UNIVERSITY OF NAIROBI

SCHOOL OF THE BUILT ENVIRONMENT

DEPARTMENT OF CONSTRUCTION MANAGEMENT AND QUANTITY SURVEYING.

ADOPTION OF GREEN BUILDING CONCEPTS IN RESIDENTIAL DEVELOPMENTS IN NAIROBI CITY COUNTY.

(A PERSPECTIVE OF HOUSE DEVELOPERS).

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B53/6665/2017

A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT FOR AWARD OF MASTER OF ARTS DEGREE IN CONSTRUCTION MANAGEMENT

July, 2021

DECLARATION

I hereby declare that this is my original work and has not been submitted for award of degree in this University or any other Institution. No Part or whole of this project may be reproduced without permission from the author and or University of Nairobi.

Signature..... Date.....16.07.2021.....

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SUPERVISOR'S DECLARATION

This research has been submitted for examination with my approval as the University of Nairobi Supervisor in the Department of Real Estate and Construction Management.

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DEDICATION

To God Almighty, without Whom I am not.

To my late papa, your legacy lives on.

ACKNOWLEDGEMENT

This study would not have been complete without acknowledging those who enabled me to undertake it. The list is long, but I feel particularly indebted to the following;

My supervisor, Mr. Nicky Nzioki, for the encouragement, assistance, guidance, and critique while conducting this research project. His incomparable dedication and timely review simplified the process of conducting this research.

The Department of Construction Management and Quantity Surveying, led by Dr. Njeri Wachira-Towey and all the lecturers for imparting knowledge and wisdom during my studies.

My friends, colleagues, and all my classmates for the enchanting discussions during classes that contributed immensely to my knowledge base in construction industry.

Finally, my family, for understanding and support throughout my academic journey.

-THANK YOU-.

ABSTRACT

The construction industry is the spine of the national economy through which the total physical development is realized. Globally, buildings alone consume approximately 38% of global energy. During construction, buildings emit greenhouse gases which have devastating effect on the environment as this contributes to global warming. Increased construction activities have therefore put a strain on resources as well caused environmental degradation. This has led to increased efforts globally in development of green buildings to help mitigate these devastating impacts on the environment. Green Buildings entails development of structures that are conscious of the environment and, throughout the building life cycle, prove to be resource efficient. In spite of the benefits of green buildings being apparent, adoption of green building concepts is perceived to be low in Kenya.

This research's main objective was to assess the level of adoption of Green Building innovation in Residential Buildings in Kenya from housing developer's perspective and the key challenges confronted by housing developers in adoption of green building concepts with an aim of identifying suitable strategies for implementing green building concepts in residential developments in Kenya. The study adopted Survey research design to address the objectives. The target population comprised of residential housing developers operating in Nairobi as well as residential estates in Nairobi perceived to have implemented green building concepts. The Unit of Analysis was 59 residential housing developers registered by KPDA and 5 residential estates that were perceived to have adopted green building concepts. The method of data collection included questionnaires, observations, and interviews. Secondary information was obtained from accessible records such as books and Journals. Information collected was then analyzed using descriptive statistics in the form of percentages and tables through Microsoft excel version 2013 and SPSS version 25.

The findings reveal that the level of awareness of Green Building concepts is at average level while adoption level of individual concepts is varied per each concept. This study recommends the need to come up with policies and guidelines for implementation of GB concepts. It also recommends providing knowledge and training of developers through seminars and workshops on GBT and introduction of incentives from the government as lack of this was intimated to be among those factors hindering the adoption of the technology.

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LIST OF ABBREVIATIONS AND ACRONYMS

UN - United Nations

USGBC - United States Green Building Council

OECD - Organization for Economic Cooperation and Development

NEMA - National Environmental Management Authority

CAGBC-Canada green building council

NGO's - Non-Governmental Organizations

LEED – Leadership in Energy and Environmental Design

KPDA-Kenya Property Developers Association

KGBS-Kenya green building Society

GBT/GBC-Green building Technology/Green building concepts

EPA-United States Environmental Protection Agency

BORAQS-Board of registration of Architects and quantity Surveyors

CHAPTER ONE

INTRODUCTION

1.1 Back ground of the Study

The construction industry is undoubtedly the engine of the economy in which the physical advancement is achieved. Worldly, the construction industry is an important element of the economy and has a significant impact on the efficiency and productivity of other sectors of the economy (Kenny, 2007; Hildebrandt, 2000). Without products of construction activities such as infrastructure, widespread investment in sectors such as manufacturing, agriculture or service sectors becomes difficult. In some of the developing countries, the construction industry growth rate outstrips Population and GDP (Memon, 2015).Locally for instance, according to data by Kenya National Bureau of statistics (KNBS); the construction industry is a key contributor to the Gross Domestic product in the recent years. The report shows that the industry contributed 7% on average to the country's gross domestic product (GDP). Besides, the industry requires other input assets such as materials, plant, funding, labor, data and organization assets whose result is yields of different built products. Therefore, from the above, the industry is indeed critical for economic development in any country.

The interest in Sustainable development subsequently tosses the construction industry into sharp focus. This sector is of such immense significance as compared to other sectors in the economy. Bourdeau (1999),in agreeing with observation, asserts that the industry, on one hand forms the main pillars of economic development such as infrastructure and buildings, on the hand, construction activities are impactful on resources such as water, land, energy materials, human/social capital, as well as affecting the living and working environment. In this manner, the construction industry has direct and indirect links with the different perspectives of sustainable advancement.

Gottfried (1996), argues that the built environment's sustainability ethics is based on three tenets namely; health and productivity and resource efficiency. Gottfried further asserts that these tenets envelop a wholesome approach in which building projects and their components are seen on full cycle basis, from planning, design, construction, maintenance and demolition. In conclusion, Gottfried observes that a Sustainable building takes into consideration the building's impact on environment as well as the economy, not forgetting it's performance from the time material is

extracted, building plan and development, operation, support and building re-use and eventually disposal.

In the USA alone, according to a 2018 report by United States environmental protection Agency (EPA), residential and commercial buildings emit about 12.3% of Carbon dioxide (CO2).This therefore qualifies the fact that air pollution is of significant impact to the world's living organisms, more so to our environment, health and property damage. Extreme release of these greenhouse gases coupled with environmental degradation due to construction activities impact immensely on the quality of life for humans. The report further observes that, during operation, buildings consume up to 38% of global energy due to lighting, heating and ventilation. Consequently, to ensure human quality of life is sustained, as well as preservation of the natural ecosystems, sustainable building ought to take center stage as the world's new Agenda, even as the world pursues economic growth. Currently, green building concepts have been adopted in many countries in the world. This is evident in many European countries, America and Australia. Asian Countries such as Singapore, China and Japan have as well connected it suitably to the requirements and advancement of creating their Society. Green advancements are not as it was vital to developed nations but also to developing Nations such as Kenya. Being a major industry in Kenya, the construction industry certainly can adopt green building concepts so as to enhance a livable environment for its population.

Interest in environmentally friendly buildings has been on the rise over the past two decades. According to a report by LEED and USGBC, by 2005, 2% of non-residential buildings were certified as green; the number, however, grew to 41% by the year 2012.Katz (2012), observes that the rating systems for residential homes also grew in the last couple of years. For instance,392 housing units were certified by the program in 2007,this number increased significantly to 17,000 units by 2013.A new report released by United State green building council (2019) provides a bold vision that buildings can reach 100% net zero energy emissions by 2050.

A report by Canada green building Council (CaGBC) observes that, since 2005, over 3,000 buildings have been certified. In India, the concept has also been on the rise with the creation of 3 rating tools, namely, green Rating for integrated Assessment Rating tool (GRIHA), Leadership in Energy and environmental design green rating system (LEED) and Indian Green building Council (IGBC).Sustainable construction though at a slow pace has picked momentum in African nation

in the recent past. This is evidenced by creation of Green building councils in a number of African Countries to champion for sustainable construction. As of today, many African nations have, however, established councils for Green buildings, with South Africa as the first country to establish its council that was named the green building council in South Africa (GBCSA). Other countries that have followed suit are Kenya(Kenya green building society(KGBs), Tanzania Green building council(TGBC), Green building council Cameroon(GBCC), Ghana Green building Council(GGBC), Namibia Green building council(NGBC), and finally Egypt green building Council(EGBC).

1.2 Statement of the Problem

Green building technology in residential developments implies construction of houses that consume minimum energy, water and natural resources and at the same time provide good air quality as well as reduce waste. Whereas these benefits of green buildings exist, the GBT adoption rate in residential developments is low. With annual demand for housing estimated at about 200,000 units, a lot of residential developments are coming up in Nairobi in an effort to meet this demand, and this is bound to affect our ecosystems, deplete resources as well as impact on global warming. With this continued development of conventional residential buildings, without appropriate measures, the development of unsustainable buildings will persist.

The degree of awareness and information of green building concepts/technologies among housing developers is perceived to be low, and yet developers are key stakeholders in Residential housing development as they provide capital that drives the construction process. In Kenya, there have been efforts by non-governmental organizations to promote green building concepts. However, such efforts have only been beneficial to commercial developments. For instance, Kenya building society lists 25 buildings as having met green building standard. Majority of these buildings are commercial developments. Thus, the residential segment has been given little attention, yet this is where most urban population spends their life.

Presently, house developers perceive green building concepts as an additional cost hence reluctant to implement the same. Demand for green residential houses is also perceived to be low due high prices. Whereas there is adequate research done and literature available on the Green building technology in residential developments, little has been done on the extent of its adoption, with a focus on residential segment. For instance, Were Solomon (2015) carried out research to

investigate the adoption of the concepts of green building in Nairobi County, particularly on commercial buildings. This research focused on Commercial development in Nairobi undertaken between 2008 and 2012.The findings indicate that whereas there was 95% awareness by building practitioners, the extent of Adoption of these concepts was only 7%.Momanyi(2017),researched on Factors influencing adoption of green building in commercial developments-A case Study Malls in Nairobi County. This research focused on influence of financial, institutional and human factors in Adoption of green building technologies. The findings indicate Top manager's perception of new technologies as well as organization culture plays a critical role in Adoption of green building technologies.

Muli (2013) researched on 'Factors influencing Adoption of building technology in Kenya-a study of Nairobi County. This research concluded that awareness of GBT, resistance to change, the influence of local experts and the cost of GBT are among the factors that affect GBT uptake. According to Ezanee Lin's qualitative research, 77 percent of developers (who were respondents in the study) have a high level of knowledge about the concept, and the government influences the acceptance of the green building concept. This study however was done in Malaysia and the findings mainly reflect Malaysian context.

It is evident therefore that there is no research that has attempted to investigate adoption of these concepts in Kenya's residential segment. As a result, the goal of this study was to assess the degree of green concept adoption in residential developments from the perspective of housing developers, as well as to identify perceived bottlenecks to implementation, with the goal of making recommendations aimed at increasing uptake.

1.3 Research Objectives

1. To assess the level of awareness of Green Building Concepts among housing developers in Nairobi City County.
2. To assess the green building concepts that has been adopted in residential developments in Nairobi City County.
3. To assess challenges faced by housing developers in adoption of green building concepts in residential developments in Nairobi City County.
4. To identify appropriate strategies for implementing green building concepts in residential developments in Nairobi County.

1.4 Research Questions

1. What is the level of awareness of green building (Residential) concepts among Housing developers in Nairobi City?
2. What green building concepts have been adopted in residential developments in Nairobi?
3. What challenges are faced by housing developers in implementing green building concepts?
4. What are appropriate strategies developers can adopt to increase the uptake of green building concepts?

1.5 Study Area and Scope

The study seeks to establish the level of adoption of Green Building concepts in residential developments in Nairobi City County with specific regard to assessing the level of adoption and implementation of the concepts of Green Buildings, identifying the specific technologies that have been implemented and assess the challenges confronted in adoption of Green Building concepts in residential developments in Nairobi County.

The research employs a Survey research design approach that will be limited to residential developments located in Nairobi County, Kenya for the following reasons: - Nairobi is the capital city of Kenya and thus introduction of new technologies would be implemented in Nairobi before being adopted in other towns. The county has the most technologically advanced recently developed residential buildings. The county was selected because the study had a limited amount of time and the likelihood of the targeted prospects sharing the needed information. Nairobi County was also chosen due to the high number of residential developments constructed in the recent past.

1.6 Justification of the Study

Residential buildings where majority of people spend a sizeable amount of time ought to be built in a way that enhances their health and general livelihood. It is therefore imperative that residential building developers adopt green building concepts for general wellbeing of those who inhabit them as well the environment at large, in turn safeguarding the world's limited resources.

The buildings minimize the effect of construction on the natural environment and human health by efficiently utilizing required resources such as water and natural resources. Therefore, these buildings can be perceived as having benefits whenever they are constructed. Construction activities account for a sixth of global water use, a fifth of global wood harvest, and two-thirds of

energy flows and materials, according to Rodman et al. (1996), therefore, it is imperative that green building concepts are adopted to reduce negative impacts on the environment.

There is a significant knowledge gap regarding the extent of adoption of green building concepts in Kenya; therefore, the research aims to improve knowledge about green building adoption in Kenya.

1.7 Limitation of the Study

The project could have followed the entire life cycle of the buildings if possible; but, due to the two-year study program, this was not possible. The life cycle of buildings is longer than the available two years, therefore, it would not have been possible to carefully analyse each step of a building's cycle before the completion of the program. The study also limited itself to housing developers operating in Nairobi and are registered by KPDA, as well as their recently completed residential developments which, through an assessment criteria; were perceived to have implemented green building concepts. It was limited to concepts of water and energy efficiencies, choices of site, use of materials, environmental quality and waste reduction.

1.8 Significance of the Study

These findings of the study contribute important information to the field of the built environment because it is one of the few ones to examine Adoption of green building concepts in Residential buildings. This new knowledge is useful to researchers and general public, especially in Kenyan context.

The study through its recommendations provides ways of increasing adoption of sustainability concepts in buildings through change and development of policy. It seeks to provide a basis for educating building construction participants in adopting green concepts. Lastly the study is destined to influence housing developers towards adopting green building concepts in residential segment. The use of specific findings will improve the quality of buildings in regard to sustainability.

As a student, the study is important not only in enabling me obtain a master’s degree in Construction Management but equip me with knowledge on better management of construction projects, and specifically apply concepts gained from this research in the practice.

1.10 Definition of terms

1.10.1 Residential Developments

Residential development as used in this research denotes any development on land that houses accommodation for one or more people. It is basically real estate development for residential use. (Law insider dictionary)

1.10.2 Green Building

As per to world green building council (WGBC),Green building or green construction refers to a structure whose design, construction or operation eliminates or reduces negative effects to the environment. It can as well create positive impact to the natural environment and climate.

