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COLLEGE OF ARCHITECTURE AND ENGINEERING

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DEPARTMENT OF REAL ESTATE, CONSTRUCTION MANAGEMENT, AND QUANTITY SURVEYING

ADOPTION OF GREEN BUILDING TECHNOLOGIES IN KENYA: A CASE STUDY OF BUILDINGS IN NAIROBI COUNTY

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A research project submitted to the University of Nairobi, Department of Real Estate, Construction Management and Quantity Surveying, in partial fulfillment for the award of degree in Masters of Arts in Valuation and Property Management.

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DECLARATION

Student's Declaration

I hereby declare that this research project is my original work and has not been presented for any award in any university.

Signature: …… Date: …**31/7/2023**…

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Supervisor's Declaration

This research project has been submitted for examination with my approval as the university supervisor.

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ABBREVIATIONS AND ACRONYMS

BORAQS - Board of Registration of Architects and Quantity Surveyors

BREEAM - Building Research Establishment Environmental Assessment Method

CaGBC - Canadian Green Building Council

CASBEE - Comprehensive Assessment System for Building Environmental Efficiency

CBCSA - Green Building Council of South Africa

CBD - Central Business District

EARB - Estate Agents Registration Board

EBK - Engineers Board of Kenya

EDGE - Excellence in Design for Greater Efficiency

GB - Green Building

GBC - Green Building Council

GBCA - Green Building Council of Australia

GBCA - Green Building Council of Australia

GBTs - Green Building Technologies

GHG - Green House Gases

GoK - Government of Kenya

GRIHA - Green Rating for Integrated Habitat Assessment

KGBS - Kenya Green Building Society

KNBS - Kenya National Bureau of Statistics

LEED - Leadership in Energy and Environmental Design

NEMA - National Environmental Management Authority

PPPs - Public-Private Partnerships

SDGs - Sustainable Development Goals

SPSS - Statistical Program for Social Sciences

UNEP - United Nations Environmental Program

UNEP SBCI - Nations Environment Programme - Sustainable Buildings and Climate Initiative

UN-HABITAT - United Nations Habitat

US EPA - The United States Environmental Protection Agency

USGBC - United States Green Building Council

ABSTRACT

Most countries have grappled with Green Building Technologies (GBTs) as a get-to-achieve concept, especially in African cities. The study's goal is to look into the use of green construction technology in Kenya. This was done to understand how green building technologies contribute to the SDGs (Sustainable Development Goals).

In order to collect data a stratified random sampling method was employed to choose participants from the professional and end-user groups which included; Property Managers, Estate Agents, Valuers, Quantity Surveyers, Project Managers, Engineers and Architects. A sample of 118 respondents was selected. Questionnaires and interview guides were used. Critical professionals directly involved in green building in Kenya were selected through purposive and snowball sampling techniques. The thematic analysis revealed strategic investment themes that could be utilized to advocate sustainable construction technologies in Kenya and other regions. The study's drawback is that it only covered the case of Nairobi City.

According to the study, there are various ways to categorize green building technologies, including those that improve interior air eminence, water and energy proficiency, the utilization of eco-friendly materials, and sustainable site activities. The implementation of these technologies was hindered by several factors, such as high initial prices, a lack of clear construction rules and regulations, a lack of knowledge and skills, opposition to change, a absence of governmental support, and a limited supply of dependable suppliers, lack of financing options, limited awareness and research, and rigid regulatory frameworks. These obstacles resulted in low adoption rates of green building technologies in Kenya. Respondents said there is some awareness of environmentally friendly building techniques among Kenyan construction industry players, but acceptance rates are still insufficient.

The study suggested several ways to advance the implementation of sustainable building practices in Kenya. These measures include creating a sustainability check-list and ensuring better enforcement by the relevant governing authorities, providing education, research, and training on green building technologies, promoting green procurement, launching public awareness campaigns on these technologies, enforcing legislation related to green building technologies, offering financial incentives for their adoption, and establishing recognition, accreditation, and certification programs for green building projects.

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Green building, as described by Amuda-Yusuf et al. (2020), was created in the late 20th century with the intention of using less energy both during construction and over the lifetime of the structure. The real estate sector has given this concept more significance due to societal, economic, and cultural changes. In order to meet sustainable goals, it is increasingly vital to integrate green techniques into building management. Sustainability has grown to be a major concern. Governments are encouraging businesses to promote energy saving, recycling, and resource reduction as the demand for sustainable properties increases. More than 10,000 commercial green buildings and more than 120,000 green-rated real estate assets may be found worldwide thanks to the implementation of green building initiatives by various nations.

The Sustainable Development Goals (SDGs) of the United Nations have an impact on the idea of sustainability since they highlight the necessity of establishing a system that strikes a balance between productivity and environmental preservation. Consumers expect sustainability to be interwoven into various facets of their lives, thus it is no longer seen as a niche idea. Globally, governments and organizations encourage sustainable activities by providing incentives like tax cuts and financial assistance.

Twenty African nations have been placed in the top 50 list of world economies witnessing substantial advancement in terms of business regulation efficiency since 2005, despite the fact that sustainable construction has not received enough attention in Africa. Green building councils are advancing the green construction agenda throughout Africa. In order to save energy and lessen the usage of fossil fuels, which benefits poor countries and encourages sustainable growth, construction businesses around the world are adopting green building technology.

1.2 Problem Statement

As the world's natural resources are being depleted, green construction has emerged as a critical component of the built environment industry globally. To advance sustainability, architects, engineers, project managers, property managers, and concerned people must collaborate. The

goal of green construction is to lessen the unfavorable ecological outcomes of technology and industrial processes brought on by the expanding global population. The responsibility of building companies includes offering low-energy and sustainable green buildings to consumers in order to convey to them their commitment to environmental sustainability. The government, developers, contractors, planners, designers, nonprofit organizations, experts, and those working within the realm of education are just a few of the groups that must assume responsibility for achieving sustainability.

According to a survey by McGraw-Hill Construction, eco-friendly construction practices are becoming more popular across the globe, with new construction and renovation projects providing the greatest opportunity. Lack of government backing and subsidies, limited knowledge about the merits of environmentally-friendly buildings, and a shortage of qualified green building professionals are all obstacles in favor of incorporating eco-friendly buildings. Despite this, implementing green construction technologies has more advantages than the alternative, and it is obvious that doing so will improve sustainability.

1.3 Research Objectives

1.3.1 Key Objective

The key objective of this study is to investigate the adoption of green building technologies in Kenya.

1.3.2 Specific Objectives

1. To determine the extent of the adoption of green building technologies in Kenya.
2. To establish the challenges and constraints facing the adoption of green building technologies in Kenya.
3. To determine the level of awareness of green building technologies by players in the construction industry in Kenya.
4. To recommend appropriate mechanisms for enhancing green building technologies in Kenya.

1.4 Research Questions

1. To what extent have green building technologies been adopted in Kenya?
2. What are the challenges and constraints facing green building technologies in Kenya?

3. What is the level of awareness of green building technologies by players in the construction industry in Kenya?
4. What are the appropriate mechanisms for enhancing green building technologies in Kenya?

1.5 Justification and Importance of the Study

The total performance of green buildings in the real estate market depends on the acceptance of sustainable construction technology. This study is important because it will instruct both experts and members of the real estate community on how to use green building methods and approaches. The study's main concern is how green building techniques would affect Kenya's real estate market. When formulating policies and strategies to develop properties or facilities in a green fashion, real estate professionals, property owners, and investors will benefit from the research analysis's ability to assist them make educated judgements. This will increase revenue generation and help them achieve their objectives. The paper examines several green building technologies, their use in Kenya, the difficulties encountered, the effects, and suggests practical ways to advance green construction in Kenya.

1.7 Limitations of the Study

Due to professional confidentiality and the confidentiality of government information, the study may have restrictions that limit how accurate the information provided by respondents can be. Additionally, the researcher may have difficulty interpreting questionnaires. In order to overcome these difficulties, the researcher made sure the questionnaire would be anonymous, that the data would only be used for academic purposes, and that she had a study permission approved. A research assistant also assisted with the interpretation and tabulation of the data.

1.8 Assumptions of the Study

The study conjectures that every one of the respondents will provide truthful responses and that the four independent variables will continue to be significant throughout the study. The researcher anticipates that the results will be sufficient to support the ability to make reliable conclusions because this assumption is crucial in establishing the acceptability of the findings.

1.9 Definition of Key Terms

Green Building refers to a structure that uses resources wisely and with consideration for the environment during its entire life.

Green Building Technologies refers to practices and innovations in sustainable building, energy-saving practices, indoor air purity, and responsible resource utilization.

Green Procurement refers to the practice of buying things and hiring people that has the fewest negative effects on the environment.

1.6 Study Area and Scope

The study focuses on eco-friendly structures that are open for business in Nairobi County. The study area includes the Strathmore Business School, the UNEP Building in Nairobi, the Coca-Cola East and Central Africa Business Unit, the Catholic University of East Africa Pope Paul VI Resource Centre, and the Strathmore Business School.

1.10 Organization of the Study

The study comprises five chapters, with chapter one introducing the study's various sections, including the statement of the problem, objectives, hypothesis, justification, significance, scope, methodology, and definition of key terms. Chapter two reviews the literature on green building and formulates a conceptual framework. Chapter three outlines the research methodology, including the research design, target population, samples, data requirements, collection tools, criteria for measurements and variables, procedures for data analysis, and presentation methods. Chapter four presents the data analysis, descriptions, presentations, and discussions of findings, while chapter five covers a summary of findings, conclusions, recommendations, areas for further research, and references and appendices.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

A thorough overview of sustainable construction technologies and their significance in fostering sustainable development, both in Kenya and other nations, is given in the second chapter of this book. The history of green building and how it has evolved into a crucial component of contemporary construction are covered at the outset. The definition of "green building" is the process of creating, running, renovating, or reusing buildings in a way that is resource- and environmentally-friendly. This strategy aids in minimizing harmful environmental effects and advancing sustainable development.

2.2 Green Building Defined

Green building technologies (GBTs) have been created to improve sustainability during the course of a building's existence. Sustainable building is described by the United States Environmental Protection Agency (USEPA) as the process of designing buildings that embody a holistic approach to resource conservation and environmental responsibility from inception to decommissioning. Energy-saving techniques are included into green buildings, including installing high-performance windows and reducing air leakage, among other things.

Green buildings can be divided into two categories: those that are newly constructed with all the green elements required by LEED (Leadership in Energy and Environmental Design) and those that are retrofitted with some green features. Energy, operation, and maintenance expenses can be lowered, building-related illnesses can be reduced, and waste and pollution can be reduced by incorporating sustainable concepts into building design. In addition, green buildings are healthier for occupants, perform better environmentally, and appreciate in value over time due to lower operating expenses than conventional structures.

2.2.1 Types of Green Buildings

There are two types of green structures. Buildings are being constructed with all the green elements required by LEED, while certain green features are being retrofitted onto existing structures (Tehrani, 2011).

Table 1: Features that make an Existing Building Green

Formaldehyde-free insulation
Dual-pane windows
Peaceful, energy-conserving ventilation
Quiet ceiling and attic fans
Evaporative water air cooling systems
Energy-saving heating or radiant in-floor heating
Recycled wood floors, doors, and panelling
Recycled glass tile
Water-efficient facets, shower heads, and toilets
. Non-toxic caulk and paints
. Eco-friendly lighting systems

Source: Tehrani and Sinha, 2011

Table 2: Features that make a Building green

Sustainable sites
Water efficiency
Energy use reduction, green power, and atmospheric protection
Resource efficiency and preservation
Interior environmental condition
Innovation and design process
Building operation and maintenance

Source: LEED, 2020

There hasn't been a division in the types of green buildings based on how much they cost to build, but rather on whether they have the attributes mentioned above. As a result, the LEED rating of a building's level of greenness depends on the features that were implemented throughout the building's construction.

2.2.2 Features of Green Buildings

Research was done on the qualities that set apart such buildings in order to better understand what makes up a green building. The Leadership in Energy and Environmental Design (LEED) grading system, which was founded in 1993 and began to receive widespread international acclaim in the early 2000s, was responsible for creating these characteristics. One of the USGBC's founders founded the LEED organization, which is committed to fostering leadership in environmentally friendly construction techniques. As a result, there is a global shift taking place in how communities and buildings are planned, built, maintained, and run (USGBC, 2019).

Sustainable management of materials and assets, interior air quality, cutting-edge design processes, building operation and maintenance, environmentally responsible locations, efficient water usage, reduction of energy use, green power, and atmospheric protection are some of the key characteristics integral to sustainable structures, according to LEED and CalRecycle.

Table 3: Green building characteristics

Feature	**Description**
Material and Resource Conservation	The goal is to lessen the adverse consequences related to the acquisition, processing, transportation, maintenance, and disposal of building materials. Recycling, waste management, procuring raw materials sustainably, and employing environmentally friendly building materials are strategies. The LEED standards for green buildings include this.
Indoor Environmental Quality	Focuses on providing proper air quality, thermal, visual, and acoustic comfort to the building's occupants to provide a space that prioritizes both comfort and the well-being of occupants. To enhance interior environmental quality, strategies include guaranteeing thermal comfort, providing user-friendly lighting, and gathering input from inhabitants. The LEED guidelines (LEED, 2016) also include this.
Innovation and Design Process	Recognizes advanced architectural attributes and environmentally-friendly approaches in building design and technology (LEED, 2016).
Building Operation and Maintenance	Kubba (2012) claims that inspecting and adjusting building systems to make sure they adhere to design specifications, training maintenance workers on equipment use, and implementing maintenance management strategies to cut operating costs are all part of building operation and maintenance. This is essential for highly effective green structures.
Sustainable Sites	According to Harrison et al. (2008), in order to create sustainable sites, building and construction projects must be in compliance with LEED standards for green buildings. This entails performing site analyses, putting pollution mitigation techniques into place, offering substitute transit options, and placing buildings in metropolitan areas close to essential social amenities.

Water Efficiency	Involves decreasing indoor and outdoor water use and waste in order to conserve and save water. Leaks can be fixed, and showers can be used in place of bathtubs (LEED, 2016).
Energy Use Reduction, Green Power and Atmospheric Protection	Green Power and Air Protection, according to Coyle (2014), focuses on energy efficiency, the use of renewable energy sources, the implementation of advanced energy metering systems, the use of green power to minimize greenhouse gas emissions, and the protection of the environment to lessen ozone depletion. This is a requirement for green buildings and is outlined in the LEED (2016) requirements.

Source: Author's Construct, 2021

2.3 History of Green Buildings

The US Environmental Protection Agency (US EPA) was established in 1970, the same year that the first Earth Day was celebrated and the modern environmental movement is said to have started, according to Yudelson (2010). According to Yudelson (2010), the Montreal Protocol, which limited the use of chlorinated fluorocarbons due to their detrimental effects on the ozone layer, was put into force in the 1980s, marking the beginning of green building. This was one of the first international environmental laws. The Brundtland Commission's definition of sustainability was based on the Committee on the Environment, which was established by the American Institute of Architects and supported environmentally friendly building plans. The 1980s are regarded as the decade that laid the foundation for green buildings, with international organisations and legislation supporting environmentally friendly technologies and sustainable design principles.

2.4 Global Perspective of Green Buildings

Berlin and Copenhagen's sustainable economies serve as examples of how green policies can promote economic growth. Meanwhile, according to PWC (2013), Hamburg has earned a number of national and international industrial honours for its cutting-edge technology, internal building systems, and effective architecture.

Green building practices in Singapore were not initially viewed as a competitive advantage. Even though perceptions have changed, developers now see green buildings as a way to increase value. The home's prestige can be increased by including green building accreditations like Singapore's Building and Construction Authority (BCA) Green Mark.

Singapore has converted a significant portion of its building inventory into green structures during the past ten years, achieved through measures such as improving energy and water efficiency, implementing eco-friendly building materials, and prioritizing healthier indoor environmentss. By 2030, Singapore will have achieved the BCA Green Mark certification requirements for greening 80% of all buildings. Singapore's public sector is leading by example by demanding that public events be place in Green Mark-certified venues and only leasing office space from buildings that have earned the Gold Plus certification.

2.5 The Rise of Green-Minded Tenants

Tenants are driving the market for green real estate as well as developers that value sustainability. Businesses that place a high value on CSR are increasingly looking for indoor locations with better air quality, lower operational costs, and higher market value. Americans are also prepared to spend more for homes with environmentally friendly amenities like higher indoor air quality materials, windows, and appliances that are energy efficient. Younger generations are increasingly buying homes and are searching for sustainable elements in them.

