Investigation into the adoption of green building concepts in commercial buildings: A case of Nairobi County

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university

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DEDICATION

This research is dedicated to my deceased mother and also to my father J.W.O from whom I inherited endurance. It is also dedicated to my loving wife Christine and children Leon, Xavier and 'Papa' all of who had to bear with many days of working late in the night while I executed this study.

And to Almighty God be great glory, for he supplied all the resources that I needed to accomplish this exceedingly difficult task.

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LIST OF ABBREVIATIONS

BREEAM	Building Research Establishment Environmental Assessment Method
CaGBC	Canadian Green Building Council
GBC	Green Building Council
GBCA	Green Building Council of Australia
CBCSA	Green Building Council of South Africa
CBD	Central Business District
CFLs	Compact Fluorescent Lamps
CIBSE	Chartered Institute of Building Services
GHGs	Green House Gases
GoK	Government of Kenya
GRIHA	Green Rating for Integrated Habitat Assessment
HVAC	Heating, Ventilation and Air Conditioning
IEA	International Energy Agency
IPCC	Inter governmental Panel on Climate Change report
IT	Information Technology
KNBS	Kenya National Bureau of Statistics
LED	Light Emitting Diodes
LEED	Leadership in Energy and Environmental Design
NEMA	National Environmental Management Authority
NSTC	National science and Technology Council
PC	Personal Computers
SPSS	Statistical Program for Social Sciences
UNEP	United Nations Environmental Program
UN – HABITAT	United Nations Habitat
UNEP – SBCI	Sustainable Buildings for Climate change Initiative
USGBC	United States Green Building Council
WRMA	Water Resources Management Authority

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ABSTRACT

The building industry is one of the major energy consumers and emitters of Green House Gasses (GHG). It consumes 38% of the global energy; and this does not include the usage of other resources such as water. Globally, this has increased the crisis of global warming and has led to development of Green buildings. In the Sub Saharan Africa alone, 56% of energy used is by building operations. Green buildings are marketed as economical, resource efficient and environmentally friendly compared to the convectional buildings.

This study investigated the extent of adoption of green building concepts in commercial buildings and the key challenges arising from their adoption with the aim of determining appropriate strategies for implementing them. The study was conducted through a survey method and used questionnaires, interviews, observations for data collection. It also reviewed documented data from available records including journals and books.

The study revealed that 93% of the building construction players and professionals involved in the recently sampled constructed commercial buildings in Nairobi were aware of the green building concepts but only 7% of the concepts had been incorporated in the buildings. Using mean item rating scale, it established that lack of enforcement of sustainable building policies (1.81) and incentives (2.43) from the government were the greatest hindrances facing practitioners in the adoption of the concepts. Some of the strategies recommended to promote uptake of the concepts include strict enforceable urban land and planning policies (1.46) and improved enforcement of the sustainability concepts by county governments (2.00). The study concludes that there is need to develop guild lines and policies for enforcement of sustainable building concepts as well as introduction of incentives from both local and national governments.

CHAPTER ONE
INTRODUCTION

1.0 Background of the Study

The building industry's sustainability ethics is based on the principles of resource efficiency, health and productivity and realizing these principles involves an integrated approach in which a building project and its components are viewed on a full cycle basis. (Gottfried, 1996), 'This ''cradle to cradle'' approach known as 'green' or 'sustainable' building, considers a building's total economic and environmental impact and performance from material extraction and product manufacture to product transportation, building design and construction, operation and maintenance and building re use and disposal' (Gottfried, 1996).

Green buildings use less energy, water and natural resources compared to the convectional buildings. They also create less waste and provide healthier living environment, further they incorporate features such as efficient use of water, energy efficient and eco-friendly environment. The buildings use renewable energy and recycled materials, embrace effective use of landscape and have improved indoor quality for health and comfort (Roy & Gupta, Cost efficiency of Green Buildings in India, 2008).

In the United States more than 30 states and regional programs promote some level of energy efficiency and environmental responsibility for the residential construction (Reposa, 2009). The green buildings have been marketed as economical and as alternatives to convectional buildings (Issa, Mohammed, & Christian, 2011), and the total number of commercial green building commissioned has hit the $10{,}000^{th}$ mark (World Architecture News, 2011).

In Canada more than 212 green buildings had been accredited since 2010 (CaGBC, 2010) whereas in India the green concept has taken root with two green rating systems namely Leadership in Energy and Environmental Design green rating system (LEED)

and Green Rating for Integrated Habitat Assessment (GRIHA) already in use. In the developing world such as Africa, sustainable construction has not received sufficient attention despite being an important aspect of sustainable development (Adebayo, 2000). According to the World Bank Development report of 2009, only South Africa has an established Green Building Council (GBC) but this is slowly changing with Morocco, Mauritius and Egypt being in the process of establishing their councils. (Habitat, Green Buiding rating in Africa, 2010). Locally, the Green Building Council of South Africa (GBCSA) in collaboration with the Kenya Green Building Society aims to develop a certification tool using the Green Star SA v1 Design/As built rating tools (Noir & Shaba, 2014).

1.1 Statement of the Problem

Whereas advantages of adopting green construction exist, the approach is not being adopted by Kenyan construction industry practitioners and developers as would have been expected. Out of an estimated 293 completed projects in Nairobi between the year 2010 and 2011 only about four can be said to have adopted Green construction concepts. The construction of commercial buildings has continued to grow within Nairobi and unless appropriate measures are put in place, development of unsustainable buildings will not stop.

Even though the government has enacted and put in place various environmental laws, regulations and policies such as the National Environmental Policy (Gok, National Environmental Policy 2012; Revised Draft 5, 2012), the Physical Planning Act, the Local Authority Building Code, the Occupation Safety and Health Act (OSHA) 2007 to promote sustainability in the built environment, the regulatory approach adopted by government agencies does not seem to promote uptake. Green buildings are marketed as economical (Issa, Mohammed, & Christian, 2011) apart from using new technologies (US Enviromental Protection Agency, 2009) yet only four buildings are said to be green in Nairobi.

This study therefore is to establish the green building concepts that have been adopted in commercial buildings and to investigate the extent to which these elements have been applied. The study aims at determining the key challenges arising from adoption and appropriate strategies for implementing the concepts with a view of making recommendations that are geared towards a higher uptake.

1.2 Objectives of the Study

The main objective of the study is to investigate the extent to which green building concepts have been adopted within Nairobi commercial buildings, and determine the challenges faced by practitioners and developers in the adoption of these concepts. This is guided by the following specific objective:-

1) To examine the Green building concepts that have been adopted in the commercial buildings.
2) To determine the level of awareness of Green building concepts by building construction players involved in the commercial buildings constructed between 2008 and 2012 in Nairobi.
3) To identify the challenges faced by practitioners in the adoption of Green building concepts
4) To identify appropriate strategies for implementing green building concepts.

1.3 Research Questions

1) To what extent have Green Building Concepts been incorporated within commercial buildings in Nairobi?
2) What is the level of awareness of Green Building Concepts by construction industry players?
3) Which green building concepts have commercial buildings in Nairobi adopted between 2008 and 2012
4) What challenges are hindering the uptake of the green concepts?
5) What appropriate strategies can stakeholders adopt to increase the uptake of green building concepts?

1.4 Justification of the Study

Implementation of resource efficient measures in all areas of human activity is imperative and the concept of sustainable development can be used to enhance sustainable construction. Buildings on their own account for one sixth of world's fresh water withdrawals, one quarter of its wood harvest and two thirds of its material and energy flows (Rodman & Lenssen, 1996), Green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by efficiently using energy, water and other resources, protecting occupants' health and improving employee productivity and reducing waste, pollution and environmental degradation (US Enviromental Protection Agency, 2009). It is therefore imperative that construction industry player adopt green building concepts to safeguard on the worlds' limited resources.

1.5 Significance of the study

The findings of this study contribute valuable knowledge to the field of Architecture, Construction and Engineering as it is one of the few studies to investigate the extent of adoption of green building concepts in commercial buildings. This new knowledge forms a useful reading material to researchers and readers in general. Further, the literature available vary from country to country, this study has put into perspective the greatest challenges in the uptake of green building concepts in Kenya.

The study through its recommendations also suggests ways of increasing adoption of sustainability concepts in buildings through change and development of policy. It provides a basis for educating building construction participants in adopting green concepts. Lastly the study influences the practice of consultants in the building industry in Kenya. The use of specific findings will improve the quality of buildings in regard to sustainability.

