. Moreover, the study enabled designers to collate the various design options centered on preliminary data. A systematic literature review was conducted on all research published and unpublished to identify

existing gaps. The systematic literature review targeted project design phases and sustainable indicators of construction projects done by Building Physics and Construction Technology of the University of Minho since 2004. Data was gathered from various databases of buildings' elements and construction solution costs. The study was applicable since decisions made during the design phase will serve as a precautionary approach that will provide the least-initial cost opportunity for process optimization.

Braganca (2014) found that a sustainable design requires a coherent design process: input from the entire design team and the design phases. However, the research concentrated only on the design phase, which contributes partly to the initial cost. The conceptual stage is considered the most crucial phase since the possibility to design and institute are more significant compared to other stages. The study concluded that it is imperative to contemplate sustainability from the first design stage to ensure proper cost control. The study recommended considering life cycle costs as one of the indicators that may have a crucial influence on a project's sustenance and be evaluated at the conceptual design phase. The current study provided information on other aspects that can be applied in the initial costs of construction projects to achieve sustainability.

Kandil (2012) conducted a study on the validity of feasibility study for infrastructure construction projects in the United States of America. The research aimed to show the importance of conducting a feasibility study to avoid erroneous and misleading input when making decisions on investment in infrastructure projects. The study carried out a case study on Tafileh-Ghor Fifa Road and later conducted a comparative analysis between previous estimates in a feasibility study and the actual data. The study contributes to the current study by showing the value of conducting a feasibility

study by ensuring proper allocation of public money and hence having control over the initial construction cost.

Kandil (2012) found that there existed discrepancies between the estimated and the actual cost data. The research concluded that there is reason to improve the feasibility studies for infrastructure projects to ensure that public funds are allocated through transparent means. Additionally, it will promote public/private partnerships, which will promote economic sustainability. However, the research did not establish the relationship between initial cost and public housing construction projects. The study advised on the importance of decision-makers exerting efforts to ensure that feasibility studies are conducted using reliable information. Finally, the research recommended that peer review reviews of feasibility studies, before and after feasibility studies should be incorporated into infrastructure projects to lower cost, time overruns, and negative environmental impacts.

Tam (2011) researched the cost-effectiveness of using low-cost housing technologies in construction in India. The objective of the study was to compare the construction costs for conventional and low-cost housing technologies. The study carried out a case study in which observations were made on foundation, walling, roofing, flooring, plastering, doors, and windows based on conventional and low-cost housing technologies. The research augments the current study by showing the impact of choosing between technologies when considering the construction cost of buildings. However, the research focused only focused on construction technologies to determine the initial cost of construction projects

The study found that approximately 22.68% of roofing costs can be lowered by adapting to low-cost housing technologies compared to conventional construction methods. More so,26.11% of

construction cost on walling can be reduced once low-cost conventional construction methods are adapted. The research concluded that adopting building technologies that ensure cost-effectiveness is necessary since house ownership for low and middle-income is becoming difficult. In addition, the study recommended the involvement of the construction team to ensure good planning and designing to achieve overall cost-effectiveness.

2.3.2 Operation costs and Sustainable Public Housing Construction Projects

Pratesyo (2018) conducted a study on using the green building concept to reduce operating costs, a case study of PT. Prodia Widyahusada. The objective of the study was to investigate the impact of green buildings on operation costs in PT Prodia. The study applied a qualitative explanatory approach to conduct the study by analyzing the operation cost of Grha Prodia. In addition to that, operation costs of Grha Prodia were compared to those of Prodia, a similar building built using conventional methods. Qualitative analysis was employed to evaluate the data gathered. The research enables the current research to expound on the importance of considering the operation cost of construction projects when implementing environmental sustainability. Nevertheless, the study only focused on a building in Grha Prodishence the need to focus on buildings in Nairobi County.

The analysis done indicated that the green building technique cuts down the operation cost of Grha Prodia due to the reduction of water and electricity consumption. Compared to Prodia Tower, Grha Prodia had less water and electricity consumption. Building technologies, such as the use of light detectors and variable refrigerant air conditioning systems, have contributed significantly to this difference. Pratesyo (2018) advocated that future studies should conduct a thorough comparative analysis of conventional and green buildings.

Marenjak (2017) investigated operation cost models for university buildings in Croatia. The research aimed to find out how best to estimate and integrate operation costs in projects. The research focused on the operation costs of buildings at the University of Osijek. The university buildings are public buildings whose operation cost is derived from the public budgets. Questionnaires were administered to various constituents of the universities. The questionnaires were sent to the associates of the universities to collect data, while data on operation costs was obtained using a predetermined cost structure. Once questionnaires were returned,76.92% of them were fully completed. The study also used historical data from 1998 to determine building characteristics and operation costs. The research conducted a stepwise regression analysis to analyze the data collected. The research established that there is a possibility of determining the operation cost for public buildings using statistical methods. The study recommended that the operation costs be modelled considering sustainability performance, especially social and environmental sustainability. Additionally, the research recommended that further research be done to determine the operation costs for other buildings like residential, commercial, and industrial buildings. The current study fills this gap by researching public housing construction projects.

Taish (2015) investigated the conceptualization of sustainability on operation management. The research aimed to provide a theoretical foundation of environmental sustainability in operation management. The paper focused on the manufacturing sector, an extremely lucrative sector. The research targeted only the operation sector in manufacturing. The research conducted systematic research to identify hidden patterns and best practices. The results indicated that the sustainability of the manufacturing sector could be achieved by coming up with operation strategies that deal with cost. The research found that sustainability is an operation strategy wholly dependent on the

type of environment and can be used by managers when planning activities for manufacturing projects. The research recommended conceptualization of operation cost and management when dealing with the sustainability of projects. The research explains how various approaches can be applied during operation to achieve the environmental sustainability of different sectors. However, the research could not conceptualize the balanced theory of sustainability; current study research filled this gap.

Miller (2010) examined the operations and management of green buildings in the United States. The research aimed to research the accomplishments of high-performance buildings from an operation and management view. Additionally, the study concentrated on utility expenditure, cleaning practices, and use of energy-saving elements in offices. The research targeted 154 buildings possessing the energy star label and 105 without the green label. Online questionnaires were administered to the buildings' managers regarding operation and sustainability. The research enables the current study to emphasize the importance of considering operation costs when implementing sustainable projects.

A comparative analysis was conducted between green and non-green buildings to analyze the collected data. The research found that the operating cost for green buildings is higher compared to non-green buildings in the country. Additionally, operation cost is correlated with the energy star score rather than the energy star label. The results indicated that green buildings save more energy utilization than non-green buildings. The study concluded that it is how a facility is operated that makes a difference.

2.3.3 Maintenance costs and Sustainable Public Construction Projects

Attar (2016) conducted a study on engineering economics and maintenance cost analysis in Mumbai. The study focused on the maintenance and repair cost analysis and coming up with an anticipated course for the next 25 years for various construction elements. Rates were collected from the district schedule rates of Mumbai and the suburban area. Some of the included elements in the study were internal plastering, external plastering, internal oil painting, cistern fittings, dedo tiling, and flooring. The study holds importance in this research since it indicates how the maintenance costs of construction projects behave in the life cycle of construction projects.

The research developed forecasts with the help of a tread line characterized by a particular curve equation, thereby producing the projected rates. Based on the projections, the study found that maintenance and repair costs for the elements increase as time passes. The study concluded that maintenance and repair costs would increase linearly while others increase exponentially. Attar (2016) recommended that managers should use graphs to predict certain repairs and maintenance costs and manage the finances according to requirements. The research by Attar presented a gap in that it focused on buildings only in Mumbai, and therefore the findings cannot be generalized to all buildings. The current research fills this gap by focusing on housing in Nairobi.

Talib (2016), in a study on preliminary investigation on the factors that influence the maintenance cost of apartments in Malaysia, aimed to investigate aspects that contribute to the escalation of the maintenance cost of apartments. The study conducted a descriptive survey, and questionnaires were distributed to personnel managing the buildings. Talib (2016) enables the current research to understand how maintenance of a building can reduce the cost of a project and improve sustainability. Out of the 76 questionnaires administered, only 35 responded, data collected was evaluated using descriptive statistics.

The outcomes of the study indicated that the five components that impact the cost of maintenance include the tenants' preferences, the age of the building, construction materials, neglect to carry out preventive maintenance, and constraints on budget. However, the study did not research public housing, which is a problem even in Malaysia. The current study fills this gap by concentrating n the sustainability of public housing construction projects. The study concluded that considering these factors will lead to the reduction of maintenance costs of high-rise buildings. Therefore, Talib (2016) recommended that the government concentrate on factors affecting the maintenance cost of buildings and allocate the needed budget.

Shah (2016) conducted a literature review on the critical review of maintenance costs for stratified buildings. The research aimed to identify factors that affect the maintenance cost of stratified buildings in Malaysia. The research systematically categorized all the published literature and reviewed it methodically. The study focused on factors affecting maintenance costs. The results indicated that building age and user's expectations are factors that determine the maintenance cost of buildings. The empirical data indicated that building characteristics could be controlled, whereas the tenant's expectation may be difficult to control because of the human factor. The research recommended that for public buildings to be sustainable, the maintenance cost should be controlled by preserving the building from an early stage, educating clients on community welfare awareness, and opting for corrective maintenance. The research explains the concept of public housing construction projects in Malaysia and why it is no longer sustainable despite efforts from the government. However, this research only focused on maintenance costs despite other costs related to the sustainability of public housing construction projects, the current study filled in this gap.

Zakaria (2014) researched on assessment of factors affecting building maintenance and defects in public buildings in Penang, Malaysia. The research aimed to identify factors that affect the maintenance of public buildings in Malaysia since most of the public buildings in Malaysia have reduced lifespans and hence can no longer function as intended. The research administered twenty-five structured questionnaires to collect data from the occupants of the public buildings. In addition, the research used descriptive analysis to analyze data that was presented using tables and pie charts. According to the research, maintenance cost was ranked to be the highest factor that affects the sustainability of buildings in Malaysia. Results indicated that overlooked site conditions, defective material, and material conditions influence the sustainability of buildings. Zakaria (2014) recommended different maintenance strategies to reduce the cost of maintenance. This research explains the importance of considering maintenance costs to ensure that buildings perform as expected. However, the research only focused on public buildings in Malaysia, and hence the results are limited to Malaysia. The current research will provide information in regard to upgrading public housing construction projects in Nairobi City County.