1.10.3 Green Building Concepts

As used in this study, it technologies and strategies associated with five major salient elements of green buildings/structures. These are; sustainable sites, energy conservation, water conservation, conservation of resources and indoor environmental quality (US Environmental Protection Agency, 2009).

1.10.4 Green Procurement

Green procurements as used in this study, mean purchase of products that have minimum effect on the environment. It involves the search for high quality products and services at competitive prices that incorporate human health and environmental concerns (CaGBC, 2010).

1.11 Organization of the Study

This research is organized in the following five chapters:

Chapter One-This chapter serves as an introduction to the review. It includes the study's context, problem statement, research questions, and study goals, as well as the study's rationale, importance, scope, and organizational structure.

Chapter Two -This Chapter reviews literature of past studies, published and unpublished research papers concerning Green buildings and Green Building concepts. The study develops a conceptual model at the end of the chapter.

Chapter three is a detailed research design and methodology that defines the research field, population, sampling techniques, sample size, research instruments, data analysis and presentation techniques, research ethics, and the study's limitations.

Chapter four -This Chapter entails a description of data presentation and analysis.

Chapter five - This chapter summarizes the research findings, draws conclusions, and offers study recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This Chapter examines literature on the green building concepts in residential developments. Literature will be reviewed from various secondary sources to give insights on the concept of green buildings and green construction with a bias on residential buildings' segment. It focuses on key challenges encountered by Housing Developers in the adoption of green buildings concepts and explores various techniques of enhancing uptake with a bias to Residential Developments. It provides the summary of key parameters that will be used for data collection.

2.2 Sustainable Development

Sustainable development refers to development that strives to meet the current generation's needs while at the same time safeguarding the ability of future generations to meet their own (Drexhage and Murphy, 2010). The United Nations General Assembly adopted this view in 1992, paving way for its continued use,(Drexhage and Murphy, 2010).Sustainability concept encompasses three pillars which are; economic development, environmental responsibility and protection and social equity(Drexhage and Murphy, 2010).

Drexhage et al. (2010), further observes that over the past 20years, the terms Sustainability and environmental responsibility and protection, have been interchangeably used. The distinction is that sustainability is concerned with economic, environmental, social needs whereas environmental responsibility is only focused on the aspects of the environment. Kibert et al. (2002) observe that the need for sustainable development arises from the fact that the resources are finite.

A report by the United States Environmental Agency (EPA, 2009) estimates that up to 72% of electricity consumption in the US in 2005 was by buildings. The number was projected to increase by 3%, reaching 75% in twenty years. The report also revealed that buildings activities accounted for 40% of waste generation, 13% of water consumption, 49% of Sulphur dioxide, and 38.9% of Carbon-dioxide. As a result, these negative effects on the atmosphere emphasize the importance of transitioning to sustainable development in order to protect the planet for future generations.

To conclude, the construction of sustainable residential houses benefits occupants by improving indoor environmental quality, improving response to the environment, and maintaining a shared

relationship with the community/environment. This strategy is also essential for modern societies to adopt. This will ensure that the structures are green or environmentally friendly/responsive to the climate.

2.3 Green Buildings

Green building, or green construction, is described by the World Green Building Council (WGBC) as a structure that reduces or removes negative environmental impacts. Furthermore, it may have some benefits to the environment. This entails the processes associated with a building's life cycle (Gottfried, 1996). This calls for cooperation amongst all project stakeholders in all project stages (Yan Ji, 2006). Green building practice builds on the traditional building design issues of economy, utility, resilience, and comfort while also complementing them (US Environmental Protection Agency, 2009).

According to Carpenter (2009), Green homes reduce depletion of natural resources such as; water, energy, and materials and at the same time improve indoor air quality. Carpenter (2009), further observes that green building process involves a number of basic considerations. These are; layout on site, orientation, climate zone, orientation, foundations, insulation, exterior finishes, roofs, windows and doors, and Systems compatibility.

According to Scheuer (2007), Adoption rates for green residential buildings were slow as of the year 2007, despite the potential benefits on the environment, the better indoor air quality of the houses as well as reduced energy consumption. Scheuer (2007) attributes this to various factors; key among them is ambiguity in terms of definition and benefits that arise from green building adoption. Scheuer further asserts that this ambiguity in valuation and definition of the standards remains an issue of relevance to the modern industry. The absence of these critical definitions can limit the implementation of green residential housing.

Buildings contribute to about 70% and 40% of the electricity burden, and all energy utilization respectively, and 40% of Carbon dioxide emissions, according to Gioregetti (2010). With this observation, the most fastest and cost effective way of reducing greenhouse gas emissions is through development of buildings which are more energy efficient, bearing in mind the rising cost of energy. This logic is further highlighted by National Science and Technology Council (NSTC) further endorses this view that by adopting environment friendly technologies, there is cutback in energy, operation and maintenance cost, decrease in building related illnesses, waste and pollution.

While comparing USBC LEED for homes and the National green program, Reposa (2009), argues that Green buildings can consume lesser energy and funding than the conventional buildings. He also argues in his study that green buildings may not be more economical based on energy consumption costs alone. He concludes that energy cost should not be used a justification for additional investments in new green buildings.

Green buildings have features that make them safe for their inhabitants, according to a Conference on Green Building Rating for Africa (Habitat, Green Building Rating in Africa, 2010). As a result, they are an improvement of conventional buildings. The conference further discussed the necessity of reduced amounts of energy, water, and other resources to reduce operational costs of these buildings for this would increase their market place value.

The next sub sections discussed various approaches to green concepts in regard to water and energy efficiencies, materials and waste, sustainable sites, integrated building design and other technologies that are applied to enhance sustainability in buildings.

2.3.1 Overview of the History and Importance of Green Buildings

The year 1970 gave birth to the modern environmental movement with celebration of the first Earth Day on 22nd of April where public education on environmental protection was conducted and formation of the USEPA.Yudelson (2010), gives a clear outline of the history of green buildings. He points out that the roots of the concept of green buildings can be traced to the 1980s when Montreal Protocol limited the use of chlorinated fluorocarbons due to their negative ozone impacts. This was amongst the first international law that protected the environment. It was then followed by the definition of sustainability by the Brundtland Commission. The formation of the Committee on the Environment within the American Institute of Architects was also a building block towards what is now known as green buildings. It began pushing for sustainable designs in buildings. The 1980s are clearly seen as the era where the foundation of green buildings was laid with concepts such as environmental friendliness and promotion of sustainable designs being encouraged by law and international institutions.

The building blocks for green buildings as we know it today were set in the 1990s with formation of the USGBC. The body was formed due to the influences of the Earth Summit 1992, which resulted in the infamous United Nations Framework Convention on Climate Change that encouraged sustainable developments in the effort to decrease the greenhouse gas emissions. The

Earth Day 1990 was the second influence. It managed to go global, mobilizing 200million people and 141 countries to join in the fight for environmental protection. The late 1990s saw the first global attempt to regulate greenhouse gas emissions by international statute through the Kyoto Protocol.

The history of green buildings gives an outline of how the concept of green buildings came into being and why it came into being. Environmental protection is the major goal of the concept. Seeing that it took around 30 years for the term green buildings to be coined and defined adequately, it is of great importance to ensure that such buildings have proper maintenance management practices so that they function as they should and contribute to reduction of the global carbon print.

The features of a green building highlight why such structures are important. Comstock (2013) echoes this view in her article, 'Importance of Green Buildings Stressed by Business and Industry.' Being that buildings are all constructed on a daily basis world-wide, the IPCC has stated that green buildings are important as they contribute to the reduction in greenhouse gas emissions, encourage environmental protection, promote cost-savings, create jobs and improve human health and productivity.

First is the reduction in greenhouse gas emissions. Conventional buildings in the world are estimated to produce 40% of the emissions on earth hence influencing the global climate change. These harmful gases result from degradation of the construction and demolition debris in landfills which generate the greenhouse gas and the extraction and manufacturing of building materials. If a green building is constructed, there is materials and resource efficiency employed as the building materials used decompose without producing greenhouse gases. This effectively reduces emissions and ensures that the maintenance, operations, demolition, materials extraction and manufacturing all comply with the LEED standards.

Second, environmental protection is attained beginning from the site selected up to the maintenance and operation of the building. The Catholic University of Eastern Africa library which is a green building has ensured environmental protection by planting trees that were indigenous to the site selected (The Standard Newspaper dated 25th February 2016).

Third, green buildings are of great importance as they promote cost-savings in various ways. Still using the example of the CUEA library, the building's internal temperature is kept cool throughout the day due to the complex layer of stones sets in the foundation of the structure which saves the institution money that could have been spent on air-conditioning. The lighting used during the day while inside the building is natural lighting due to the long windows and the translucent roofing installed hence the cost that should be paid on electricity is greatly minimized (The Standard Newspaper dated 25th February 2016).Green buildings have substantial financial benefits compared to conventional buildings, according to a study done by the Massachusetts Technology collaborative Green buildings will reduce 20-year life-cycle costs by $49.90 (Kshs5,074.83) to $66.30 (Kshs6742.71) per square foot of building space, according to the report (Environmental Building Strategies, 2015).

Creation of jobs is the fourth importance of green buildings. This field is new in Kenya hence there is a deficit in professionals trained in the use of green technology in the country. Individuals who have the knowledge in the specialized knowledge in this area are sitting on a gold mine when it comes to Kenya.

Lastly, green buildings are of great importance as they contribute to the improvement of health and productivity of the individuals using them. (Cesarati & Misso, 2015).The importance of green buildings has been emphasized by various international institutions and authors. The implication it has on the building's maintenance management is that it will influence the stakeholders to adopt sound maintenance practices and come up with mitigation mechanisms to counter any negative impacts so that the structure serves its purpose.

2.3.2 Features of Green Buildings

To further understand what green buildings are, literature was reviewed on the attentions that result in structures being referred to as green buildings. These characteristics that a green building should possess were developed by the green building grading system known as LEED which was founded in 1993 but only became popular internationally with the turn of the twenty-first century. LEED is a body which was established by one of the founders of the USGBC. Its main objective is leadership in green building. The concepts on how buildings and communities are constructed, designed, operated, and maintained across the globe are undergoing transformations (USGBC, 2019).

According to LEED and CalRecycle, green buildings should have the following characteristics: Environmental quality in the home, material and resource conservation, and the design process; Building operations and maintenance; environmentally friendly sites; Water management and energy conservation, as well as green power and environmental security, are both priorities.

a) Material and Resource Conservation

Material and Resource Conservation focuses on reducing embodied energy of the building materials. It also focuses on the whole process involved in material extraction, processing, transportation and maintenance and disposal of the material. According to LEED (2016), the aim is to design a process that support a life cycle approach which entails improvement of performance as well as promotion of resource-efficiency. Strategies used to achieve material and resource conservation include: storing and gathering of recyclables, management of construction and demolition waste, sourcing of raw materials and testing the building materials to ascertain that they are environmentally friendly.

b) Indoor Environmental Quality

Under this umbrella, the indoor air quality and thermal, visual, and acoustic comfort is what is taken into consideration. The atmosphere inside a green building should be one that is comfortable for the building occupants or users to ensure that their health and well-being are protected. This internal environment also encourages them to be productive. Strategies that are put in place to ensure the building reflects this trait include: thermal comfort (not hot during the hot weather and not cold during the cold weather for the users or occupants), the lighting-both for the day and the night should be user friendly and collection of views of the building occupants on areas to improve so as to ensure that the indoor environmental quality is achieved (LEED, 2016).

c) Innovation and Design Process

This has to do with the green building's technology and overall architecture. The aim of this LEED category is to highlight projects with creative building features while also encouraging the development of sustainable building practices and strategies (LEED, 2016).

d) Building Operation and Maintenance

According to Kubba (2012), verifying that all the systems in green buildings perform as they should upon completion of the structure is important as it enables the buildings to deliver the results intended according to their design. Testing and modifying the mechanical, plumbing, and electrical systems are among the tasks performed here. These practices are primarily intended to ensure that the building follows the design standards. It also entails training the maintenance team on how to operate and maintain the equipment so that it can function at its best in accordance with its specification. These features of green buildings are the determinants of the type of maintenance management practices that will be employed to ensure the building performs as per the design specifications. All these features must be present for a building to be called a high performing building or a green building. Several authors hold the view that, where a building contains all these features or some of them, the overall operational and maintenance costs for an institution are reduced.

e) Sustainable Sites

Harrison et al. (2008) says that sustainable sites involve the location chosen for the building and the building project itself. Both of these must be in line with the LEED requirements on green buildings for new construction. According to LEED (2016), the requirements that need to be met under this pillar include: performance of a site assessment showing the topography of the location, the climate and several other elements of the location and how they impact the environment; presence of mitigation strategies to prevent construction related pollution such as soil erosion and airborne dust; alternative transportation to and from the location should be readily available and easily accessible and the location should be within an urban area where there is dense development to enable ease of access to social amenities that may be needed in the building process.

f) Water Efficiency

Moghadam (2009), defines water efficiency as reducing wastage and use of water. This simply means saving or conserving water. According to LEED (2016) water efficiency involves both the outdoor water use in activities such as irrigation and the indoor water usage in duies such as dishwashing and showering or bathing. Additionally, Moghadam states that mending leaking taps and conducting showers instead of baths are some other ways to increase water efficiency.

g) Energy Use Reduction, Green Power and Atmospheric Protection

According to Coyle (2014), energy use reduction is using less energy to accomplish the same amount of work. LEED (2016) proposed strategies such as renewable energy production to reduce environmental and economic harm caused by fossil fuels and advanced energy metering so as to save more energy and monitor general energy use. As for green power, it was encourage as it reduces greenhouse gas emissions thus effectively reducing global warming. Lastly, atmospheric protection was encouraged to reduce ozone depletion. It is fundamental for green buildings to comply with this characteristic as it is ranked as the topmost green building standard followed by indoor environmental quality.

2.3.3 Benefits of Green Buildings

The advantages of green buildings have been categorized as being threefold (Cesarati & Misso, 2015) when incorporated at the early construction stages. That is, environmental, economic and social.

The **environmental benefits** include conservation of the natural resources by ensuring the extraction and manufacturing of building materials does the least amount of harm to the environment. Improvement of the air and water quality and protection of the biodiversity and ecosystems are also covered here.