1.6 Scope of the Study

This study was confined to buildings which were five floors and above and constructed between 2008 and 2012 within Westlands and Upper hill – Nairobi in the republic of

Kenya. Westlands and Upper hill were chosen because they had the largest number of commercial buildings which had been constructed between 2008 and 2012. To obtain a homogeneous population, buildings which were five floors and above were targeted. These buildings had lifts as required by the local authority.

Participants considered in this study were those who were involved in the design, construction and management of the completed commercial buildings within the study area. The study was conducted between January 2013 and March 2014 through survey design, where opinion was sought from 152 respondents which included Architects, Quantity surveyors, Property Managers and Engineers by use of questionnaires which were reinforced by a check list.

1.7 Limitation of the Study

Ideally the study should have been undertaken from conceptualization all through to design and construction, operation and maintenance and disposal of commercial buildings, however, this could not have been possible due to the fact that the study program was 2 years. The study therefore considered newly completed buildings between 2008 and 2012 and the consultants who were involved in the design, construction and their maintenance.

It was limited to concepts of water and energy efficiencies, choices of site, use of materials, environmental quality and waste reduction. Lastly lack of properly documented baseline data especially on buildings' information posed some level of limitation though the study relied on the data available at the Kenya National Bureau of Statistics (KNBS) and the Nairobi City County for information. The KNBS manage and coordinate the entire national statistical system with core mandate to collect, compile, analyze and publish statistical information whereas the county council is the custodian of all approved plans.

1.8 Assumption of the Study

The study assumed that stakeholders who were not limited to developers, Architects, Real estate professionals, Contractors, Engineers in the construction industry were aware of the benefits of green practices and had adopted some of the green building concepts in their projects. It also assumed that there was some extent of adoption of these practices in the commercial buildings in Nairobi.

1.9 Definition of Terms

The following are the definition of key terms used in this study:-

1.10.1 Commercial Building

Used in this study to describe buildings used for general office space, professional office or administrative offices (EIA, 2011), also defined as a building with more than half of its floor space is dedicated to commercial activities (Cambridge, 2014). In this study the second definition was used.

1.10.2 Green Building

Green building also known as green construction refers to a structure using a process that is environmentally responsible and resource-efficient throughout a building's life-cycle, (Gottfried, 1996).

1.10.3 Green Building Concepts

Use in this study to describe strategies and technologies which are associated with five major elements of green building design namely sustainable sites, water conservation, energy, indoor environmental quality and conservation of materials (US Enviromental Protection Agency, 2009).

1.10.4 Green Procurement

Green procurement means purchasing products and services that cause minimum adverse environmental impacts. It incorporates human health and environmental concerns into the search for high quality products and services at competitive prices (CaGBC, 2010).

1.10.5 System

A system is viewed as a whole made up of many parts or subsystems which are interconnected, each subsystem may itself be viewed as a system, leading to hierarchy of systems (Oxford, 2014).

1.10 Outline of the Study

The study was organized in five chapters. Chapter one discussed green building activities in the global construction industry and the adoption trends, the slow uptake in Africa and particularly Kenya. The research problem was stated, objectives, research questions, limitations and scope were stated and the study was justified.

Chapter two contained related studies on green buildings and discussed various concepts of Green buildings adopted in the world and in the Kenyan context. The study was then conceptualized and a general system view of green building was adopted.

Chapter three discussed the methodology used in conducting the study. The research design, population, data collection procedures and analysis were also discussed. Chapter four presented analysis of the data, interpretation and discussions and finally chapter five had recommendations and conclusion.

CHAPTER TWO
LITERATURE REVIEW

2.0 Introduction

This chapter examined previous works related to the study. The review of literature examined research undertaken in relation to the concept of green buildings and green construction. It focused on key challenges in the adoption of green buildings concepts and strategies of enhancing uptake of the concepts.

2.1 Green Buildings

Green building also known as green construction refers to a structure using a process that is environmentally responsible and resource-efficient throughout a building's life-cycle from sitting to design, construction, operation, maintenance, renovation, and demolition (Gottfried, 1996). This requires close cooperation of the entire project stakeholders all project stages (Yan Ji, 2006). The Green Building practice expands and complements the classical building design concerns of economy, utility, durability, and comfort (US Enviromental Protection Agency, 2009).

Although new technologies are constantly being developed to complement current practices in creating greener structures, the common objective is that green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by efficiently using energy, water and other resources , protecting occupants' health and improving employee productivity and reducing waste, pollution and environmental degradation (US Enviromental Protection Agency, 2009).

Green buildings include measures to reduce energy consumption. To reduce operating energy use, designers use details that reduce air leakage through the building envelope. They also specify high-performance windows and extra insulation in walls, ceilings, and floors. Designers orient windows and walls and place awnings, porches, to shade windows and roofs (Simpson, 2002). In addition, effective window placement can

provide more natural light and lessen the need for electric lighting during the day. Solar water heating further reduces energy costs.

Buildings account for about 70% of the electricity load, 40% of all energy consumption, and 40% of CO_2 emissions (Gioregetti, 2010). Hence, making buildings more energy efficient can be one of the fastest and, with rising energy prices, most cost effective ways to reduce greenhouse gas emissions. In the United States more than 30 states promote some level of energy efficiency in residential construction alone (Reposa, 2009). This argument is further emphasized by National Science and Technology Council (NSTC) that by adopting sustainability concepts there is reduction in energy, operation and maintenance cost, reduced building related illnesses and reduced waste and pollution (Science and Technology Council, 1995).

According to Reposa (Comparison of USGBC LEED for homes and the NAHB National green building Program, 2009), Green buildings can indeed use less energy and incur less cost than the convectional buildings, but he argues in his study that energy consumption costs does not necessarily make green buildings more economical. Further he argues that energy cost savings should not therefore be used to justify additional cost investment in new green buildings.

The Conference on Green Building Rating for Africa (Habitat, Green Buiding rating in Africa, 2010), confirmed that green buildings have improved environmental performance over standard buildings and have features that make it healthier for its occupants. The conference further stressed that by reducing the amount of energy, water and other resources green buildings are consistently less expensive to operate and become more valuable in the market place.

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.

2.2.1 Energy Efficiency

Building heating and cooling are the most energy-intensive activities, followed by electricity use for lighting and appliances (Harvey, 2009). Greenhouse gas emissions from buildings energy use significantly exceed those from transportation. The increasing demand for residential and commercial building spaces in developing countries will further push up energy consumption from building.

According to US Enviromental Protection Agency (Green buildings, 2009), most buildings can reach energy efficiency levels beyond the requirements in the green standards when passive design strategies such as building shape and orientation, passive solar design and use of natural lighting are taken into consideration.

International Panel on Climate Change (IPCC) predicted that CO_2 emissions from buildings including through the use of electricity could increase from 8.6 billion tons in 2004 to 15.6 in 2030 under a high growth scenario (IPPC, 2007). Developing countries will contribute substantial increases in CO_2 because of high energy usage from the building sector. IPCC argues that such a building boom offers an opportunity to commercialize energy efficient technologies to reduce both CO_2 emissions and energy usage. Improved efficiency in the building sector and de-carbonizing the power sector could offer significant potential emissions reduction (IEA, 2008).

2.2.1.1 Ways of Reducing Energy consumption

Studies show that there are several ways of reducing energy consumption in buildings and much effort has sought to apply renewable materials and renewable energy resources in buildings to use energy efficiently (CIBSE, 2004). Discussed below is how reduction in energy consumption can be achieved in buildings.

2.2.1.1.1 Lighting

Lighting accounts for 4% of energy consumption in houses and up to 30% of energy use in commercial buildings (Scott, 2009). Light control and smart meters are being promoted as good practice to reduce energy use in buildings. They consist of a network

of sensors that can turn off lights when there are no people in the building. Smart meter scan monitor where and how energy is used in the building, and thus helps to identify the solution to improve energy efficiency (Scott, 2009).

Electricity can also be reduced through improved Light Emitting Diode (LED) or increased use of natural lighting and the use of energy-efficient appliances. Integrated building design and the modification of building shapes, orientation and materials can also reduce energy use (UNEP, The clean development mechanism, and the building and construction sector., 2008). According to Zhang, Solar panels can be attached to the roofs of building and mini-wind turbines can be attached to walls to generate electricity from natural resources. Biomass boilers can provide heating and hot waters. More renewable resources are explored for generating energy (Zhang, 2009).