In order to help tenants, adopt responsible environmental practises without negatively impacting their operations, real estate intermediaries are also addressing these demands by providing green leases and facilities management services. When choosing materials for sustainable building construction, it's important to keep things like resource efficiency, indoor air quality, energy and water conservation, and economic cost in mind. Alternative materials are preferred over conventional materials since they are recyclable, easily accessible locally, durable, and devoid of hazardous components. When choosing building materials, indoor air quality is a crucial consideration as well because materials with low volatile organic compound emissions and moisture resistance are better for your health.

2.6 What is Green Building Technology?

The use of cutting-edge techniques to create structures that have little to no negative environmental impact throughout their entire life cycle from planning and design to operation, maintenance, repair, and demolition is referred to as "green building technology." Green building technologies have been adopted by builders all over the world due to their benefits, resulting in structures that are less expensive to construct and maintain.

Although regional differences in construction methods exist, the major goals of green building technology are the efficient consumption of energy, materials, and water, the improvement of operations and maintenance, and the reduction of waste and harmful materials. The key goal of green building is to lessen the unfavorable ecological outcomes attributable to the structures such as carbon dioxide emissions and the diminution of natural resources caused by the unsustainable harvesting of building materials.

The building sector is changing towards sustainability thanks to a number of cutting-edge technologies.

2.6.1 Zero-Energy Buildings

Zero-energy structures are constructed using renewable energy sources like solar and wind to generate all of their own electricity without having to connect to the conventional electrical grid. These structures are a shining example of green building technology because they have zero nett annual energy consumption and zero carbon emissions.

Although it may seem like a future idea, governments in developed nations are already encouraging the construction of zero-energy buildings by offering subsidies. For instance, in the United States, the federal government provides a 30% tax credit for solar investments, while California offers additional incentives to consumers who choose renewable energy sources.

2.6.2 Electro-chromic Glass

The amount of light that is reflected by electro chromic glass, commonly referred to as smart glass, can be changed by utilising a little amount of energy to charge ions on a window layer. Smart glass allows users to regulate the quantity of light that enters through the windows using

intelligent building management systems, in contrast to low-emittance windows that filter some solar radiation.

It is anticipated that future buildings would have windows that can automatically change their colour throughout the day and become transparent at night, even if the technology is still being perfected for commercial usage. According to proponents of electro chromic glass, it might save heating, ventilation, and air conditioning expenditures by 25%.

2.6.3 Cool Roof System

In contrast to a typical roof, a cool roof is a kind of rooftop made to reflect sunshine and absorb less heat. Traditional dark shingle roofs may get incredibly hot during the summer, reaching temperatures of up to 65.5 degrees Celsius. Air conditioning systems may be under stress as a result, increasing carbon emissions. The temperature of the roof surface can be greatly reduced with the use of cool roofs thanks to their increased solar reflectance and lower thermal emittance, which also improves the building's interior temperature. As a result, there is less need for air conditioning, which lowers carbon emissions. The heat island effect, which occurs when urban and suburban regions in hot weather have greater temperatures than nearby rural areas, can also be reduced using cool roof systems.

2.6.4 Smart Appliances

Modern household appliances are made with the dual goals of being energy-efficient and offering users ease. To reduce their energy use, appliances like refrigerators, dishwashers, and washing machines have been outfitted with cutting-edge technology and connected to smart metres. Smart metres are sophisticated electric measuring tools that collect data in real-time and interact with appliances to provide insightful data on energy use. These devices can compute energy prices and carry out automatic tasks when costs are at their lowest with the use of this information.

2.6.5 Green Infrastructure

Due to flooding in streets and buildings, excessive rainfall can cause dangerous driving conditions and considerable property damage. Green infrastructure is used to combat this. By utilising vegetation and soil to control water absorption, systems must be specifically planned

and landscaped to manage storm water in metropolitan settings. By promoting plant growth in metropolitan settings, green infrastructure helps to lessen the heat island effect that results from the usage of metal street furniture and heat-absorbing pavements. Additionally, by absorbing carbon dioxide, plants are efficient at improving city air quality. There are many ways to build green infrastructure, but the simplest solutions include installing plant boxes and tiny areas of grass and soil alongside streets.

2.7 Necessity of Green Building Technology

The terms "green building technology" and "sustainable building technology" are synonymous and describe architectural plans for buildings that use less energy, allow for more design flexibility, improve the quality of the air within, and require less upkeep. Up to 3 billion tons of raw materials are used by the construction industry each year, yet green building techniques can drastically cut this amount without sacrificing the strength and longevity of buildings. Through lower energy, water, and maintenance costs, green buildings provide owners, residents, and operators with financial advantages without greater upfront costs. The entire cost of a green construction can be made to equal, or even be less expensive than, that of a conventional structure by applying contemporary methods and integrated designs. Despite some people's unwillingness to change, some green building designs may have slightly higher initial prices, but over time, their life cycle and cost savings can balance these expenses out.

2.8 Benefits of Adoption Sustainable Building Technologies

As stated by McNaughton et al. (2016), green building has numerous important advantages environmentally, socially and economically. Threatened ecosystems are protected, solid waste is reduced, natural resources are conserved, and water and air quality are improved, among other environmental advantages. This results in improved health for people, animals, and plants. Through effective lighting and ventilation, green buildings also support environmental health and occupant well-being.Green Buildings offer convenience and health, alleviate pressure on community resources and enhance overall well-being, and lessen the detrimental effects of buildings on climate change. Additionally, they support the growth of flora on land and roofs and advocate for alternative modes of transportation. Green buildings also use less water, electricity, and fuel, which reduces their carbon footprint and the amount of greenhouse gases they emit. Accordingly, as emphasized by (Liobikien et al., 2016; Lazzerini et al., 2014,

2016; Coomb et al., 2016; Van-Hilst et al., 2017), green building is a crucial strategy for combating climate change.

2.9 Challenges and Constraints facing the Adoption of Green Building Technologies

Based on the survey results by McNaughton et al.(2016), there are major barriers and restrictions that prevent the widespread use of Green Building Technologies (GBT), especially in poor countries. These challenges include high upfront costs, insufficient knowledge and experience among builders, ignorance of the advantages of GBT, a lack of government incentives, and opposition to change. In addition, there aren't many reliable green vendors, and there aren't any building rules or codes. To solve these challenges, appropriate strategies and regulations should be created. These issues are divided into five groups: those linked to the government, to people, to knowledge and information, to markets, and to cost and risk. The majority of them are tied to the government. Important stratagems for promoting the adoption of eco-friendly construction methods include funding, market-based incentives, improved information access, green labelling, and information dissemination. Water and energy efficiency, as well as company image and reputation, are elements that support the implementation of GBT. The lack of skilled personnel, government support, and restrictions are the biggest barriers to GBT's adoption and spread in Saudi Arabia.

2.10 Mechanisms of Enhancing Adoption Green Building Technologies

The examination and updating of regulatory and control mechanisms must be done on a regular basis to keep up with market developments and technological advancements. Even though incorporating green ideas into new construction is simpler, regulatory tools like building regulations, appliance guidelines, procurement policies, energy saving mandates, and utility demand response agendas can be used to enact sustainability laws (UNEP - SBCI, 2007).

Due to outdated laws like the Kenya Building Code (Building) Order 1968, Local Government (Adoptive By-Laws) Local Government (Adoptive) Building By-Laws 1968, Planning and Building Regulations 2009, Environmental Management & Coordination Act 1999, Physical Planning (Building and Development) (Control) Rules, 1998, and Physical Planning Act Cap 286 it is difficult for county governments in Kenya to implement some policies. Compliance with these regulations is challenging because they don't follow the current sustainability

standards. Voluntary efforts can be launched and gradually incorporated into building codes to increase compliance.

2.11 Future Adoption of Green Building Technologies

According to Alsharif (2018), the "go green" movement was sparked by the increasing awareness of people throughout the world about climate change and difficult environmental conditions. Encouragement of the preparation, formation, and construction of Environment-friendly structures in the United States that support energy and water saving, healthy indoor and outdoor environments, and material recycling are one approach to do this. In order to address climate change, which has far-reaching repercussions including rising sea levels and fatal heat waves, the building industry must be changed. Sustainable designs should also be introduced into the education sector in order to teach future generations to be responsible for protecting the environment. Solar power utilization and harnessing ambient light should be encouraged in building designs. Multiple ideas should be implemented, and incentives like tax breaks should be made available to encourage individuals to use green building principles in order to attain sustainable practices. The government frequently imposes these incentives, which can be internal or external, to encourage project owners to fulfil particular requirements for green housing (Olubunmi et al., 2016).

2.12 Legal, Policy and Institutional Framework

According to Alsharif (2018), worldwide concerns about climate change and environmental deterioration have given the "go green" movement more traction. Developers in the US are promoting sustainable building methods that involve saving energy and water, creating healthy surroundings, and recycling materials. This is an important step in dealing with the extensive repercussions of climate change, like rising sea levels and severe heat waves. To teach future generations about the value of environmental stewardship, it is equally crucial to include sustainable design principles into the education sector. The use of technical abilities like solar energy and natural light should be promoted through building design. Governments can compel compliance by enforcing mandatory green construction standards and enticing green incentives. Incentives, such as tax subsidies, can encourage people to adopt green building approaches both externally and internally. 2016 (Olubunmi et al.).

2.12.1 Rating Systems and Tools for Green Buildings

The green building rating methods used in various nations may or may not be comparable. The ranking systems mentioned by Say et al. (2008) are as follows:

Table 3: Rating Systems and Tools for Green Buildings

Rating Systems and Tools	**Features**	**Countries Adopted**	**Comments**
Leadership in Energy and Environmental Design (LEED)	It encompasses new commercial construction and significant renovation endeavors, ongoing operations and maintenance, commercial interior projects, core and shell development initiatives, residential properties, neighborhood improvements, schools, and retail establishments.	United States of America based. Worldly adopted.	Internationally recognized sustainability rating system for the built environment.
Building Research Environmental Assessment Method (BREAM)	Established with the aim of mitigating environmental impact, promoting optimal environmental practices in building design, operation, and management, and raising awareness about the environmental effects of buildings.	UK-based. Worldly adopted.	Internationally recognized sustainability rating system for the built environment.
Comprehensive Assessment System for Building	Within the assessment, the categories encompass the building's life cycle pre-design, initial construction, pre-existing	Japanese Based	Internationally recognized sustainability rating

Environmental Efficiency (CASBEE)	properties, and redevelopment stages	Adopted in Asia	system for the built environment.
Green Globes	The assessment encompasses new building design or substantial redevelopments, administration and functioning of established edifices, building emergency protocols, building automation, and fit-up evaluations.	US and Canada based. Worldly adopted.	Internationally recognized sustainability rating system for the built environment.
Excellence in Design for Greater Efficiency (EDGE)	It comprises a platform for green buildings, incorporating a worldwide eco-friendly construction framework, a digital tool, and accreditation process.	Worldly adopted.	Internationally recognized sustainability rating system for the built environment.
Green Star	Its formation aimed to create a unified rating tool for assessing eco-consciousness and awareness in mindful design, with a specific focus on the building's life-cycle impacts.	Australia Based. Adopted in South Africa and Kenya	Internationally recognized sustainability rating system for the built environment.

Source: Author's Construct, 2021

These scoring systems share a number of characteristics. All of them base their recognition on a building's LEED-defined green attributes. They also understand how crucial building upkeep is to preserving the structure's certification after it has been granted. As a result, the Say et al. (2008) study underlines the need for all grading systems to promote the management and upkeep of green buildings. However, the writers don't go into detail about any of the potential reasons why the maintenance might be affected or offer any potential solutions.

2.13 Theoretical Framework for Adoption of Green Building Technologies

An examination of the relevant academic sources led to the identification of a various theories that could potentially elucidate the incorporaion of environmentally-conscious building innovations. These theories encompass the following concepts: general system, convention, adoption and diffusion, sustainability, and innovation framework. The innovation-decision process is modelled by adoption and diffusion theory, which contends that adoption takes place over time as potential adopters move through the knowledge, persuasion, decision, implementation, and confirmation stages. Conventional wisdom can be applied to the emerging green construction sector to describe how market and non-market entities interact. Throughout a building's lifecycle, sustainability theory places an emphasis on resource efficiency and environmental responsibility. According to general system theory, a system can be built to function successfully despite external circumstances since it is made up of interrelated pieces or subsystems. These theories offer practical frameworks for comprehending and addressing the difficulties in implementing green building practices. The creation of a complete system that includes numerous elements during the design, construction, usage, and disposal phases is essential to the successful implementation of sustainable construction principles. It is possible to divide eco-friendly construction technologies into sub-systems, and the adoption of these sub-systems is influenced by extraneous factors including rules, resources, incentives, and education. The success of incorporating these practices determines the adoption level, and complete integration yields a system.

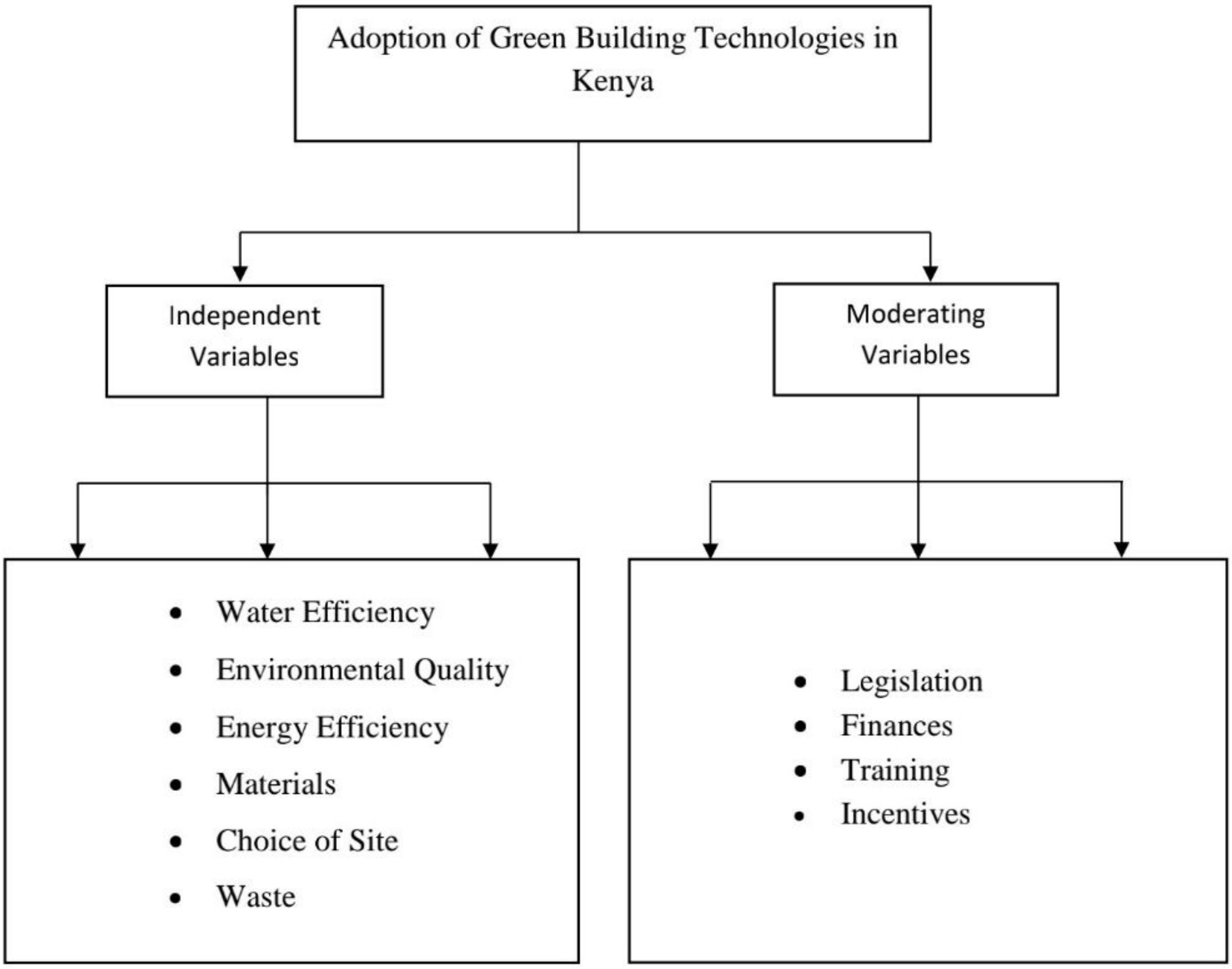
2.13.1 Conceptual Framework

A conceptual framework, as stated by Reichel and Ramey (1987), is a group of overarching ideas and principles drawn from pertinent disciplines of study that serve as the framework for a future presentation. This framework is a research technique meant to improve communication and help in comprehending the situation under investigation. A conceptual framework, on the other hand, is defined by Mugenda & Mugenda (2003) as a concise explanation of the phenomenon being examined and a visual depiction of the key study variables.