Economic benefits of green buildings entail creation of market for green building products/technologies and services as well as reducing the operating costs. According to the General Services Administration (GSA), LEED-certified buildings use 25% less energy and have a 19% lower total operating cost than non-certified buildings. Green buildings have reduced costs because of utilizing renewable sources of energy. The ripple effect of reduction in the operating costs is that many more individuals and institutions become more interested in green buildings as sound business practices always ensure huge savings.

Social benefits include the improved the quality of life. This is because the green building design ensures that the building users are comfortable and health and safety regulations are adhered to in the design criteria. Since the buildings reduce the global carbon print, the quality of life of all human beings is improved as there is reduction in the greenhouse gas emissions causing minimal global climate change.

In the article, 'The Business Case for Green Building' further benefits given are: Green buildings gain **competitive advantage** over their industry contemporaries due to the fact that they provide reduced operating costs, improved indoor environmental standards and have attained the LEED certification.

The high performing buildings **attract tenants** due to the fact that most of them are looking to enjoy the benefits enjoyed by the buildings possessing LEED certification such as waste reduction, water efficiency, cost savings, etc. In the developed countries, this benefit is enjoyed more as the lease-up rates for green buildings ranges from average to 20 percent above average (USGBC, 2015).

Better health standards for residential building tenants were also seen to be a benefit accruing from green buildings as documented by McGraw-Hill (2013). In the U.S., 90% of time spent indoors increases the contact with pollutants since they are higher than outdoor (EPA, 1987). LEED-certified buildings have improved the quality of air, increasing its benefits to the occupants.

These benefits are enjoyed where the building has been constructed based on the green principles from the onset or being a conventional building, has been retro-fitted with some features of green buildings. The impact of this is that the building users enjoy these benefits throughout its life cycle which is estimated at being 100 years. Having an outline of the benefits derived from green buildings informs the study of the desired performance level that the structure is expected to meet and maintain in order to allow the building users to holistically enjoy the use building. These benefits shed light on some factors that may interfere with the benefits thus effectively influencing the maintenance management negatively.

Green buildings also have improved economic and environmental benefits, according to the literature. This also enables them to meet the requirements for a green rating system.
They also provide a healthier environment to live and work in because they contain materials with reduced amounts of harmful emissions. Living and working in green buildings is likely to improve efficiency because most people spend more than 90% of their time indoors (EPA, 2009). As a result, the developers will experience increased economic value. Green buildings also have lower maintenance and operational costs, offsetting the initial costs of construction due to their energy efficient strategies.

The Environmental benefits of green buildings entail reduced negative impact to the environment, compared to conventional buildings. The Journey to 100% sustainable buildings is long, but for now, most green building aim to mitigate to near-zero their damages to the environment.
Carbon-neutral buildings, which are currently preferred, create the same amount of energy they consume in the period of one year, commonly known as Net-Zero energy buildings. With these potential positive impact, these building cannot, however heal the damaged ecosystems within the surrounding environments. Kibert (2008) argues that regeneration, which denotes healing and restoring the environment, should be the next target of environment friendly buildings.
Adoptions of green building concepts also face many barriers and obstacles. First of all, the average residential owners are yet to fully perceive the benefits of these buildings, therefore, strategies to raise awareness are necessary. The current building codes only define the minimum building performance requirements and hence an obstacle to adoption of green building concepts as it does not encourage the owners to go beyond the bare minimum. Moreover, based on initial costs, green buildings are perceived as not competitive compared to conventional buildings, which discourages developers as initial costs are usually important to them. According to Yudelson (2008), construction industry professionals agree that green building raises construction costs by at least 10%.

2.3.3.1 Building Materials, Technology and Waste

On an annual basis, the construction of buildings uses 40% of raw stone, gravel, and sand, 40% of energy, 25% of wood, and 16% of water used globally. Gottfried (1996) explains that, one way of improving building environmental performance is through the selection of sustainable building materials. Gottfried further asserts that ultimately, there has been a balance between environmental performance and economic performance.

Locally, contractors and developers explain that they face a myriad of challenges which prevent them from delivering green residential developments, key among them being restrictive government regulations that inhibit the use of alternative cheaper building materials. As an intervention, the government can generate policies for procurement, contract specifications, building codes and building performance that support sustainable initiatives.

Many societies face growing scarcity issues because of the unsustainable use of ecosystem resources. Green buildings present an opportunity to address these issues because they are excellent at efficient land use and materials. It also provides an opportunity to resolve other concerns such as noise and chemical emissions, as well as hazardous waste materials like asbestos and lead-based paint (UNEP SBCI, 2010).

2.3.3.2 Water efficiency

Due to water conservation and efficiency programs, there is a substantial decrease in use of water. According to Gottfried (1996), Consumption of water can be reduced up to 30% if efficient fixtures and appliances are used, and investing in such programs can yield a short payback period.

Apart from changing or maintaining behavior, the use of new and more efficient products can reduce water consumption. Ezilondo et al (2010), points out that some of the simple solutions to help keep track and reduce consumption of water include feedback gadgets and timers. A report by UNEP SBCI (2010), reveals that some of the innovations used in green buildings include the harvesting of rainwater with segregation of surface and rooftop runoff. It further observes that pervious paving can maximize ground water recharge if employed.

Tessema (2010), also shares this view that one of the ways to conserve water in our context is through harvesting by using the roof top as the first catchment area through a gutter system that then finds its way to the storage tanks. Later, this can be used in cleaning and irrigation. Waste water can also be collected at the house hold level.

According to Mudgal et al (2009), the utilization of water effective installations and gadgets is more prevalent within inns than in residential buildings. Areas like bathrooms, Laundry and Kitchen can offer considerable saving if energy efficient fixtures are used.

According to a Nairobi Water and Sewerage Company (NWSC) survey, only a small percentage of buildings recycle water. It also notes that most of the faulty water pipes were responsible for much of the water lost. Therefore regular maintenance of the water pipes is needed to conserve as much water as possible.

According to Geller et al (1983), installing water efficiency devices did not result in water and energy savings. The findings, therefore, suggested that this development was due to increased

toilet usage after realization of the quantity of saved water. Herring and Roy (2006) termed this as a rebound effect caused by the knowledge of the users regarding the savings made. The researchers identified that reduced knowledge by the users resulted in the expected savings.

In conclusion, changing user behavior is one way of tackling water and approaches must center on the components behind different water related exercises. The aim of these approaches should be to gradually change the behaviors and must link up different ways. This includes educating the user and giving feedback in order make it easier for the users to embrace the product as well as updating the legislations accordingly. Moreover, campaigns, policies, and strategies must also take into account the cultural and social context of the region, as well as financial and technical accessibility.

One of the goals of the National Housing Policy, according to Sessional PaperNo.3 -National Housing Policy, 2004, is to encourage the construction of housing that is practical, safe, aesthetically pleasing, and ecologically sensitive. Apart from addressing environmental concerns, Tessema, et al. (Sustainable Buildings & Construction in Africa,2010) argue that sustainable construction must address social and economic perspectives and that it is necessary to combine traditional practice and local knowledge in addressing the environmental concerns.

2.3.3.3 Waste and Material benefits of green buildings

Unsustainable use of resources in the ecosystem lead to scarcity issues which many societies face today. Green buildings help in addressing this through efficiency in use of materials. Establishing a low affect criterion amid plan, development support and disposal is imperative to reduce building impact to the environment as well as fulfill a complete life cycle of building.

The criteria to be followed when choosing material that is sustainable include; availability of resources, low embodied energy, minimal environmental impact, potential re-use and recyclability According to MCDonough Braungart (2002), one of the ways of allowing higher recyclability and reuse is by reduction of the number of material components used in products. Separation of natural from synthetic materials will also increase the rates of recyclability as well as reuse, and Laweson (1996), concurs with this observation. Laweson discovered that reusing building materials would save up to 95 percent of embodied energy in a study he conducted.

Thomark (2006), observed that reusing materials reduces environmental impacts by 55 percent when compared to using new materials. Sa'ra (2001) observes that recycling delivers net emission savings despite possible energy consumption in the process. Further, studies observe that in recycled construction materials are often of high quality and cheaper in developing Nations. (UNEP SBCI, 2010).

Locally, the selection of materials is backed up by the National Housing Policy Sessional Paper No. 3 from 2004. The government committed to encouraging the advancement of creative building designs and traditional architecture through the mentioned policy, as long as they prove to be cost efficient. They must also make use of low-cost resources that are easily obtainable in the region. Furthermore, the policy discusses the methods for handling housing inputs, which includes both construction materials and technology (GoK, Sessional PaperNo.3 - National Housing Policy, 2004).

2.3.3.4 Integrated Building Design

This involves a systematic, systemic approach in which multi-disciplinary teams of building professionals collaborate to optimize the building's sustainability efficiency. Arbor (2015) describes that a sustainable green building is accomplished through a sequence of steps that include first, site design, second, determining the configuration of the building, third, components, and at long last, systems as stand-alone parts of an entire framework. The teams also have to optimize their interaction for the sake of economic and environmental benefits.

In modern times, green materials in conjunction with advanced technologies can be used during the building's design to ensure that it consumes minimal amounts of energy. Design for green buildings requires several professionals to work together. There are also other factors that have to be considered such as climate and the building's shape.

An integrated design approach widely used in green buildings, according to Cassidy (2003), blends technical inputs with environmental values. Baker et al (1999) reinforces this view and then adds that it has to include rigorous assessment procedure for it to comply with the developed performance targets.

Cassidy (2003), concludes that designing green buildings while considering the environment, requires consistent feedback between the various teams who focus on the different aspects of the construction such as orientation, and other components.

2.4 Energy Efficiency in Residential green buildings.

According to (Harvey, 2009), heating and cooling consume the largest amount of energy in a building. Greenhouse gas emissions from buildings are observed to surpass those in the transportation industry. Harvey, further observes that an increase in demand for buildings will cause an increase in energy demands in the future.

EPA points out that when passive design strategies such as use of natural lighting, ventilation, rain water harvesting, Orientation among others are used, it can increase the energy efficiency of buildings that may even surpass the requirements in the green standards.

Carbon dioxide emission from buildings, as per the International Panel on Climate Change (IPCC), could rise by up to 15.6 billion tons in 2030, up from 8.6 billion tons in 2004. Further, the report projects that developing nations are bound to increase their carbon dioxide output due to the rise in development thereby causing increased energy demands by their industries. The report concludes that the boom in construction activities provides an opportunity to embrace energy efficient technologies in order to avert increases in Carbon emissions as well as reduce energy use in buildings. IEA (2009) also endorses this view that improved efficiency in construction sector could offer an opportunity for significant reductions in carbon emissions.

2.4.1 Ways of Reducing Energy consumption

Buildings can minimize their energy consumption by using a variety of techniques, according to CIBSE (2004). To use energy effectively in buildings, one of these may be increased use of recycled materials and renewable energy sources. The following discussion focuses on potential building energy use reduction.

2.4.2 Lighting

According to Scott (2009), 4% of energy consumption in houses can be attributed to lighting. Lighting in commercial buildings, on the other hand consumes up to 30% of a building's energy supply. Good practices which are being promoted to reduce energy use in buildings as regards to

lighting include smart meters and light control. This entails a network of sensors which is capable of switching on and off lights in the building, depending on the presence of people. Smart meters, According to Scott, can scan and monitor energy consumption throughout a building. The data can then be used to analyse possible weaknesses and then improve on the building's energy efficiency.

Electricity consumption can be lessened through use of Natural lighting as well as adopting energy efficient appliances in houses. Further to this, Solar panels can be mounted on the roofs of buildings as well as mini-wind turbines fastened to the walls of building and this can be used to create electricity from Natural Sources.

A report by IEA, observes that 19% of World's electricity consumption is attributed to lighting. This In turn produces 1.9 gross tonnage of carbon dioxide on an annual basis (Nuttall, 2010).Nuttall, (2010), while comparing traditional bulbs and LED lighting, observes that the latter offers more benefits in comparison to the traditional bulbs. If used in houses, Nuttal argues that it can reduce electricity demand by up to 75%.LED lighting together with smart-control, are more efficient when compared to the traditional lighting technologies. The initial cost, however, is higher when adopting LED lights compared to traditional bulbs. Financial support from the government is needed to transform the market from conventional lighting to LEDs.The report also observes that the first large LED programs were adopted by China, with this achieving 210,000 LED street lamp installation in 21 cities.

Locally, Kenya Power and lighting company, a government parastatal; has been in the forefront in promoting energy efficiency through lighting programs. The program outlines the government intention to replace ordinary bulbs with CFLs (Fluorescent compact lamps).This exercise is expected to save 49mega watts of power. Furthermore, according to Xinhua (2013), the government intends to offer interest free long-term loan to firms investing in local production of these energy saving devices. Table 1 compares the energy consumption of various light bulbs.

Table 1 compares the energy consumption of various light bulbs.

Minimum Light Strength	Electricity Consumption in Watts		
(Lumen/Brightness)	Incandescent	Compact Fluorescent	LED
400-500	40	8-12	6-7
650-850	60	13-18	7-10
1000-1400	75	18-22	12-13
1450-1700+	100	23 -30	14-20
2,700+	150	30-55	25-28

Source: Author archives, 2020

2.4.3 Temperature Control

Scott (2009) observes a significant difference in the energy consumption of buildings because of temperature control. Temperature management accounts for 55% of energy consumption in residential buildings and 35% in industrial buildings in Europe. Scott, further argues that the energy produced by the computers can be used to heat up the building should it be properly designed. The argument is advanced by the Green economy suggests that all the energy produced in the building should be considered in the design phase. Thus, the necessity for a holistic approach (Rode, 2011).

Baker & Steemers (1999) observes that Kenya and many developing countries are beginning to integrate new forms of green energy generations. Furthermore, studies show that efficient ventilation and lighting can reduce energy use by 64 per cent. Other studies put this number at between 50-60 per cent (CIBSE, 2004)

According to Zhang (2009), every building can experience an improvement in its energy efficiency by between 20-30%, and this can be achieved through optimization of the systems such as the cooling system and the building's management system. In Kenya, the heating of buildings is uncommon because of the climate; however, some buildings make use of cooling technology. Temperature control in commercial buildings within Kenya prefers the use of electricity as the source of energy to power the cooling technology over other sources of energy such as charcoal and kerosene. However, residential buildings and homes mostly make use of other forms of energy.

2.4.4 Passive Design Strategies.

Passive deign strategies use natural means to achieve energy efficiency and sustainability in buildings. They include strategies such as maximum day lighting, natural ventilation as well as use of solar energy. Another way to save energy is to use materials with low embodied energy. Studies have shown that there is a difference in embodied energy based on type of materials. Wood was observed to have a lower embodied energy in comparison to the other materials (USLCI, 2012).