LED lighting offers better brightness and contrast, energy savings, ten times as efficient as 8 traditional bulbs. It will reduce electricity demand by 75% if used. (Nuttall, 2010). According to an IEA report, lighting accounts for 19% of the world's electricity consumption and produces 1.9Gt of CO_2 annually (Nuttall, 2010). LED lighting and smart-control are more efficient than traditional lighting technologies. However, they are more expensive than conventional lamps. The market transformation from conventional lighting to LEDs requires financial support from government to support the LED market. China is the first country to establish a large LED programs, installing 210,000 LED street lamps in 21 cities in China.

In Kenya, the government through Kenya Power; the electric power distributing company has been spearheading campaigns for efficient lighting programs. Under this retrofitting program the government intends replaces ordinary bulbs (incandescent lamps) with compact fluorescent lamps (CFLs). The free distribution of energy saving bulbs is expected to save 49 megawatts of power. The government further intends to offer free long term loans to companies investing in local production of energy saving

devices. (Xinhua, 2013). Table 2.1 shows how different bulbs compare in terms of power consumption.

Table 2.1: How different Bulbs Compare in terms of Power consumption

Minimum Light Strength	**Electricity Consumption in Watts**		
(Lumen)	Incandescent	Compact Fluorescent	LED
450	40	9 – 13	4 – 9
800	60	13 – 15	10 – 15
1,100	75	18 – 25	Not Available
1,600	100	23 – 30	Not Available
2,600	150	30 – 52	Not Available

Source: Daily Nation, 2013

2.2.1.1.2 Temperature Control

Most of energy use in building in Europe goes to heating, ventilation and air conditioning (HVAC) cooling, accounting for 55% of energy use in residential buildings and 35%in commercial buildings (Scott, 2009). The heat generated from computers and other electronic appliances can be recycled to heat the building if the rooms are properly designed. Heat pumps and heat exchangers can transfer heat from IT server rooms to other parts of a building or to heat up offices during cold seasons. This argument by Scott is advanced by Green economy that a more holistic approach to the design of buildings and their use also requires consideration of all energy related components including appliances (Rode, 2011).

In Kenya and in other developing countries, new forms of green energy generations are being integrated in building projects and studies show that the use of energy efficient lighting, ventilation and air conditioning can achieve a 64 percent reduction of energy use (Baker & Steemers, 1999). In other studies energy consumption guidelines indicate that the introduction of natural ventilation can achieve 55 – 60 percent reduction in energy consumption in office buildings (CIBSE, 2004).

Siemens has proven with its energy efficiency solutions that every building has already today an energy efficiency improvement potential of 20-30% on average this can be achieved by optimizing the building management system, lighting, heating and cooling system, water and energy distribution and many more areas (Zhang, 2009). In the local context, heating is not common even though cooling is in hotels and a few residential buildings. Despite kerosene, charcoal and gas being commonly used for heating in most homes; commercial buildings prefer the use of electricity for heating and lighting.

2.2.1.1.3 Passive design strategies

Studies such as the U.S Life Cycle Inventory data base project show that buildings built primarily on wood will have a lower embodied energy than those built primarily with brick, concrete or steel (USLCI, 2012). In order to reduce the embodied energy, high efficiency windows and insulation in walls, ceiling and floors increase the efficiency of the building envelop.

Use of passive solar building designs are other strategies that designers put in place to achieve energy efficiency. They orient windows, walls and place trees to shade windows and roofs to maximize solar gain. Additionally, correct window placement for day lighting provides more natural light and lessen the need for electric lighting during the day (Rode, 2011).

According to Rode (Towards a green economy, investing in energy and resource efficiency, 2011), passive design strategies can dramatically affect building energy performance. The measures include shape, orientation, passive solar design and use of natural lighting. A study by Lamonica (Solar concetrators graces University Roof tops, 2011) appears to confirm that passive technologies like solar collectors can heat up buildings' water up to 200 degrees and provide energy savings.

2.2.2 Building material, Technologies and Waste

According to World Watch Institute, building construction consumes 40% of raw stone, gravel and sand used globally each year, and 25 percent of wood (Roodman & Lenssen, 1995) . It also account for 40 percent of the energy and 16 percent of water used annually worldwide. Selecting environmentally preferable building materials is one way to improve building environmental performance; however environmental performance must be balanced against economic performance (Gottfried, 1996).

In Kenya builders and developers explain that they face a number of barriers which prevent them from delivering sustainable housing including restrictive government regulations that limit the use of alternative cheaper building materials. The local government can create policies for procurement, contract specifications, building performance and building codes that support sustainable initiatives. It further argues that careful position of openings and selecting building materials can minimize the requirement of lighting and heating (Ripin & Roger, 2012).

Considering efficiency in use of land and materials, green buildings present an opportunity to address growing scarcity issues that many societies face owing to the unsustainable use of ecosystem services. It also presents an opportunity to address other environmental and health problems such as noise pollution, chemical pollution and hazardous waste issues such as asbestos and lead content in paint (UNEP SBCI, 2010).

2.2.3 Water Efficiency

In regard to water, water conservation and efficiency programs have begun to lead to substantial decrease in the use of water in commercial buildings. Water efficient appliances and fixtures can reduce consumption up to 30% and investments in such initiatives can yield payback within a short period of time (Gottfried, 1996).

Studies indicate that large office buildings can consume up to 15,000 kilo liters of fresh water per annum and with the advent of waterless urinal technology the need to flush down small amount of urine with 5 – 10 liters of perfectly good drinking water can be

eliminated (Davidson, 2010). The argument of Hauber and Barbara is supported by Stuart (Sustainanable Water Management in Commercial Office Bulding, 2003) that commercial office buildings can make use of technological advances to improve water usage. Stuart argues that sustainable water management help identify alternative sources of water to meet the demand.

New and more efficient products are one of the choices to reduce water consumption apart from changing or maintaining behavior. A paper by Ezilondo further points out that simple solution such as feedback gargets and timers that help keep track of water used can reduce consumption (Ezilondo, Maria, Lofthouse, & Victoria, 2010).

Innovation in indigenous and green building approaches include rain water harvesting with segregation of surface and roof top run off. There is also the use of pervious paving to maximize ground water recharge. (UNEP SBCI, 2010). For instance in Melbourne, City Council House 11, a 72 percent reduction in mains water usage was achieved through a combination of water efficiency, rainwater harvesting, water recycling and sewer mining (Weizsacker, Smith, & Desha, 2009).

Tessema (2010) also concurs that one of the water conservation ways in our context is harvesting, where the first catchment takes place on the roof top through a gutter system which flows into storage tanks that can be later used for irrigation and cleaning. Waste water can also be harvested at the house hold level (Tessema, Taipale, & Jan Bethge, 2010).

The use of water efficient fixtures and devices is more popular in the hotels than the office block; areas that can offer considerable savings by using efficient fixtures include bathrooms, laundry and kitchen. Other than efficient fixtures metering individual tenants can considerably reduce consumption by users (Mudgal, Lauranson, & Bain, 2009).

According to Nairobi water and Sewerage Company there are very few buildings currently recycling the water they use in the buildings and most water go to waste due to

burst water pipes. Regular checks and fixes on linkages from pipes and other fixtures will go a long way in conserving water (Nairobi City Water and Sewerage Company, 2011).

According to Eziliondo, et al (Towards A sustainable Use of Water at Home: Understanding How Much,Where and Why?, 2010), Geller et al (1983) indicated that with the installation of water conservation devices, the expected saving of water and energy were not achieved in a study carried out; the findings suggested that this was because it was done along with the distribution of information regarding the savings and people could justify using the toilet more times. Eziliondo, et al (Towards A sustainable Use of Water at Home: Understanding How Much,Where and Why?, 2010) points out that Herring and Roy (2006) calls this a rebound effect in which energy efficient appliances and new technologies do not always achieve lower energy consumption, but when the users are unaware of the water devices installed, the predicted savings will be achieved.

In concluding water reduction must be tackled by changing user behavior and approaches must focus on the factors behind various water related activities. Policies, methods and campaigns must be designed in view of local cultural and social background, alongside financial and technological accessibility. The approaches must change the behavior in a gradual manner and must interconnect various means from informing the user and providing feedback to making the new product be embraced by users and updating legislation accordingly.

2.2.4 Integrated building design

In integrated design, multi-disciplinary teams of building professionals work together from the pre design phase through post occupancy to optimize a building's environmental sustainability, performance and cost savings. The design approach recognizes that a successful green building is achieved by planning the site, structure,

components and systems as interdependent parts of a whole system, and optimizes their interaction for economic and environmental benefits (Arbor, 2005) .