This study makes use of several characteristics or factors to assess the implementation of eco-friendly construction approaches. Water efficiency, environmental quality, energy efficiency, materials, site selection, and waste management are examples of independent variables. The

utilization of eco-friendly construction technologies in Kenya is the dependent variable, while the moderating variables are laws, resources, education, incentives, and other aspects of environmentally friendly construction in Kenya.

Figure 1: Conceptual Framework



Source: Author's Construct, 2021

2.14 Summary of the Chapter

After conducting research on existing literature, the ensuing key features of green buildings were identified and outlined underneath.

Table 4: Summary of Green Building Concepts

Green Building Feature/ Strategy	**Description of the Feature or Strategy**
Optimizing on Site Potential	This involves thoughtful location assessment, evaluation of current constructions, and roadway layout and structures to optimize solar and passive strategies. It also includes the conservation of critical natural features like trees, waterways, and ecosystems.
Indoor Air Quality	This strategy aims to achieve maximum natural light, proper air circulation, humidity management, and utilization of modest VOC products in order to maintain a healthy and comfortable indoor environment.
Minimizing Energy Use and Use Renewable Energy Strategies	This entails minimizing overall energy demands by utilizing energy-efficient equipment and lighting, along with meticulous design of the entire building envelope. Additionally, it encompasses the integration of renewable energy systems, such as photovoltaic solar and water heating, among other sustainable technologies.
Conserving and Protecting Water	This precept emphasizes the reduction, control, or treatment of site run-off and incorporates water-conservation measures both indoors and outdoors in the design and construction of the house, rainwater harvesting, recycling, and re-use.
Optimizing Operation and Maintenance Practices.	This strategy involves the use of structural elements and mechanisms that streamline and minimize operational demands, necessitating less water, energy, toxic chemicals, and cleaners for maintenance. Moreover, they should be economical and curtail life-cycle losses

Flexible Design	This concept promotes an expandable design that accommodates and foresees future additions to prolong the building's lifespanIt allows for modifications without compromising the integrity of the original design.

Source: Author's Construct, 2021

Table 5: Green Building Concepts and Technologies in a Project

Project Development Stage	**The issue to Consider in every Stage**
Land planning	When planning the land use, it is important to cluster buildings, reduce the amount of paved surfaces, and preserve natural vegetation.
Site planning	During site planning, it is crucial to consider the basic layout of buildings in relation to the sun, wind, and views. Additionally, eco-friendly waste disposal practices and wells, as well as outdoor design and sheltering should be included.
Construction Process Planning	During the construction process, it is important to manage and recycle construction waste, minimize site disturbance, store and re-use excavated waste, and properly dispose of hazardous waste.
Basic Design	The basic design of the building should incorporate natural sunlight illumination by designing adequate window sizes and optimal alignment in response to solar and wind.
Specifications	Specify structural elements with minimal embodied energy, energy-saving plumbing, and electrical fixtures and fittings in the standards. Additionally, include energy-efficient appliances in the guidelines
During Construction	Any changes made during construction must not impact other structural components, and should neither increase power usage nor detract from sustainability goals.
Post Construction	After construction, home buyers should receive operation training and manuals, and proper maintenance should be carried out.

Source: Author's Construct, 2021

CHAPTER THREE

CASE STUDY AREA AND RESEARCH METHODOLOGY

3.1 Introduction

Research methodology, in accordance with Mugenda and Mugenda (2003), relates to the subject of survey and the techniques utilized to perform the research. In this study, the chapter on research methodology covers a vast array of issues including data collection, analysis, and presentation. Additionally, it specifies the data requirements and explores questions regarding the data's authenticity, reliability, and reproducibility. The study employs a case study methodology, which entails the collecting and analysis of data using both quantitative and qualitative techniques.

3.2 Rationale for Case Study

A case study typically entails a thorough and in-depth analysis of a particular context that is connected to a specific location, such as a community or an organization (Bryman, 2004). The main goal of a case study, pursuant to Mugenda and Mugenda (1999), is to thoroughly investigate the phenomenon of interest and develop a wide perspective of the community to which the particular instance applies.

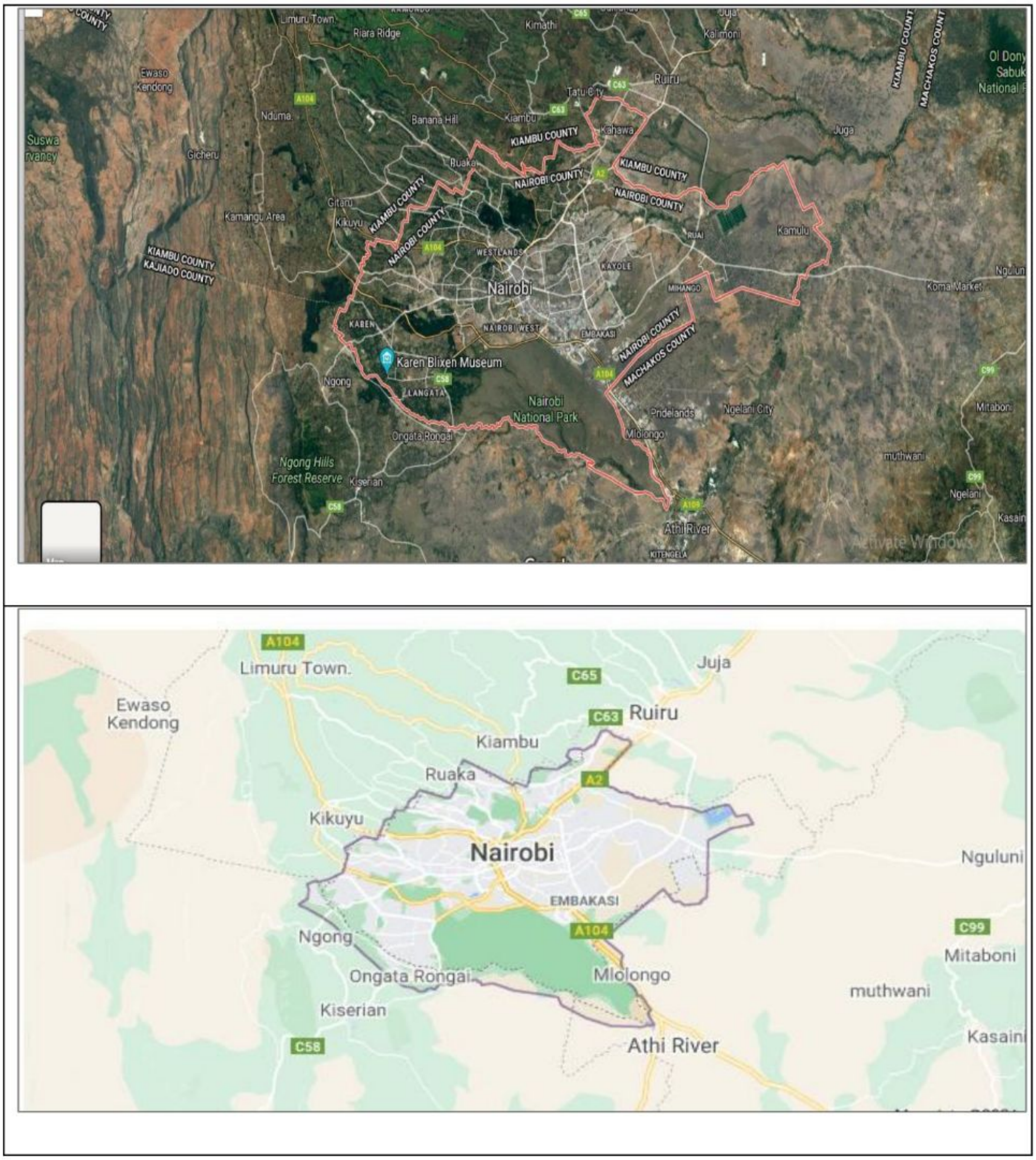
3.2.1 Location of Study

Kenya's capital city is Nairobi, which is situated 1.19° south of the Equator and 36.59° east of the meridian. It is situated at a height of 1661 meters above sea level and has a surface area of 684 square kilometres (260 square miles). According to the Government of Kenya (GoK, 2009), the city is situated at the southern - farthest extent of Kenya's agricultural region and shares borders with the Counties of Kiambu to the north, Kajiado to the south and west, and Machakos to the east.

Nairobi County was chosen for this study based on its reputation as Kenya's most vibrant and fast developing region. With a population of 4.735 million in 2020, Nairobi city - the largest metropolis in Kenya - dominates the region in the main. The city experiences a 4% yearly growth rate, which is driven by rural residents moving to the city in pursuit of employment.

According to the World Urbanization Prospects (2020), population growth is projected to persist, reaching six million people by 2025.

Map 1: Map of Nairobi County



Source: Google Maps, 2021

3.2.2 Area of Study

In Nairobi, efforts are being made to make commercial structures more ecologically friendly in order to use less energy. Nairobi is home to a number of green structures, including the UNEP headquarters, the Learning Resource Centre for Catholic University of East Africa, the Coca-Cola headquarters, and the Stanchart building. All of Kenya's green buildings, with the exception of one in Bomet County, are located in Nairobi, the country's primary commercial centre. The Pope Paul VI Resource Centre at Catholic University of East Africa, the Strathmore Business School, Coca-Cola East, the Central Africa Business Unit, and the UNEP Building Nairobi were among the green buildings in Nairobi County that were chosen for this study to serve as Kenya's green buildings.

3.2.3 Growth and Development

Nairobi was selected as the location for the Kenya-Uganda railway due to its advantageous features, including safety, climate, topography, and freshwater. In 1898, a city plan that featured shops, offices, staff housing, and train workshops was designed. The concept was built on racial segregation, with junior Indian employees living in the marshy areas and senior European railway officers living on the hill.

The Nairobi city plan recognized Africans as a race with legal status as residents in 1927. After that, the city was segmented into racial and socio-economic class-based zones. Upper Hill, Lavington, Milimani, and Riverside were all populated by Europeans. Westlands, Nairobi West, South B and C were all populated by Asians. Africans lived in the Eastlands during this time.

3.2.4 Population Growth

In recent decades, Nairobi's population has grown rapidly similar to other growing cities. According to his KNBS assessment in 2009, the city's population increased from about 800,000 in 1979 to 2,10,000 in 1999 and 3.1 million in 2009, at an annual rate of 4.7-4.8%.This growth rate exceeds both the global urban growth rate of 1.8% and the average growth rate for developing cities of 3.4%. Slums and illegal colonies have appeared in Nairobi as a result of the rise in the demand for inexpensive and sustainable housing. Nairobi was chosen as the research area because it is the national center for green building organizations and has the largest demand for green structures.

3.3 Research Methodology

The term "research methodology" refers to methodological and scientific techniques for compiling knowledge and data regarding a particular field of research. In-depth research conducted in logical order is research that constitutes a thorough and critical investigation of a particular subject. Data collection, sampling techniques and procedures, quantitative measures, and data evaluation are all part of the research process.

This study employs a number of variables to assess the implementation of eco-friendly construction techniques in Kenya. Independent variables include water efficiency, environmental quality, energy efficiency, materials, site selection and waste management. The use of green building techniques in Kenya is the dependent variable. In addition, mitigating factors such as regulations, funding, incentives and training associated with the incorporation of sustainable buildings in Kenya are also considered.

3.3.1 Research Design

Due to the dispersed target group, a descriptive survey methodology was chosen for the study. With the help of this strategy, the researcher was able to collect from the population both quantitative and qualitative data. While qualitative data offers insights that cannot be found by the use of only quantitative data, quantitative data is useful for testing hypotheses and comparing results. The research design acts as a road map that directs the researcher in solving the research challenge and giving the research process structure. The descriptive research design was utilized in this study to collect data from the respondents because it offers precise and useful information to address who, when, what, where, why, and how.

3.3.2 Population

3.3.2.1 Population of Relevance

A population, as per Mugenda & Mugenda (2003), is a collection of people, things, or events that exhibit similar observable traits. The entire set of phenomena is what a researcher seeks to analyse in order to make judgements about. Population is defined by Cooper and Schindler (2013) as the total number of research cases that satisfy a certain set of requirements.

Professionals and end users who play key roles in the delivery and maintenance of present and future green buildings made up the population for the purposes of this study. The individuals or groups from which the samples were drawn for the delivery of the questionnaires and interviews were chosen were identified as being these two groupings.

3.3.3 Sampling

In this study, sampling was done with the intention of gathering information from the two designated groups—professors and end users. Non-probability sampling was used, which entails the researcher choosing a sample based on particular criteria using their own discretion. Based on their expertise, roles, and responsibilities in green building technology, professionals and end users were chosen. The four buildings used for this study were Strathmore Business School, Coca-Cola East and Central Africa Business Unit, Catholic University of East Africa - Pope Paul VI Resource Centre, and UNEP Building Nairobi. From each building, particular respondents were picked to receive the surveys.

3.3.4 Sampling Techniques

3.3.4.1 Purposive Sampling

Purposive sampling, a type of non-probability sampling, was used as the sample strategy in this investigation. Purposive sampling, according to Cooper and Schindler (2013), is used to choose people based on their credentials or traits pertinent to the research issue. With this study's focus on green building technology, the researcher chose people with knowledge and experience in the field, including architects, engineers, property managers, and end users.

3.3.4.2 Random Sampling

Following the use of the purposive sample strategy to identify the important populations, the study used simple random sampling. A probability sampling technique called simple random sampling provides an equitable opportunity for every member of the population to be selected. By ensuring that the sample accurately reflects the population, this strategy makes the study's conclusions reliable (Lunsford & Lunsford, 1995).

3.3.5 Sampling Frame

The technique used to choose members of the target population who will take part in data collecting is known as the sample frame. It is a significant component that influences both the cost and quality of study results (Alvi, 2016).

3.3.5.1 Architects

In order to choose licensed architects to take part in the study, the researcher used a published record of active architects provided by the Board of Registration of Architects and Quantity Surveyors (BORAQS) Kenya. There were 1,069 licensed architects, and their addresses and phone numbers could be easily accessed. 13 architects were chosen for this study after the researcher utilized a formula for the general population to calculate the sample size. Section 3.4.6 contains further details.

3.3.5.2 Engineers

With the exception of using publications on active engineers as per the Engineers Board of Kenya (EBK), 2020, the process for selecting licensed engineers was comparable to that of picking architects. The researcher selected 13 engineers at random to participate in the study using a population of 2,135 licensed engineers from the EBK website, as described in section 3.4.6 below. To make contact easier, their addresses were taken from the EBK website.

3.3.5.3 Property Managers

The Estate Agents Registration Board (EARB), 2021, provided a list of licensed property managers. 440 licensed property managers were included in the population. The EARB website was used to generate a random list of property managers' responses, together with their addresses and phone numbers. According to the sample size calculation formula for a known population in section 3.4.6 below, 13 property managers were deemed suitable for the study survey.

3.3.5.4 End Users

Non-probability sampling was employed to choose end users because it was unknown who would make up their population. According to the American Marketing Association (2017),

the minimum sample size needed to accurately estimate proportions can be calculated by taking into account the average standard deviation set at a 95% confidence level (1.96), the percentage of respondents who chose a course of action (50%) and a confidence interval (0.05). 384 end users were chosen as respondents for this study based on these calculations, as described in section 3.4.6.