2.3.4 End life costs and Sustainable Public Housing Construction Projects

Banshai (2016) carried out a study regarding re-cycling and re-using construction and demolition waste as a sustainable approach in India. The objective of the study was to elaborate on the re-cycling potential of C&D waste since most of the buildings in India are demolished before the completion of their design life. A case study was done in the Municipal Corporation of Delhi, where laboratory experiments were conducted on the material aggregates. The study implied that waste materials after the end of life of a construction project could be economically unviable

compared to the natural aggregates depending on the demolition technique. Furthermore, the study found that C&D waste is regulated in green buildings requiring certification.

Moreover, dealing with the C&D waste problem requires all sections of society to pledge to protect the environment and future generations. The study recommended Use-Reuse-Recycle –Landfill strategy where the natural resources are used to their maximum potential with minimal waste. The waste is re-used in that or other projects, which can later be re-cycled under environmentally friendly conditions—lastly, landfilling is to be done only in designated locations. The study explains how end-life costs can be applied to achieve the sustainability of construction projects. Nevertheless, the research does not cover public housing construction projects which the current research covers.

Chau (2015) carried out a study on the new life of the building materials-recycle, re-use, and recovery in Hong Kong. The study aimed to prove that energy can be saved at the end of life and used to run a building's new life. LCA was performed on the building at the end-of-life of a concrete high-rise commercial building. The study focused on thirteen Grade A commercial buildings in Hong Kong with a lifespan of approximately 60 years. The study indicated how decisions made at the end of the life of a project could impact the cost and waste management of a construction project.

The energy associated with the building was calculated for each management strategy to identify which was best. The results showed that re-cycling had the highest energy-saving strategy and hence the most viable approach. Re-using was found to be the most viable for building elements with high aluminium content. The study recommended that engineers and architects perform LCA quickly to decide on the most suitable waste management option to reduce the environmental

burden. The research links end life costs and environmental sustainability; however, it only focuses on commercial buildings and leaves out public housing. The current study fills this empirical gap by researching public housing construction projects.

Sodagar (2013) researched the sustainability of housing refurbishments in the United Kingdom. The research aimed to survey the overall potential of feasible refurbishment and renovation of existing houses by embracing a different technique to achieve sustainability. The study targeted two research projects whose funds were sourced externally and completed in January 2013. Questionnaires were administered to analyze the environmental impact savings, improved health, well-being, and satisfaction of users of the refurbished homes. In addition, the study emphasized how refurbishment increases savings by reducing construction waste and time compared to building new houses.

Data collected was analyzed using descriptive analysis, where the cumulative frequency was applied. The study found that tenants in the refurbished buildings enjoyed a tremendous amount of appreciation for the different elements of the building. Additionally, the study found that the building should have a longer life span to keep environmental impact at a minimum. The refurbishment of buildings can quickly achieve this goal, and hence more attention should be paid to it. Sodagar (2013) emphasized only how refurbishment can reduce the end-life cost of construction projects. However, the recent study investigates different aspects of end life costs and whether they relate to the sustainability of construction projects.

2.3.5 Sustainability of Public Housing Construction Projects

Parkolwa (2016) conducted a research in Laikipia East sub-county on the factors affecting project sustainability of community-managed water supplies. The main objective of the research was to

identify various aspects influencing the sustainability of community-managed water supplies. The target population comprised 12,162 house water consumers, key informants, and executive committee members. A sample size of 419 respondents was developed using probability and non-probability techniques. Additionally, questionnaires, household surveys, and purposive identification of the key informants were used to collect data from the relevant government bodies. Data was analyzed using descriptive and inferential statistics, where a multiple regression model was used to develop a correlation between the research variables. The research established that involvement and skills of the community, sustainability of the project, skills of the management team, and government policies affect the sustainability of water supplies in Laikipia East Sub-county.

The research recommended that uring the various planning activities, all the stakeholders should be involved to ensure that the sustainability of water supplies projects can be achieved. However, the findings were restricted to water projects, and hence findings cannot be generalized for all projects. The current research fills this gap by looking into public housing construction projects. Additionally, the project only dealt with sustainable projects in Laikipia County, whereas the current research will address the sustainability of upgrading housing construction projects in Kibera Soweto Slum.

Ibem (2015) researched the assessment of the sustainability of public housing projects in Ogun State, Nigeria, a post-occupancy evaluation approach. The main objective of the study objective was to analyze all the elements that make public housing projects sustainable, focusing on Ogun State. The study surveyed 517 residents from the nine public housing estates. The research collected data from the residents of Ogun Estate using questionnaires, interviews, and observation

schedules. Descriptive statistics and content analyses analyzed the data gathered. The study explained the concept of sustainable public housing construction projects and how it can be achieved by considering the affordability of house units and climatic conditions. The study found that public housing projects in Ogun State achieved sustainability criteria since they considered the affordability of house units, climatic conditions, and buildings responding to site conditions.

Additionally, Ibem (2015) found that the projects were unsustainable since they used asbestos-based materials during construction, lacked adequate domestic space, and had poor infrastructural facilities. The study concluded that public construction projects in Nigeria needed to adapt to the user's requirements when designing, constructing, and managing the structures to attain sustainability. Ibem (2015) recommended using environmentally friendly building materials that promote healthy living conditions. Also, public house providers can endorse a strategy of providing centralized facilities where facility management and maintenance are at one point for several housing estates, reducing the cost of providing social amenities. However, the research was confined to environmental sustainability and how to achieve it. This has created an empirical gap that the current research covers by concentrating on all factors of sustainability.

Mutisya (2015) conducted a study on Urban housing affordability in Kenya, a case study of the mortgage housing sector in Nairobi. The study aimed at investigating factors affecting housing affordability. In addition, the survey method was applied while data was collected by administering questionnaires to a sample size of 390 households with mortgage loans from Housing Finance Institutions and Banks. Statistical Package for Social Sciences (SPSS) software was used to enter the data collected which was analyzed using a quantitative and qualitative approach. Unfortunately, the study failed to get opinions from professional respondents; despite this, the

research explains the role of affordability in attaining economic sustainability in housing construction projects.

The study found that housing affordability and interest on loans, dependents, construction cost, and size of household are immensely related. Mutisya (2015) concluded that the affordability of houses is controlled by factors related to the households' social-economic characteristics. The study recommended that policy measures that improve affordability will reduce or stabilize mortgage interest rates, reduce housing prices, and improve households' income.

Wiesel (2012) conducted a study on developing sustainable, affordable housing, through a project-level analysis. The study suggested how trade-offs can be managed to achieve the three dimensions of Australia's sustainability of affordable housing projects. The study targeted eight affordable housing projects which possessed diverse social, financial, and environmental features. The projects were selected from a list of affordable housing projects that non-profit organizations had developed. Data was collected by conducting interviews, site visits, design checklists, focus groups with residents, and document analysis. The study conducted a thematic analysis to identify issues that emerged across the projects. The study allowed the current study to explain how to attain the three pillars when planning for sustainable public housing construction projects.

2.4 Summary of Literature and Research Gap

This segment discussed the relationship between project life cycle costing and public housing construction project sustainability. Theories were discussed that support the study of the association; some of the theories mentioned above include the Four Capital Model Theory, the theory of constraint, and Weiber's least cost theory. The four capital model theory supports the dependent variable since it explains how a project should incorporate relationships with all groups

involved. The theory of constraints explains that running an organization is faced with a lot of constraints. However, it reduces the operation cost since it manages to keep the inventory low. Finally, Weiber's Least cost theory emphasizes the need for the location of the construction project to reduce the initial cost of the construction project.

According to the empirical review, most research has concentrated on environmental and economic sustainability, leaving aside the social sustainability of construction projects. However, most local projects focused most on environmental sustainability through a construction project's life cycle without considering the expenses incurred. Therefore, there has not been much work done emphasizing the importance of considering the cost incurred during the project life of a sustainable housing upgrading construction project.

Table 2. 1: Summary of Literature Review

Author(s)	**Focus of study**	**Key findings**	**Knowledge Gaps**	**The focus of the Current Study**
Pratesyo(2018)	Usage of green building concept to reduce the operating costs, a case study of PT Prodia, Widyahusa	Green building technology reduced the operating cost of Grha Prodia compared to Prodia, a conventional building. This is because there was minimum water and electricity consumption in the green building compared to the traditional structure.	The study was conducted in Indonesia	The current research targeted the Kenyan construction Industry
Marenjak (2017)	Operation cost models for university buildings in Croatia	The research established that there is a possibility of determining the operation cost for public buildings using statistical methods.	The research findings are limited to university buildings	The current study fills this gap by researching public housing construction projects.
Bansai 2016)	Recycling and re-use of construction and demolition waste as a sustainable approach	The study found that C&D waste is regulated for use in green buildings requiring certification. Additionally,	The study only concentrated on C&D impact on end life cost of construction project	The current study looked at all aspects of end life cost and created a relationship with the sustainability of upgrading construction projects

		waste problems require all sections to pledge to protect the environment and future generations.		
Attar(2016)	Engineering economics and maintenance cost analysis in Mumbai	Maintenance and repair costs of different elements increase as time passes either linearly or exponentially	The study was carried out to manage the finances involved in construction projects in Mumbai.	The current study dealt with how maintenance costs can impact sustainable construction upgrading projects in Kenya.
Talib(2016)	Preliminary investigation on the factors that influence the maintenance cost of apartments in Malaysia	The expectation of tenants, building age, budget cost, building materials, and failure to carry out maintenance at the expected time as some of the factors influencing maintenance cost	The study only focuses on high-rising buildings in Malaysia	The research focused on construction projects in Kenya
Shah(2016)	Maintenance Cost for Stratified Buildings: Critical Review	Building's age and user's expectations are some of the factors that determine	Research only focused on maintenance costs despite other costs relating to the sustainability of public	The research focused on all the costs incurred during the life of a construction project

		the maintenance cost of buildings	housing construction projects.	
Parkolwa (2016)	Factors affecting project sustainability of community-managed supplies in Laikipia East Sub-County, Laikipia County, Kenya	The research established that involvement and skills of the community, sustainability of the project, skills of the management team, and government policies affect the sustainability of water supplies in Laikipia East Sub-county.	The research focused only on public water projects, and hence findings cannot be generalized for all projects	The current study focused on public housing construction upgrading projects in Nairobi County
Chau(2015)	The new life of the building materials-recycle, re-use, and recovery	The study found that recycling is the highest energy-saving strategy in end-of-life costing, but reusing is more viable when dealing with aluminium elements.	The study focused on commercial buildings	The current study focused on a variety of buildings.