Today, it is possible to apply green materials and advanced technologies in the building design projects to consume less energy. Building design for green buildings involves many professionals across different areas. Many factors need to be taken into account, including climate, building shape, comfort levels, material and systems, and health.

According to a white paper on sustainability (Cassidy, 2003), an integrated design methodology of green buildings combines environmental principles and technological inputs at various design stages. It requires a multidisciplinary approach and broadens conventional building design by including rigorous assessment procedure to comply with performance targets (Baker & Steemers, 1999).

Designing buildings based on the environmental considerations implies continuous feedback between different design components as decisions regarding building form, orientation, components, other architectural aspects as well as building systems are entirely integrated (Cassidy, 2003).

Locally one of the objectives of the National Housing Policy is to promote the development of housing that is functional, healthy, aesthetically pleasant and environmentally pleasant (GoK, Sessional PaperNo.3 - National Housing Policy, 2004). Tessema, et al, (Sustainable Buildings & Construction in Africa, 2010) argues that Sustainable construction must not only be viewed from the environmental point but must also address social and economic perspective and there is need to integrate both the traditional practice and the local knowledge.

According to Arbor (Building Green For the Future, 2005), the key success in integrated design is to think of the different disciplines as a cohesive structure by involving key players early from pre design stage, mistakes and miscommunication diminish and opportunity to maximize savings increase.

2.2.5 Waste and Material benefits of Green buildings

Considering efficiency in materials, green buildings address growing scarcity issues that many societies face due to unsustainable use of ecosystem services. To reduce building impact and to fulfill a complete life cycle of building and material construction impact, it is necessary to establish low impact criteria during design, construction, maintenance and disposal (Rode, 2011).

The criteria to be followed include resource availability, minimal environmental impact, embodied energy efficiency, potential re use and recyclability. Reducing the number of material components in products as well as separating natural from synthetic material allows higher rates of recyclability and reuse (Donough & Mbraungart, 2002). According to Lawson the above criteria show that, for example, sustainably sourced wood is one of the best options for ensuring low embodied energy and minimal environmental impact. Lawson's study reported that 95 per cent of embodied energy that would otherwise go to waste can be saved by the reuse of building materials (Lawson, 1996).

Studies on re cycling indicate that environmental impacts caused by reused materials are at 55 per cent of the impact caused if all materials had been new. (Thormark, 2006) Although recycling materials requires energy consumption, studies show that recycling materials still delivers net emissions savings (Sa'ra, 2001). In developing societies recycled building components are often cheaper and of higher quality than conventional materials (UNEP SBCI, 2010).

In Kenya the choice of materials is supported by sessional paper number 3 of 2004 on National Housing policy; where the government in schedule (f) commits to promote the production of innovative building designs and traditional architecture that are cost effective and compatible with the use locally available and affordable materials. The policy also addresses ways of managing the housing inputs including building materials and technology (GoK, Sessional PaperNo.3 - National Housing Policy, 2004).

2.2 Key challenges of adopting Green buildings Concepts

Among the challenges highlighted by Tessema et al (Sustainable Buildings & Construction in Africa, 2010) is urban planning. Most urban buildings are densely constructed and prevent air movement after construction. Planning the site is significant element of sustainable building as the construction process has a significant impact on several sustainability aspects. Most of the time large green areas are destroyed instead of integrating them in the built environment (Tessema, Taipale, & Jan Bethge, 2010).

Adebayo (Sustainable Construction In Africa, 2000) Argues that in many urban areas of Africa and especially in the cities, construction of buildings generally, but especially residential buildings has been carried out to occupy the entire site. The natural green system has been destroyed and compaction has taken place to a level that prevents air movement even after construction is completed. The existing natural environment has in many cases been destroyed beyond repair.

Other key challenges include the non-incorporation of the traditional Architecture in our designs. The traditional Architecture integrated buildings into their natural environments and used local materials. Today, however, the use of imported materials and designs has put our tradition and our sustainable ways of building in danger (Tessema, Taipale, & Jan Bethge, 2010).

Problems linked with forests as they supply timber for construction is another challenge. Further, massive deforestation in Africa can be attributed to the building material industry. Timber for construction and related industries is often harvested, sometimes from indigenous forests and not necessarily replaced. While forestry and timber harvesting is an important economic activity, it can only continue to be so if deliberate steps to replace the harvested trees are taken (Adebayo, 2000).

Waste especially during construction is disposed in pits and landfills or adjacent to construction site; this causes environmental degradation and there is extensive need to strengthen the waste management practice within the whole life cycle (Gottfried, 1996).

Energy efficiency in construction and production of building materials is an important area of sustainable construction in developing countries. Its efficiency is not only in the usage of direct energy, but also in the amount of fuel used in obtaining the raw materials, the production process and the transportation of materials (Adebayo, 2000). According to Tessema, et al. (Sustainable Buildings & Construction in Africa, 2010), reducing the energy demand and increasing efficiency and use of renewable energy resources is needed to reduce the building environmental burden.

Cultural barriers are also key challenges in implementing green concepts; introduction to western technologies before and after colonial times could cause a strong reaction in terms of intolerance to further interferences in local mindset, even if already touched by western influence. In addition the long technological dependency on foreign knowledge could end in lack of confidence in home grown traditions discouraging the shift towards greener building solutions and low impact traditional practices (Tessema, Taipale, & Jan Bethge, 2010).

Finally lack of financial resources hampers the shift to more sustainable buildings; it is not only availability but also the institutional framework to access it (Tessema, Taipale, & Jan Bethge, 2010). But Gottfried (Sustainable Building Technical Manual - Green Building Design, Construction & operation, 1996) points out that as much as the initial cost of green investment is high; the payback period is normally shorter because of the savings. These arguments are confirmed by Issa, et al (Energy consumption i convectioanal,energy - retrofitted & green LEED Toronto Schools, 2011) that there are savings in green buildings energy consumption but these savings on energy should be addressed together with savings from other aspects such as indoor environment and other less tangible health and productivity aspects.

2.3 Strategies of promoting green construction Concepts

Regulatory and control mechanisms have to be monitored, evaluated and updated regularly to remain in touch with technological developments and market trends (UNEP SBCI, 2007). It is easier to enforce green concepts with respect to new rather than

existing buildings. The regulatory instruments can include but not limited to appliance standards, building codes, procurement regulations, energy efficiency obligations and utility demand side management programs (UNEP SBCI, 2007).

The local authorities can promote some level of adaptation by developing building sustainability checklist during the approval process and the check lists can be included during the issuance of occupation certificates. Improved enforcement also requires adequate education and training. According to Plessis (Action for Sustainability: Preparing an African Plan for Sustainable building & Construction., 2005), education and training programs focusing on sustainable buildings should be an integral part of built environment courses taught in learning institutions, further he points out that there should be continued professional development courses that would provide accreditation system for green building professionals.

In Kenya the local authority have had challenges in implementing certain policies because of the building code which has not been revised to suite the current sustainability needs. Improved enforcement can start with voluntary schemes and gradually integrated in the building codes.

Energy audits should be made mandatory and buildings should display their energy performance certificates publicly although critics point out that it does not account for energy used by buildings' occupants, which constitutes a large part of overall performance (Ries & Jenkins, 2009). Grants and subsidies are also well suited to make investment in energy efficiency even if the developers have access to capital. Developers can be given reduction or temporary freeze in property taxes tied to energy performance of buildings.

Public sector financial institutions also have an important role to play in addressing the credit barriers. Other than the finances there is need to promote green procurement to drive the green transformation in the building sector. There is also need for large number

of skilled professionals and therefore training becomes one of the key strategies in adaptation of these concepts.

Integrated policy framework that combines regulatory instruments, such as standards or mandatory audits in buildings, capacity buildings, training, and information campaigns as well as demonstration projects coupled with incentives are strategies that are likely to promote uptake green construction. Discussed below are various criteria of rating Green Buildings.

2.4 Criteria, Evaluation and Rating of Green Buildings

In order to assess the sustainability of buildings and construction activities it is necessary to be able to measure and verify their performance. Various criteria and rating systems have been designed that provide an indication of the performance of buildings and construction activities in terms of sustainability. These systems main objectives are; to aid the design of sustainable buildings and to help evaluate the sustainability of buildings (Tessema, Taipale, & Jan Bethge, 2010).