3.3.6 Sample Size Determination

The number of respondents who were a part of the study is referred to as the sample size. The sample size used affects the study's accuracy. Participants are typically indicated by the letter "n." Regardless of whether the population size is known or not, sample size can be calculated. The researcher is aware of the size of her population for architects, engineers, and property managers for this study. The sample size for each category was calculated using the formula below;

$$n = \frac{z^2pqN}{e^2(N-1)+ Z^2pq}$$ (Syagga, 2019)

Where;

n = sample size

z = standard deviation (1.645)

p = % target population assumed to have similar characteristics (say taken as 95%, the higher the %, the higher the reliability)

q = 1-p (0.05)

N= population size

e = confidence interval (margin of error (say, 0.1)

The researcher used the above formula to help determine her sample size as follows;

1. **<u>Architects</u>**

N= 1069

(Board of Registration of Architects and Quantity Surveyors (BORAQS) Kenya, 2021)

$$n = \frac{1.645^2 \text{ x } 0.95 \text{ x } 0.05 \text{ x } 1069}{0.1^2 \text{ x } (1069-1)+1.645^2 \text{ x } 0.95 \text{ x } 0.05}$$

n = 13

2. **Engineers**

N= 2135

(Engineers Board of Kenya (EBK), 2021)

$$n = \frac{1.645^2 \text{ x } 0.95 \text{ x } 0.05 \text{ x } 2135}{0.1^2 \text{ x } (2135-1)+1.645^2 \text{ x } 0.95 \text{ x } 0.05}$$

n = 13

3. **Property Managers**

N= 440

(Estate Agents Registration Board (EARB), 2021)

$$n = \frac{1.645^2 \text{ x } 0.95 \text{ x } 0.05 \text{ x } 440}{0.1^2 \text{ x } (440-1)+1.645^2 \text{ x } 0.95 \text{ x } 0.05}$$

n=13

4. **End Users**

$$n = \frac{Z^2*(p)*(1-p)}{C^2}$$ (American Marketing Association , 2017)

Where;

n = sample size

Z = 1.96, the standard normal deviate at the required confidence level of 95%

p = 0.5, percentage picking a choice, (expressed as a decimal)

c = 0.05, confidence interval (0.07= + 2)

Therefore,

$$n = \frac{1.96^2 \times 0.5 \times (1- 0.5)}{0.05^2}$$

n = 384

Total number of respondents =13+13+13+384

Total number of respondents = 423

Table 6: Sample Size

Category	**Target population**	**Sample size (40%)**
Architects	1069	13
Engineers	2135	13
Property Managers, Valuers, Estate Agents and Quantity Surveyors	2216	52
Project Managers	4400	40
Total		**118**

Source: Author's Construct, 2021

From the above calculations, 423 respondents were obtained to represent the entire target population.

3.4 Data Collection

According to Zikmund et al. (2010), data collecting tools are gadgets used in research to collect data. The three main approaches of gathering data are often questionnaires, interviews, and observational methods. The problem being studied, the amount of time and money available, and other considerations all have an impact on the choice of a suitable data collection strategy.

3.4.1 Secondary Data

A thorough examination of the existing literature was carried out by the researchers, who looked at books, scholarly publications, periodicals, journals, research papers from the past, as well as other published and unpublished works. In the literature review part, they carefully examined and presented all the pertinent data linked to the investigation

3.4.2 Primary Data

In this study, original data were obtained by personally interviewing sources like study participants or a field survey. The primary data were gathered using the following methods.

A questionnaire is a tool used in data collecting that is created by the investigator to effectively articulate envisioned purpose to the respondent and elicit the necessary empirical data to meet research goals, according to Mugenda & Mugenda (2003) and Zikmund et al. (2010). It can also be used to compile data about people's views, convictions, perceptions, and experiences. The format of a questionnaire can be designed to provide specific information, such as yes-or-no replies, brief responses, or item checking, or it can be left open-ended to elicit more detailed responses. In the institutions mentioned in this study, questionnaires pertaining to green building technology were distributed to experts and end users. These questionnaires contained both kinds of inquiries. The questionnaires were created to fulfil the research objectives, and open-ended questions were employed when more information was required.

3.4.2.1 Inspection check-list

To ascertain the degree of acceptance of green building technologies in the four (4) sampled buildings, an inspection check-list that describes sustainable building involving multiple factors from limited to comprehensive inclusion of the technologies was created.

3.4.2.2 Interviews

A way of delivering an oral questionnaire or an interview schedule is described as an interview by Mugenda & Mugenda (2003). To acquire thorough, descriptive narratives depicting population behavior, view themselves, or are seen by others, one-on-one interviews are conducted. To get the most cooperation possible from the responders, building a good rapport is essential (Miller and Salkind, 2002). In this instance, interviews served as one of the main sources of data.

The researchers employed chain-referral sampling or snowball sampling to speak with people who had a wider understanding of green building. In this non-probability sampling method, individuals with hard-to-find features are chosen, and those individuals are then asked to recommend other potential participants. The issues surrounding the implementation of eco-friendly construction practices in Kenya, the viability of such practices, and potential solutions to these issues were the main topics of the researchers' inquiries.

3.5 Data Analysis and Presentation

Descriptive data including mode, frequency distribution tables, and percentages were included in the analysis. Graphs, bars, tables, and other graphical elements were used to show the results. The descriptive data were also accompanied by explanations.

3.5.1 Statistical Analysis

By coding, editing, tabulating, and interpreting the data in light of the theoretical framework, the acquired data was studied. As recommended by Alreck & Settle (2007), a series of statistical methods were used to accomplish this goal by summarizing the data and highlighting crucial details and correlations. In this research project, Excel was expressly used to help with data analysis.

3.5.2 Comparative Technique

The study itself, which was utilized to examine the data gathered from questionnaires, interviews, and published works subjectively and qualitatively, served as the main source of support for the statistical analysis. Both parametric and non-parametric methods were employed for the comparison methods in this research investigation.

3.6 Data Validity, Reliability and Replicability

This study's expert interviews and inspection check-list served as the foundation for establishing the data's validity. A more extensive sample from the target population was used to increase reliability. The research instruments, such as the questionnaire, were also pretested to detect and revise any ambiguous, obstinate, or objectionable questions or practises, improving the validity of the data collected. In addition, only four fully operational and accredited green buildings were chosen for the sample population, resulting in enhanced homogeneity and data dependability. In light of these factors, other researchers in Kenya and elsewhere can replicate this research study using valid and reliable data.

3.7 Data Needs Matrix

The aims of this study's research guided the data requirements. The data needs matrix, shown in the table below, gives a general overview of the system the researcher utilized to gather, organize, and present data. Each objectives statistics, data sources, indications, data collection tools, significant informants, and unit of measurement are succinctly listed.

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND PRESENTATION

4.1 Introduction

This section offers an examination of data collected from respondents using structured and unstructured questions described in this chapter. Unstructured questions provided qualitative data, whereas structured questions were utilized to produce statistical data. Quantitative data were examined employing descriptive statistical analysis and are presented in tables and figures. Qualitative data were subjected to textual analysis. All study discussions, conclusions, interpretation of results, and commendations are in accordance with the findings of data analysis. Through the results of the field survey, the section: -, the section attempted to accomplish the research goals. Each of the following goals is related to the findings in this chapter: -

Key Objective

The key objective of this study is to investigate the adoption of green building technologies in Kenya.

Specific Objectives

1) To determine the extent of the adoption of green building technologies in Kenya.
2) To establish the challenges and constraints facing the adoption of green building technologies in Kenya.
3) To determine the level of awareness of green building technologies by players in the construction industry in Kenya.
4) To recommend appropriate mechanisms for enhancing green building technologies in Kenya.

4.2 Response Rate

The research utilized a random sampling method to distribute questionnaires to various professionals in the built environment who participated in the implementation of eco-friendly building technologies. These professionals belonged to different disciplines, such as Engineering, Architecture, Quantity Surveying, Project Management, Property Management,

and other related fields. The targeted population was chosen indiscriminately, and the questionnaires were allocated based on this selection. As per Mugenda & Mugenda (2008), a response rate of 50% is appropriate for data analysis and reporting, while a response rate of 60% is reasonable, and a response rate of 70% is great. The field survey revealed that Property Management (34%) had the highest representation, followed by Project Management (25%), Engineering (18%), Architecture (10%), Quantity Surveying (7%), Valuation (3%), and Estate Agency (1%).

Table 7: Response Rate Analysis of Questionnaires Administered

Sample Categories	Respondents	Response	Percentage Response
Property Management, Estate Agency, Valuation, Quantity Surveying	52	31	59.6%
Project Management	40	17	42.5%
Engineering	13	12	92.3%
Architecture	13	7	53.8%
TOTAL	**118**	**67**	**56.8%**

Source: Field Survey, 2021

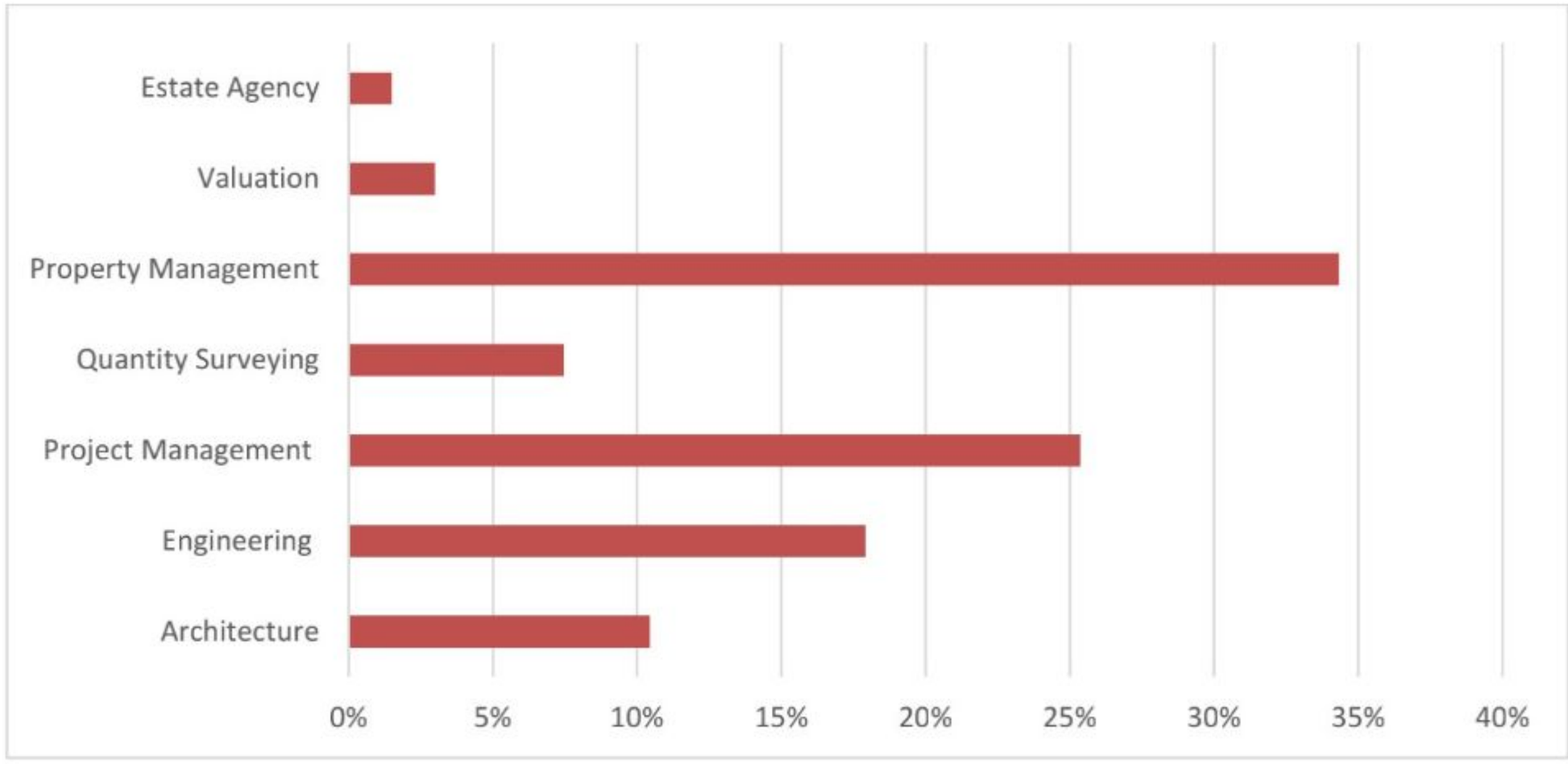
4.3 Section 1: General Information

In this section, we present the overall information about the questionnaires that were administered to investigate the implementation of sustainable building technologies (SBTs). Specifically, we provide details on the professional backgrounds of the respondents.

4.3.1 Professional Orientation of the Respondents

The outcomes obtained from the field survey reveal that most of the participants were from the following professions: Property Management (34%), Project Management (25%), Engineering (18%), Architecture (10%), Quantity Surveying (7%), Valuation (3%), and Estate Agency (1%).

Figure 2: Professional Orientation

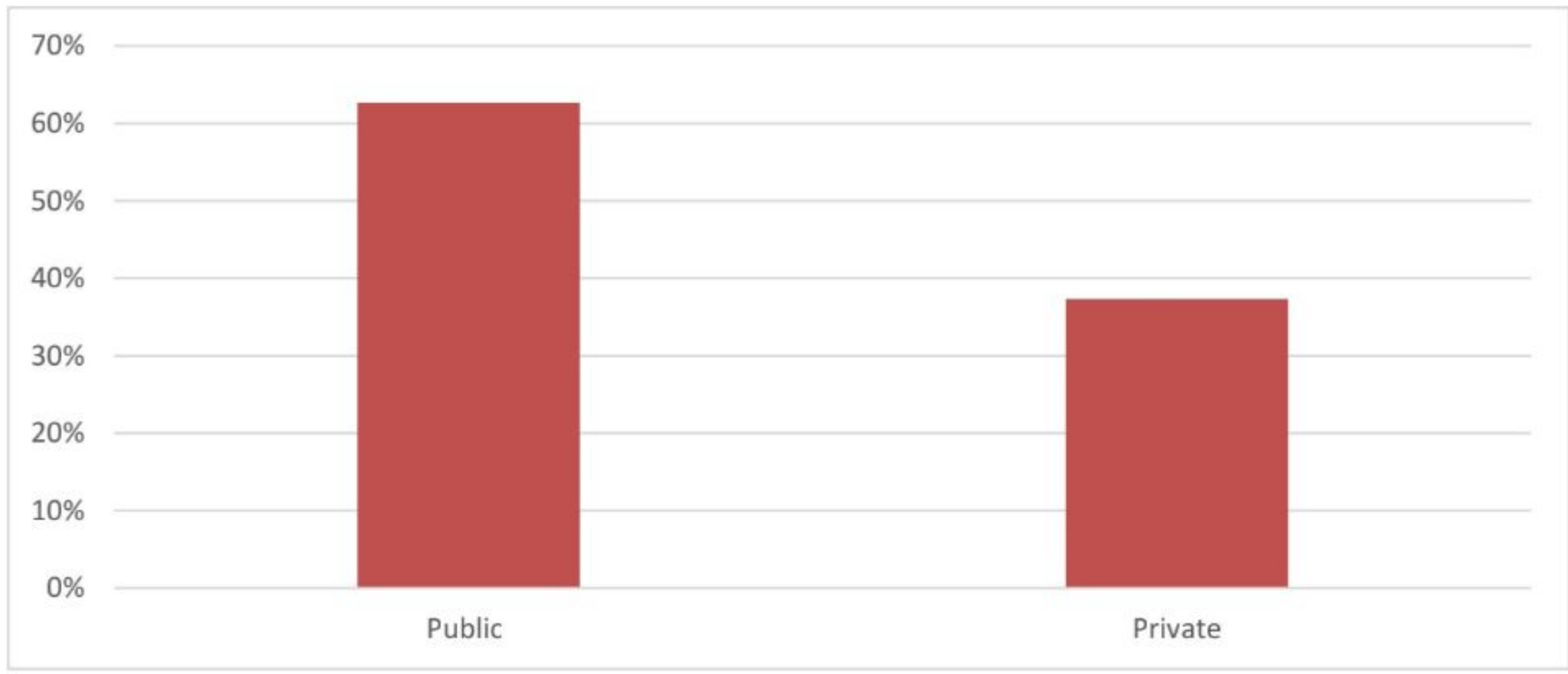


Source: Field Survey, 2021

4.3.2 Sector of Professional Orientation of the Respondents

The findings obtained from the field survey reveal that majority of the participants were from the following professions: Property Management (34%), Project Management (25%), Engineering (18%), Architecture (10%), Quantity Surveying (7%), Valuation (3%), and Estate Agency (1%).