Ibem(2015)	Assessment of the sustainability of public housing projects in Ogun State Nigeria, a post-occupancy evaluation approach	Public housing projects in the area were sustainable since they considered the affordability of house units, climatic conditions, and buildings responding to site conditions.	The study centered on the sustainability of public housing in Nigeria.	The current research focused on the sustainability of public housing construction projects in Nairobi County.
Mutisya(2015)	Urban housing affordability in Kenya, a case study of the mortgage housing sector in Nairobi.	A relationship exists between housing affordability and the interest on loans, dependents, construction cost, and size of household.	The study only focused on the economic feasibility of the housing sector in Nairobi.	The current study focused on creating a balance in the three dimensions of sustainable public housing construction upgrading projects in Nairobi.
Taish (2015)	The conceptualization of sustainability in operation management	Sustainability is an operation strategy wholly dependent on the environment, and managers can use it when planning manufacturing projects.	The research focused only on environmental sustainability in the manufacturing sector.	The current research focused on all sectors of sustainability in public housing construction projects.
Braganca(2014)	Early-stage design decisions and the way to achieve	LCC as an indicator has a significant influence on	The study focused on the only incorporation of	The study focused on other aspects that can be applied to the initial cost to

	sustainable buildings at a lower cost	sustainability and should be assessed at the conceptual design phase.	LCC in the design phase to reduce the initial cost of sustainable buildings.	control the cost of construction projects in sustainable upgrading construction projects.
Zakaria (2014)	Assessment of Factors affecting building maintenance and defects of Public Buildings in Penang, Malaysia	Maintenance cost is ranked highest as a factor contributing to the unsustainability of public buildings in Penang.	The study was focused only on public buildings in Penang	The current research focused on public housing in Nairobi, Kenya
Sodagar(2013)	Sustainability of housing refurbishments in the United Kingdom	The study found that the end of life of a building should be extended for as long as possible to minimize the environmental impact and refurbishment easily achieves this goal,	The study emphasized only how refurbishment can reduce the end-life cost of construction projects.	The recent study investigated different aspects of end life costs and whether they relate to the sustainability of the public housing upgrading construction project
Kadiz(2012)	Feasibility study for infrastructure construction projects in the United States of America	Discrepancies existed between the actual cost and the feasibility estimated cost	The study was conducted in the United States of America	The study was conducted in Kenya

Tam(2011)	Cost-effectiveness of low-cost housing technologies in construction in India	26.11% and 22.68% of construction costs can be saved by implementing low-cost housing compared to traditional construction methods	The study only dealt with how the choice of technology in initial cost can affect the construction cost	The current study will look at all aspects of the initial construction cost of a project
Miller(2010)	Operation and management of the green building in the United States	Green buildings are more efficient with savings on electricity, fuel gas, and water costs compared to non-green buildings	The study looked at one aspect of sustainability, environmental sustainability	The study focused on all aspects of sustainability, not only environmental sustainability.

Source:(Author,2020)

2.5 Conceptual Framework

The research developed a conceptual framework to give a diagrammatic representation of the casual relationship existing between the dependent and independent variables. The figure below breaks down the concepts that have been used to develop the objectives of the study. The independent variables include the initial, operation, maintenance, and end-of-life costs of construction projects. The sustainability of housing construction projects can be determined by environmental, social, and economic sustainability.

Independent Variable

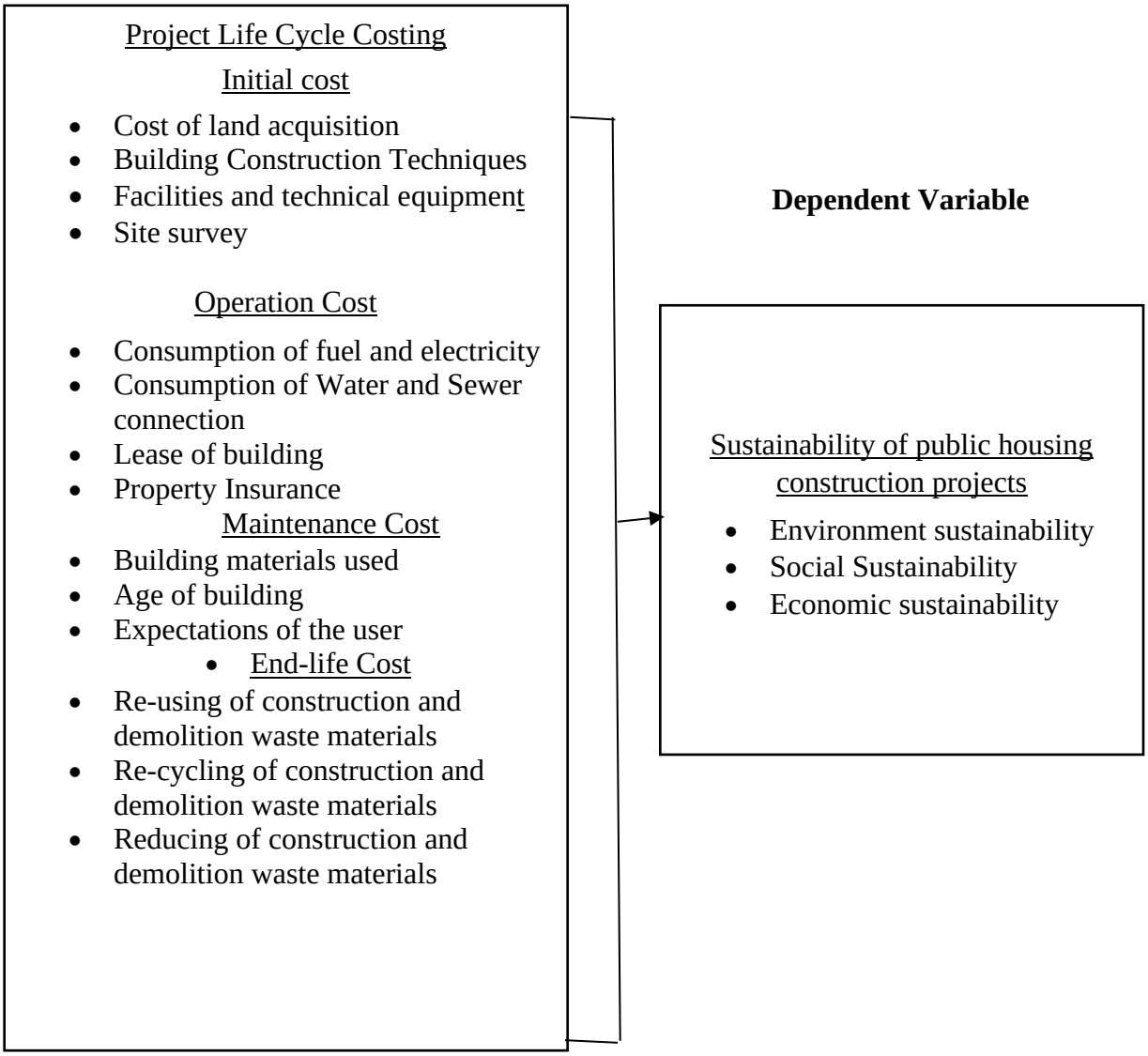

Figure 2. 1:Conceptual Framework

(Source: Author,2020)

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This section details the approach incorporated for the acquisition and analysis of data to be studied. The methodology covers in-depth the target population, size of the sample, method and procedure applied to collect data, pilot testing, the study's validity, reliability, and how data will be analyzed and displayed.

3.2 Research Design

This research adopted both descriptive and explanatory research designs. Descriptive design deals with how we think something is and describes a situation to express a norm (Walliman, 2010). Additionally, the methods collate information that explains existing phenomena by inquiring about their observations, behaviour, or principles (Ojera, 2016). The research adopted this type of research design because it is neutral, objective, and positive. The researcher has no control over the variables. (Walliman, 2010).

The research used the explanatory research design to explain the forces that cause a specific phenomenon (Cooper & Schindler, 2014). In contrast to descriptive research, explanatory asks 'how 'questions. It is carried out to discover some relationships among different variables under study. When using an explanatory research design, the researcher will quickly understand how and why things happen. However, this particular research design does not provide conclusive results because of its inadequate statistical strength (Grey, 2014).

3.3 Target Population

The target population is defined as a collection of entities with the desired set of information that determines whether or not a sample should be selected (Cooper & Schindler, 2014). For example, the Kibera-Soweto public housing upgrading construction project under the Kenya Slum Upgrading Project was the target population due to its location and uniqueness. The target respondents of the research were the professional members involved in the project. The professional members included 40 members from the State Department of Housing and Urban Development, five members from the United Nations Human Settlements Programme (UN-HABITAT), 17 members from the Settlement Executive Committee,14 members from Muungano wa Wanavijiji, 16 members from Pamoja Trust, and 19 members from Soweto High-rise Housing Co-operative Society Limited. These organizations deal directly with KENSUP Programme (UN-Habitat, 2016).

Table 3. 1:Target Population

Organization	Target Population
State Department of Housing and Urban Development (Project Implementation Unit)	25
United Nations Human Settlements Programme (UN-HABITAT)	5
Settlement Executive Committee	17
Muungano wa Wanavijiji	14
Pamoja Trust	13
Soweto High Rise Housing Cooperative	16
Total	90

3.4 Sampling Size and Sampling Design

Determining a sample size of research entails selecting a number of observations that should neither be too large nor too small but of optimal size (Ajay & Micah, 2014). Should the sample size be too large, huge costs and waste resources are incurred. On the other hand, if the sample size is too small, the objectives set may not be achieved (Kothari, 2015). Sample design involves developing a plan to obtain a sample from the sampling frame. The research applied stratified random sampling, which is applied in cases where there is a heterogeneous population and contains several different groups.

At the same time, it ensures the representation of all groups in the population (Creswell, 2014). The research applied stratified random sampling because it allowed the involvement of a larger population and allowed professionals from different organizations to be involved. The stratification was done based on the different organizations involved in the organization. The sample size was tabulated using a formula by Taro Yamane (1967) assuming an error of 5 % where:

n signifies the sample size of the research
N signifies the population of the research
E signifies the margin of error
n=N/(1+N(e)2)

n=90/(1+90(0.05)2)

n=73

A sample size of 73 represents 80% of the total population.

The sample size is represented in the table below:

Table 3. 2: Sample Size

Organization	Target Population	Sampling Factor	Sampling Size
State Department of Housing and Urban Development (Project Implementation Unit)	25	0.81	20
United Nations Human Settlements Programme (UN-HABITAT)	5	0.81	4
Settlement Executive Committee	17	0.81	14
Muungano wa Wanavijiji	14	0.81	11
Pamoja Trust	13	0.81	11
Soweto High Rise Housing Cooperative	16	0.81	13
Total	90		73

3.5 Data Collection Instrument

Primary data depict all original work done or raw data that has not been altered. Furthermore, primary data can be pronouncements representing official opinions or positions (Cooper & Schindler, 2014). On the other hand, secondary data sources interpret primary data. Questionnaires were applied to gather primary data from the selected respondents. When collecting data, structured questionnaires made up of close-ended questions were employed to collect the primary data in line with the study's objectives. (Mathu & Milkah, 2016). This particular method of data collection is popular since the researcher incurs low costs even when the sample is large.