The predominant rating systems include Building Research Establishment Environmental Assessment Method (BREEAM) widely used in the UK, Leadership in Energy and Environmental Design LEED which was developed by the US Green Building Council (USGBC), Green Star developed by the Green Building Council of Australia and the Green Rating for Integrated Habitat Assessment GRIHA of India among others (Tessema, Taipale, & Jan Bethge, 2010). No single measuring scheme can provide a fully comprehensive and undisputable assessment of all sustainability aspects of a building (Roy & Gupta, Cost Efficiency of Green Buildings in India - pdf, 2008).

Early rating systems like BREEM and LEED began as basic checklist on what to do and not what to do and progressed further to systems that awarded points for certain achievements. The focus areas try to combine environmental, social and economic aspects of sustainability (Tessema, Taipale, & Jan Bethge, 2010). The environmental dimension contains criteria related to energy use, water and material use and waste management; the social dimension range from accessibility of the building, occupants'

well-being and preservation of social and cultural values while economic criteria relate to aspects of affordability and life cycle costs (Tessema, Taipale, & Jan Bethge, 2010).

LEED rating system encompasses five environmental categories namely sustainable sites, water efficiency energy and atmosphere, materials and resources and indoor environmental quality plus innovation and design category (Cassidy, 2003). It also quantifies aspects such as energy consumption, waste generation and renewable energy adoption and evaluates the environmental performance of a building holistically over its entire life cycle. The four sub categories of GRIHA are site selection and planning, building planning and construction, building operation and maintenance and innovation (Tessema, Taipale, & Jan Bethge, 2010).

BREEAM on the other hand is used measure the sustainability of new non domestic buildings in the United Kingdom. It has a two stage assessment process including the design stage and post construction. The areas for assessment include energy, water, materials, waste, health and well-being, pollution transport and biodiversity (Breeam, 2013).

Generally the scale of assessment can range from assessing an individual design feature of a building to assessing the sustainability of a whole community. Some systems focus on a certain stage of the construction process or on existing buildings while others focus on specific issues such as energy health and safety aspects. In the South African context the assessment is on the whole building but at the same time take into account how the building supports the development of a sustainable surrounding system (Tessema, Taipale, & Jan Bethge, 2010).

According Habitat (Conference on promoting Green Building Rating in Africa, 2010) nearly all tools look at similar environmental issues and the differences lie in how the impact issues are categorized within the tools, the performance benchmarks for each initiative, the type of documentation required to prove compliance with the rules of the tool and the methods by which the buildings are assessed under the scheme. Most

systems look at the energy, water, indoor environmental quality, management of the construction process (including waste) ecological impacts, relationship of the building to its physical context, transportation impacts and building materials (Habitat, Conference on promoting Green Building Rating in Africa, 2010).

In Kenya as well as many other African countries, there are no rating tools available for assessment of buildings and it is the government codes that determine the minimum levels of performance. The more developed tools may not be relevant to the context of the countries with less mature market. According to UN Habitat Conference on promoting Green Building Rating in Africa, there are options to modify these tools, adapt and improve them to create positive transformation in the built environment in Africa (Habitat, Conference on promoting Green Building Rating in Africa, 2010). Kenya for example is in the process of adopting the Green Star SA for use in sustainability assessment (Noir & Shaba, 2014).

Table 2.2: 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 Canada
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: World Bank Development Report 2009 and the World Green Building Council

2.5 Theoretical and conceptual frame work for adoption of green building concepts

Some of the theories deduced from the literature review that can be used to conceptualize the adoption of green building concepts include adoption and diffusion theory, convention theory, sustainability theory, innovation theory and the general system theory. The adoption and diffusion theory is mostly used in adoption of innovations and has a model; the innovation – Decision Model (Rogers, 1995). This model suggests that adoption is not a single act but a process that occur over time with potential adopters going through five stages when interacting with innovation.

The 'Knowledge' stage has the potential adopters finding out about innovation and gaining basic understanding of what it is and how it works. The second stage is 'Persuasion' and the adopters form positive or negative impression of the innovation and it is only in the third stage that innovation is adopted or rejected. The fourth and the fifth stage are on implementation and confirmation (Rogers, 1995). The green building concepts are in themselves innovations and the theory of adoption and diffusion can be used to conceptualize their adoption.

The convention theory's aim is to explain how market and non-market organization interpenetrate each other. Its idea is to have an overarching theory of rules that coordinate human activity, of which the market rules are one part, but not the only ones (Loza & Valceschini, 1994). This theory is mostly applied in the agro- food industry; however, the newly developing green building industry can also adopt this theory. Green building industry as an example of an economic production relies on multiple constructions of quality in its production and consumption processes. This quality can be determined by simultaneously incorporating multiply ways as opposed to the assumption that only one aspect of quality can achieve the desired results.

Theories of sustainability attempts to prioritize and integrates social responses to environmental and cultural problems. An economic model looks to sustain natural and financial capital; an ecological model looks to biological diversity and ecological integrity whereas a political model looks to social systems that realize human dignity. In

literal terms, sustainability means a capacity to maintain some entity, outcome, or process over time. Sustainability theory can be conceptualized in the adoption of Green buildings since Green buildings themselves are about sustainability; and the concept revolves around environmental responsibility and resource-efficiency throughout a building's life-cycle.

In this study the general system theory is applied to conceptualize the extent of adoption of green buildings concepts in commercial buildings. A system is viewed as a whole made up of many parts or subsystems which are interconnected, each subsystem may itself be viewed as a system, leading to hierarchy of systems. System thinking has been used to solve present day complex organizations' problems with spectacular outcomes.

In an example of the system view of fluctuation in output in the construction industry, fluctuations are attributed to external factors, 'the main causes of fluctuations in the output of an organization (i.e. a system) are considered to be interaction within the organization, but not influences from outside the organization' (Mbiti & Blismas, 2009). The problems of the system are not blamed on the outside circumstances. The view that system thinking attributes the behavior of a system to the feedback control structure of the system itself does not mean ignoring effects of external factors. A system can therefore be designed in a way that the external factors do not adversely affect the performance of the system (Senge, 1990).

This study has conceptualized the general system theory in an attempt to address the extent and challenges of adoption of green buildings concepts in commercial buildings as discussed below.

2.6.1 Conceptualizing Green Building Concepts and General System Theory

Green building as an output of a building process can be achieved after various inputs in the process from design; construction, use and disposal are incorporated. This makes a green building a system. The incorporation of the concepts can be under five broad environmental categories including sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality plus innovation and design. These categories therefore form sub system which operate as systems themselves.

The inputs for adoption of green concept are influenced by '*outside factors'* such as legislation, finances, training, and incentives among others. These external factors should not adversely affect the adoption of green building concepts. The degree of adoption is the extent to which the concepts have been incorporated and full incorporation becomes a complete system.

This study will attempt to relate how these inputs have a bearing on the degree of adoption of the green building concepts. The figure below shows the output - green building, being the independent variable and the inputs the dependable variables. The other variables will be the external factors outside the system boundary as indicated in figure 2.1 below.