Figure 3: Sector of Professional Orientation

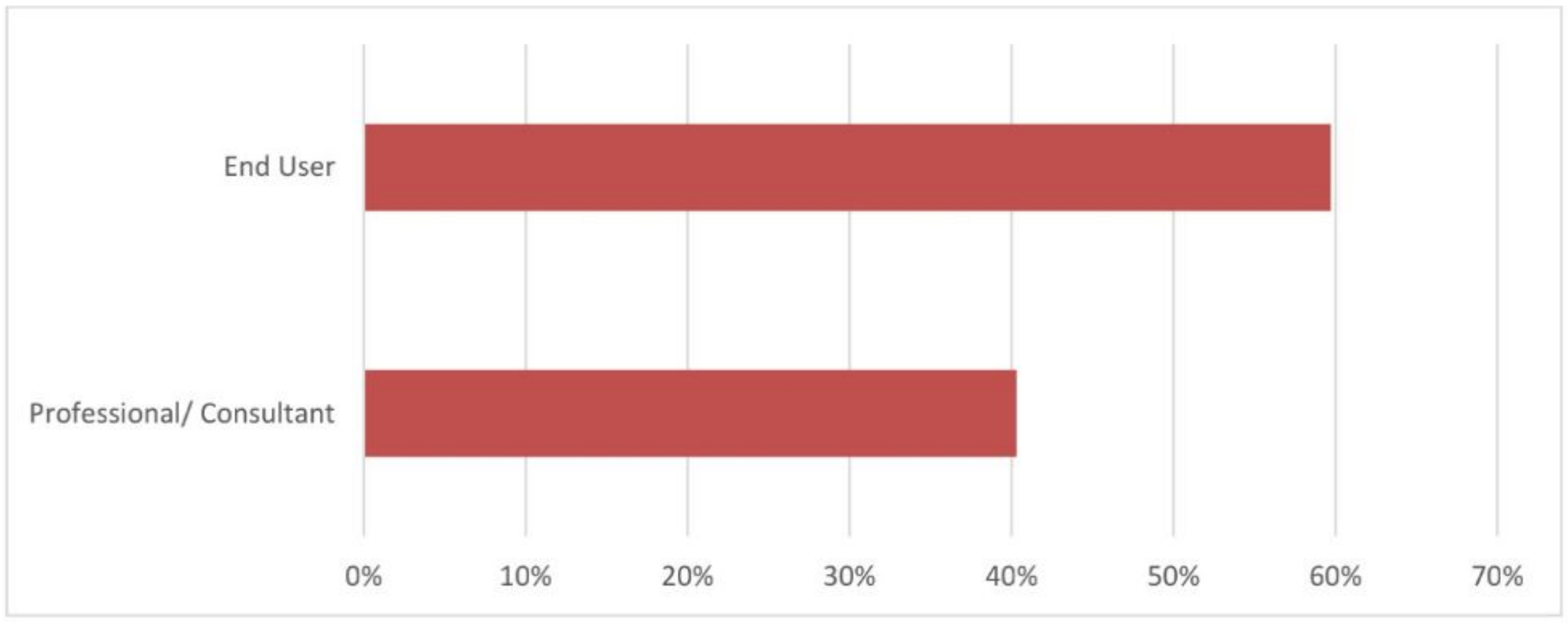


Source: Field Survey, 2021

4.3.3 Role of the Respondents in Green Building

The research findings defined themselves as follows; end-users 60% and professionals or consultants 40%, respectively.

Figure 4: Role in Green Building

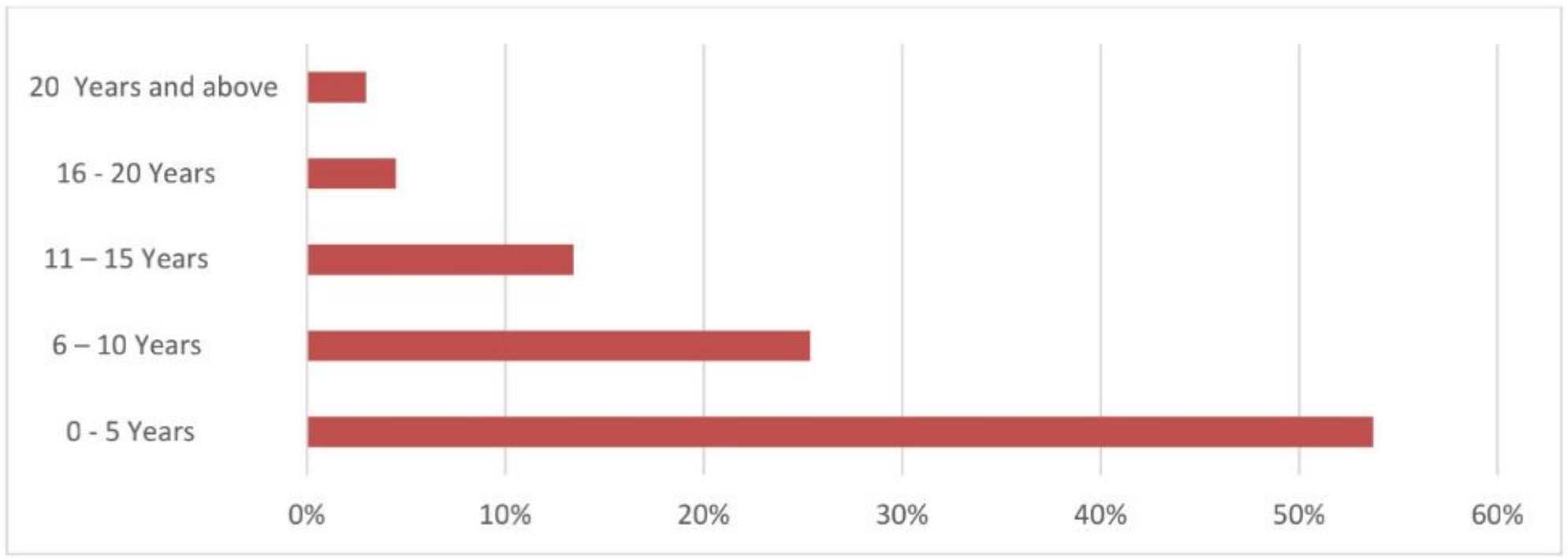


Source: Field Survey, 2021

4.3.4 Experience in dealing with Green Building Technologies by the Respondents

In grading the experience in dealing with environmentally-friendly construction methods by the respondents, the research findings were tabulated as follows; 54% 0 – 5 Years, 25% 6 – 10 years, 14% 11 – 15 years, 4% 16 -20 years, and 3% 20 years and above respectively.

Figure 5: Experience in dealing with Green Building Technologies

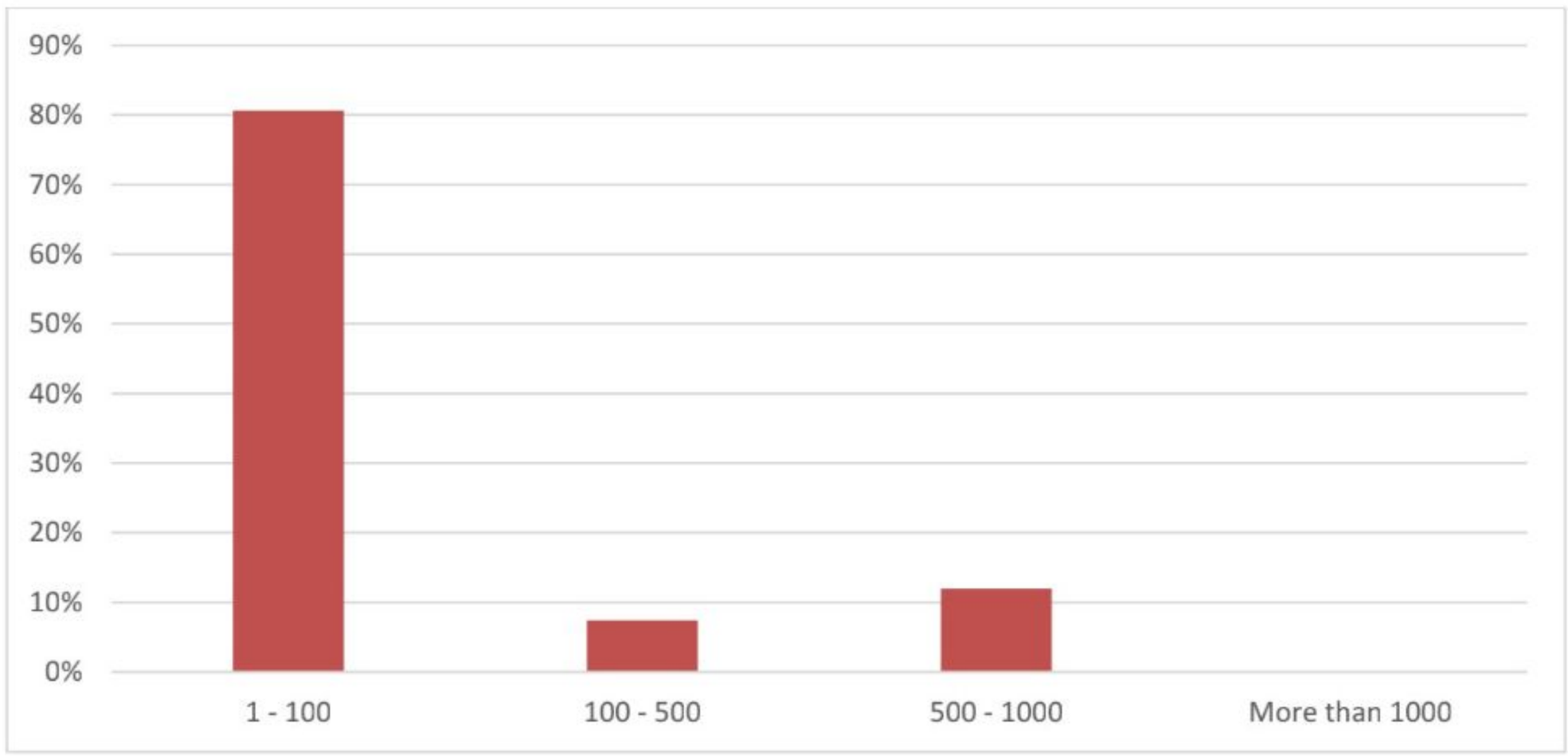


Source: Field Survey, 2021

4.3.5 Number of Building Projects put up by your Company/ Institution in the Last Three (3) Years

According to the research's findings, the respondent's organization or institution had the following number of building projects in the last three years: 80% between 1 and 100 projects, 8% between 100 and 500 projects, and 12% between 500 and 1000 projects. None of the respondents' institutions or businesses had submitted more than a thousand projects.

Figure 6: Number of Building Projects put up by your Company/ Institution in the Last Three (3) Years

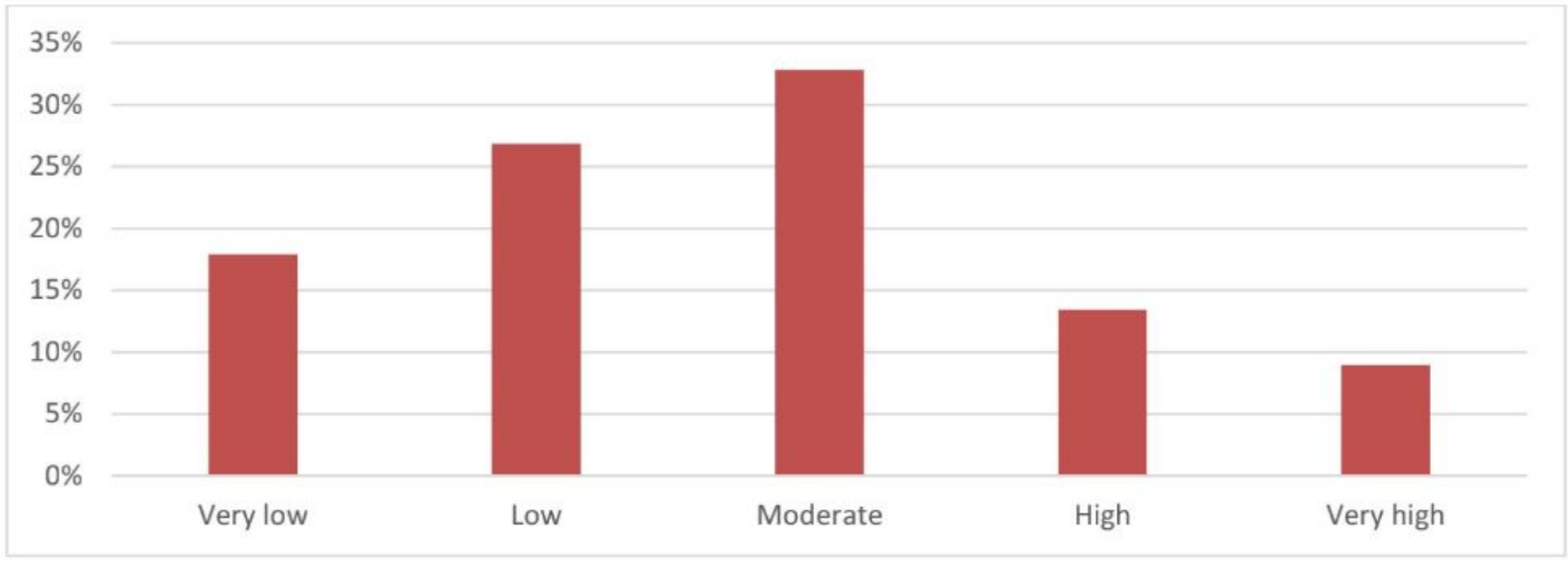


Source: Field Survey, 2021

4.3.6 Extent of Adoption of Green Building Technologies

The survey discovered the following, as indicated in the chart below, when attempting to assess the level of implementation of sustainable building practices: 17% deficient, 27% low, 33% moderate, 13% high, and 9% extremely high.

Figure 7: Extent of Adoption of Green Building Technologies

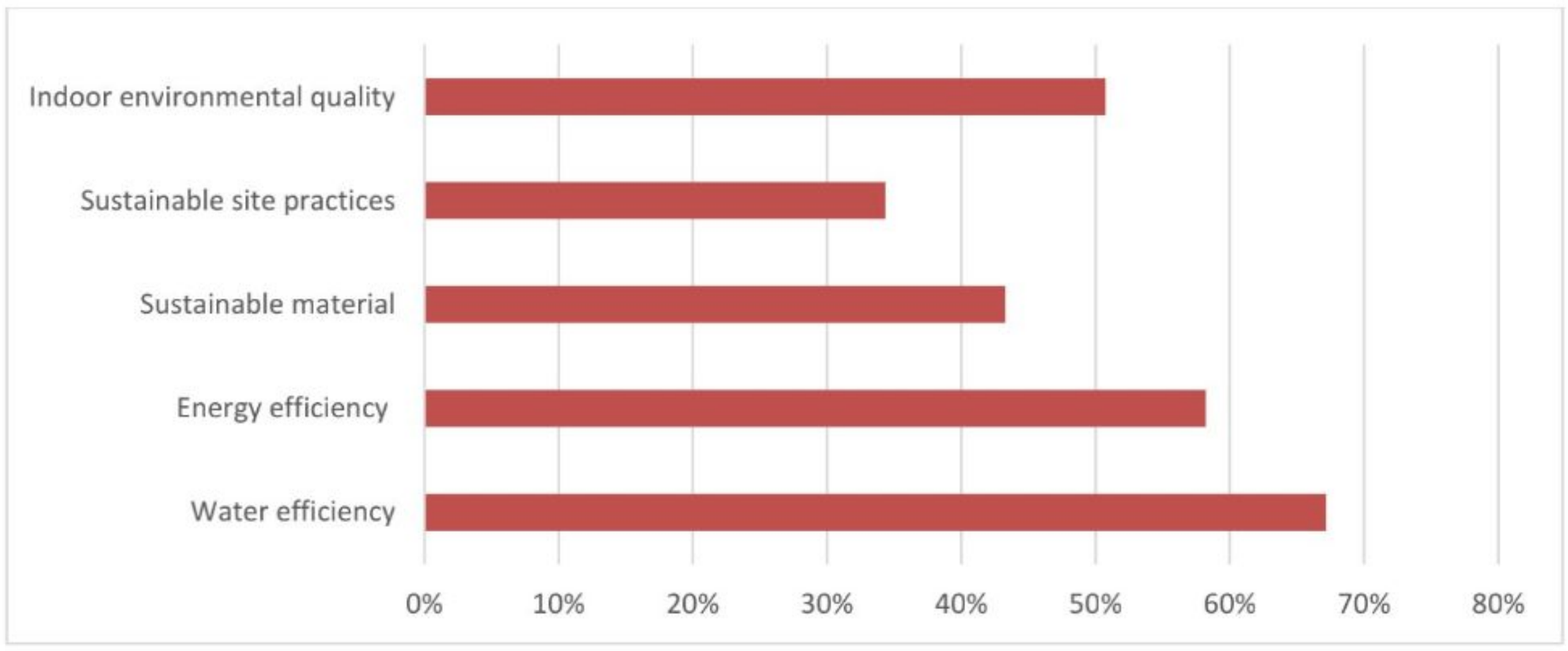


Source: Field Survey, 2021

4.3.7 Awareness of Green Building Concepts and Technologies

The goal of the investigation was to ascertain the respondents' level of familiarity with green building theories and practices. According to the graph below, interior environmental quality, energy efficiency, and undersea efficiency all received above-average popularity ratings of 50%, with 66%, 58%, and 52%, respectively. Green building approaches under sustainable materials and site practices, on the other hand, were less well-liked, receiving only 44% and 34%, respectively, of the replies.