In addition, the use of passive solar building designs are other techniques that designers establish to attain energy effectiveness. Orientation of the Windows, walls and placement of trees to shade windows and roofs capitalize solar yield. Daylighting involves accurate positioning of windows to attract maximum daylight as sizing them in a manner that adequate daylight in a building to prevent use of energy to light up spaces during daytime.

According to Rode (2011), using passive design techniques can significantly boost a building's energy efficiency. These design strategies include the use of natural lighting, orientation and on-site, among others. A study by Lamonica (Solar concentrators graces University Rooftops, 2011) ascertained that the available passive technologies could provide energy savings by increasing the building's water temperature up to 200 degrees while providing the building with energy for other functions.

2.5 Key Challenges in Adoption of green building concepts

According to Tessema et al (2010), one of the challenges facing adoption of green building concepts is urban planning. Most urban dwellings are compactly constructed with little or no space left and this prevents air movement after construction. Site Planning is one of the most noteworthy components of sustainable building as the construction process has a tremendous effect on numerous fronts of sustainability. More often than not, expansive green areas are ruined instead of incorporating them in the built environment. (Tessema, Taipale, & Jan Bethge, 2010).

Adebayo (2000) observed a problem in site planning among many of the African's cities as well as urban areas. Adebayo further mentions that when buildings are constructed, they are designed to occupy the entire site destroying the immediate green environment while also limiting the movement of air after the completion of the construction. He adds that because of this poor site planning, many urban areas have committed irreparable environmental damage.

In addition, Traditional Architecture has not been incorporated into our designs. This is another key challenge. Traditional Architecture constructed buildings while maintaining the existing natural environment. On top of this, the materials were sourced locally. Modern buildings do not follow this tradition since imported materials, as well as designs, are used. The negative impacts of this decision are the emergence of unsustainable buildings and the loss of traditional building ways (Tessema, Taipale, & Jan Bethge, 2010).

Another challenge is the destruction of forests since they provide timber that is then used in construction. In continental Africa, the destruction of forests is directly linked to the construction industry in the supply of materials. Timber that is used in the construction of buildings is acquired from indigenous forests, and in most instances, it is never replaced. According to Adebayo (2000), forest use has to be made sustainable by ensuring that harvest trees are replanted; thus appropriate measures need to be taken.

According to Gottfried (1960), waste regulation is a critical issue in the construction industry. The author observes that in most instances, the waste produced is disposed of in landfills or sometimes pits. These methods of waste management, however, have some of the worst impacts on the environment. As a result, procedures should be undertaken to make sure that waste management is sustainable in the building process.

Adebayo (2000), observes that another critical part of sustainable construction in developing countries is Energy efficiency in construction and production of building. This efficiency, according to Adebayo, is not only attributed to direct usage of energy, but also usage of fuel in the production process, obtaining of raw materials and eventually transportation of the same to various construction sites. This argument is further endorsed by Tessema,et al. (Sustainable Buildings & Construction in Africa, 2010),that one of the ways of reducing the building environmental burden is through increasing energy efficiency and reducing energy demand, in addition to renewable energy sources.

Furthermore, Cultural barriers inhibit the implementation of green building concepts. During the process of colonization, African countries were more likely to develop a strong intolerance towards western technologies. Because of this, green energy technology became less adopted. In addition, according to Tessema et al. (2010), an over-reliance on foreign technology as well as knowledge

could significantly reduce the confidence of the citizens in traditional methods of construction or internal knowledge. As such, the shift towards green buildings could be significantly reduced.

Tessema et al. (2010) attribute lack of financial resources as another factor owing to the slow uptake of green building technologies. Under this larger issue, there are other challenges, such as the availability of the funds and also strategies for its access whenever it is available. But Gottfried (1996) points out the payback period is usually shorter due to savings, as much as the initial investments in green buildings tend to be higher. These arguments are further reinforced by Issa et al. (2011). The author explains that green buildings result in savings in energy consumption. However, these savings will need to be compiled with other savings from the indoor environment, health benefits, and productivity.

2.6 Strategies of Promoting green building concepts

There are a variety of techniques that can be used to increase green building adoption. According to a UNEP report, 2007, one of the strategies is monitoring Regulatory and control mechanisms, evaluating and updating them frequently to ensure that they match with modern technological advancements as well as the trends within the market. Green building concepts can easily be enforced when dealing with new buildings as opposed to old ones. Utility demand-side management systems, established building codes, energy efficiency obligations, set appliance standards, and set procurement regulations are just a few examples of regulatory instruments (UNEP SBCI, 2007).

Local authorities can also participate in promoting the adoption of the concepts of green building. They can achieve this through several ways such as the development of a checklist in regards to a sustainable building that construction teams have to meet. The checklists can be issued by the local authorities when issuing the occupation certificates. Adequate education and training are required for improved enforcement. According to Plessis (2005), Built environment courses should endeavor to incorporate sustainable building contents. They should also consider professionals within the industry by providing them with continuous development courses. The courses will then provide the accreditation systems for the industry's professionals.

The building code in Kenya has not been reviewed to suite the current sustainability issues thus presenting a big hurdle to local authorities in implementing green building concepts. Progressed authorization can begin with intentional plans and steadily coordinated within the building codes.

In addition, according to Reis Jenkins (2009), energy audits should be made mandatory, and buildings should reveal their energy performance certificates publicly. Some critics of this idea suggest that these still do not reveal the true amount of energy that is consumed by the occupants, yet it contributes towards the building's overall performance. The government's input through Grants and subsidies can also increase the investment in the energy industry; however, the investors have to have access to adequate capital. The government can also benefit the developers by reducing or freezing their property taxes that is linked to the buildings' energy performance.

Furthermore, Credit barriers can be addressed by public sector financial institutions. Financial barriers notwithstanding, there is need for institutions to promote green procurement to enhance adoption of these concepts in building process. Another key strategy is training as there is need for an increased number of professionals who are skilled in sustainability concepts. This enhances adoption of the same.

An integrated policy system that includes regulatory properties such as building standards or obligatory audits, capacity building, training, and awareness campaigns, as well as demonstration projects with incentives, is likely to help green construction adoption. The following sections dwell on various criteria for rating Green Buildings.

2.7 Criteria, Evaluation and Rating of Green Buildings

A comparison of a building's performance with developed standards may be used to determine its sustainability. Several rating systems have been established around the world to evaluate the sustainability of buildings and other construction activities. The key goals of the rating systems are to assess a building's sustainability index and to act as a benchmark for green building design (Tessema, Taipale, & Jan Bethge, 2010).

As per Tessema et al. (2010), the most common grading systems include; LEED developed in the United States USA by the country's USGBC. The rating system is used to assess new and existing buildings. LEED-Canada is the second grading system. The Green Building Council of Australia created the Green Star rating system, which is used to score mainly office buildings and office interiors. Buildings in the United Kingdom are assessed using the BREEAM method. Finally, in India, the Green Rating for Integrated Habitat Assessment (GRIHA) is widely used. The majority of these rating tools assess different aspects of sustainability, and no one tool can assess all of the undeniable green building features.

It has been generally accepted that the world's first green building rating tool was BREEAM. This tool was developed by Building Research Establishment (BRE) an independent government funded research institution) in the 1990s. (Cole & Jose Valdebenito, 2013). When first developed, BREEAM and other early rating systems provided a basic checklist that then progressed into a system that awarded points whenever buildings made achievements. According to Tessema et al.(2010), this rating tool try to focus on a combination of sustainable aspects such as environmental, social and economic factors. Under environmental aspects, the focus is usually of use of energy, water and materials and management of wastes. On the other hand, social aspects focus on occupants' wellbeing, preservation of social and cultural values as well as accessibility index of buildings. Finally, economic aspects tend to focus on issues of affordability and life cycle costs. Ding (2008), notes that the vast experience of this rating system (BREEAM) in building evaluation has led to methodology to be the bedrock of new assessment tools in most countries in the world.

The LEED rating system, which was created in1998, is made up of five environmental categories: materials and services, sustainable places, water efficiency, indoor air quality, and energy efficiency, not to mention the design and innovation category (Cassidy, 2003). Furthermore, this ranking system assesses the performance of various environmental issues such as energy use, waste management, and the use of renewable energy over the life cycle of a house. Green Rating for Integrated Habitat Assessment (GRIHA), according to Tessema et al.(2010), covers the four main aspects of a building's life cycle. Like BREEAM, the LEED tool has become a foundation from which different countries develop their own assessment tools based on their climatic as well as environmental conditions.

In the United Kingdom, BREEAM is applied in the measurement of non-domestic buildings' sustainability. The assessment tools consist of a two-stage assessment process. The first is in the design stage, and the second after the construction process. The tool assesses various areas such as water and biodiversity. (BREEAM, 2019).

Table 2: BREEAM Rating Benchmarks.

Rating	**Percentage score (%)**
Outstanding	≥85

Excellent	≥70
Very good	≥55
Good	≥45
Pass	≥30
Unclassified	<30

Source: Author, 2020

According to Tessema et al. (2010), the scale of assessment varies in that the assessment tool can focus on an individual design feature in a building or the community's sustainability. There are two kinds of rating systems—the first focus on the building's construction. The second focuses on the building's environmental effects. Tessema et al. (2010) further observe that in South African, the assessment is usually performed on the entire building and also focuses on the building's role in the sustainability of the immediate environment.

Most of the evaluation tools center on similar environmental issues. However, differences emerge in the categorization of the impact issues. The tools also have a variation in the performance benchmarks. The document that is used to display compliance to the assessment also varies from tool to tool. More so, there is a difference in the methods through which buildings are assessed, and this is according to the UN Habitat (2010). The report further explains that most systems consider environmental aspects like energy use, water, Indoor air quality among others and also the activities during construction process such as waste management. The assessment tools also consider a building's relationship with the external environment as well as other factors such as the transportation impacts.

Just like many African nations, Kenya relies mostly on government building codes and by laws to establish minimum levels of performance, as the rating tools for buildings assessment are not in existence. More developed Tools used in western countries may not be suitable in our local context as the market is not yet mature. According to a report by the UN-Habitat Conference there are some available options that can be used to modify these developed assessment tools. They can also be tweaked to adapt to modern trends and can also be improved. After which, they will create a positive transformation to Africa's environment. Kenya for example has adopted the Green Star SA for use in sustainability assessment. However, Kenya Green building society (KBS) is in the

process of developing a rating tool that best suits Kenya's social, economic and environmental conditions.

Table 1: Established GBCs and African Countries

Country	**2007 GDP (millions USD)**	**2007 Pop. (millions)**	**2004 CO2 emissions per capita (metric tons)**	**GBC Status**	**Green Building Rating System(s)**
United States	13,811,200	302	20.6	Established	LEED
Japan	4,376,705	128	9.8	Established	CASBEE
Germany	3,297,233	82	9.8	Established	DGNB
Britain	2,727,806	61	9.8	Established	BREEAM
Canada	1,326,376	33	20	Established	LEED
Brazil	1,314,170	192	1.8	Established	LEED
Australia	821,716	21	16.2	Established	Green Star
Netherlands	754,203	16	8.7	Established	BREEM-NL
South Africa	277,581	48	9.4	Established	Green Star SA
Colombia	171,979	46	1.2	Established	LEED
Nigeria	165,690	148	0.8		
New Zealand	129,372	4	7.7	Established	Green Star NZ
Egypt	128,095	75	2.2	Associate	Green Pyramid
Morocco	73,275	31	1.4	Prospective	LEED
Kenya	29,509	38	0.3		
Cameroon	20,644	19	0.2		
Tanzania	16,181	40	0.1		
Ghana	15,246	23	0.3		
Zambia	11,363	12	0.2		
Mauritius		1.2	2.6	Prospective	
Namibia		2	1.2		

Source: Noir & Shaba, 2014

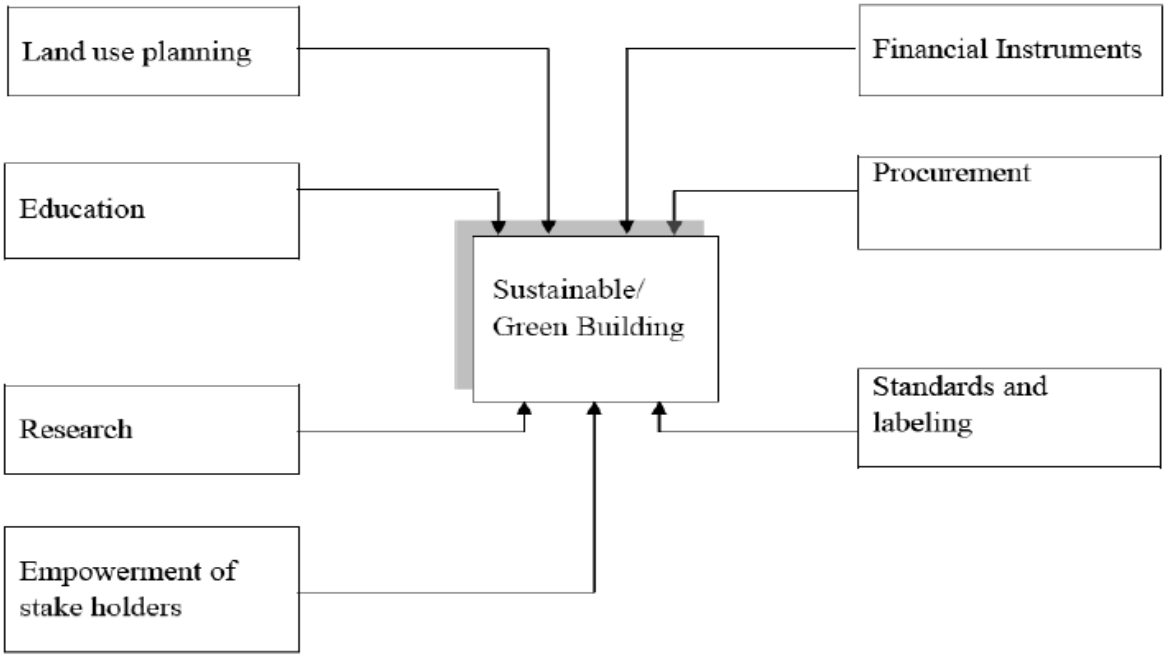
2.8 Green Building Trends

According to a report conducted by McGraw-Hill Construction (2013), certain places had the greatest potential for green buildings between 2012 and 2015. These areas are the new construction and also renovation projects around the planet. The main triggers for the rapid adoption of green buildings worldwide include; lower operating costs, branding/public relations, client demand and market demand. Its sample population was 62 countries, with Kenya included, but the main focus was on nine countries representative of every continent. According to the report, most countries are experiencing a rise in green building trends; however, the rates of this occurrence vary. The study went on to say that there are problems in various parts of the world when it comes to green building adoption. The challenges included a lack of knowledge of the advantages that these structures provide, as well as a lack of government funding.