Moreover, questionnaires ensure that information is not biased and that the respondent has enough time to give contemplated answers (Kothari, 2015). The research adopted close-ended questions since they encourage speedy responses and cover a broader range of topics. Close-ended is easier to answer and therefore increase the enthusiasm of respondents to answer. In addition to that, data collected can be quickly coded, entered, and analyzed. Finally, close-ended questions require little interviewing skills, and that is why such questions dominate self-administered questionnaires (Hyman, 2016)

The questionnaire was divided into different sections as per the objectives of the study. Section A enquired about the demographic profile of the respondents. The section covered the respondent's profession, educational background, and years of work experience. Section B entailed how initial costs impact the sustainability of the upgrading construction project. Section C covered how operation costs impact the sustainability of the upgrading construction project. Section D entailed how maintenance costs affect the sustainability of the upgrading construction project. Lastly, section E entailed how end life costs affect the sustainability of the upgrading construction project.

The study applied Likert scale questions in determining the various degrees of attitudes and opinions on particular statements. The respondents were required to describe their degree of concurrence in five points: (1) strongly disagree, 2(disagree),3(neutral),4(agree), and 5(strongly disagree). The study preferred the Likert scale since it is easy to construct. Additionally, the researcher provided room for each item to meet the empirical test for bias between the favourable and unfavourable perspectives of the respondents. Further, Likert scales are considered more reliable and can provide a considerable volume of data compared to other scales. Lastly, Likert scales can produce interval data (Cooper & Schindler, 2014).

3.6 Pilot Testing

Pilot testing was administered to determine the validity and reliability of the selected research instrument and techniques to detect and remove hindrances before the actual research. A pilot test enabled the research to apply corrective measures to the instrument. Hence, the data collected would check for reliability and validity (Mugenda & Mugenda, 2012). In addition, pilot testing enabled the researcher to identify and alter any confusing, awkward questions following feedback from the selected respondents, hence avoiding failure (Cooper & Schindler, 2014). Pilot testing was conducted by administering the questionnaires to 8 residents of Kibera-Soweto. When conducting pilot testing, the number of respondents was not vast but between 1% and 10% (Mugenda & Mugenda, 2012). The researcher relied on the comments and suggestions made by respondents during the pretest to improve the questionnaires. The respondents from the pretest were exempted from the actual research.

3.6.1 Validity

Validity is a vital criterion used to show how accurately a selected instrument measures it is intended to evaluate in a study (Kothari, 2015). Any difference registered in the measurement tool reflects the difference existing among the participants drawn from a population (Cooper & Schindler, 2014). The research employed content validity to determine the magnitude to which the questionnaires cover a good area of the topic under study while containing a representative sample (Kothari, 2015). The instrument's content validity was improved by seeking a peer review of the content and requesting two supervisors in the Department of Management Information Science, Kenyatta University, to determine the significance of the content used.

3.6.2 Reliability

Reliability is considered to use the same principle as repeatability since it is a measurement conducted on the research instrument to ensure the consistency of the research. (Mugenda,2012). Reliability looks at the internal consistency of research instruments. The research instrument will be assumed reliable if it gives consistent results from trials done at intervals. (Wanjohi, 2014). The research applied a test-retest method to determine the instrument's reliability, which saw eight professional members at the State Department of Housing and Urban Development being administered questionnaires twice over an interval of time (Cooper & Schindler, 2014). For this study, questionnaires were allocated two times to the same group of respondents over a break of one week. Should the results not be similar, the questionnaires will need to be modified.

3.7 Data collection procedure

Before the actual data was collected, the researcher secured a letter introducing the researcher from the respective university, explaining the study's objective, and requesting the concerned parties to permit the researcher to collect needed data. The researcher engaged the National Council for Science, Technology, and Innovation (NACOSTI) to apply for research permits. Later the researcher informed the management or institutions of the intended research. Authorization letters were collected before administering the questionnaires

Questionnaires were self-administered, where the researcher dropped one questionnaire to the organizations and picked them later. The researcher left contacts so that the participants could inform them once they had filled out the questionnaires. Self-administered questionnaires allowed the participants time to think about their responses. This method of administering questionnaires is considered to incur lower costs as compared to the other options. Besides, participants that

cannot be reached by phone(voice)are easily accessible to the researcher. Lastly, respondents get incentives from the researcher, increasing the respondent rate (Cooper & Schindler, 2014).

3.8 Data Analysis methods

The research employed descriptive statistics to describe data collected in particular percentages, means, and standard information. Data collected was entered into SPSS to carry out an analysis. Multiple regression analysis is used to link two or more independent variables and one dependent variable and determining the strength of association (Kothari, 2015). The researcher used inferential statistics to assess the quantitative data collected. Lastly, a multiple regression model was applied in determining the correlation between initial cost, maintenance cost, operation cost, end life cost, and sustainability of the public housing upgrading construction project. The regression used was as follows:

$Y=\beta 0+\beta_1 X_{1+}\beta_2 X_2+\beta_3 X_3+\beta_4 X_{4+}€$

Where:

Y=Sustainable the Public Housing upgrading Construction Project

B_0=Constant term

β1, β2, β3, and β4 = Beta coefficients;

$X_{1=}$Initial Cost

X2=Maintenance Cost

X3=Operation Cost

X4=End life Cost

€=Error term

Multiple regression determines the relationship between a dependent variable with more than one independent variable in a research (Gulden & Nese, 2013) The data analyzed was presented using

graphs, pies, and pie charts for an easier and quicker understanding. Each section on the presentation of data provided a numerical score and percentages as per the associated categories.

3.9 Diagnostic Tests

Diagnostic tests were conducted on the regression model to determine its validity. The analysis was conducted by analyzing the model's statistical assumptions and the structure to establish poorly represented models. Furthermore, the assessment will identify which variables significantly affect the regression model's prediction (Everitt & Skondral, 2010).

3.9.1 Normality Tests

Normality tests assume the existence of a perfect linear relationship between variables and are done to ascertain the normality of the error terms. Should the model not be normally distributed, the model exhibits a sig value less than 0.05. The study conducted a Shapiro Walk test to test for normality by calculating the mean and mean distribution. The smaller the maximum difference, the more likely the distribution is normal. The non-normal distribution stipulates that either one of the independent variables or dependent variables has the wrong functional form. Data that is approximately normally distributed indicates that the data is reliable. In the event that the normality test is violated, the research will use a histogram and a normal probability plot to identify if there is an outlier(Anderson & Mats, 2015).

3.9.2 Multicollinearity

Multicollinearity is a statistical phenomenon where more than one explanatory variable in the regression model has a higher linear relationship level. This means that one variable can project another variable very accurately. Should multicollinearity exist, the computation of the individual

predictors is affected, and the coefficient estimates of the model may change, accounting for the differences in the model or data. The research will then need to remove the variable with the highest VIF score. The research applied the VIF and tolerance levels to gauge the intensity of multicollinearity. When conducting a VIF analysis, a value higher than one but less than 5 shows little or no multicollinearity.

Additionally, a VIF greater than five and less than 10 illustrate multicollinearity. Lastly, a VIF higher than 10 shows high levels of multi-multicollinearity. On the other hand, tolerance levels less than 0.20 indicate the presence of multicollinearity (Gujarati, 2004). The study conducted this test to ensure accuracy in judging the relationship between project life cycle costing and sustainability of the public housing upgrading construction project.

3.9.3 Heteroscedasticity

In econometrics, assumptions exist that disturbances existing in the regression model possess similar variances, hence, homoscedastic. However, different scenarios show that the disturbances in regression models do not exhibit the same variances (Gujarati, 2004). Once exposed to heteroscedasticity, the regression model will give impartial estimates of the interrelation linking the variable. In the event that heteroscedasticity is detected, the research will use the Weight least square method. Leven's test was used to test the heteroscedasticity of the regression model. Results of significance levels not more than 0.05 will interpret the variances as significantly different, so the research does not suffer from heteroscedasticity. Furthermore, the test will aid in identifying any critical variable that was left out of the regression model and later refits the model with these variables (Klein & Gerhard, 2016).

3.10 Ethical issues

To ensure the respondent's rights such as confidentiality are protected, the research deprived access to participant identification to unauthorized personnel. Moreover, the researcher secured informed consent from the participants by fully disclosing the procedures of the proposed survey. Additionally, the researcher obtained research permits showing authorization to collect Kenyatta University Graduate School data. Lastly, the researcher submitted an introductory letter indicating their name to eradicate any suspicions on the information collected.

CHAPTER FOUR: RESEARCH FINDINGS AND DISCUSSION

4.1 Introduction

The chapter details the results and findings regarding project life cycle costing and sustainability of public construction upgrading projects in the Kibera Soweto Slum in Nairobi City County. The results have been analyzed on the basis of research objectives. The chapter also collates the response rate and reliability of the instrument. Finally, the results of the diagnostic tests conducted are presented in this section.

4.1.1 Response Rate

The response rate is widely defined as the total number of people who returned fully answered questionnaires divided by the number of participants who administered the questionnaires (Morton, Dinusha, Elizabeth, & Polly, 2012). The research targeted 73 respondents in total as the sample size. The sample size comprised employees from the State Department of Housing and Urban Development, UN-Habitat, Pamoja Trust, Muungano wa Wanavivjiji, and the Settlement Executive Committee. From the 73 questionnaires administered,62 valid questionnaires were completely answered and submitted to the researcher, representing a response rate of 85 %, which was considered.

The response rate was considered to be high, thus pointing to the results being representative of the target population. An overall response rate of fifty percent is regarded as standard, whereas more than sixty percent is considered a sufficient representation of the population. Additionally, where research records more than seventy percent response rate, it has performed excellently. Finally, a research response of a hundred percent is considered to be appropriate (Kothari & Garg, 2014).