Figure 8: Awareness of Green Building Concepts and Technologies



Source: Field Survey, 2021

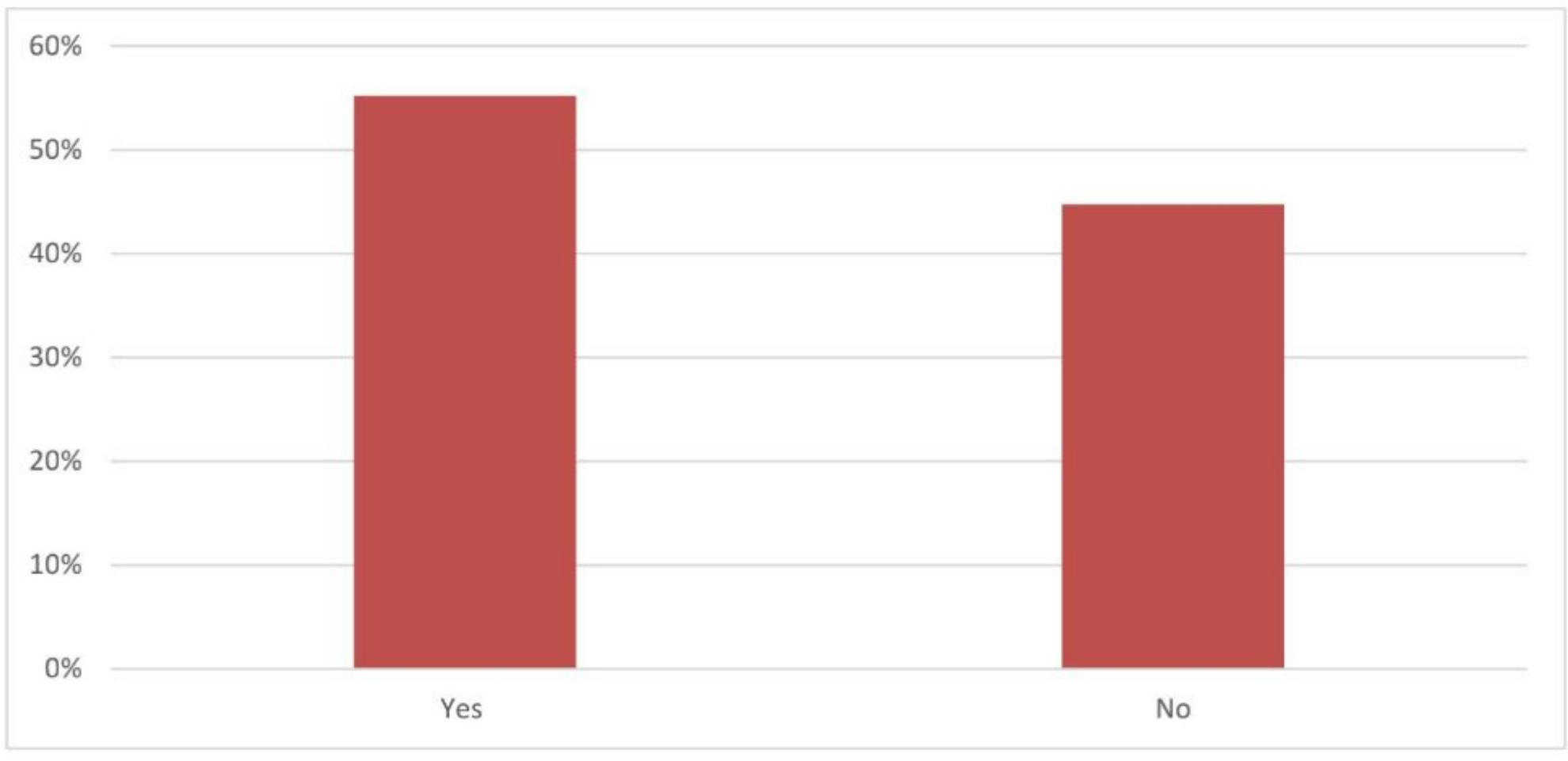
4.4 Section 2: Adoption of Green Building Technologies (GBTs)

According to the questionnaire that is linked to the appendices and serves as a guide, this section presents the opinions, attitudes, and perceptions of professionals regarding the utilization of eco-conscious construction methods.

4.4.1 Incorporation of Green Building Concepts and Technologies in Projects over the Last Ten (10) Years

The data results show that 55% of respondents agreed that they have used green building concepts and technology in their projects over the previous ten (10) years, whereas 45% disagreed as analysed in the table below.

Figure 9: Incorporation of Green Building Concepts and Technologies in Projects over the Last Ten (10) Years



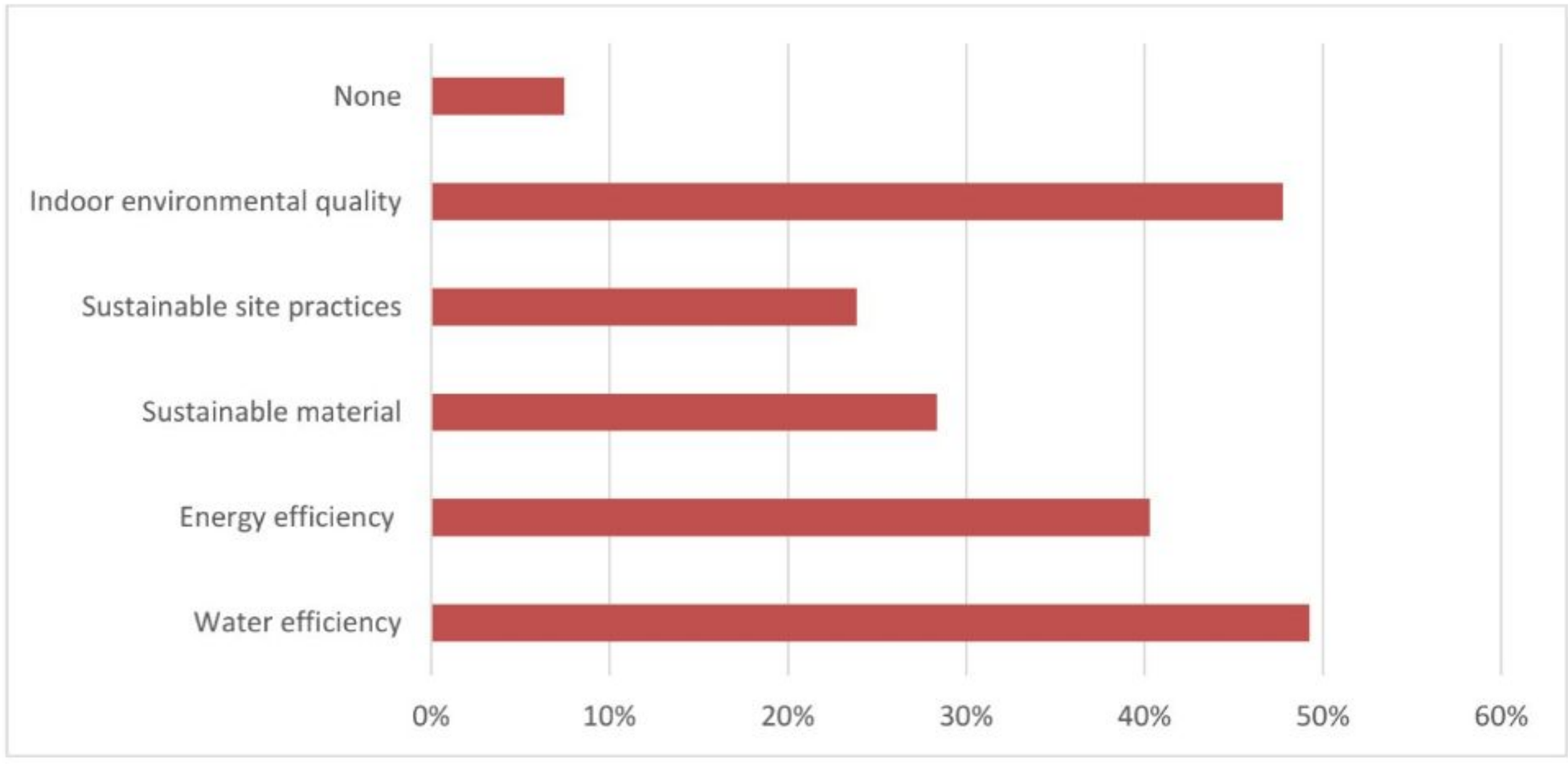
Source: Field Survey, 2021

4.4.2 Green Building Concepts and Technologies Applied in Projects

The purpose of the study was to determine how green construction ideas and technology were used by the respondents in their projects. According to the graph below, indoor environmental quality, energy efficiency, and undersea efficiency were the green building technologies used the most frequently, with 48%, 40%, and 46% of the total votes. On the other hand, the frequency of green building technologies under sustainable materials and sustainable site

practices was low, with 27% and 24%, respectively, of the replies obtained falling below the 50% mark. Furthermore, 7% of the respondents said they did not use green building techniques in all of the areas offered.

Figure 10: Green Building Concepts and Technologies Applied in Projects

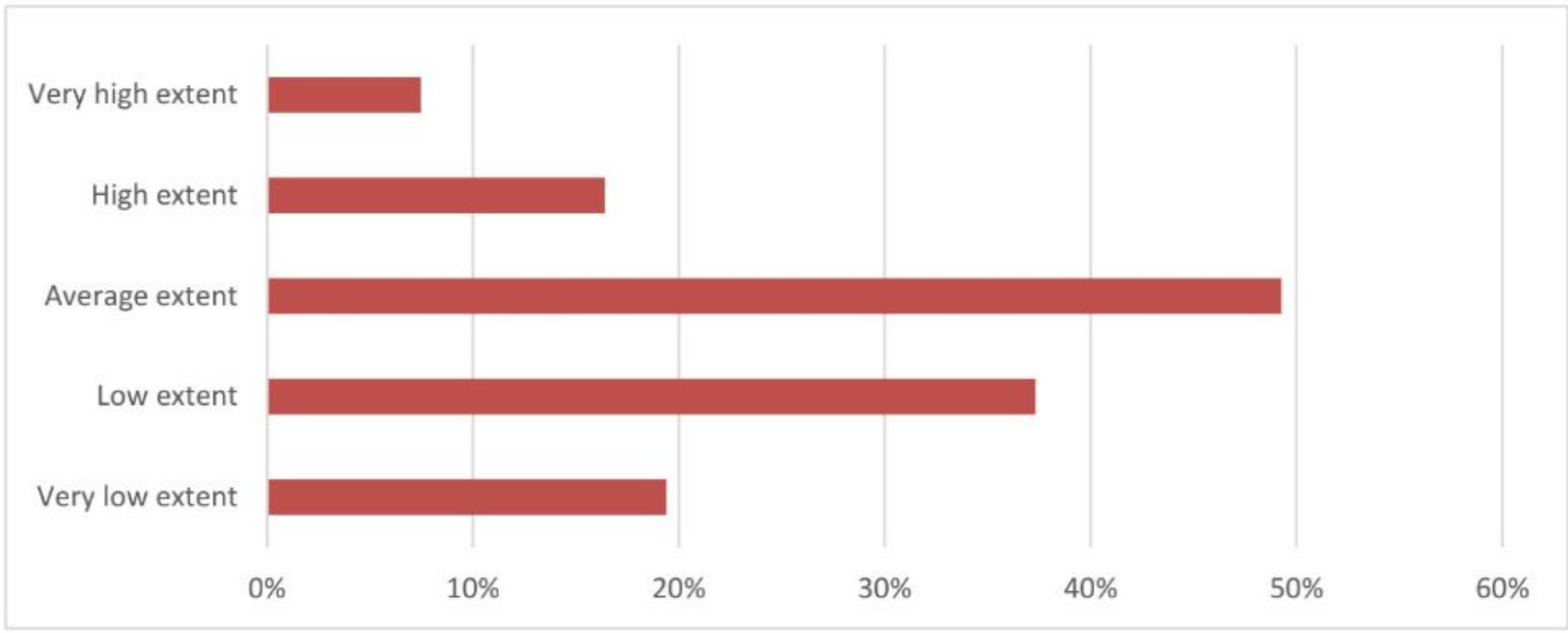


Source: Field Survey, 2021

4.4.3 Extent of Incorporation of Green Building Concepts Categories in Projects

The amount of incorporating building principles in projects was graded as follows based on the findings, as shown in the chart below: 18% shallow extent, 36% low extent, 48% average extent, 16% great extent, and 7% very great extent, respectively.

Figure 11: Extent of Incorporation of Green Building Concepts Categories in Projects

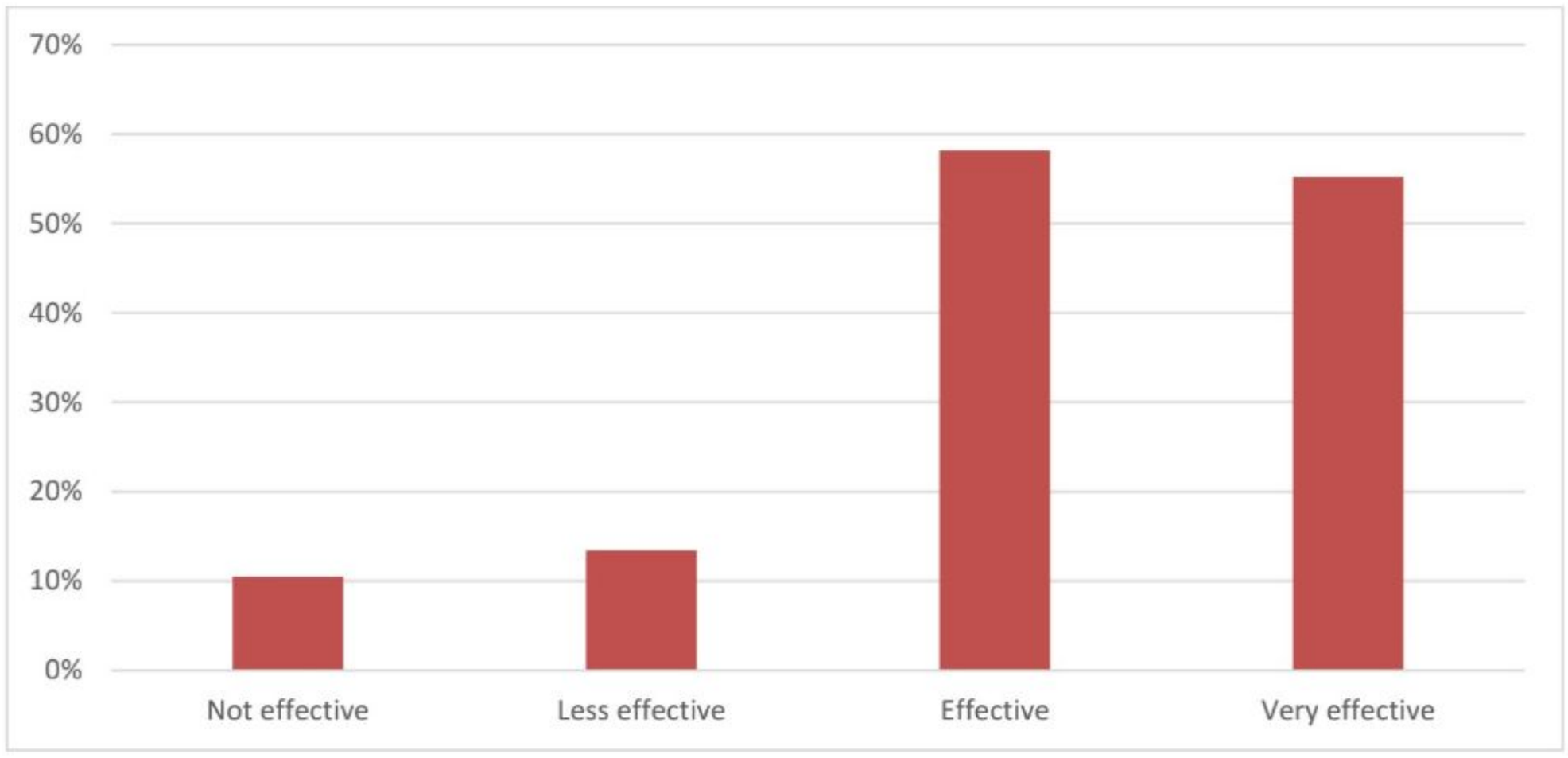


Source: Field Survey, 2021

4.4.4 Level of Effectiveness of the Green Building Technologies

The effectiveness of green building technologies was judged as follows from the field survey, as shown in the chart below: 10% not effective, 12% less practical, 58% effective, and 56% highly effective, respectively.