2.9 Linkages and actions towards sustainable buildings

Tessema et al. (2010) outline various linkages and Actions that can be followed in order to achieve sustainable building in Africa. Land-use planning is one of the most important factors to be considered. This should be given priority at both national and local levels. The local level of the government should be empowered, and there should be more strict criteria in regards to planning developed in the region. Additionally, financial instruments should be introduced by the government, and they should include tax exemptions and loans targeted at the greenhouses. More investment in research that will improve sustainable development should also be included. Should sustainability be included in the formal curricula, education (both formal and informal) should follow suit. Empowerment of Stakeholders and the creation of demonstration centres is also key to promoting sustainable practices. The establishment of standards by professionals and the government would also play a critical role. Tessema et al. (2010) observe that the set standards should include mandatory recycling of waste acquired from demolition, the introduction of a building passport, and defined standards for zero energy buildings; however, it should not be limited to these.

Figure 1: Linkages and actions towards sustainable buildings



Source: Author, 2020

Whenever there are attempts to increase efficiency regarding the use of resources, the construction industry should play a big part because there is great room for efficiency improvement. A broader and more holistic approach to construction of buildings can yield great gains. An ideal approach would be through evaluating the whole building life cycle that captures every process from planning, design and extraction of building resources, to construction, usage and recycling or disposal of material. A wide range of benefits come from the process of making buildings green and their subsequent use. These includes social benefits such as improved wellbeing, productivity and wellbeing of those who use them

Despite these opportunities, they are a number of barriers towards investment in green investment in green buildings. One of the barriers is financial constraints due to exaggerated premiums as well as the fragmented nature of the Industry. The other is the behavioral culture, low awareness by the stakeholders, and also limited capacity. In Kenya, the adoption of green buildings will require significant input from the government in the form of policies and regulatory mechanisms.

To fill the gap, it is paramount that the challenges be identified so that strategies can be developed to handle the challenges. After this, it would be easier for the companies in the construction industry to adopt the concepts of green buildings.

2.10 Summary Review

From Literature Review, the following Key Features of Green buildings were deduced as tabulated below.

GREEN BUILDING FEATURE/STRATEGY	DESCRIPTION
Optimizing on Site Potential	• The team should locate and select a proper site. • The team should then consider existing structures, if any. • Structure and the streets should be well oriented to optimize on solar and passive strategies, • The team should then consider the presence of high priority resources such as animal habitats that ought to be preserved.
Indoor Air Quality	Strategies to achieve this include; • maximum daylight, • The availability of ventilation that is appropriate to the building, • The control of moisture as well as the use of low VOC products.
Diminishing Energy Use and Use Renewable Energy Strategies	Entails reduction of overall energy loads through use of • efficient energy loads through use of efficient equipment and lighting, • skillful detailing of entire enclosure, • incorporating renewable energy systems like photovoltaic, solar water heating etc.
Conserving and Protecting Water	This principle entails • The reduction, control or treatment of site runoff, • The design and construction of the house to conserve both the inside and the outside water, • Rainwater harvesting, recycling and reuse.
Optimizing Operation and Maintenance Practices.	• This Principle involves materials as well as systems whose role is to simplify as well as reduce operation requirements. • They can also be fewer water, electricity, hazardous substances, and cleaners to maintain, as well as being cost-effective and reducing life-cycle losses.

Flexible Design	• This principle advocates for 'loose design' that allows and anticipates future additions to extend building's useful life.

Table: Summary of green building concepts (source: Author 2020)

2.10.1 When to apply green building concepts in a project

Design stage	Issues to consider
Land planning	• Clustering • Reduced Paving • Saving natural Plants
Site planning	• Basic layout relative to sun, wind and views • Sustainable waste management systems and wells • Landscaping and Shading
Construction Process Planning	• Construction waste management and Recycling, • Reducing site disturbance, • Storage and reuse of waste excavated • Hazardous waste Disposal
Basic Design	• Natural lighting by deigning adequate window sizes • Proper orientation in response to solar and wind
Specifications	• Specification of materials with low embodied energy • Specification of energy efficient plumbing and electrical fixtures and fittings. • Energy efficient appliances
During Construction	• Changes that don't impact other aspects, don't raise energy demand, as well as do not compromise green building goals in some way
Post Construction	• Home buyer operation training and Manual

2.10.2 Successful Cases of Green Residential buildings

Senderos Del comendador Homes in Guatemala

This is a recently completed residential estate in Ciudad Vieja, Guatemala. The Edge-certified project consists of 158 residential units designed with an objective of conserving natural resources, reducing carbon footprint as well as helping residents save on utility bills to conserve natural resources, helping residents save on utility costs. Some of the notable green building features include;

30% Savings on Energy.

This has been achieved through reduced window to wall ratio, use of energy saving lighting system on external and internal spaces. Reflective paint and roofing tiles have also been used to reduce on internal heat gain.

33% water savings (Water Conservation)

This has been achieved through use of Duel flush water closets and low flow showerheads and faucets for kitchen sinks and washrooms. **52% less embodied energy in Materials**

In-situ reinforced concrete floor and roof and medium weight hollow concrete blocks for internal and external walls.

Plate 1: Senderos del comendador homes, Guatemala

Waterfall Park, South Africa

This is an infill project located in Benoni, South Africa. The development has both rental and owner occupied sectional property titles. It has 232 units which are certified by edge from Green building council of South Africa. Some of the green building technologies adopted in this development include;

32%Savings on Water

This has been achieved through use of low flow shower heads, low flow faucets in the kitchen and bathrooms, and duel flush toilets.

21%Savings on Energy

This has been achieved through insulation of the roof as well as use of solar hot water collectors on the roof.

Materials.

Solid dense concrete blocks have been used for external walling. Hollow core precast slab has been used as well as micro-concrete tiles on timber rafters for roofing.

Plate 2: Water fall Park, South Africa

2.11 Theoretical and Conceptual Framework for Adoption of Green Building Concepts

Akinwumi (2009) explains that a model may take two forms. The author further mentions that these forms can be a diagram or a construct. The purpose of the model, he adds, is to further the explanation of a theory by supporting it in a visual manner. In another perspective, Lunenburg and Irby (2008) mention that models play a descriptive role and also simplifies a term for easier comprehension. They also mention that models are sometimes empirical as well as testable. Daresh and Playko (1995) further assert that a model creates a relationship between a theoretical statement and also a variety of factors in a graphical manner.

From literature review, the theories deduced that can be used to develop the appropriation of green building concepts include adoption and diffusion theory, sustainability theory, convention theory, innovation theory and the general system theory.

Adoption and Diffusion theory

As per to Rogers (1995), whenever there is an urgency to adopt an innovation, this theory is often used. The theory usually incorporates the innovation-decision model. The described model explains that Adoption is a process that occurs in five stages as opposed to a single act. This occurs over some period when adopters interact with innovation. The five stages are described below:

According to Rodgers (1995), the first stage, known as the 'Knowledge stage', and here the team associated with the adoption of an innovation gather all the relevant knowledge regarding the innovation inclusive of its functionality. According to Anzagira et al. (2019), potential adopters can only choose an innovation that they are knowledgeable about. The second stage is known as 'Persuasion', and here the adopters of the innovation begin discussions regarding the innovation. In this stage, they normally form opinions regarding the innovation. After this stage, the information acquired is then used to decide whether the innovation should be adopted or it should be rejected. The adoption or rejection of innovation occurs only in the third level. Rodgers (1995) mentions the last two stages as implementation and confirmation. The adopters put the innovation to use. The decision to adopt can, however, be reversed if the adopters are exposed to conflicting information about the innovation. Since green buildings are innovative in nature, the theory is useful in the process of adoption.

Sustainability theory

Sustainability theory has a key aim of prioritizing as well as integrating available social responses to any problems that may fit under the category of environmental as well as cultural problems. Since green buildings are about sustainability, this theory can be used to conceptualize GBC adoption since the idea seeks to solve issues related to the use of environmental resources over the course of a building's life cycle. The economic model emphasizes the preservation of both financial and natural resources. Ecological models, on the other hand, help to preserve both biological and ecological diversity.

Convention theory

The aim of convention theory is to explain the interpenetration between the market and non-market organization. Furthermore, according to Loza&Valceshini (1994), the idea of convention theory is to have overall set of rules that synergize human activities, in which the market rules are one part but not the only ones. Convention theory is mostly applied to agro food industry, but the new concept of green building technology can also adopt this theory.

General System theory

Whenever the degree of adoption of the concepts of green buildings needs to be conceptualized in relation to residential buildings, this theory becomes applicable. According to Were (2015), subsystems can become interconnected, forming a system. However, the individual sub systems can also be perceived as systems on their own. Through this, there is a formation of a hierarchy of systems. The author further adds that the theory has been used to solve problems within organizations with great success.

Challenges facing the adoption of the concepts of green buildings have been conceptualized by using the general systems theory.

2.11.1 Conceptualizing Green Building Concepts and General System Theory

From a construction process, Green building can be achieving by incorporating various green building concepts (inputs) in the process from design stage, construction phase, use, maintenance and disposal of the same. These Activities involves in creating green buildings make it a system. Incorporation of green building concepts can be categorized into 5 broad areas which include; Sustainable sites, Energy and water efficiency, Indoor air quality as well as materials and waste management. These sub categories can be termed as sub systems which in turn serve as systems on their own.

'Outside factors' such as government legislations, finances, incentives and tax waivers among others influence the inputs for adoption of green building concepts. These external factors should not however adversely influence adoption of green building concepts. This study will attempt to show how various inputs affect the adoption of green building concepts with a focus on residential property segment.

2.11.2 The conceptual framework of the study

The figure below represents Conceptual framework in which Green building as an output is the dependent variable whereas water and energy efficiency, selection of site, environmental quality, waste and material are the independent variables. Even though the five environmental categories have been adopted in the conceptual frame work, certain aspects of these categories were not applicable because the study sample was drawn from existing completed buildings.

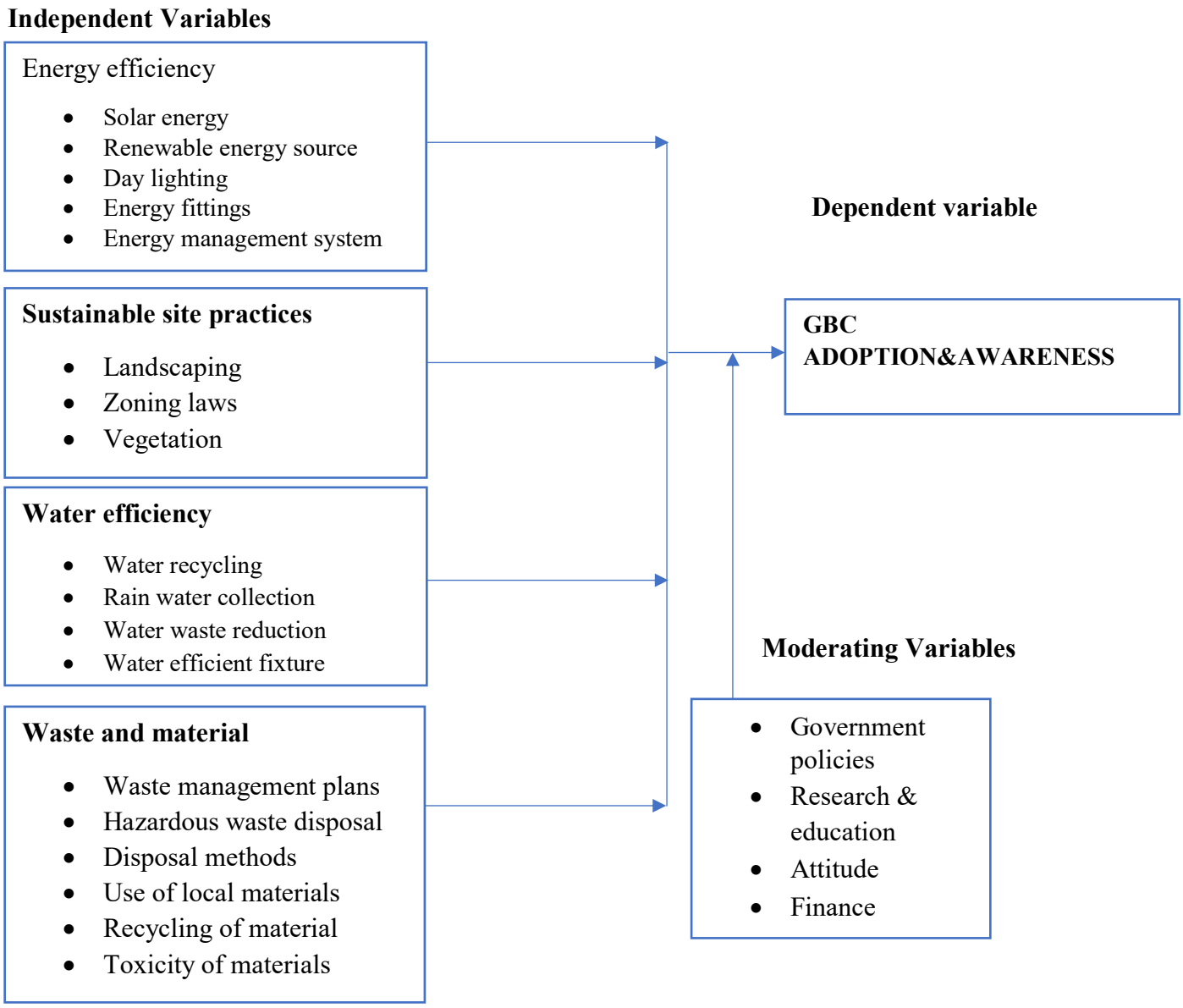


Figure 1.1 Interaction between the independent variables and the dependent variable

Chapter two evaluates the existing knowledge in the subject of study and the next chapter, methodology shows the research design, and the methods of attaining the study objectives.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The Chapter is an explanation of the methods and processes that have been adopted to attain the objectives of this research. Discussed below are the subtopics under this chapter that include research design,background and study area,methods of data collection and techniques,population and sampling,data processing,data analysis and presentation ,measurement of variables,statistical analysis and ranking among others.