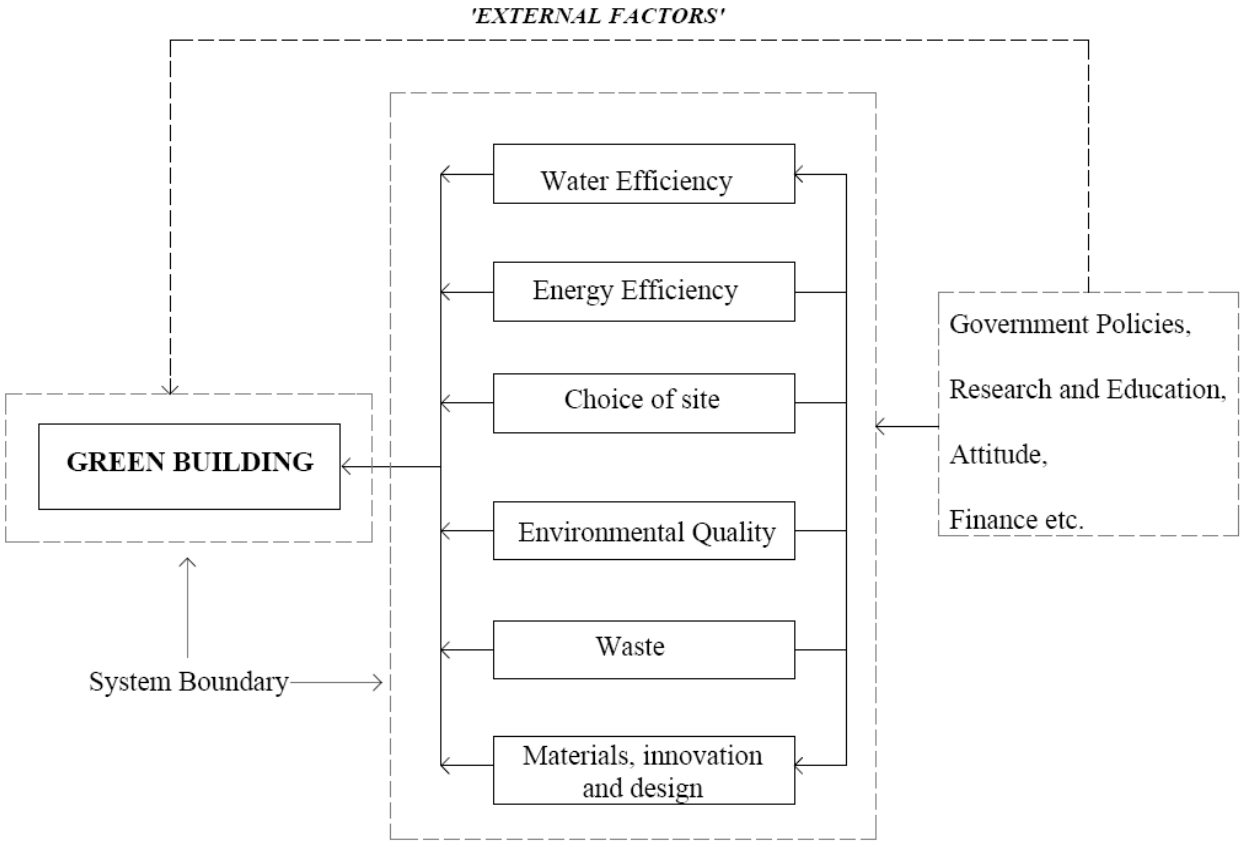


Figure 2.1: Conceptual Frame Work

Source: Author (2013)

2.6.2 Independent and dependent Variables in the Study

The Green building in the conceptual framework is the dependent variable whereas water and energy efficiency, choice of site, environmental quality, waste and material are the independent variable as shown in the figure 2.1 Even though the five environmental categories have been adopted in the conceptual frame work, certain aspects of these categories were not be applicable because the study sample was drawn from existing completed buildings.

The other independent variables also considered include government policies, attitude and education and research. The study will investigate what extent each category has been incorporated in the commercial buildings using questionnaires, observations and interviews.

2.6 Linkages and actions towards sustainable buildings

According to Tessema, et al., (Sustainable Buildings & Construction in Africa, 2010) the following linkages and actions towards sustainable buildings in Africa can be followed in order to achieve green buildings. Land use planning at both national and local levels should be given priority where the local authorities are empowered and more stringent criteria for planning are put in place. Financial instruments such as funding, green house loans and tax exceptions need to be introduced and sustainable public procurement put in place. Further there is need for increased funding for sustainable building research.

Education, both formal and informal would play an important role especially when sustainability is integrated into formal curricula. Stakeholders need to be empowered and demonstration centers created. The professionals should have a network and standards established. The established standards would include but not limited to mandatory recycling of demolition waste, defined standards for zero energy buildings and introduction of a building passport. (Tessema, Taipale, & Jan Bethge, 2010).

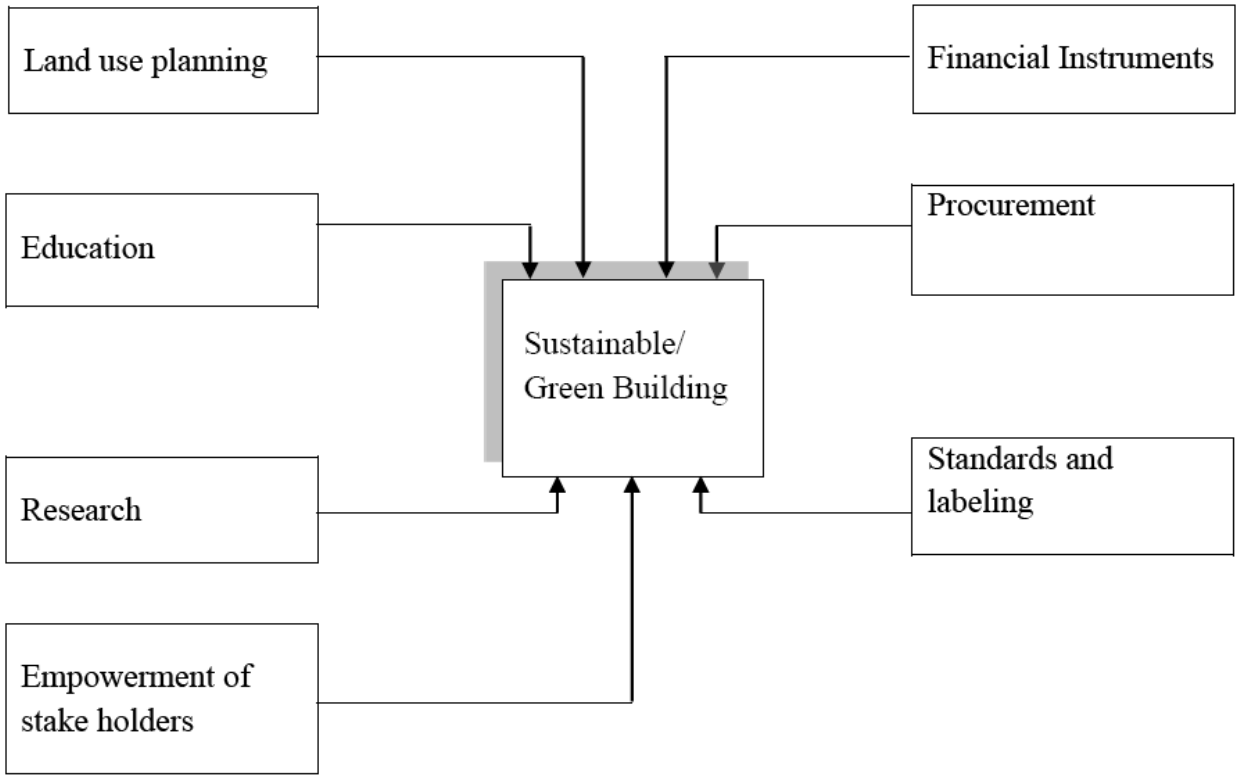


Figure 2.2: Linkages and actions towards sustainable buildings

Source: Author (2013)

The building sector should be central to any attempt to use resources efficiently. Opportunities to improve efficiency are huge. Great gains can be achieved from a broader more holistic approach to buildings; a life cycle perspective that covers each stage from design and extraction of resources to construction and usage and through to disuse and recycling or disposal of material. The process of greening the buildings and their subsequent use provides a wide range of direct social benefits including improved health, productivity and well-being of those who use them.

Despite these opportunities, investment in green buildings is held back owing to assumed cost premiums that are exaggerated and a range of barriers that range from financial constraints to the fragmented structure of the industry. Other barriers relate to

behavioral culture lack of awareness and capacity. In the Kenyan context there is need to create an enabling environment and determine appropriate mix of policy and regulatory mechanisms for adoption of green buildings. To fill the gap, there is a need to pin point the key challenges facing increased adoption of green building concepts and to determine appropriate strategies for their implementation. Chapter two examined the existing knowledge in the subject of study and the next chapter, methodology outlined research design, and the methods of achieving the study objectives.

2.7.1: Government Policies

In Kenya there are problems of institutional frame work and legal provision by the presence of many acts of development on development control domiciled in many government departments, including county governments Act, Physical planning act etc. there are also development control institution in place, however, the policies are fragmented which make effective enforcement mechanisms weak (AAK, 2015).

Most counties do not also have Physical development plans or spatial plans which lead to absence of standards for development. This means that there are no instruments including zoning plans against which development control standards are set.to this end there is need to have regular review of existing plans as well as developing the non-existing ones.

CHAPTER THREE
RESEARCH METHODOLOGY

3.0 Introduction

This chapter provides a systematic description of the research methodology that was used to answer questions described in chapter one of the study. The chapter specifically dealt with research design, research site, and target population, sampling design, data collection methods and analysis procedures.