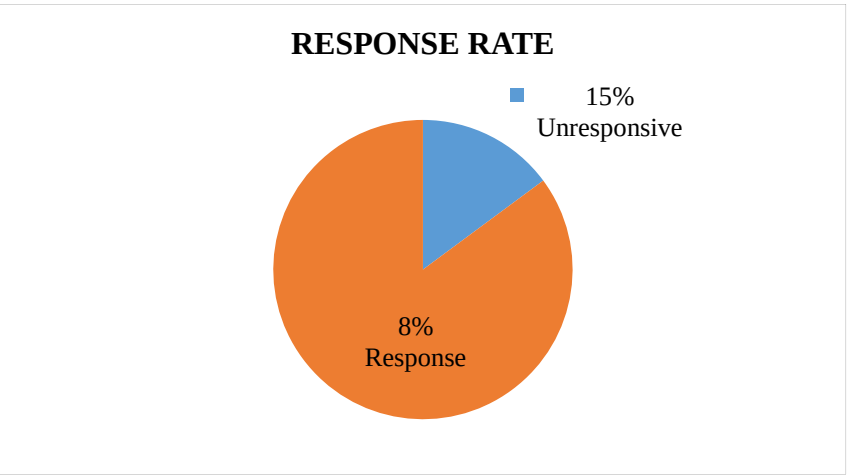

Figure 4. 1**:Response Rate**

(Source: Survey Data**,2021)**

4.1.2 **Pilot Study Results**

Pilot testing was conducted by administering the questionnaires to 8 residents in Kibera Soweto. When conducting pilot testing, the number of respondents should not be vast but between 1% and 10% (Mugenda & Mugenda, 2012). The researcher considered the comments and suggestions made by respondents during the pretest to improve on the questionnaires. The respondents from the pretest were not included in the actual research.

4.1.2.1 Validity

The research employed content validity to determine the degree to which the questionnaires cover an adequate area of the topic under study while containing a representative sample of the sample (Kothari, 2015). In addition, a peer review established the content validity of the instrument where two supervisors from the Department of Management Information Science at Kenyatta University were requested to determine the significance of the contents used in the research.

4.1.2.2 Reliability

To establish the instrument's reliability, a test-retest method was applied where the same test was administered to 8 employees from the State Department of Housing and Urban Development twice to similar subjects over an interval of time (Cooper & Schindler, 2014). The employees were not part of the main study since they were not involved in the project. For this study, questionnaires were allocated two times to the same group of respondents over a break of one week. Below is the table representing the results.

Table 4. 1**:Results of the Reliability Test**

		Pretest Results	**Post Test Results**
Pretest Results	Pearson Correlation	1	0.872
	Sig (2-tailed)		0.001
Posttest Results	Pearson Correlation	0.872	1
	Sig (2-tailed)	0.001	

****Correlation is significant at the 0.05 level (2-tailed)**

Source: Pilot Study,2021

The results from the table above suggest that the Pearson correlation is 0.872, and the p-value is 0. 001. A coefficient correlation is considered negligible below 0.10 and weak below 0.39. Additionally, correlation values ranging from 0.40 to 0.69 indicate a moderate correlation. Finally, values above 0.70 stipulate a strong relationship (Schober & Lothar, 2018). The test-retest correlation analyzed with the Pearson Correlation was in good agreement, stipulating that the results obtained in the first assessment are accordant with the second assessment.

4.2 Demographic Characteristics

4.2.1 Age Distribution

Table 4. 2**:Age Distribution**

Age Group	Frequency	Percent	Valid Percent	Cumulative Percent
21-29	20	32.3	32.3	32.3
30-40	19	30.6	30.6	62.9
41-50	20	32.3	32.3	95.2
Above 51	3	4.8	4.8	100
Total	**62**	**100**	**100**	

Source: Survey Data,2021

From table 4.2, 32,3% of respondents are aged between 21-29,30.6% are between 30 and 40 years old,32.3% are aged between 41 and 50 years old, and the remaining 4.8% are above 51 years old. From the analysis done, the average age for the respondents is 21-50 years old. The findings indicate that the research was evenly distributed across the three different age groups. Age diversity was necessary for the research as employers of different ages contribute different ideas, styles, methodologies, and perspectives.

4.2.2 Highest Level of Education

From the analysis conducted,17.7 percent of the respondents have achieved a certificate in their specific areas of education,14.5% have achieved a diploma,4.8% have attained a higher national Diploma,41.9% have achieved bachelors, and the remaining 21% of the respondents have attained masters. This implies that respondents were able to answer the questionnaire deeming the data fit

for analysis. The levels of education were essential to the research because the majority of the respondents have knowledge and skills and can articulate matters on the public housing upgrading construction project in the Kibera Soweto slum. According to the Australia Bureau of Statistics (2018), respondents showing high levels of literacy will act as a key when answering the questionnaires.

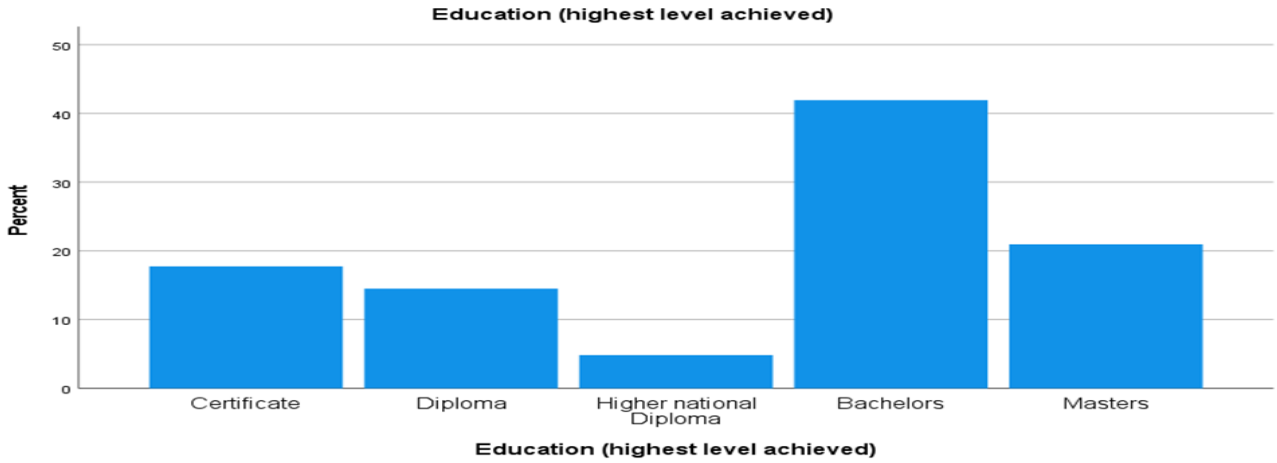

Figure 4. 2**:Highest Level of Education**

(Source: Survey Data**,2021)**

4.2.3 Type of Organization

The research targeted organizations identified to be involved in public housing in Kibera.

Table 4. 3**:Type of Organization**

	Frequency	**Percent**	**Cumulative Percent**
State Department of Housing and Urban Development	18	29.03	29.03
UN-HABITAT	3	4.8	33.83

Kibera Soweto High Rise Co-operative Society	12	19.35	53.18
Pamoja Trust	8	12.90	66.08
Muungano wa Wanavijiji	10	16.12	82.2
Settlement Executive Committee	11	17.77	100
Total	**62**	**100**	

Source: Survey Data,2021

The State Department of Housing and Urban Development recorded the highest response rate from the above table, while respondents from UN-Habitat were 4.8% of the respondents' rates. Additionally, 19.35% of the respondents were from the Kibera Soweto High Rise Co-operative Society. From the total responses,12.9% were from Pamoja Trust, and 16.12% were from Muungano wa Wanavijiji. Finally, 17.77 of the valid responses were from respondents from Settlement Executive Committee. The results indicate that organizations of different natures participated in developing the public housing upgrading construction projects in Kibera Soweto. The type of organization was essential for this research since it shows social participation in the Kibero Soweto public housing projects.

4.3 Descriptive Statistics

4.3.1 Initial Cost

Regarding the initial cost of construction projects as an independent variable, the research ventured to determine how the respondents rank aspects of the initial cost of construction projects. The researcher requested the respondents to rank the relationship between the initial cost of construction projects and the sustainability of the public housing upgrading construction project

on a 5-point Likert scale. The research applied standard deviation and computed means to analyze the data collected.

Table 4. 4**: Initial Cost of Public Housing Construction Projects**

	N	Mean	Std.Deviation
The decision on where, when, and how to acquire land ensures the sustainability of the public housing upgrading construction project	62	3.53	1.290
Taking into consideration the site survey of a project improves the sustainability of the public housing upgrading construction project	62	3.69	1.168
Building construction technologies of the project improve the sustainability of the public housing upgrading construction project	62	3.82	1.033
Choice of facilities and technical equipment to be used guarantees the sustainability of the public housing upgrading construction project	62	3.47	1.141
Aggregate Mean		**3.63**	**1.1175**

Source: Survey Data,2021

Table 4.8 stipulated that building construction technologies affect the sustainability of the public housing upgrading construction project with a record of 3.8 and a 1.033 mean and standard deviation, respectively. Additionally, the study found that land acquisition is paramount in determining the sustainability of the public housing upgrading construction project in Nairobi, with a mean of 3.53 and a standard deviation of 1.290. The results also indicated that a site survey

is vital in determining the sustainability of the public housing upgrading construction project, as evidenced by a mean of 3.69 and a standard deviation of 1.168. Finally, with a mean of 3.47 and a standard deviation of 1.141, the findings indicate the significant role of the choice of facilities and technical equipment in explaining the sustainability of the public housing upgrading construction project.

The results are in line with previous studies by Ngigi (2016) that alternative construction technologies reduce the cost of housing and promote competitive advantage. Furthermore, alternative construction technologies have improved the functional performances of public houses and made them affordable to people. Nahmens (2013) suggested that there is a current global trend in building construction to promote sustainability by applying copious choices of construction technologies for homeownership. However, the trend has encountered resistance due to the perception of the high initial cost. According to Muchoki (2016), compensation made to the people affected by the project during land acquisition contributed to the socio-economic sustainability of the project.

4.3.2 Operation Cost

On the second independent variable, the researcher sought to investigate how the operation cost of projects improves the sustainability of the public housing upgrading construction project in Soweto East. The results of the research are summarized in table 4.5.