3.2 Research Design

A research design is a framework created to answer research questions, John W. (2014). Selltiz et al. (1962), cited in Kothari (2004), explains that a research design has to follow a specific organization of conditions and apply analysis methods specific to this organization. Further, research design is defined as the theoretical structure where research is carried out and also contains a blueprint used in data collection, measurement and analysis. Descriptive research design was preferred for this study. Mugenda&Mugenda (2007) describes descriptive survey design as a technique of data collection by interviewing or issuing questionnaires to individuals sampled, objects or events. This survey design was preferred as it explains the existing status of the two variables i.e. Green Building Concepts and Factors affecting adoption of green building concepts in residential developments in Nairobi County. It includes any measurement processes that involve asking questions through questionnaires.

The key role of design is to help curb situations where the available evidence fails to address the initial research questions. The study is exploratory in nature and adopted a case study approach. Case study research method is a thorough study done once or in few events to better understand the phenomenon being studied. The approach focuses mostly on carrying out complete analysis of a small number of events and how they relate. Preferred also is the carrying out of contemporary examination of events only in circumstances where the relevant behavior remain constant. Through this approach the researcher is able to maintain complete and meaningful characteristics of events that happen in reality, situation such as individual life cycles, organizational and managerial processes.

In reference to this study the researcher studies the selected residential developments in Nairobi, Kenya thoroughly to have a deeper understanding of their concepts of GBC that have been implemented and how it impacts on the management of the buildings.

3.2.1 Population

As per Mugenda and Mugenda (1999), a population in this study can be described as events or people, or even items that have the characteristics to be studied. Since the population of interest is likely to be large, a working population has to be selected that will represent the whole. According to Rea and Parker (2007), an active population possesses the interest and is part of the larger population. For this study, the working population comprised of residential property developers operating in Nairobi city county and residential estates located in Nairobi city county that have implemented concepts of Green Building.

3.2.2 Sampling

Sampling refers to the process of choosing a sub-group to act as representation of the whole population where the inferences are obtained concerning the entire population. A list of registered property developers from the Kenya Property Developers Association (KPDA) was used as a guide. Purposive sampling technique was used in the selection of the firms to be included in the survey. Kumar (2005) describes purposive sampling as the discernment of the researcher on who can supply the most relevant data to accomplish the set goals of the study, therefore, the researcher approaches the sources who according to him can provide the required data and at the same time can willingly share it. Green Building technologies are not common in Kenya and this being a new concept brought about by changes in technological innovation. Purposive sampling is the most relevant sampling technique to be employed as it enables a careful and non-random selection of cases whose characteristics permits an understanding of the research questions. Accordingly, fifty-nine (59) residential real estate development companies registered by KPDA were chosen for the Survey. A list of Residential developments by these companies was also obtained and 5 residential estates perceived to have implemented green building concepts were also included for survey.

A census of residential property development companies actively owning residential properties in Nairobi was conducted and questionnaires were sent to all these companies. The use of census technique was applied to a small number of respondents who have a high opportunity of inclusion (Kothari 2004).

Table 2: Registered Real Estate Development Companies

Registered Property Development Companies with KPDA	Registered Residential Real Estate Development Companies	% Percentage
78	59	75.6%

Source: Author, 2019

3.3 Background Information on the Study Areas

The study is majorly focused on Nairobi City County. A list of residential estates was obtained from fifty nine (59) residential property developers registered with KPDA.From the list, an assessment was done to identify residential estates perceived to have adopted green building concepts were used to collect data. The assessment criteria included;

i. The residential estate must have at least one green building feature under the broad categories of water efficiency; Energy efficiency; sustainable site practices; Material and waste management.
ii. Projects completed within the last 10years.

Observations were therefore done in five residential estates that were perceived to have adopted green building concepts. The properties are located in the outskirts of Nairobi CBD.

Map 1: Map of Nairobi showing the Boundaries and Neighboring Counties

Source: Google map, 2019

3.3.1 Typical Description of Residential Properties in Nairobi

Map 2: Map of Nairobi showing the location of the observed Estates

Source: Google Earth, 2020

3.3.2 Pictorial View of Residential Estates

Plate 3: Eagle plains estate, Mombasa road

Source: Field Survey, 2019

Plate 4: Nyayo Estate, Embakasi

Source: Field Survey, 2019

Plate 5: Runda gardens, Kiambu Road

Source: Field Survey, 2019

Plate 6: Phenom estate, Lang'ata

Source: Field Survey, 2019

Plate 7: Garden estate villas, Thika Road

Source: Field Survey, 2019

3.4 Data Collection

Data was gathered from the respondents using a structured questionnaire. To familiarize themselves with the field of analysis, the researcher performed a pilot study. This made it easier for the assigned to meet management for explanations of the requirement to run the research in the Residential Real Estate Development Companies.

Data were obtained from primary and secondary sources. Secondary data were obtained from published books, peer reviewed articles and internet sources. Primary data were obtained from interviews and questionnaires administered. The researcher carried out intensive interview on the main informants within the area of study to obtain the required information from them. This method of data collection is significant as it helps in the collection of first-hand information from the direct users of green building technologies.

Questionnaires were administered to property developers while an observation list was used to collect first-hand information on the available green building technologies. Information obtained from the source by the researcher was majorly their opinions on various aspects of the green building technologies and their levels of implementation.

3.4.1 Instrumentation

For the legitimacy and reliability of the questionnaires, a pilot study was conducted on 3 real estate residential companies in Nairobi County which were not included in this study. This instrumentation was used for piloting. While figuring a point by point instrument, unwavering quality and validity were two of the most vital properties inspected.

3.4.1.1 Validity

Validity, according to Joppe (2000), is a measure of what the study intends to examine. Similarly, Mugenda and Mugenda, the measure by which findings obtained from the examination of the knowledge truly speak to the wonder under study (1999). The supervisors were enlisted to help assess and develop the questionnaire's validity. As a result, the final questionnaire was able to gather all of the necessary information. The Content Validity Index was used to quantify content validity in the sample (CVI).

3.4.1.2 Reliability

As it is concerned with the accuracy of the methods used to analyze data, determining reliability of a research instrument is critical. The ability of research instruments to yield consistent results

when used repeatedly is what determines their reliability (Fraenkel and Wallen, 2000). Cronbach's alpha coefficient value was used to examine the research instrument's reliability in this analysis. When Cronbach's coefficient value was greater than.7, the result was reliable; when it was less than.7, it was not. Both of the instruments were found to be trustworthy.

3.5 Ethical Consideration

By behaving in a manner that ensures their decency, the researcher considered the research on Registered Residential Real Estate Development Companies. Ethics are rules of conduct that differentiate between what is permissible and what is not, particularly when conducting research. The respondents were guaranteed that the information they provided would only be used for academic purposes in this report.

The university's board of postgraduate studies reviewed and approved this report, and it was carried out with their full support.

3.6 Data Processing, Analysis and Presentation

After collection of the needed information, data processing was carried out. Information collected was analyzed by using descriptive statistics in the form of percentages and tables through Microsoft excel version 2013 and SPSS version 25. Through descriptive statistics, systematic data collection analysis and interpretation of the collected data the desired research objectives were met.

3.7 Chapter Summary

This chapter lays down the procedures that were adopted in this research. The methods and the procedure used during data collection forms the basis of any meaningful research and also a well-defined explanation of the target group of the respondents. The topics of study design, population, sample design, data collection, and data analysis were discussed. A descriptive research design was used for this analysis. According to (Mugenda & Mugenda, 2007), descriptive survey design is a method of gathering data by interviewing a sample of people, items, or events by use of questionnaires to. This survey design was preferred as it explains the existing status of the two variables i.e. Green Building Concepts and Factors affecting adoption of green building concepts in residential developments in Nairobi County.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND FINDINGS

4.1 Introduction

The objectives of this study were to assess the level of awareness of Green Building Concepts in Residential Buildings in Kenya, to assess the green building concepts that has been adopted in residential developments in Kenya, to assess problems encountered by housing developers in appropriation of green building concepts in residential developments in Kenya and to identify suitable techniques for implementing green building concepts in residential developments in Kenya. Microsoft excel version 2013 and SPSS version 25 were employed in data analysis and presentation.

4.1.1 Fieldwork

Fieldwork was conducted at different times between the months of March 2020 and May 2020. The main purpose of the fieldwork was to establish the level of green building concepts adoption in residential buildings, to identify specific green building concepts adopted, establish the problems faced in adoption of green building concepts and recommend measures for ease of the adoption of green building concepts. This was achieved through administered questionnaires to property managers of Residential properties identified in Nairobi, observation was used to identify specific technologies and was documented by taking photographs.

Selection of residential property development companies was done through purposive sampling where 59 residential real estate development companies were identified and issued with questionnaires within the delimitation of Nairobi County.

4.2 Response Rate

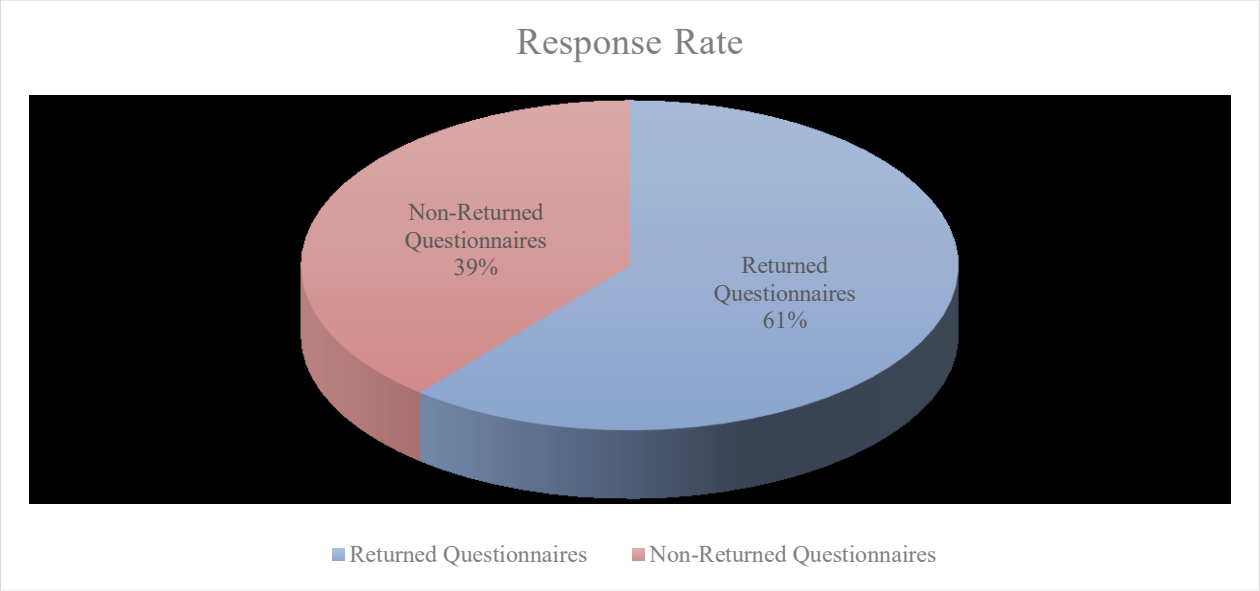
The researcher had identified 59 property development companies operating in Nairobi City, the companies are believed to be behind development of high-quality residential buildings. These companies own the most recently completed residential estates buildings as well as old residential buildings. Table 3 below represent response rate.

Table 3: Questionnaires Response Rate

Target Respondents	Number of Questionnaires Issued	Number of Questionnaires Returned	Response Rate
Property Developers	59	36	61%

Source: Field Survey, 2020

Figure 2: Response Rate



Source: Field Survey, 2020

Mugenda and Mugenda, (2003) opines, a response rate of 50% is considered enough for analysis and reporting while 60% is good and 70% or above is considered very good. Therefore, a response rate of 61% is adequate for reporting. Although both the reasons for non-participation and the features of the non-respondents are defined, the above average response was assumed to be due to tight schedule of the respondents.

4.3 Level of Awareness of Green Building Concepts in Residential Buildings in Kenya

One of the objectives of the study was to examine the rate at which Green Building concepts had been implemented within Nairobi residential buildings.

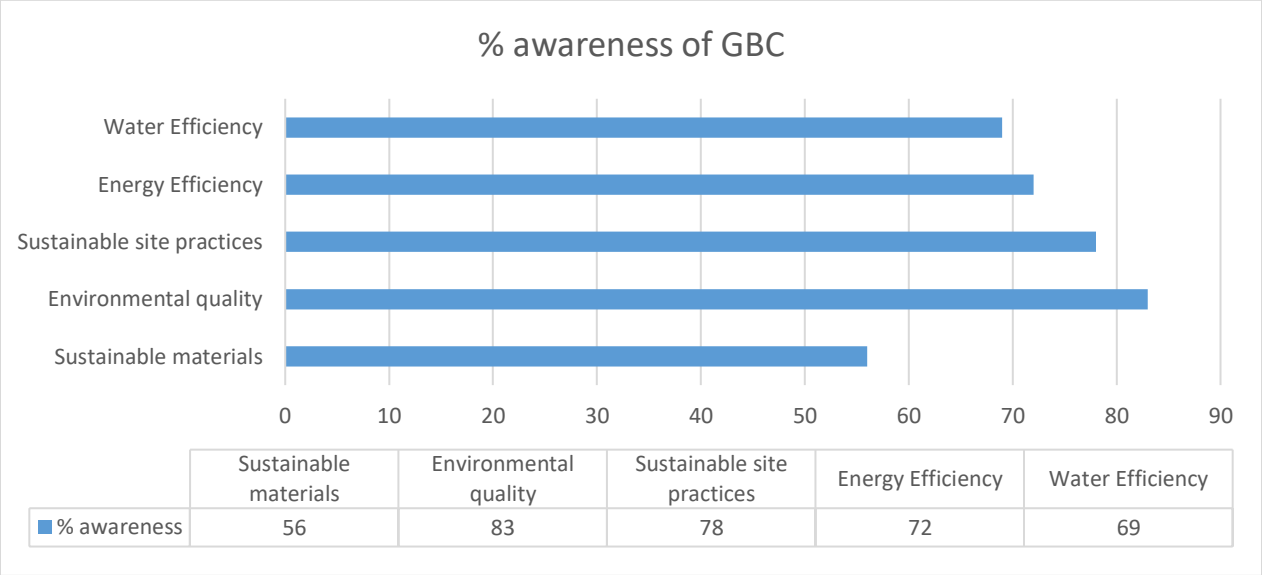
To investigate the magnitude of awareness of Green Building Concepts, the property development companies were asked to state which among the concepts they were familiar with. The technologies were further grouped into five categories namely sustainable materials, Environmental quality, Water quality, sustainable site quality and energy efficiency.