3.1 Research design

This study was conducted through a survey research design and made use of both qualitative and quantitative modes of inquiries to investigate the adoption of green concepts in commercial buildings. According to Mugenda and Mugenda (1999), a combination of qualitative and quantitative methods is advantageous because they supplement each. Quantitative methods provide hard data whereas qualitative methods provide in depth explanations therefore the findings derived from one method validates the other.

The focus was on the commercial buildings within Nairobi's Upper Hill and Westlands areas with more concentration of new buildings constructed between 2008 and 2012 as relates to the scope of this study. Westlands and Upper hill areas have experienced a steady rise in the number of commercial buildings in the last five years.

The primary data was obtained through observations, interview schedules and by administering questionnaires to individuals who were behind the design, construction and management of the buildings. For quantitative method, parameters that define green construction with a range of variables from minimal to complete incorporation of the elements determined the degree of adoption. The degree of adoption was statistically analyzed on the sampled commercial buildings. These buildings being in the same geographical neighborhood and near similarity in design minimized sampling error.

3.2 Population and Sample

3.3.1 Population

Population in this study consisted of commercial buildings completed between 2008 and 2012. A total of 50 buildings were identified for this study in Nairobi Upper Hill and Westlands areas as indicated in appendix 2. The choice of these two areas was informed by the fact that over 80% of major commercial buildings have been constructed in these two locations between the periods of the study. To maintain uniformity, premises that were sampled were limited to at least five floors and above. This ensured that the composition of the accessible population had the same characteristics hence homogeneous.

Table 3.1 shows the number of buildings completed in major towns in Kenya with Nairobi having completed the highest number in the year 2011 both in residential and non-residential properties. In Nairobi about 293 commercial buildings were completed, these buildings formed the basis of the study population as described above.

Table 3.1: Reported completion of buildings for private Ownership in Main Towns

Details Number of New Buildings	Nairobi	Mombasa	Thika	Nakuru	Eldoret	Kisumu
Residential	2,835	281	-	435	295	302
Non-Residential	293	73	-	48	4	5

Source: Kenya National Bureau of Statistics **(2012)**

3.3.2 Sample and Sampling procedure

Due to time and resource constraints, the study was restricted to a portion of the target population. It focused on 75% of the target population; Mugenda & Mugenda, (Research Methods, Quantitative & Qualitative approaches, 1999) recommend a minimum sample of 30 items. A bigger sample of 75% which translated to 38 commercial buildings was selected through simple random sampling.

3.3.3 Response Rate

In this study a population size of 152 respondents from 38 sampled buildings was expected (n=152) from Architects (38), Quantity surveyors (38), Property Managers (38), and Engineers (38), respectively. Electrical, structural and Mechanical engineers were grouped together under Engineers and the respondents chose the category they fell into.

Data was obtained from self-administered questionnaires, completed by 94 participants (n=94), this constituted a 62% response rate. Not all respondents answered all of the questions therefore percentages reported correspond to the total number of consultants who answered the individual questions. Although neither the reasons for non-participation nor the characteristics of the non-respondents are known, the slightly above average response was due to the tight schedules of the consultants.

3.3.4 Response to Questionnaires

Questionnaires were sent out to consultants who were involved in the design and implementation of 38 sampled commercial buildings in Nairobi. The corresponding responses received are tabulated and represented graphically in figure 3.1

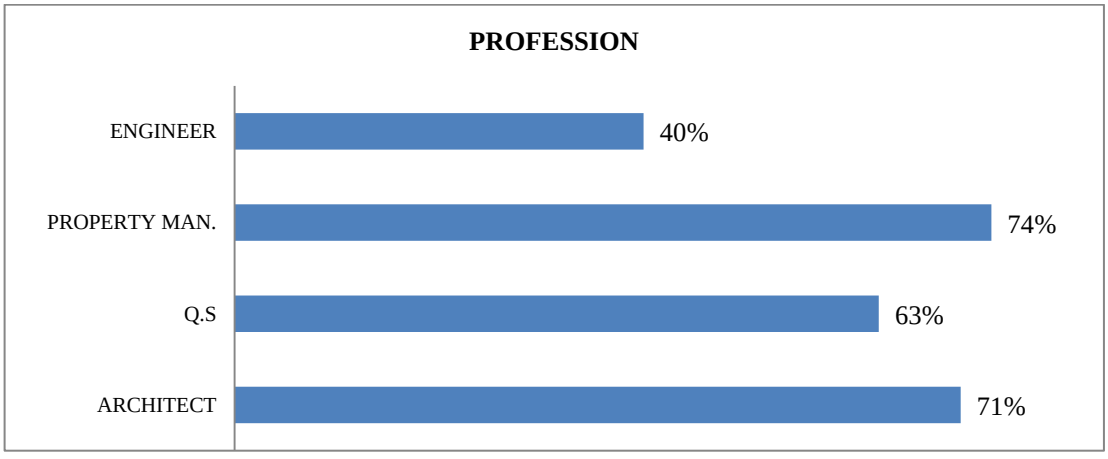


Figure 3.1: Response to questionnaires

Source: Author, 2014

The results indicate a cumulative response rate of 62%, even though the Architects and the Property managers had a response of 71% and 74% respectively. The 62 % was attributed to the average response by the Engineers (40%). The average response by the Engineers was perhaps because of their secondary roles in the projects, i.e. they are usually brought on board by the Architects or clients after project identification and initially feel not part of the team project team. The high response rate increased representativeness of data and minimized errors.

3.3 Data Collection instruments

In this study, structured questionnaires, semi structured interview schedule and inspection checklist were used as the instruments for data collection.

Structured Questionnaire (Appendix 3A)

Questionnaires designed in the form of a likert scale with closed and open ended questions were directed to different respondents which included Architects, Engineers, Property officers and Surveyors behind the sampled buildings.

Semi - Structured interview schedule (Appendix 3B)

Enquiries were be made from policy makers in the building industry particularly from the technical department of the Nairobi County Government, Ministry of Environment, water and Natural Resources, Ministry of Lands and Housing and Ministry of Energy through direct or personal contact. These interviews were open ended and directed mainly to the experts at the level of job assistant director and above.

Inspection Checklist (Appendix 3B)

An inspection checklist that defines green construction with a range of variables from minimal to complete incorporation of the elements was prepared to determine the degree of adoption.

3.4.1 Sources of Data

Both primary and secondary data were sourced from the field through the use of semi structured interviews, structured questionnaires and an inspection checklist. The primary data emanated from questionnaires directed to Architects, Engineers, Quantity Surveyors and Property Managers. Further primary data were obtained from semi structured interviews with policy makers in addition to observations made during inspections. Secondary data was collected through review of past work, journal articles, text books and from the internet.

3.4 Data Collection Procedure

The questionnaires were pretested on samples that were similar to the actual samples intended for the study and the procedure for pretesting were identical to those that were used during the data collection. This enhanced the reliability of the instrument as questionnaires were adjusted before the final edition was released. For examples under water efficiencies, it was suggested that an example of the concepts be given to participant, this comment was adopted for all the concepts in the questionnaire.

3.5 Data analysis methods

Data from questionnaires, observation checklist and interview schedules were coded to assist in analysis. Responses from closed ended questions were assigned numerical values and analyzed quantitatively using mean item score and percentages whereas the open ended questions were analyzed qualitatively.

For closed ended questions, the analysis involved the use of mean item score, frequency count and ranking generated through use of statistical program for social sciences (SSPS) version 16 to generate tables, pie charts, trend curves and histograms. Microsoft office excel was also used to generate other charts and graphs for discussion.

3.6 Data Validity, Reliability and Replicability

To check on data validity the study relied on interview experts and use of an inspection checklist. The reliability was enhanced by adopting a larger population sample of the

target population. In this study 75% of the target population was considered which translated to 38 buildings out of the 50 commercial buildings targeted for the study. The validity was also enhanced by selecting the 38 buildings by random sampling.

Further, limiting the sample population in a particular geographical zone (Nairobi) and zeroing on commercial buildings of at least five floors and above, increased homogeneity and the level of data reliability. With valid and reliable data, the study can be replicated by other researchers in other counties within Kenya.

3.7 Summary of Methodology

Table 3.2 shows a summary of the objectives, research questions, the variables, how they were measured and the sources of information. The research instruments which were used included observations, questionnaires and interview schedules. They are attached in the appendices.