Table 4. 5**: Operation Cost of Public Housing Construction Projects**

	N	Mean	Std.Deviation

The rate of fuel consumption has improved the sustainability of the public housing upgrading construction project	62	3.15	1.171
Water consumption and sewer connection ensure the sustainability of the public housing upgrading construction project is achieved	62	3.56	1.210
The decision on leasing of buildings improves the sustainability of the public housing upgrading construction project	62	3.39	1.219
Insurance of buildings helps to attain the sustainability of the public housing upgrading construction project	62	3.27	1.058
Aggregate Mean		**3.32**	**1.1736**

Source: Survey Data,2021

According to Table 4.5 above, insurance of buildings contributes to the sustainability of public housing construction in Nairobi City County (mean=3.27, standard deviation=1.058). Additionally, the research found that the lease of the building increases the probability of achieving sustainability of the public housing upgrading construction project n Nairobi City County with a mean of 3.27 and a standard deviation of 1. 058. The research also found that electricity consumption improves the sustainability of the public housing upgrading construction project in Nairobi City County; this was evidenced by a mean of 3.24 and a standard deviation of 1.210. Finally, with a mean of 3.56 and a standard deviation of 1. 210, water consumption and sewer connection were found to impact the sustainability of the public housing upgrading construction project. This indicated that most respondents agree that water consumption, fuel consumption, and leasing of buildings affect the sustainability of public housing construction projects compared to insurance of buildings.

These findings do not conform with Yang (2016) and pine (2016) that investors and developers have shown interest in sustainable design for buildings with high uncertainty levels. The insurance company has identified the business opportunity due to sustainable design's unique features, and developers will start looking for insurers to insure their properties against risks. Additionally, homeowners will be attracted to convert their conventional buildings to sustainable buildings due to the incentives offered by the insurance coverage. However, the results coincide with Enkyu (2016) that lease structure affects the tenant's disposition to make deposits predominantly for buildings with financially related sustainable features.

The findings accede with Barosso(2013) that water consumption in residential buildings is relatively high, rendering the buildings unsustainable. Barosso (2013) identified the recycling of greywater and reducing leaks to reduce water consumption and make buildings more sustainable. Warmak (2015) argued that the water footprint should be a crucial sustainability issue to consider rather than choosing the building materials. The current findings are in consonance with Wallhagen (2021) that electricity costs, fuel costs, annual cost changes, and discount rates are factors that determine the sustainability of the public housing upgrading construction project.

4.3.3Maintenance Cost

In regards to the third variable, the research aimed to identify the relationship between maintenance cost and the sustainability of the public housing upgrading construction project. In light of this, respondents were required to identify the impact on a 5-point Likert scale. Again, computed means and standard deviation were used to analyze the data.

Table 4. 6**: Maintenance Cost of Public Housing Construction Projects**

	N	Mean	Std.Deviation
The choice of building materials increases the sustainability of the public housing upgrading construction project	62	3.82	1.064
The expectation of users on the maintenance of the building helps to achieve the sustainability of the public housing upgrading construction project	62	3.55	1.141
The age of building contributes to the sustainability of the public housing upgrading construction project	62	3.65	1.073
Aggregate Mean		**3.67**	**1.09**

Source: Survey Data,2021

As illustrated in Table 4.6 above, maintenance cost contributes to the sustainability of the public housing upgrading construction project (mean=3.67, standard deviation=1.09). Respondents concurred that users' expectations on the maintenance influence the sustainability of the public housing upgrading construction project least (mean=3.55, standard deviation=1. 141). Further, research established that the choice of building material improves the sustainability of the public housing upgrading construction project (mean =3.82, standard deviation=1.06). Finally, the age of the building was agreed to impact the sustainability of the public housing upgrading construction project (mean=3.65, standard deviation=1.073). Hence, the building age and choice of building materials are vital in explaining the sustainability of public housing construction projects.

According to Urban (2015), the end-user expectation deals more with the functionality and is service-oriented. Due to this, it is considered to promote higher quality, a satisfactory level of performance, and lower maintenance costs than conventional buildings. These findings have been

supported by Wallhagen (2021) that using high-quality building materials which incur low maintenance cost is a possible solution to ensure that the sustainability of construction projects is obtained. Patil (2017) demonstrated that there had been an increase in demand for residential dwellings, which led to high energy consumption levels. Patil (2017) commented that the choice of material would highly contribute to sustainability by reducing the production cost transportation cost, creating employment, and improving skills. Finally, Ihuah (2016) commented that the choice of building materials would help control the environmental impacts, improving the sustainability of real estate.

These results have been supported by Runeson(2016), who demonstrated that buildings aged between 16 and 30 years have mostly incorporated sustainable technology, followed by buildings aged less than 15 years. Further, most of the buildings over 45 years have incorporated sustainable technology to make them more energy-efficient. Additionally, Anderson (2019) agreed with the findings that buildings with higher life expectancy are calculated to have a lower maintenance cost and directly influence the economic sustainability of a building (Anderson, 2019). These findings are also supported in research on building depreciation and sustainable development (Yiu, 2011).

4.3.4 End-Life Cost

One of the objectives is to assess the relationship between the end life cost of construction and the sustainability of the public housing upgrading construction project in Kenya. Table 4.7 shows an analysis of the data collected.

Table 4. 7**: End-Life Cost of the Public Housing Construction Projects**

	N	Mean	Std.Deviation

The decision on reusing materials will reduce waste cost and hence improves the sustainability of the public housing upgrading construction project	62	3.74	1.214
Reducing wastage increases the sustainability of the public housing upgrading construction project	62	4.08	0.911
Recycling of materials improves the sustainability of the public housing upgrading construction project	62	3.58	1.209
Aggregate Mean		**3.8**	**1.1113**

Source: Survey Data,2021

The outcomes from the above table imply that the respondents agree that end life costs affect the sustainability of the public housing upgrading construction project in Kibera Soweto Slum. Furthermore, respondents agree that reducing construction waste ensures the sustainability of the public housing upgrading construction project (mean=4.08, standard deviation =0.911). Subsequently, reusing materials increases the sustainability of the public housing upgrading construction project, as indicated by a mean of 3.74 and a standard deviation of 1.214. Finally, (mean=3.58, standard deviation = 1.209, implies that recycling materials affect the sustainability of public housing construction projects. This indicates that most professionals incorporate reduction, recycling, and reusing materials when determining the sustainability of public housing construction projects.

The outcome of the research has been supported by Olomomaliye (2012) that the end of life of a building should be taken into consideration to control the functional requirements. Moreover, the probability of a resale value will be improved by the ability to adapt to the new users and subsequently reduce the end-of-life cost of adapting to the new users. Therefore, creating effective

end-of-life of a building is one of the strategies that will promote sustainability in a building. Wallgen (2021) commented that estimating the cost incurred when reusing, recycling, and reducing materials are vital when assessing the built environment's sustainability. Assumptions were made that dissembling costs may end up being higher than the demolition cost.

Gibberd (2015) commented that the demolition of buildings after the end-of-life is unpreventable; however, sustainability should be achieved. One of the ways to achieve this is by reusing materials as much as possible. In a study by Morsi and Radwan (2018), an investigation was conducted to identify how reusing materials can be integrated into sustainability. It was established that recycling and reusing materials would save on energy consumption while creating job opportunities for the public and achieving sustainability. Furthermore, reusing, reducing, and recycling materials will promote environmental and economic savings since parts of the buildings will be used for other purposes (Wallhagen, 2021) . As demonstrated by Pradeep (2017), recycling buildings is considered the most effective method to achieve the sustainability of buildings.

4.4 Diagnostic Test Results

4.4.1 Normality Test

The Shapiro Wilk test is widely employed to determine if data is normally distributed. The research conducted a test to determine whether the variables followed a normal distribution.

Table 4. 8**:Results for Normality Test**

	Statistics	**Df**	**Sig**
Initial Cost	0.918	62	0.791
Operation Cost	0.974	62	0.204

Maintenance Cost	0.938	62	0.564
Endlife Costs	0.923	62	0.601

Source: Survey Data,2021

Data is considered to be normal should p be greater than the significance value of 0.05, which is the case for this research.

4.4.2 Multicollinearity

To identify the presence of multicollinearity, the research used the Variance Inflation Factor.

Table 4. 9**:Variance Inflation Factors Output**

	Tolerance	**VIF**
Initial Cost	0.712	1.405
Operation Cost	0.615	1.627
Maintenance Cost	0.678	1.475
End life Costs	0.878	1.139

Source: Survey Data,2021

According to the findings, the VIF for the independent variables is between 1 and 5 while tolerance is below 0.2. A lower tolerance indicates lower multicollinearity between the variables. Additionally, a VIF ranging from 1 to 5 shows no multicollinearity, whereas a VIF greater than 5 shows there is the presence of multicollinearity (Shrestha, 2020). According to the results, multicollinearity does not exist between the variables.

4.4.3 Heteroscedasticity

Levene Test was conducted to assess if there exists equality of variances. Table 4.10 shows a tabulation of the results of the test.

Table 4. 10**:Results for Heteroscedasticity Test**

	Levene Statistics	**df1**	**df2**	**Sig.**
Initial Cost	2.914	18	34	0.04
Operation Cost	1.817	18	34	0.03
Maintenance Cost	3.670	18	34	0.01
End life Costs	3.166	18	34	0.01

Source: Survey Data,2021

According to the tabulation in table 4.10, the significance for all the variables is less than 0.05. Significance levels less than 0.05 stipulate that there is no presence of heteroscedasticity in the data.

4.5 Inferential Statistics

According to Kothari(2014), where two or more independent variables exist, an analysis investigating the relationship between the variables is known as multiple correlations. Pearson's correlation coefficient is widely employed when identifying the correlation between two sets of variables. The 'r-value is estimated to be between +1 and -1. If 'r' is positive, there exists a positive correlation between the variables. On the other hand, when the 'r-value is recorded as negative, it interprets a negative relationship between the variables.

4.5.1 Correlation Analysis

Table 4. 11**: Pearson Coefficient of Correlation**

	Sustainability of Public Housing Construction Projects	**Initial Cost**	**Operation Cost**	**Maintenance Cost**	**End life Costs**
Sustainability of Public Housing	1	.533	.510	.486	.446

Construction Projects					
Initial Cost	.533	1	.487	.442	.229
Operation Cost	.510	.487	1	.522	.335
Maintenance Cost	.486	.442	.522	1	.246
End life Costs	.446	.229	.335	.246	1

Source: Survey Data,2021

Results outline that end life cost, and the initial cost recorded the weakest relationship ($r=0.229$, $p<0.001$). With a p-value of 0.05, the relationship is deemed significant. The strongest positive relationship is between the initial cost and sustainability of public housing construction projects($r=0.533, p<0.001$). This means that an increase in the initial cost translates to an increase in the sustainability of public construction projects. The aforementioned relationship is considered significant since the p-value is less than 0.05. The research found a strong positive relationship between operation cost and sustainability of public housing construction projects ($r=0.510, p<0.001$).From the data analyzed this means that an increase in operation cost will subsequently increase the sustainability of public housing construction projects. Additionally, the research found a moderate positive relationship between the sustainability of public housing construction projects and maintenance cost($r=0.486, p<0.00$. The results depict that an increase in the maintenance cost will lead to an increase in the sustainability of construction projects. Finally, research established a strong relationship positive between end life cost and sustainability of public housing construction projects. With end life cost having a moderate relationship with the sustainability of a project, its increase will consequently increase the sustainability of public housing construction projects.