Figure 12: Level of Effectiveness of the Green Building Technologies

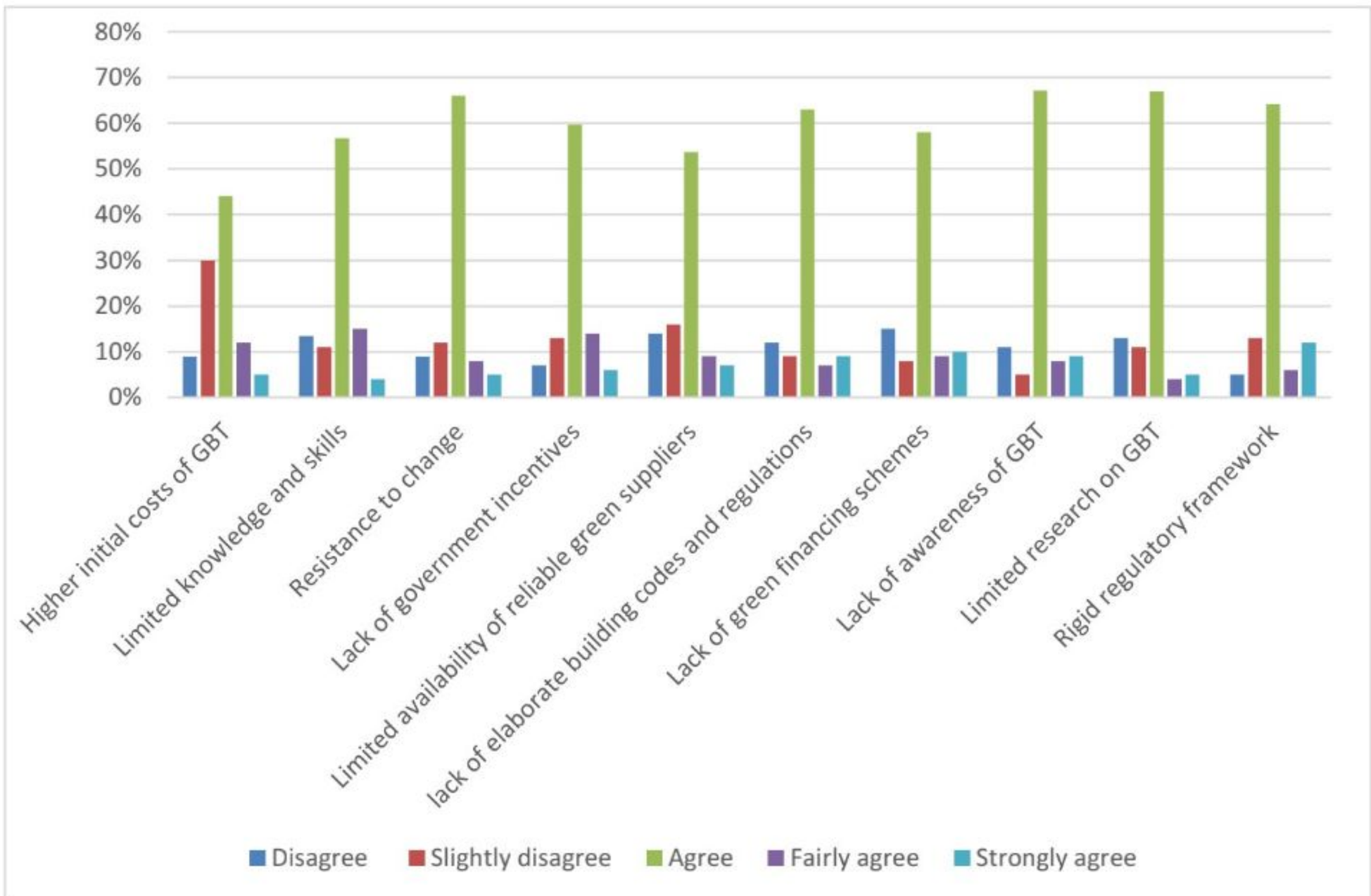


Source: Field Survey, 2021

4.4.5 Challenges and Constraints of Green Building Technologies (GBTs)

According to the study's conclusions, there are a number of difficulties that green building technology must overcome. The respondents agreed that GBTs have higher initial costs (42%), limited knowledge and skills on GBTs (58%), reluctance to adopt (66%), absence of government incentives (60%), insufficient reputable green suppliers in Kenya (62%), absence of elaborate construction standards guiding on green building (64%), absence of green financial arrangements (48%), limited knowledge of GBTs (58%), limited research on GBTs (56%) and rigid regulatory framework.

Figure 13: Challenges and Constraints of Green Building Technologies (GBTs)



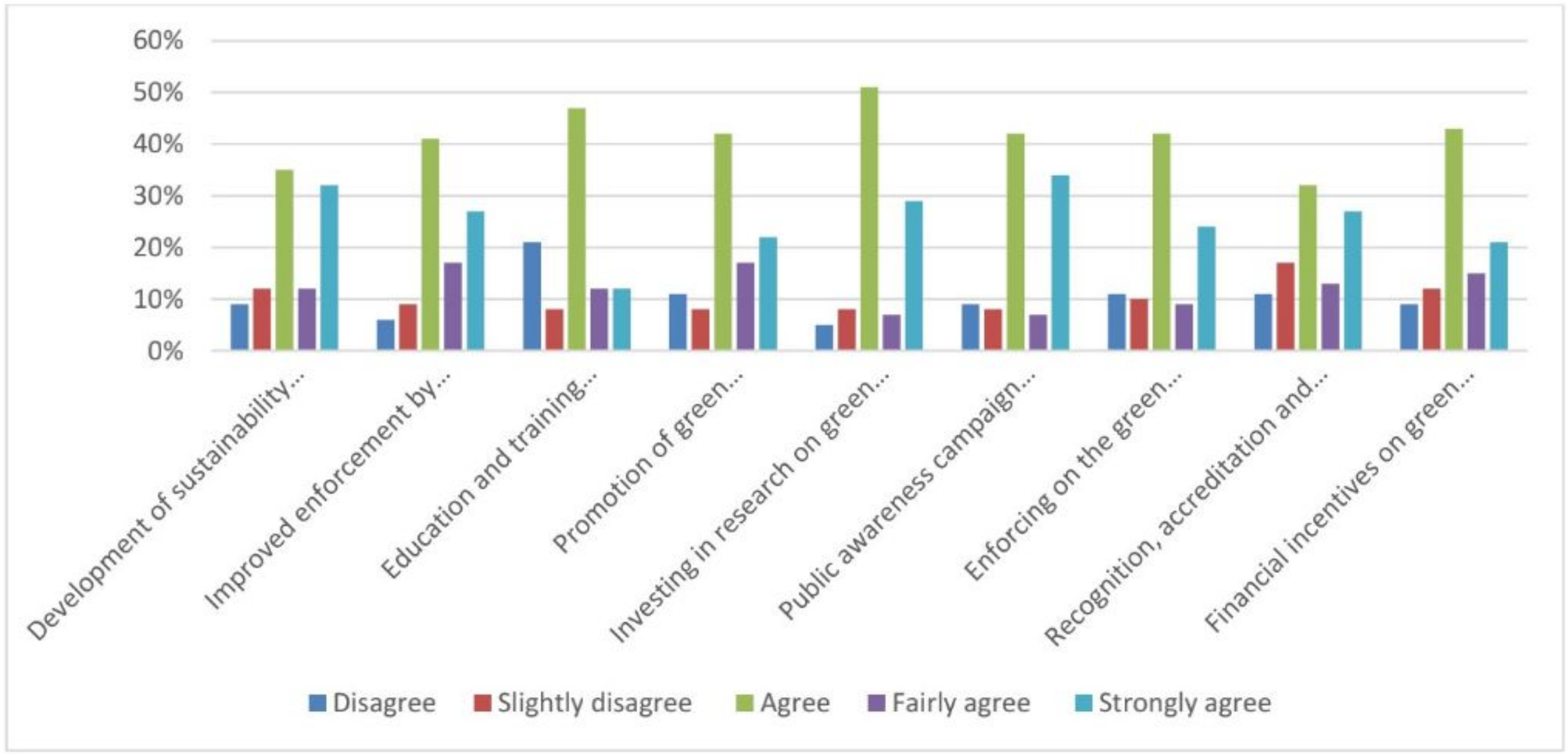
Source: Field Survey, 2021

4.4.6 Mechanisms of Enhancing the Adoption of Green Building Technologies in Kenya

The chart below summarizes the suggestions provided regarding ways to advance green building technology in Kenya as expressed by the respondents. The following results were tallied: creation of a sustainability check-list and improved enforcement by governing authorities (agree - 35%); education, research, and training on GBTs (moderately agree - 40%);

promotion of green procurement (moderately agree - 46%); public awareness campaign on GBTs (agree - 40%); enforcement of GBTs related legislation (agree - 42%); financial incentives on GBTs (agree - 32%); and Other measures mentioned included upgrading the legal framework governing green building technology, increasing public awareness through seminars, community groups, and education, passing legislation on green building, and zoning regulations to support green buildings.

Figure 14: Mechanisms of Enhancing the Adoption of Green Building Technologies in Kenya



Source: Field Survey, 2021

4.5 Section 3: Content Analysis End Users', Key Informants and Researcher's Observations Perspectives

According to interview questions and an inspection check-list that are attached as appendices, this section presents the thoughts, attitudes, and perceptions of key informant respondents, end-users of green buildings, and other stakeholders, as well as observations regarding the incorporation of eco-friendly construction methods.

4.5.1 Registration Green Building Projects

Three rating techniques are used in Kenya to register, accredit, and certify green buildings and projects, according to a field study of key informants conducted by the Kenya Green Building

Society (KGBS). These rating systems included Green Star, EDGE, and LEED for Kenya. The projects that were registered, accredited, and certified for each tool as of the time of data collection were tabulated as shown below.

Table 8: Kenyan-LEED, EDGE, and Green Star Registered Projects

USGBC LEED	**Green Star**	**EDGE**
Skynet	Garden City Residential Phase 1	Delta Centre – World Bank Group Office Nairobi
Forests capes	Garden City Residential Phase 2A	Executive Residency by Best Western Nairobi
Capital - M Apartments	Garden City Residential Phase 2B	ALP North
Nairobi Towers – Hotel	Dunhill Towers	ALP West
Nairobi Towers – Commercial	SABIS International School	Aashiana
Wrigley Nairobi Confection		The promenade
Lumen Square		Qwetu – Parklands
Vienna Court		Qwetu - Wilson View
Garden City Retail		
Ascot (Block F)		
Eaton Place		
Citibank Gigiri Branch and COB		
World Bank Group-Delta Centre		
Design/Build/Con. JKIA Greenfield Terminal		
Leadership Centre		
Campus Diplomatique Francais Nairobi		
The Grove Ltd		
Al Jamea Tus Saifiyah, Nairobi		

Newmarket-Aintree Block D-E		
Strathmore University Phase III		

Source: Field Survey, 2021

4.5.2 Findings and Discussions

Green buildings are built with the goal of using sustainable and eco-friendly materials, using less energy, and using less water. The updated guidelines cover a range of topics including building site sustainability, sustainable water usage, energy conservation, the use of construction components, interior environmental health, progressive approaches, operation, and maintenance. When determining a structure's green rating, it's essential to consider factors like land use, ecological impact, emission levels, and sewage waste management in addition to energy efficiency.

4.5.2.1 Efficiency Measures for Green Buildings

4.5.2.1.1 Energy Efficiency Measures

The EDGE standard consists of three main resource categories, one of which deals with energy efficiency. To obtain certification, the design and construction team must adhere to specific criteria for various measures, including the ratio of windows to walls, reflective roofing and exterior walls, external shading structures, roof thermal protection and outer facades, the effectiveness of glass, ventilation control, fresh air circulation, ceiling fans, efficiency of cooling systems, use of variable speed drives, implementation of a fresh air pre-conditioning system, efficiency of space heating systems, utilization of room heating controls with thermostatic valves, efficiency of DHW systems, implementation of demand control ventilation utilizing CO_2 sensors, use of efficient lighting for internal and external areas, installation of skylights, insulation for cold storage envelopes, use of an efficient refrigerator/freezer, installation of sub-meters for heating and/or cooling systems, implementation of automated energy measurement systems, utilization of onsite sustainable energy, purchasing renewable energy from external sources, and implementation of carbon offsets, among other measures.

4.5.2.1.2 Water Efficiency Measures

A number of actions must be taken, including the installation of water-efficient shower heads, facets, urinals, and toilets in both private and public restrooms, in order to assure water efficiency. Bidets, facets, dishwashers, washing machines, and pre-rinse spray valves for kitchens are a few other methods. Pool covers, water-wise irrigation systems for landscaping, rainwater collection systems, sustainable water treatment and reuse systems, condensation water capture systems, and automated water meters should also be used.

4.5.2.1.3 Materials Efficiency Measures

A list of pertinent specifications for each building component, including roofs, external and interior walls, and floor finishes, among others, should be chosen from a drop-down list in the Materials section. The prevailing standard should be selected for each building component, and Thicknesses for the external and interior walls, roof construction, and floor slabs must be specified. This encourages the effective use of resources and ensures sustainability.

4.5.2.2 Legislation Guiding Green Building

Public buildings in Kenya are designed and built by the State Department for Public Works, and in 2013 a draft policy on green building standards was created. It may be approved in 2015. By offering subsidies and precise instructions, the program encourages the business sector to support green building. Additionally, as part of a four-year effort to advance sustainable energy practices in structures in East Africa, the United Nations Human Settlement Programme (UN-Habitat) has been collaborating with the Architectural Association of Kenya and other organizations since 2011.

4.5.2.3 Challenges facing Adoption of Green Building Technologies

Integration of eco-friendly construction is impeded by multiple factors in Kenya, Africa, and beyond. These difficulties include the fact that major players in the construction industry do not prioritize green building standards, that the private sector is slow to comply with green building standards, that materials meeting green building standards are expensive, that equipment for generating renewable energy is taxed, that climatic data is out-of-date and unreliable, and that local building materials are not evaluated for their suitability as green building materials.

4.5.2.4 Recommendations for Enhancing Adoption of Green Building Technologies

The formation of a sustainability check-list, improved governmental enforcement, education, research, and training on green building technologies, promotion of green procurement, public awareness campaigns, enforcement of laws relating to green building technologies, financial incentives, and recognition, accreditation, and certification of eco-friendly construction projects are among the recommendations made to increase the adoption of these technologies. The legal framework should be strengthened, public awareness raised through seminars, community organizations, and education, green buildings should be included in zoning laws, legislation on green building should be passed, and government subsidies and tax breaks should be offered.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Introduction

Conclusions and recommendations are informed by an analysis of the study's key findings from the previous Chapter. The purpose of the research project "**To Investigate the Adoption of Green Building Technologies in Kenya**" was to:

a) To determine the extent of the adoption of green building technologies in Kenya.
b) To establish the challenges and constraints facing the adoption of green building technologies in Kenya.
c) To determine the level of awareness of green building technologies by players in the construction industry in Kenya.
d) To recommend appropriate mechanisms for enhancing green building technologies in Kenya.