Table 4: Awareness of Green Building concepts

Green Building Concepts	**Awareness of the Green Building Concepts**		**% awareness**
	Yes	**No**	
Sustainable materials	20	16	56
Environmental quality	30	6	83
Sustainable site practices	28	8	78
Energy Efficiency	26	13	72
Water Efficiency	25	11	69

Source: Field Survey, 2020

Figure 3: Awareness of Green Building Concepts



Source: Field Survey, 2020

The level of awareness of Green Building Concepts was varied with environmental quality having the highest level of awareness at 83% of the respondents while sustainable site practices was second with 78% level of awareness Table 5 and Figure 2 above shows the percentage of awareness of the Green Building Concepts property developers who participated in the study.

4.4 Green Building Concepts Implemented in Residential Buildings in Kenya

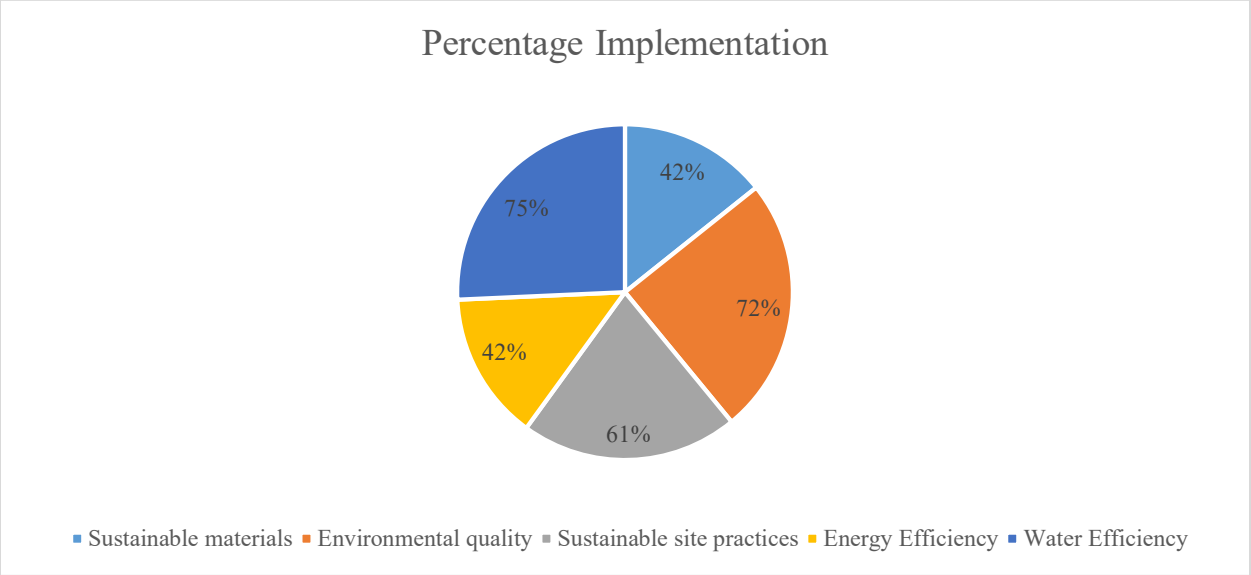
The study sought to find out specific green building concepts that have been incorporated in residential buildings in Kenya. Property developers were asked to indicate the green building aspects that had been incorporated in the residential buildings on their portfolio.

Table 5: Green Building Concepts Implemented in Residential Buildings in Kenya

S/No.	Green Building Concepts	Implemented	Not Implemented	Percentage Implementation
1	Sustainable materials	15	21	42%
2	Environmental quality	26	10	72%
3	Sustainable site practices	22	14	61%
4	Energy Efficiency	15	21	42%
5	Water Efficiency	27	9	75%

Source: Field Survey, 2020

Figure 4: Green Building Concepts Implemented in Residential Buildings in Kenya



Source: Field Survey, 2020

The study sought to find out which Green Building aspects had been adopted in the residential buildings by the respondents. The findings in figure 3 reveal water efficiency concepts had been incorporated in residential buildings by 75% of the developers. Ezilondo et al (2010) as observed in the literature review indicate that current and efficient products are one of the selections to reduce water consumption and associated bills. For example, Davidson (Water conservation Group, 2010) states that waste water is used mostly for landscaping, irrigation, cleaning among other uses. One of reason therefore why water efficiency had a greater score was because there was probably need to recycle water for landscaping that triggered the thought of users to recycle. However, studies suggest that most effective measures are in attitude instead of the incorporation of the concepts (Ezilondo, Maria, Lofthouse, & Victoria, 2010).

The results further revealed that Environmental Quality and Sustainable site practices had 72% and 61% of the respondents indicating that they had implemented these concepts.

4.4.1 Level of Adoption of Green Building Concepts Residential Buildings in Kenya

The study sought to find out specific GBC concepts that have been implemented in residential buildings in Kenya, residential property developers were asked to give their opinions on the devices that had been implemented in properties they were managing, the opinions were on a one to five Linkert scale with 1 representing very low level of adoption and 5 representing very high

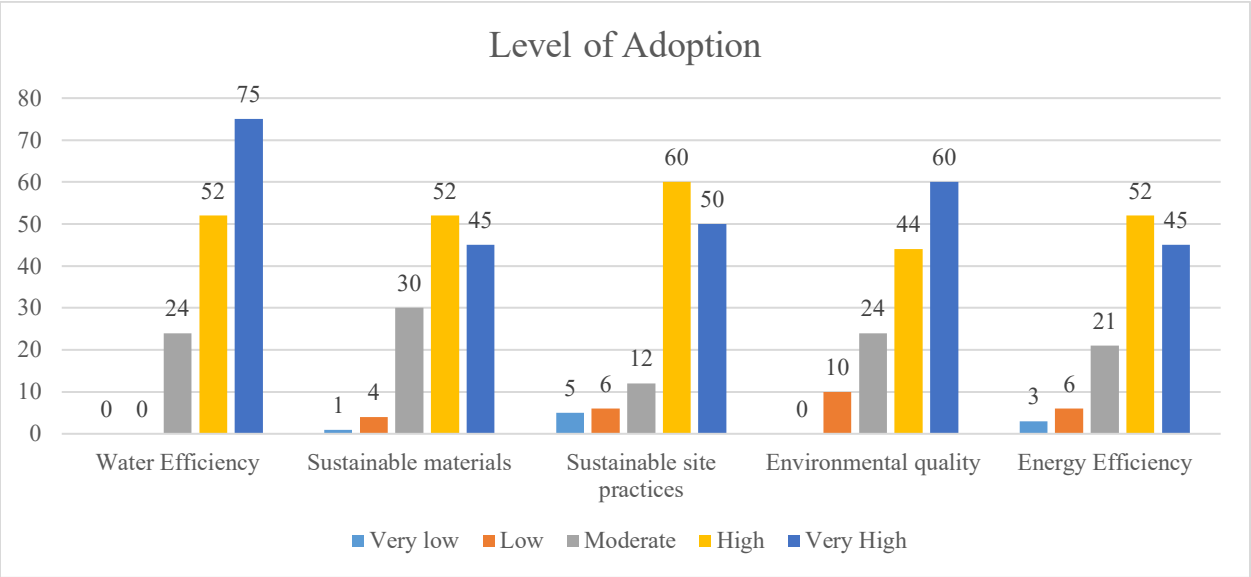
level of adoption of the concept. The means of the concepts were determined and ranked to determine the most adopted concept. Table 7 below represents the means of the levels of adoption of the concepts. The rank is calculated by determining the mean score of each item or by calculation of the relative importance index.

Table 6: Level of Adoption of Green Building Concepts Residential Buildings in Kenya

S/N	Green Building Concepts	Very low	Low	Moderate	High	Very High	Total	mean	No. of Respondents	Rank
1	Water Efficiency	0	0	24	52	75	151	4.19	36	1
2	Sustainable materials	1	4	30	52	45	132	3.67	36	4
3	Sustainable site practices	5	6	12	60	50	133	3.69	36	3
4	Environmental quality	0	10	24	44	60	138	3.83	36	2
5	Energy Efficiency	3	6	21	52	45	127	3.53	36	5

Source: Field Survey, 2020

Figure 5: Level of Adoption of Green Building Concepts Residential Buildings in Kenya



Source: Field Survey, 2020

The study further the extent to which the concept of water efficiency and its usage had been implemented in projects; it was noted that the level of adoption was high after scoring a mean of 4.19. Environmental quality ranked second with a mean score of 3.83 while energy efficiency

To determine the difficulties was ranked last after scoring a mean of 3.53.

4.5 Challenges Faced in Adoption and Implementation of Green Building Concepts in Residential Buildings in Kenya

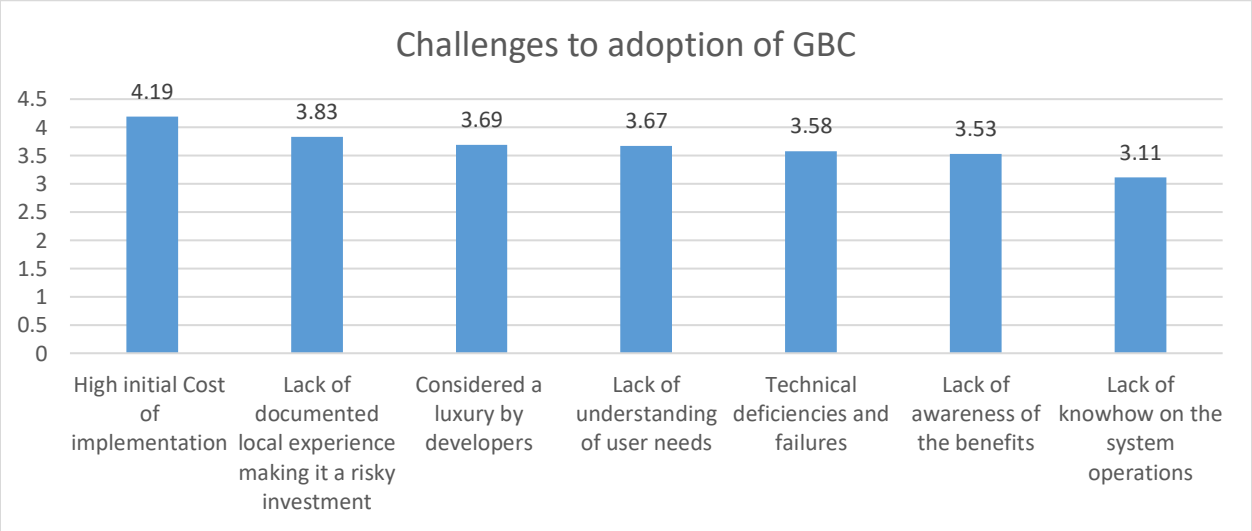
Respondents used a 5-point scale to determine the rate at which the problem found inhibits acceptance of Green Building Concepts. An average score was measured, with a higher mean score indicating a high difficulty, and a lower mean indicating a lower challenge in adopting the green building concept.

Table 7: Challenges faced in adoption and implementation of Green Building Concepts Residential Buildings in Kenya

Challenges faced in GBC in Residential Buildings	Mean
High initial Cost of implementation	4.19
Lack of documented local experience making it a risky investment	3.83
Considered a luxury by developers	3.69
Lack of understanding of user needs	3.67
Technical deficiencies and failures	3.58
Lack of awareness of the benefits	3.53
Lack of knowledge on GBC	3.11

Source: Field Survey, 2020

Figure 6: Challenges faced in adoption and implementation of Green Building Concepts Residential Buildings in Kenya



Source: Field Survey, 2020

The study findings indicated that high initial cost of adoption and installation with a mean of 4.19 was the major hindrance to adoption of GBC, this explains why old buildings are specifically slow at adopting these technologies, and implementation in these cases would require major structural modifications to the buildings as stated by Ciesielska and Li (2011). Lack of documented local

experience scored second as a hindrance to the adoption of GBC with a mean of 3.93 while consideration of such technologies as a luxury by developers placed third with a mean of 3.69 and lack of understanding of user needs placed fourth with a mean of 3.67. Respondents were of the view that studies needed to be done to isolate critical user needs in residential buildings. Technical deficiencies including lack of support staff in case of breakdown of the technologies ranked fifth as a hindrance to adoption of GBC with a mean of 3.58 while ignorance of GBC benefits and lack of knowhow of the systems operations placed sixth and seventh with means of 3.53 and 3.11 respectively.

4.6 Strategies to facilitate widespread adoption and implementation of Green Building Concepts Residential Buildings in Kenya

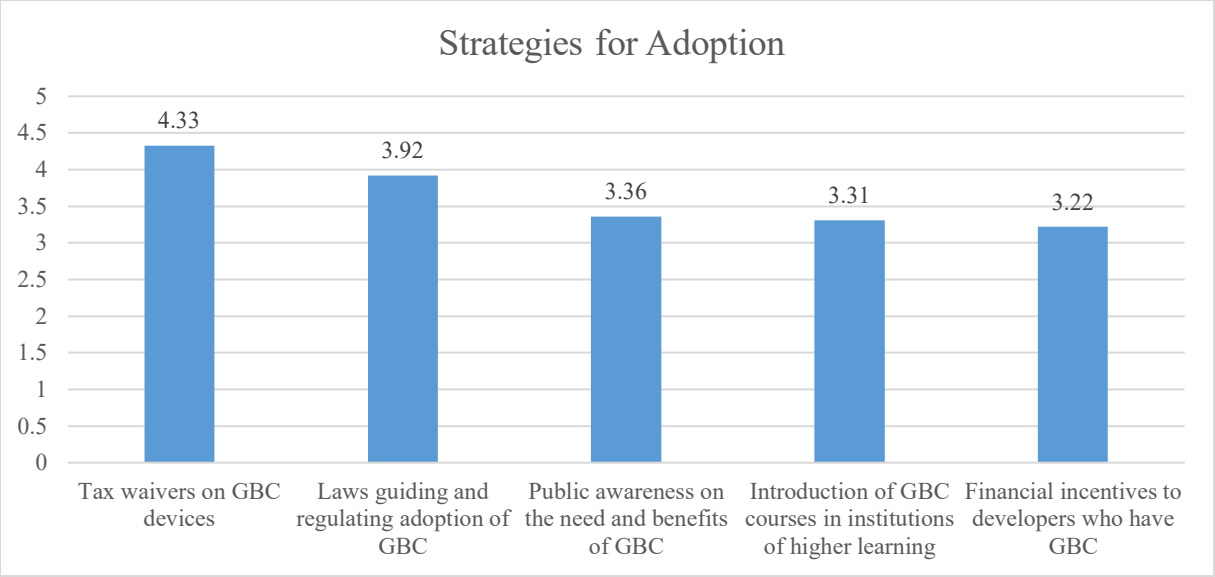
The study further asked the respondents to give their opinions on what should be done to ensure widespread adoption of Green Building Concepts in residential buildings in Kenya, respondents were expected to grade the opinions on a scale of 1 to 5 with 1 being the factor that would lead to least widespread adoption and 5 being the factor that would lead to highest rate of adoption, the ratings were ranked by calculation of mean score of each rate and ranked.