4.5.2 Multiple Linear Regression

Table 4. 12**: Model Summary**

Model	R	R Square	Adjusted R Square	Std error of the estimate
1	.681[a]	.464	.427	.43239

a. Predictors: (Constant), End life Cost, Initial Cost, Maintenance Cost, Operation Cost

b. Dependent Variable: Sustainability of Public Construction Projects

Source: Survey Data (2021)

According to the findings in Table 4.12, the regression coefficient (R) is 0.681, R Square is 0.464, the Adjusted R square is 0.427, and the standard error estimate is 0.43239. The moderate R Square indicate that These findings indicate that 42.7% of the variance in the sustainability performance of public construction projects is attributed to the initial cost, maintenance cost, operation cost, end of life cost.

Table 4. 13**: Analysis of Variance(ANOVA)**

Model	Sum of Squares	Df	Mean Square	F	Sig
Regression	9.230	4	2.308	12.343	001[b]
Residual	10.657	57	0.187		
Total	19.887	61			

a. **Dependent Variable: Sustainability of Public Housing Upgrading Construction Projects**

b. Predictors: (Constant), End life Cost, Initial Cost, Maintenance Cost, Operation Cost

Source: Survey Data,2021

According to the results. significance of the F statistics is 0.001, which is less than 0.05, indicating that the model is reasonable. This implies that project life cycle costing is statistically significant in explaining the sustainability of public housing construction projects in Kenya

Table 4. 14**:Regression Coefficients**

	Unstandardized B	**Coefficients Std Error**	**Standardized Coefficients Beta**	**t**	**Sig**
Constant	1.688	0.301		5.601	0.104
Initial Cost	0.182	0.069	0.301	2.621	0.011
Operation Cost	0.108	0.079	0.169	1.368	0.032
Maintenance Cost	0.122	0.072	0.198	1.682	0.048
End Life Cost	0.157	0.060	0.271	2.622	0.011

Source: Survey Data,2021

According to the SPSS generated output, the equation ($Y=\beta_0+\beta_1x_1+\beta_2x_2+ \beta_3x_3+\beta_4x_4+€$ becomes:

$Y_{\text{Sustainability of Public Housing Construction Projects}} =1.688+0.182X_1 +0.108X_2+0.122X_3 +0.157X_4$

One of the research objectives was to evaluate the relationship between the initial cost of projects and the sustainability of public housing construction projects. The results were a co-efficient of 0.1882 and a p-value of 0.011. The results suggest that the initial cost of projects has a significant positive relationship with the sustainability of public housing construction projects in Nairobi City County, Kenya. Furthermore, the results corroborate Alnsour (2019) findings where research indicated that the initial cost of sustainable construction projects is 10% more than traditional construction projects.

According to Muchoki (2016), the initial cost of projects has a significant positive relationship with sustainable construction housing projects through land acquisition. Similarly, Salihu (2019) argued that the low-cost acquisition of land in the initial cost of projects by the government, together with low mass housing development and the rampant population growth in Niger estate, make achieving public houses more of a mirage. Furthermore, Noppen(2013) commented that the initial cost is exceptionally expensive in Kenya, making public housing unsustainable. Finally, Ngige (2016) found that incorporating alternative construction technologies in the initial cost of projects reduces the cost of housing and promotes competitive advantage. Furthermore, alternative construction technologies have improved the functional performances of public houses and made them affordable to people.

The study's second objective was to evaluate the correlation between the operation cost and sustainability of public housing construction projects in Nairobi City County, Kenya. With a coefficient of 0.108 and a p-value of 0.032, results imply a significant positive relationship between operation cost and sustainability of the public housing upgrading construction project in Kibera Soweto. Additionally, the findings show that if operation cost increases within one unit sustainability of public housing construction projects will increase by 0.032.

These findings are consistent with research done by Barroso (2013), that operation cost in residential buildings is relatively high due to the high water consumption rendering the buildings unsustainable. Additionally, the findings accede with Hwang (2017), who argued that sustainable buildings are leased at a faster rate, reduce operation costs and create a pool of tenants of better quality. Other studies that agree with the aforementioned statement include (Collins & Junghans, 2015), among others. Finally, these findings are supported by Ghoul (2016), who stated that

operating costs could be extremely expensive and among the factors that determine the sustainability of construction projects.

Additionally, the research aimed to identify the relationship between maintenance cost and sustainability of the public housing upgrading construction project in Kibera Soweto Slum. The results from the analysis indicate a coefficient of 0.108 and a p-value of 0.032, which implies a positive significance. Consequently, maintenance cost has a positive relationship with the sustainability of public housing construction projects. Therefore, an increase in maintenance costs increases the sustainability of public housing construction projects in Nairobi City County.

These findings are in line with Heralova (2019), who documented that the maintenance cost of public construction projects has not been taken into consideration when making decisions on the sustainability of construction projects which, in turn, led to poor performance of the projects. Additionally, sustainable construction projects have contributed to long-term profits for building owners and occupants by reducing maintenance costs and creating more comfortable internal spaces (Wang, Zainon, & Yusoff, 2014) Furthermore, Runeson (2016) concluded that there exists a strong relationship between the building age and sustainability. In regards to the age of a building, buildings with higher life expectancy are calculated to have a lower maintenance cost and directly affect the economic sustainability of a building (Anderson, 2019) . Lastly, Wallhagen (2021) found that using high-quality building materials which incur low maintenance cost is a possible solution to ensure that the sustainability of construction projects is obtained.

Lastly, the research aimed to evaluate the relationship between end life costs and sustainability of the public housing construction project in Kibera Soweto Slum. From the results, the coefficient and P-Value were recorded to be 3.168 and 0.01, respectively. The results imply that end life cost

has a significant positive relationship with the sustainability of public housing construction projects in Nairobi City County. This suggests that a unit increase in end life costs increases the sustainability of public housing construction projects in Nairobi City County by 3.168. The current findings have been supported by Olomomaliye (2012) that the end of life of a building should be taken into consideration to control the functional requirements of residential buildings.

Moreover, the probability of a resale value will be improved by the ability to adapt to the new users and subsequently reduce the end-of-life cost of adapting to the new users. Therefore, creating effective end-of-life of a building is one of the strategies that will promote sustainability in a building. Gibberd (2015) commented that the demolition of buildings after the end-of-life is unpreventable and should ensure sustainability is achieved. One of the ways to achieve this is by reusing materials as much as possible. In a study by Morsi and Radwan (2018), an investigation was conducted to identify how reusing materials can be integrated into sustainability. It was established that recycling and reusing materials would save on energy consumption and create job opportunities for the public, hence achieving sustainability. As demonstrated by Pradeep (2017), recycling buildings is considered the most effective method to achieve the sustainability of buildings.

CHAPTER FIVE: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Introduction

This section summarizes the research objectives, methodology, conclusions, recommendations, and suggestions for further study. Moreover, the study is structured having in mind the research objectives sequentially

5.2 Summary of the study

The research aimed to assess the correlation between project life cycle costing and sustainability of the public housing upgrading construction project in Kibera Soweto Slum in Nairobi City County, Kenya. The general objective of the research was to identify the relationship between project life cycle costing and the sustainability of public construction projects. Other objectives of

the research included investigating the relationship between initial capital cost, maintenance cost, operation cost, end-of-life cost, and sustainability of public housing construction projects.

The research applied explanatory and descriptive research designs to assess the correlation between the variables. The research focused on the Kibera-Soweto public housing construction project. Further, the research applied random stratified sampling to develop the sample size and identify the respondents**.** In addition, through close-ended questionnaires, the research collected data from the respondents. Lastly, the multivariate regression model was applied to establish the correlation between each project life cycle cost.

5.2 .1 Initial Cost

The research aimed to investigate the relationship between the initial cost and sustainability of the public housing upgrading construction project in Kibera Soweto Slum in Nairobi City County, Kenya. The research used land cost acquisition, building construction techniques, facilities, and technical equipment to evaluate the correlation between the two variables. Respondents agreed that land acquisition determines the sustainability of public housing construction projects. Additionally, the respondents concurred that site survey improves the sustainability of public housing construction projects. The research found that the choice of facilities and technical equipment to be used increases the sustainability of public housing construction projects. Further, results indicated that building construction technologies have the strongest impact on the sustainability of public construction housing projects. According to the research findings, initial cost strongly positively correlates with the sustainability of public housing upgrading construction projects in Nairobi City county.

5.2.2 Operation Cost

The research was conducted to establish whether operation costs related to the sustainability of public construction projects in Nairobi City County. The research found that the operation cost of construction projects contributes to the sustainability of the public housing upgrading construction project in Kibera Soweto Slum in Nairobi City County, Kenya. On the rate of electricity consumption, respondents agreed that it improves the sustainability of public housing construction projects. Regarding water consumption and sewer connection, the respondents agreed that water consumption and sewer connection affect the sustainability of public housing construction projects, whereas the rest disagreed. Additionally, the respondents agreed that leasing the building relates to the sustainability of the public housing construction project in the Kibera Soweto slum. Further, the majority of the respondents did not agree that the insurance of buildings relates to the sustainability of public housing upgrading construction projects. The research discovered a strong significant positive correlation between operation cost and sustainability of public housing construction projects.

5.2.3 Maintenance Cost

On the choice of building materials, the research found that the choice of the building ensures the sustainability of the public housing upgrading construction projects is achieved. Therefore, the majority of these respondents indicated that the choice of building materials relates to the sustainability of public housing construction projects in the Kibera Soweto slum upgrading housing scheme. Furthermore, with respect to the age of the building, the respondents agreed that the age of the building relates to the sustainability of public construction housing projects. Additionally, the respondents agreed that the expectation of the users relates to the sustainability

of public housing construction projects in Kibera Soweto. The research discovered a moderately significant positive correlation between maintenance cost and sustainability of public housing construction projects.

5.2.4 End Life Cost

Concerning this objective, the research aimed to establish the relationship between end-life cost and sustainability of the public housing upgrading construction project in Kibera Soweto Slum in Nairobi City County, Kenya. From the analysis done, the reuse of construction materials impacts the sustainability of public housing construction. Additionally, most respondents agreed that recycling materials affect the sustainability of public construction projects. Lastly, the majority of the respondents agreed that reducing construction materials relates to the sustainability of public housing construction projects. Moreover, the reduction of construction materials recorded the least mean and hence deemed to have the most negligible impact on the sustainability of public housing construction projects in the Kibera Soweto slum upgrading housing scheme. The research found end life costs has a moderate positive correlation with public housing construction projects' sustainability. Among the four independent variables, the research found that initial cost has the strongest relationship followed by operation cost. Maintenance cost was ranked third, and then end life cost was deemed to have the weakest relationship with the dependent variable.