5.2 Summary of Research Findings

The components of adopting green building technology were divided into governance- and operational-management-related components for analysis. Legal framework, policy or strategy, and financing were seen to be aspects of governance, whereas management and maintenance, culture, and the calibre of eco-friendly construction technologies were considered to be aspects of operational management. Additionally, a description of the obstacles and limitations to the implementation of sustainable building practices was made.

5.2.1 Governance of Green Building Technologies Adoption

5.2.1.1 Policy or Strategy guiding on the Adoption of Green Building Technologies

A report that emphasizes the need for a clear direction and efficient implementation of eco-conscious building guidelines has called attention to the lack of a particular government strategy for green construction in Kenya. Although the closest piece of legislation governing green building, the Kenyan Constitution, recognizes citizens' rights to a healthy and clean environment, inclusive and sufficient housing, and a sound standard of hygiene, these

principles have not been adequately communicated to county governments. The nation's transition to an inclusive green economy is hampered by this lack of knowledge or adherence to the concepts. Therefore, it is essential to review these standards and encourage green construction and maintenance in Kenya. This is reflected in the nations in order to hasten the move to a low-carbon footprint, the National Climate Change mitigation and the the plan for implementing the environmentally responsible economy strategy 2016–2030 both have as their goals based on inclusive green economic growth.

5.2.1.2 Legal Framework for Green Building Technologies

Implementation of sustainable construction practices is not governed by legislation in the same way that policy is. Even if there aren't any clear legislation in Kenya governing sustainable construction and maintenance, it seems that the ideas and laws can still help, albeit weakly. The problem is that they hardly address the financial issue, which needs to be regulated for sustainability. Once more, there is the problem of carrying out current regulations

5.2.1.3 Finance structure for Green Building

The study finds that the only readily available source of funding for implementing green building technologies is private investment. Unfortunately, the high expense of acquiring, setting up, and maintaining these technologies has made this challenging for developers. The main responders said that laws governing complex finance was required. Additionally, it was claimed that Public-Private Partnerships (PPPs) were essential for attaining green building. Furthermore, it is specifically specified that the government must offer incentives to companies or individuals who adopt green construction technologies in their projects and green procurement.

5.2.2 Operational Management of Green Building Technologies

5.2.2.1 Management and Maintenance of Green Building Technologies

Green buildings were thought to be odd, thus in order to maintain the environmentally conscious construction achieved via the application of environmentally conscious technology in developments, it was necessary to employ unusual management and maintenance methods.

Achieving the green concept required professional capacity building for specialists including property managers and building surveyors.

Unique design elements in green buildings ensure efficient use of water and energy resources. By utilizing a task lighting approach and lots of natural light, sustainable buildings, for example, significantly cut down on power consumption required in lighting systems, allowing a one-third reduction in energy usage on their water and energy expenditures. Because operation and upkeep expenses amount to as much as 80% of a structure's lifespan costs, they have a substantial impact on the revenue of building owners who receive rent from their buildings. The upfront investment in sustainable buildings is greater to construct than their non-green counterparts, but in the long term they are less expensive due to lower running and maintenance costs.

5.2.2.2 Culture for Green Building Technologies

The study examined the uptake of sustainable construction practices in both newly constructed and older buildings. It has shown up in the types of repairs made, how frequently faults are checked for, how quickly complaints from tenants are addressed, and whether or not there are any minimal green building criteria in place.

According to the report, actors and stakeholders in the built environment are not being responsive. Lack of experts with the requisite skills and education, as well as a shortage of professionals who are knowledgeable about green building practices, can all be factors in the absence of a green culture. The poor culture may also be explained by frustrations brought on by a lack of maintenance funds and a lack of clear management and maintenance procedures.

5.2.2.3 Quality of Green Building Technologies

The term "green building quality" refers to structures that are constructed and maintained in accordance with predetermined standards. According to the assessment, the majority of structures did not adhere to the fundamental guidelines for green building. Few existing green structures were also being properly maintained. Even the certified or accredited green buildings were only fully green to a certain extent because they only addressed a few categories, such as water and energy-saving practices, environmentally conscious materials, eco-conscious site management, and interior air conditions, as opposed to doing so thoroughly.

5.2.3 Summary of Challenges and Constraints

This section discusses potential solutions to the issues and restrictions related to the incorporation of eco-friendly construction methods in Kenya. The earlier chapters have demonstrated that these problems have a detrimental effect on the use of green building technology. First off, Kenya has few legal and administrative regulations pertaining to green building practices. Developing nations like Kenya must create green building policies and regulations even though the usage of green building technologies varies greatly between affluent and developing nations. Second, there is uncertainty and inefficiency due to the vagueness of the management and maintenance framework for green building systems. It would be more beneficial to create instructions that would help with green management. Thirdly, Kenyan building professionals lack the knowledge, skills, and experience necessary to deal with green building technologies. Building professional competence is essential for spreading knowledge of green construction techniques. Fourth, a significant problem is the lack of a long-term funding source for the purchase, installation, and upkeep of green building technology. In order to remedy this, the government should offer rewards to businesses or individuals who incorporate green building practices into their endeavours. Fifth, neither professionals nor end users are knowledgeable about green building technology. Enhancing accountability, improving financial control, and reducing bureaucracy all depend on public engagement. Structures that facilitate public interaction must be put in place, and they may be specified in laws or regulations.

5.3 Conclusions of the Study

It is impossible to stress how crucial sustainable building technology is to the advancement of the idea of sustainable building. Despite this, those involved in the built environment have attacked the idea of sustainable building and blamed it on management, care, and governance. The limitations of green construction technology in Kenya were the subject of this investigation.

The study's conclusions indicate that governance is woven within the framework of legislation and regulations. The implementation of sustainable building technologies was split into two groups in the study. These groups included elements relating to operational management and governance. Legal framework, policy or strategy, and financing made up the governance components, whilst operational management components included management and

maintenance, culture, and the calibre of eco-friendly construction technology. The study examined the impediments to the adoption of green building technologies, which incur greater upfront expenses of GBTs, absence of information and expertise about GBTs, adamant to change, a dearth of government incentives, and a dearth of dependable sustainable sellers in Kenya. Lack of comprehensive green building standards and guidelines, absence of green financing programs, ignorance of GBTs, scant research on GBTs, rigorous regulatory frameworks, and other restrictions. These issues are not exclusive to Kenya; they affect many other African nations as well. It is hoped that this research would encourage debate among academics and professionals so that lasting solutions can be found.

5.4 Recommendations of the Study

County governments can promote the use of sustainable building techniques by requiring energy audits for all structures and adding a sustainability check-list into the permitting process. Furthermore, green building specialists' continued education and education and training programs for building professionals can help strengthen the enforcement of these standards. Energy performance-based property tax incentives can also be a helpful tool for increasing energy efficiency. While green procurement can help propel the green transformation of the building sector, public sector financial institutions can help loosen lending restrictions for sustainable building projects. The need for training programs is highlighted by the significance of competent personnel in putting these concepts into practice. The adoption of green building techniques can be effectively encouraged by an integrated policy framework that includes obligatory audits or construction standards, capacity building, training, and information campaigns, along with incentives and demonstration projects. Overall, these tactics can support Kenya's adoption of green building technologies while addressing some of the issues this industry faces.

a. The development of a sustainability check list and improved regulatory enforcement.

b. GBT instruction, study, and research.

c. A public awareness campaign for GBT.

d. Green procurement promotion.

e. Adherence to GBT-related laws.

f. Financial rewards for GBTs.

g. Recognition, accreditation, and certification of green construction projects.

5.5 Areas of further Study

Throughout the examination, the need for future study in the following areas relevant to the issue came to light;

1) To make sure that the planned short and long term goals are achieved, a study on monitoring and evaluating green projects for sustainable housing should be done.
2) It is important to do empirical research on the best ways to include green building technologies from the outset of projects.
3) Research into applying green building principles to already-built housing complexes.

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Appendix 1: Questionnaire to Professionals and End Users.

Preamble

My name is **Mwanzui Evans Mutinda**, a final year student at the University of Nairobi pursuing a Master of Arts in Valuation and Property Management. I want to request your assistance in data collection for my research entailing: **An Investigation into the Adoption of Green Building Technologies in Kenya**.

All information provided here is confidential, shall be treated with the utmost confidentiality, and will be used for academic purposes only. Kindly answer the following questions by ticking the appropriate option (if provided) or providing written answers/comments for open-ended questions. Please answer the questions freely and objectively.

Your assistance and co-operation are highly appreciated.

Section A: General Information

1. Which of the following profession best describes you? (If applicable)

Profession	**Tick (√)**
Architecture	
Engineering	
Project Management	
Quantity Surveying	
Property Management	
Any other (Please specify)	

2. Depending on your profession, as specified in the question above, which sector do you orient yourself to/with?

Sector	**Tick (√)**

Public	
Private	

3. Which of the following best describes your role in the green building?

Role	**Tick (√)**
Professional/ Consultant	
End-User	

4. How long is your experience in dealing with green building technologies?

Experience	**Tick (√)**
0 - 5 Years	
6 – 10 Years	
11 – 15 Years	
16 - 20 Years	
20 Years and above	

5. What was the number of building projects put up by your company in the last three (3) years? (If applicable) Please Tick (√)

Number of Units	**Traditional Building Projects**	**Green Building Projects**
1 – 100		
100 - 500		

500 - 1000		
More than 1000		

6. What is the extent of the adoption of green building technologies by your company? Using a 5-point Likert scale, where: 1=Very low, 2=Low, 3=Moderate, 4=High, 5=Very high. Tick accordingly.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Section B: Adoption of Green Building Technologies (GBTs)

1) Are you aware of the following green building concepts and technologies? Please tick (√) **Yes** or **No**

Green Building Concept	**Green Building Technology**	**Yes**	**No**
Water efficiency	Water conservation measures, water efficiency fixtures		
Energy efficiency	Use of daylighting, use of renewable sources of energy, e.g., solar		
Sustainable material	Use of recyclable and low toxic materials		
Sustainable site practices	Landscaping, sticking to zoning regulations		
Indoor environmental quality	Provision of adequate ventilation, thermal and sound control		

2) Among the projects you have completed in the last ten (10) years, have you incorporated any of the green building concepts and technologies?

Yes ☐ No ☐

3) If yes, Green Building Concepts encompasses five environmental categories, namely Water and Energy efficiency, Sustainable Site, Materials, and indoor environmental quality. Which concept did you apply in your project? Please tick **(√) Yes** or **No**

Category	**Yes**	**No**
Water efficiency		
Energy efficiency		
Sustainable material		
Sustainable site practices		
Indoor environmental quality		
None		

4) To what extent did you incorporate the five environmental categories in your projects? Use a 5-point Likert scale: 1 - Very low extent, 2 - Low extent, 3 - Average extent, 4 - high extent, 5 - Very high extent.

Category	**1**	**2**	**3**	**4**	**5**
Water efficiency					
Energy efficiency					
Sustainable material					

Sustainable site practices					
Indoor environmental quality					

5) How would you rate the level of effectiveness of the green building technologies in question?

1 - Not effective	**2 - Less effective**	**3 - Effective**	**4- Very effective**

6) The following are some of the challenges and constraints experienced in adopting green building technologies. Rate them on a 5-point Likert scale where; 1 – Disagree, 2 – Slightly disagree, 3 – Agree, 4 – Fairly agree, 5 – Strongly agree

Challenges and Constraints of Green Building Technologies (GBTs)	**1**	**2**	**3**	**4**	**5**
Higher initial costs of GBT					
Limited knowledge and skills					
Resistance to change					
Lack of government incentives					
Limited availability of reliable green suppliers					
lack of elaborate building codes and regulations					
Lack of green financing schemes					
Lack of awareness of GBT					
Limited research on GBT					

Rigid regulatory framework					
Any other					

7) From your experience, to what extent have the following challenges and constraints hindered the adoption of green building technologies in Kenya?

Use a 5-point Likert scale: 1 - Very low extent, 2 - Low extent, 3 - Average extent, 4 - high extent, 5 - Very high extent.

Challenges and Constraints of Green Building Technologies (GBTs)	**1**	**2**	**3**	**4**	**5**
Higher initial costs of GBT					
Limited knowledge and skills					
Resistance to change					
Lack of government incentives					
Limited availability of reliable green suppliers					
lack of elaborate building codes and regulations					
Lack of green financing schemes					
Lack of awareness of GBT					
Limited research on GBT					
Rigid regulatory framework					
Any other					

8) The following are some mechanisms for enhancing green building technologies in Kenya. Rate them on a 5-point Likert scale where: 1 – Disagree 2 – Slightly disagree

3 – Agree 4 – Fairly agree 5 – Strongly agree

Mechanisms of Enhancing Adoption Green Building Technologies	**1**	**2**	**3**	**4**	**5**
Development of sustainability check-list by governing authorities					
Improved enforcement by governing authorities					
Education and training focusing on green building technologies					
Promotion of green procurement					
Investing in research on green building					
Public awareness campaign on green building technologies					
Enforcing the green building-related legislation					
Recognition, accreditation, and certification of the green building projects					
Financial incentives on green building technologies					
Any other					

9) From your experience, to what extent have the following mechanisms enhanced the adoption of green building technologies in Kenya? Use a 5-point Likert scale: 1 - Very low extent, 2 - Low extent, 3 - Average extent, 4 - high extent, 5 - Very high extent.

Ways to Increase Adoption of Green Building Technologies	**1**	**2**	**3**	**4**	**5**
Creation of a sustainability check-list by regulatory bodies					
Strengthening enforcement by regulatory bodies					

Education and training programs on green building technologies					
Encouraging green procurement					
Funding research on green building technologies					
Public awareness campaigns on green building technologies					
Strict enforcement of green building-related laws and regulations					
Recognizing, accrediting, and certifying green building projects					
Providing financial incentives for green building technologies					

10) Any other mechanism of enhancing adoption of green building technologies you would like to suggest

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Thank You!

Appendix 2: Interview Questions to Key Informants on Green Building Technologies

Preamble

Hello, my name is Mwanzui Evans Mutinda, and I am a final year Master of Arts student in Valuation and Property Management at the University of Nairobi. I am conducting a research study on the adoption of green building technologies in Kenya and would appreciate your help with data collection. Please be assured that all responses will be kept confidential and used solely for academic purposes. Your honest and objective answers to the following questions would be greatly appreciated:

1. How familiar are you with green building technologies?
2. How do Kenyans perceive the idea of green buildings?
3. What laws and regulations govern green building practices in Kenya?
4. What rating systems and tools are used in Kenya to assess green buildings?
5. What measures are used to rate a building's energy, water, and material efficiency?
6. Which buildings in Kenya have been accredited and certified as green?
7. What challenges hinder the adoption of green building technologies in Kenya?
8. What recommendations do you have to improve the adoption of green building technologies in Kenya?

Appendix 3: Inspection Check-list for GBTs Adopted in Selected Buildings in Nairobi

S/NO.	GREEN BUILDING TECHNOLOGIES	YES	NO	REMARKS
WATER EFFICIENCY				
	Water harvesting			
	Water recycling			
	Waste Water reduction			
	Innovative ways of waste water use			
	Any other			
CHOICE OF SITE				
	Preservation of existing vegetation			
	Landscaping			
	Management of storm water			
	Adherence to planning regulations			
	Any other			
MATERIALS				
	Use of low toxic materials			
	Use of local materials			
	Use of recyclable and reusable materials			
	Any other			
WASTE REDUCTION				
	Provision of the waste management plan			
	Provision of maintenance services			
	Any other			
ENVIRONMENTAL AND IN USE QUALITY				
	Noise prevention			
	Provision of smoking areas			
	Proper ventilation and circulation of spaces			

	Low emissions from paints and adhesives			
	Complaints from users			
	Any other			
ENERGY EFFICIENCY				
	Use of renewable energy sources			
	Daylighting			
	Use of energy management systems			
	Employment of energy conservation measures			
	Any other			