Table 8: Strategies to facilitate widespread adoption of GBC in Residential Buildings in Kenya

Strategies to facilitate adoption of GBC	**Mean**
Tax waivers on GBC devices	4.33
Laws guiding and regulating adoption of GBC	3.92
Public awareness on the need and benefits of GBC	3.36
Introduction of GBC courses in institutions of higher learning	3.31
Financial incentives to developers who have GBC	3.22

Source: Field Survey, 2020

Figure 7: Strategies to facilitate adoption of GBC



Source: Field Survey, 2020

The study findings indicated that certain initiatives should be put in place to enable wide spread adoption of GBC in residential buildings in Kenya. Tax waivers on GB concepts ranked highest with a mean of 4.33, the respondents noted that tax waivers would lower the cost of importing these devices and thus make them readily available. Adoption of regulations enforcing adoption of GB concepts ranked second with a mean of 3.92 respondents had the opinion that laws enforcing adoption would speed up the rate of GBC adoption. Increased public awareness on the need and benefits of GBC and introduction of training on GBC at institutions of higher institutions ranked third and fourth with means of 3.36 and 3.31 respectively. Financial incentives to developers who have implemented GBC ranked fifth with a mean of 3.22 the respondents also stated that property developers considered financial incentives should be on tax laws and not direct financial refunds.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

From analysis in chapter for, vital findings of the study have been determined which advises the conclusions and the recommendations of the study. The study sought to find "**the level of adoption of Green Building Concepts in residential buildings in Kenya"** set out to:

a. To assess the level of awareness of Green building Concepts in Residential Buildings in Kenya.

b. To examine the green building concepts that have been adopted in residential developments in Kenya.

c. To assess the challenges faced by housing developers in adoption of green building concepts in residential developments in Kenya.

d. To identify suitable strategies for implementing green building concepts in residential developments in Kenya.

Further, the objectives were converted to research questions to enable carrying out research while answering these questions at the same time. The previous chapter contains a representation of information that was gathered from the field and their analysis, on the other hand, this chapter presents summarized findings as well as the conclusion for the study. Recommendations are reached on the backbone of the research objectives and findings.

5.2 Summary of Major Findings

5.2.1 Awareness of Green building Concepts in Residential Buildings in Kenya

The study found that the rate of awareness of GB concepts was average. The level of awareness of Green Building Concepts was varied with environmental quality having the highest level of awareness at 83% of the respondents while sustainable site practices was second with 78% level of awareness.

5.2.2 Green Building concepts that have been adopted in residential developments in Kenya

The second aim of the study was to determine green building concepts had been incorporated in the residential developments. Five GBC categories namely Sustainable materials, environmental quality, sustainable site practices, energy efficiency and water efficiency were taken into consideration. The level of adoption of each concept was determined by observation of the concepts that were in place in specific residential buildings. A percentage of implemented concepts in the vis-à-vis not implemented was then determined.

The results revealed that Environmental Quality and Sustainable site practices had 72% and 61% of the respondents indicating that they had implemented these concepts.

5.2.3 Challenges encountered by housing developers in adoption of green building concepts in residential developments in Kenya.

The third objective of the study was to determine the challenges faced by developers in adopting GB concepts in residential buildings. The study findings indicated that lack of widely available low-cost GBC is the main hindrance to the widespread appropriation of Green building technologies with a mean of 4.22. Second on the rank was the high cost of adoption and installation with a mean of 4.19. Lack of documented local experience scored third as a hindrance to the adoption of GBC with a mean of 3.93 while consideration of such technologies as a luxury by developers placed fourth with a mean of 3.69 and lack of understanding of user needs ranking fifth with a mean of 3.67.

The study revealed that poor implementation of durable building policies and incentives from the government was the extreme hindrance facing developers in the implementation of GBC these two factors rank one and two with a mean of 1.81 and 2.43 respectively. Lack of awareness (3.74) was the least challenge practitioners faced in the adoption of the concepts. Lack of awareness GBC benefits ranked seventh.

5.2.4 Techniques for implementing green building concepts in residential developments in Kenya

The fourth objective of the study was to determine strategies that can be used to ensure enhanced adoption of GB concepts in residential buildings. Tax waivers on GB concepts ranked highest with a mean of 4.33, implementation of regulations enforcing the adoption of GB concepts ranked second with a mean of 3.92 while increased public awareness on the need and benefits of GB concepts and introduction of training on GB concepts at institutions of higher institutions ranked third and fourth with means of 3.36 and 3.31 respectively. Financial incentives to developers who have implemented GB concepts ranked fifth with a mean of 3.22.

5.3 Methodology Adopted

This study adopted a case study design. The population consisted of five purposively selected real estate development companies and residential properties developed by these companies. A total of 59 developments were identified for this study, the properties were located in Nairobi County. The choice of these companies was made considering the fact that they are the top real estate development companies in the country and they manage the largest and most recently completed Residential developments in the study area

The 59 questionnaires were sent and 36 questionnaires were received back representing 64% response rate. Mugenda and Mugenda, 2003 opines, a response rate of 50% as ideal for analysis and detailing while 60% is good and 70% or above is considered very good. Therefore, an overall response rate of 64% is adequate for reporting.

5.4 Conclusions

The level of awareness of GB concepts is at average level while adoption level of individual concepts is varied per each concept.

There is need to come up with policies and guidelines for implementation of GB concepts and introduction of incentives from the government as lack of this factor was intimated to be among those hindering the adoption of the technology. Consequently, the strategy would be to ensure that policies and education are enforced.

5.5 Recommendations

From the findings of this study, the noted recommendations are therefore made with a view of heightening awareness and adoption of green building concepts in residential buildings. As per the study findings and conclusions of the objectives, the study shows that the level of adoption varied per each concept. The study therefore recommends the developers should adopt the most current green building technologies as this will result in cost savings in the long run, while at the same time safeguarding the environment and positively impacting on human health. The study also shows that adherence to legal and regulatory framework is the major determinant of choice of GB concepts, it therefore recommends that the government should develop procedures and strategies for enforcement of adoption of GB concepts. Regulatory framework for adoption of green building concepts is required. This can be done during approval process at the county level where a checklist for green building technologies can be adopted and this should be followed up during construction and occupation stage. Incentives from the government are also critical to adoption of green building technologies in residential developments.

5.6 Areas of further study

The study dwelt on Green Building concepts in Residential Buildings in Kenya with a focus on Nairobi City County, by looking at awareness, Adoption challenges from a perspective of house Developers. The study recommends further studies on Comparative Analysis of green building residential house vs. Conventional house from a cost perspective. The study also advises further research on post occupancy evaluation of green buildings.

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APPENDICES

a) Study Schedule

Acivity	Duration	Target
a) Proposal writing	10weeks	April 2020
b) Preparation of questionnaires	2 weeks	July 2020
c) Distribution of questionnaires	2 weeks	July 2020
d) Filling in questionnaires	2weeks	August 2020
e) Collecting questionnaires	1 week	August 2020
f) Interviews	1 week	August 2020
g) Data analysis and discussions	6weeks	October 2020
h) Compiling the final thesis report	4weeks	November 2020
i) Project defense	1 day	May 2021

b) BUDGET SCHEDULE

N0.	Item	Specification	Cost
i.	Support services	Secretarial costs, data input and analysis	Kes 20,000
ii.	Filed work costs	Transport and other expenses	Kes 50,000
iii.	Overheads	Stationery, photocopying& other printing charges	Kes 15,000
iv.	Research materials	Books, magazines& journals	Kes 30,000
v.	Conferences	Attendance fee & other expenses	Kes 20,000
vi.	Journal	Journals payments	Kes 15,000
		Total	Kes 150,000

Appendix I: Consent letter

Joseck Wakhungu

B53/6665/2017

Nairobi-Kenya

15th May 2020

RE: TO WHOM IT MAY CONCERN

I am a Masters Student at the University of Nairobi Undertaking M.A in Construction Management.

I am carrying out Research Entitled: ***Adoption of green building concepts in Residential development in Nairobi County (Housing Developers Perspective)***

The Purposes of this Questionnaire is to help achieve that aim.

The Questionnaire is purely for academic purposes and the information shall be kept confidential. Kindly fill in the Questionnaire as per Instruction.

Should you wish to make a clarification, kindly use the address below;

School of built Environment

Department of Quantity surveying and construction management

University of Nairobi

Joseck Wakhungu

B53/6665/2017

INSPECTION CHECKLIST

WATER EFFICIENCY	**YES**	**NO**	**COMMENTS**
a) Water Recycling			
b) Rain Water Collection			
c) Water Waste Reduction			
d) Water Efficient Fixture			
e) Others			
ENERGY EFFICIENCY	YES	NO	COMMENTS
a) Use of Solar			
b) Use of renewable energy sources			
c) Day lighting			
d) Use of energy efficient fittings			
e) Use of Energy Management Systems			
f) Others			
MATERIALS	**YES**	**NO**	**COMMENTS**
a) Use of local materials(no imports)			
b) Use of materials that can be re-used/recycled after building life			
c) Use of materials with low environmental impact			
d) Use of low toxic materials			
e) Others			
CHOICE OF SITE	YES	NO	
a) Site Landscaping			
b) Adherence to local Zoning laws			
c) Preservation of existing vegetation			
d) Others			
WASTE DISPOSAL&REDUCTION	**YES**	**NO**	**COMMENTS**
a) Provision of waste management plan			
b) Hazardous waste management and disposal			
c) Provision of different disposal methods			
d) Others			

Appendix II: Questionnaire

Specific Questions

1. Adopting green building concepts in Residential Developments in Residential houses

a) Are aware of the following green building concepts?

CONCEPT	DESCRIPTION	Yes	No
Energy efficiency	Use of renewable energy sources, Maximum daylight, use of energy efficient fittings.		
Water Efficiency	Rian water harvesting, Water recycling, water waste reduction, water efficient fixtures		
Sustainable site Practice	Site landscaping, preservation of existing vegetation,		
Sustainable Materials	Use of local materials that can be recycled, low embodied-energy materials		
Waste Management	Waste Management Plan, different disposal method, hazardous waste collection and disposal		
Indoor Air Quality	Provision of ventilation, furnishings etc.		

b) Have you incorporated any of the above concepts in your Projects?

YES ☐

NO ☐

c) If yes, which concept did you apply in your residential project, **tick Yes or No**

Category	**Yes**	**No**
1) Energy efficiency		
2) Water Efficiency		
3) Sustainable site Practice		
4) Sustainable Materials		
5) Waste Management		
6) Indoor Air Quality		
7) None		

d) To what extent did you apply the above green building concepts? Use a five point scale where **5**(no extent);**4**(little extent);**3**(moderate extent) ;**2**(high extent); **1**(Very high extent)

Category	**5**	**4**	**3**	**2**	**1**
1) Energy efficiency					
2) Water Efficiency					
3) Sustainable site Practice					
4) Sustainable Materials					
5) Waste Management					
6) Indoor Air Quality					

e) The table below shows different green building concepts used in Kenya, Using a scale of 5, rate the extent to which you have applied these concepts.

	Not at all	**Low**	**Moderate**	**High**	**Very high**
WATER EFFICIENCY	**1**	**2**	**3**	**4**	**5**
f) Water Recycling					
g) Rain Water Collection					
h) Water Waste Reduction					
i) Water Efficient Fixture					
j) Others					
ENERGY EFFICIENCY	**1**	**2**	**3**	**4**	**5**
g) Use of Solar					
h) Use of renewable energy sources					
i) Day lighting					
j) Use of energy efficient fittings					
k) Use of Energy Management Systems					
l) Others					
MATERIALS	**1**	**2**	**3**	**4**	**5**
f) Use of local materials(no imports)					
g) Use of materials that can be re-used/recycled after building life					

h) Use of materials with low environmental impact					
i) Use of low toxic materials					
j) Others					
CHOICE OF SITE	**1**	**2**	**3**	**4**	**5**
e) Site Landscaping					
f) Adherence to local Zoning laws					
g) Preservation of existing vegetation					
h) Others					
WASTE DISPOSAL&REDUCTION	**1**	**2**	**3**	**4**	**4**
e) Provision of waste management plan					
f) Hazardous waste management and disposal					
g) Provision of different disposal methods					
h) Others					

2. Challenges Hindering Adoption of Green building Concepts in Residential Developments

a) Using a scale of 1-5,rank the factors you feel largely affect the adoption of green building concepts in Residential developments in Kenya, where **1** is the lowest Rank and **5** the highest Rank.

FACTORS HINDERING ADOPTION OF GBC IN RESIDENTIAL DEVELOPMENTS	**5**	**4**	**3**	**2**	**1**
i. Lack of government incentives					
ii. Lack of urban planning and land use policy					
iii. Lack of awareness					
iv. Lack of financial Instruments on Green Buildings					
v. Lack of enforcement of sustainable building policies					
vi. Limited research on green building concepts					
vii. Others……..(specify)					

3. Strategies to promote adoption of GBT in Residential Developments

a) Which of the following strategies do you think will promote uptake of GBT in residential developments in Kenya? Use scale of 1-5 where 1 is the lowest and 5 is the highest

STRATEGIES TO PROMOTE UPTAKE OF GBT	**5**	**4**	**3**	**2**	**1**
i. Financial Incentives(i.e. tax holidays, green loans)					
ii. Awareness and campaign					
iii. Education on GBT					
iv. Strict enforcement of sustainability laws by government.					
v. Development of sustainability checklist by local authority					
vi. Recognizing and certifying green homes					
vii. Others……..(Specify)					

b) Using a five point scale where **5**(not at all);**4**(little);**3**(moderate) ;**2**(high); **1**(Very high),indicate to what extend can these strategies promote uptake of GBC in residential segment?

STRATEGIES TO PROMOTE UPTAKE OF GBT	**5**	**4**	**3**	**2**	**1**
i. Financial Incentives(i.e. tax holidays, green loans)					
ii. Awareness and campaign					
iii. Education on GBT					
iv. Strict enforcement of sustainability laws by government.					
v. Development of sustainability checklist by local authority					
vi. Recognizing and certifying green homes					
vii. Others……..(Specify)					

Any Additional information you would like to make on this subject?

……
……
……
……

Thank you for participating and for your time.