5.3 Conclusions

The research concludes that initial cost influences the sustainability of the public housing upgrading construction project in Kibera Soweto Slum in Nairobi City County, Kenya. The positive relationship between initial cost and sustainability of public housing upgrading construction projects leads to the conclusion that it is necessary for the cost of land acquisition,

building construction technologies, facilities, and technical equipment and site survey to be considered when implementing sustainability of public construction projects.

The research concluded that operation cost influences the sustainability of the public housing upgrading construction project in Kibera Soweto Slum in Nairobi City County, Kenya. In addition, the research established that the rate of water consumption is critical to ensure that the sustainability of public housing upgrading construction projects is achieved. The research also concludes that electricity consumption, lease, and insurance of buildings should be incorporated when implementing sustainability of public housing upgrading construction projects.

According to the findings, the researchers concluded that maintenance cost significantly relates to the sustainability of the public housing upgrading construction project in Kibera Soweto Slum in Nairobi City County, Kenya. Further, the study concluded that considering the choice of materials to be used is a good measure to ensure that the sustainability of public housing construction projects is achieved. Moreover, the study concluded that the built environment should understand both the age of the building and the expectation of the users to attain sustainability in public housing construction projects.

Finally, the research concludes that the end life cost influences the sustainability of the public housing upgrading construction project in Kibera Soweto Slum in Nairobi City County, Kenya. As such, it was deemed fit to conclude that reusing and recycling materials is a measure that can be implemented to achieve the sustainability of public housing upgrading construction projects. Besides, the researcher concludes that the reduction of construction materials should be practised to mitigate any chance of not achieving sustainability of public housing upgrading construction projects.

5.3 Recommendation for policy implementation

The conclusions made from the research were a guide in making recommendations on practice. The county government of Nairobi should integrate the initial cost of construction projects when considering the sustainability of public housing construction projects. This should be matched with improving on the building construction technologies to deal with the modern-day sustainability challenges. It also recommends that the county government conduct thorough site surveys to ensure proper relocation of people affected to enhance the sustainability of their projects.

Secondly, the study encourages the county government to consider integrating operation costs in the project costs of public housing construction projects to attain sustainability. Once the operation cost is taken into consideration, stakeholders will be ascertained of a holistic view of a project's actual cost, subsequently leading to the use of cost-efficient solutions. Furthermore, the estimation of operation cost leads to stakeholders coming up with operation strategies that ensure the sustainability of a project. Moreover, the respondents ranked water and sewer connection in operation to have a strong relationship with the sustainability of the public housing construction project. Therefore, the county government should put stringent measures to concentrate on water consumption and sewer connection during operation.

Research recommends that the county government estimate the maintenance cost to determine the sustainability of public housing construction projects. In addition, estimating maintenance costs will ensure that the project achieves high quality, cuts down the total cost, and determines the end-users' satisfaction. Finally, the project will achieve environmental and social benefits.

The research recommends that the county government of Nairobi should implement policies that govern the end life costs of public housing upgrading construction projects. This will allow

investors to balance the functional and disposal requirements when planning for the building. In addition, this will enable investors to identify early how to finance the disposal of the buildings and ensure sustainability is achieved.

5.5 Suggestions for Further Research

According to the research, emphasis was only placed on creating insight into the relationship between project life cycle costing and the sustainability of the public housing upgrading construction project in Kibera Soweto in Nairobi City County, Kenya. Despite this research, further research should be conducted to determine the level of adoption of project life cycle costing in the construction industry. The research further suggests that research should be conducted targeting other construction projects to determine if project life cycle costing can achieve sustainability.

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APPENDIX 1: QUESTIONNAIRE INTRODUCTORY LETTER

Kenyatta University,

P.O Box 43844-00100,

Nairobi

4th January 2021

To whom it may concern

Dear Sir/Madam.

RE: QUESTIONNAIRE INTRODUCTION

I am a student at Kenyatta University undertaking my MBA and am required to research for academic purposes.

Your firm has been sampled for this research. The title of the study is:

"Project Life Cycle Costing and Sustainability of the Public Upgrading HousingConstruction Projects in Kibera Soweto Slum Nairobi County, Kenya."

Your involvement in the research will only be allowed if deemed voluntary. Your confidentiality and anonymity are ensured. Information collected from this survey will only be used for data collection for this study. Your responses will contribute to an effective integration of Life cycle costing in sustainable construction projects.

Thank you.

Yours faithfully.

Vivian Wangigi Muriuki.

APPENDIX 11: LETTER OF AUTHORIZATION

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke

Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 8710901 Ext. 57530

Our Ref: D53/PT/27840/2018

DATE: 9th July, 2021

Director General,
National Commission for Science, Technology
and Innovation
P.O. Box 30623-00100
NAIROBI

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION FOR MURIUKI VIVIAN WANGIGI. – REG. NO. D53/PT/27840/2018.

I write to introduce Muriuki Vivian Wangigi who is a Postgraduate Student of this University. The student is registered for M.B.A degree programme in the Department of Management Science.

Muriuki intends to conduct research for a M.B.A Project Proposal entitled, "Project Life Cycle Coasting and Sustainability of Public Housing Construction Projects in Kibera Soweto Slum Upgrading Housing Scheme in Nairobi City County, Kenya".

Any assistance given will be highly appreciated.

Yours faithfully,

PROF. ELISHIBA KIMANI
AG.DEAN, GRADUATE SCHOOL

EM/lnn

APPENDIX 111: NACOSTI RESEARCH PERMIT

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **326167**

Date of Issue: **06/September/2021**

RESEARCH LICENSE

This is to Certify that Miss.. Vivian Wangigi Muriuki of Kenyatta University, has been licensed to conduct research in Nairobi on the topic: PROJECT LIFE CYCLE COSTING AND SUSTAINABILITY OF PUBLIC HOUSING CONSTRUCTION PROJECTS IN NAIROBI COUNTY, KENYA: CASE OF KIBERA –SOWETO SLUM UPGRADING HOUSING SCHEME for the period ending : 06/September/2022.

License No: **NACOSTI/P/21/12528**

326167

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

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The Grant of Research Licenses is Guided by the Science, Technology and Innovation (Research Licensing) Regulations, 2014

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Website: www.nacosti.go.ke

APPENDIX 1V: QUESTIONNAIRE

SECTION A: PERSONAL INFORMATION

This section is about your personal information, for each of the questions please tick accordingly.

1. Age of respondent

   21-29 ( ) 30-40 ( ) 41-50 ( ) Above 51

2. Years of experience

   0-5 years ( ) 5-10 years ( ) 10-15 years ( ) 15 years above ( )

3. Education (highest level achieved)

   Certificate ( )

   Diploma ( )

   Higher national Diploma ( )

   Bachelors ( )

   Masters ( )

   PhD ( )

4. Type of Organisation

   State Department of Housing and Urban Development ( )

   UN-habitat ( )

   Muungano Wa Wanavijiji ( )

   Pamoja Trust ( )

   Kibera Soweto High Rise Co-operative Society ( )

Settlement Executive Committee ( )

SECTION B: INITIAL COST

To what level do you acknowledge the following statement on the relationship between initial cost and sustainability of the public housing construction project in Kibera Soweto Slum, Kenya, as per the Likert scale values of 1-5. Using a Likert scale, please indicate your response using the values 1,2,3,4,5 representing strongly disagree, disagree, neutral, agree, and strongly agree, respectively.

Statement	1	2	3	4	5
The decision on where, when, and how to acquire land relates to the public housing construction project sustainability					
Building construction technologies of the project relate to the public housing construction project's sustainability					
Site survey of the project relates to the public housing construction project's sustainability					
The choice of facilities and technical equipment to be used relates to the public housing construction project's sustainability					

SECTION C: OPERATION COST

To what level do you acknowledge the following statement on the relationship between operation cost and sustainability of public housing construction projects in Nairobi County, Kenya? Using a Likert scale, please indicate your response using the values 1,2,3,4,5 representing strongly disagree, disagree, neutral, agree, and strongly agree, respectively.

Statement	1	2	3	4	5
The rate of electricity consumption relates to the public housing construction project's sustainability					
Water consumption and sewer connection relate to the public housing construction project's sustainability					
The decision on leasing of buildings relates to the public housing construction project's sustainability					
Insurance of buildings relates to the public housing construction project's sustainability					

SECTION D: MAINTENANCE COST

To what level do you acknowledge the following statement on the relationship between maintenance cost and sustainability of public housing construction projects in Nairobi County, Kenya, as per the Likert scale values of 1-5. Using a Likert scale, please indicate your response using the values 1,2,3,4,5 representing strongly disagree, disagree, neutral, agree, and strongly agree, respectively.

Statement	1	2	3	4	5
The choice of building materials relates to the public housing construction project's sustainability					
The age of building relates to the public housing construction project's sustainability					

The expectation of users on the maintenance of the building relates to the public housing construction project's sustainability					

SECTION E: END-LIFE COST

To what level do you acknowledge the following statement on the relationship between end-life cost and sustainability of public housing construction projects in Nairobi County, Kenya, as per the Likert scale values of 1-5. Using a Likert scale, please indicate your response using the values 1,2,3,4,5 representing strongly disagree, disagree, neutral, agree, and strongly agree, respectively.

Statement	1	2	3	4	5
The decision on reusing materials will reduce waste costs and hence relates to the public housing construction project's sustainability					
Recycling of materials relates to the public housing construction project's sustainability					
Reducing wastage relates to the public housing construction project's sustainability					

SECTION F: SUSTAINABILITY OF PUBLIC HOUSING CONSTRUCTION PROJECTS

To what extent do you agree that the following are indicators of the sustainability of public construction projects? Kindly use a scale of 1 to 5 where 1 = Strongly Disagree", 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly agree.

Statement	1	2	3	4	5
Pollution and waste from construction projects.					
Material consumption of construction projects.					
Energy consumption of construction projects					
Use of land by construction projects					
Construction technologies					
Accessibility for the disabled					
Internal layout					
Ease of maintenance					
Seismic safety					
Visual Comfort					
Employment creation					
Security					
Social Equity					
Thermal comfort					
Property value					
Long and short-term benefits					
Competitive advantage					
Material cost					