Table 3.2: Summary of Methodology

Objective of the Study	Research Questions	Variables/Indicators	Instrument	Source of Data	Unit of Measure
To investigate the extent	To what extent have				
of adoption of GBcs	the GBCs been			Architects	
	incorpoated within	Water efficiency		Engineers	
	commercial buildings	Energy efficiency		Property,	
	in Nairobi?	Sustainable site		Planning,	1 in 5 likert Scale
		practices (site use)	Observation /	Ministries &	
	Which GBcs have	Sustainable materials	Questionnair	Parastal	
	commercial buildings	Building perfomance		officers.	
	in Nairobi adopted				
	within the last 5 years?				
To determine the Level	What is the level of	Water efficiency		Achitects	
of awareness of GBcs	awareness of GBCs	Energy efficiency		Engineers	
by building construction	by construction	Sustainable site	Questionnair	Property	Percentage
players involved in the	industry players?	practices (site use)		officers	
recently constructed		Sustainable materials			
commercial buildings		Building perfomance			
To determine	What challenges are	Urban land use			
appropriate strategies	hindering the uptake of	Finance		Architects	
for implementing GBcs	GBCs	Education &	Questionnair,	Engineers	1 in 5 likert Scale
		awareness	Secondary	Property	
		Government/County	Data	officers	
		enforcement laws			
	What appropriate	Development of GB		Architects	
	strategies can	checklist,		Engineers	
	stakeholders adopt to	Improved	Questionnair,	Property,	1 in 5 likert Scale
	increase the uptake of	enforcement,	Secondary	Planning,	
	GBcs.	Education & training,	Data	Ministries &	
		Mandatory Audits,		Parastal	
		Financial incentives		officers.	
		and awareness.			
To identify the challenges	What challenges are	Urban planing		Architects	
faced by practitioners in	hindering the uptake of	Land use		Engineers	
the adoption of Green	the green concepts?	enforcement laws		Property,	
building concepts		Education		Planning,	1 in 5 likert Scale
		Research		Ministries &	
		Incentives		Parastal	
		Empowerment		officers.	

Source: Author, 2014

3.8 Ethical considerations

This study was approved and undertaken with the full consent of the university's board of post graduate studies. The participants consent was sought through a cover letter that explained the aim of the study. They were also assured that the information provided was purely for academic purposes only.

The caretakers of the buildings were encouraged to participate voluntarily and were assured that the observations were only going to be used for the study, though the study intended to include photos, the caretakers did not allow the use of cameras in their premises and therefore no photos were included in the study

3.9.1 Research Program Implementation Constraints

Field data collection took a total of 8 weeks, 4 weeks more than anticipated. It was conducted between 2nd of July and 4th of September 2014. The delay was occasioned by the initial reluctance of the practitioners to fill and return the questionnaires because of their busy schedules. The researcher had to follow up the practitioners in some cases for a week to get back the questionnaires.

Getting information both from the county government offices and at the Kenya Bureau of Statistic also delayed the implementation program because the government officials were uncooperative despite the fact that the researcher had authority from the university. Other than being uncooperative, the records were poorly kept and it took a whole month to obtain information. To catch up with lost time semi structured interviews went concurrently with administering questionnaires.

4.0 CHAPTER FOUR
DATA ANALYSIS, INTERPRETATION AND DISCUSSION

4.0 Introduction

This chapter presents the analysis, interpretation and discussion of data obtained from administered questionnaires, conducted interviews and observations made with a view to drawing conclusions and recommendations to the study. The specific areas of interest covered in the study included adoption of green building concepts, the extent of their adoption, the challenges hindering their uptake and the strategies that can be put in place to promote their uptake.

4.1 Extent of Adoption of Green Building Concepts

One of the objectives of the study was to investigate the extent to which green building concepts had been adopted within Nairobi commercial building with a view to determine the challenges faced by practitioners and developers in the adoption of these concepts.

To investigate the extent of adoption, the green building concepts were grouped into five environmental categories namely water efficiency and conservation, energy efficiency, choice of site, material and environmental quality. The practitioners were initially asked if they were aware of the green building concepts and whether they had incorporated them in their projects in the last 5 years (2008 – 2012). Below are their responses on both awareness and incorporation of the concepts.

4.1.1 Awareness and Incorporation of Green Building Concepts in Projects

The study revealed that the professional and the practitioners in the sampled buildings were aware of the green building concepts under the five environmental categories. Water efficiency had the highest percentage of awareness at 97.8% whereas awareness on sustainable materials was 91%. Figure 4.1 shows the percentage of awareness of the green building concepts by practitioners who participated in the study.

The study further revealed that 93% of the consultants and the practitioners in these buildings had incorporated some of the concepts in the projects they were involved in during the last 5 years. This was further confirmed during interviews with green buildings consulting firms who indicated that practitioners were aware and had incorporated the green building concepts in their projects. Other than the interviews, it was observations that various concepts such as rain water harvesting among others had been incorporated in some projects. The high scores in both awareness and incorporation of the concepts shows that the consultants and practitioners were in a position to indicate the extent they had incorporated the green building concepts in the projects.

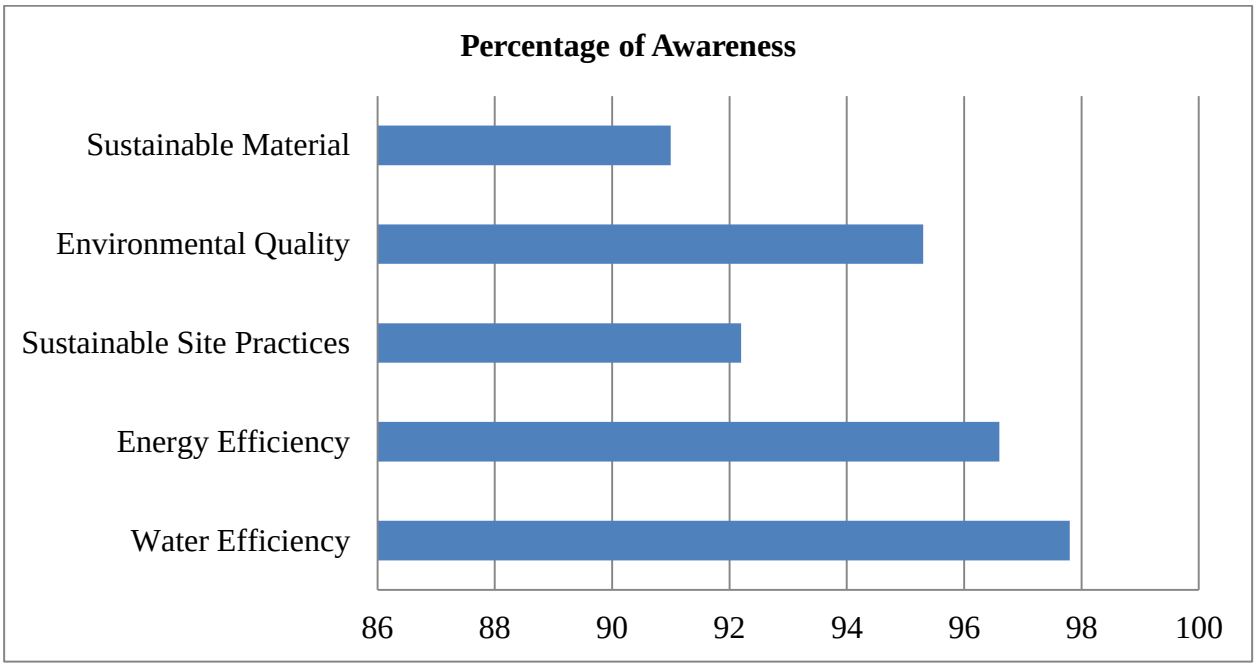


Figure 4.1: Awareness of green building concepts

Source: Author (2014)

4.1.2 Environmental categories of GBC applied in Commercial Buildings

To further investigate the extent of adoption of the green concepts, it was important to find out which among the five environmental categories had been applied in the projects during the last 5 years. The study found that consultants and practitioners had engaged in

some level of green activities in all the environmental categories. The level of incorporation of the five environmental categories is discussed below.

4.1.3 Level of Incorporation of the environmental categories

The study established that certain concepts in all the five environmental categories had been applied in the completed commercial buildings. Concepts in the category of water and energy efficiency had been applied most with a score of 94.6% and 91.4% respectively. Water and energy efficiencies attracted high scores perhaps because of their daily usage in buildings which calls for monitoring besides the high bills associated with their provision as indicated during the interviews.

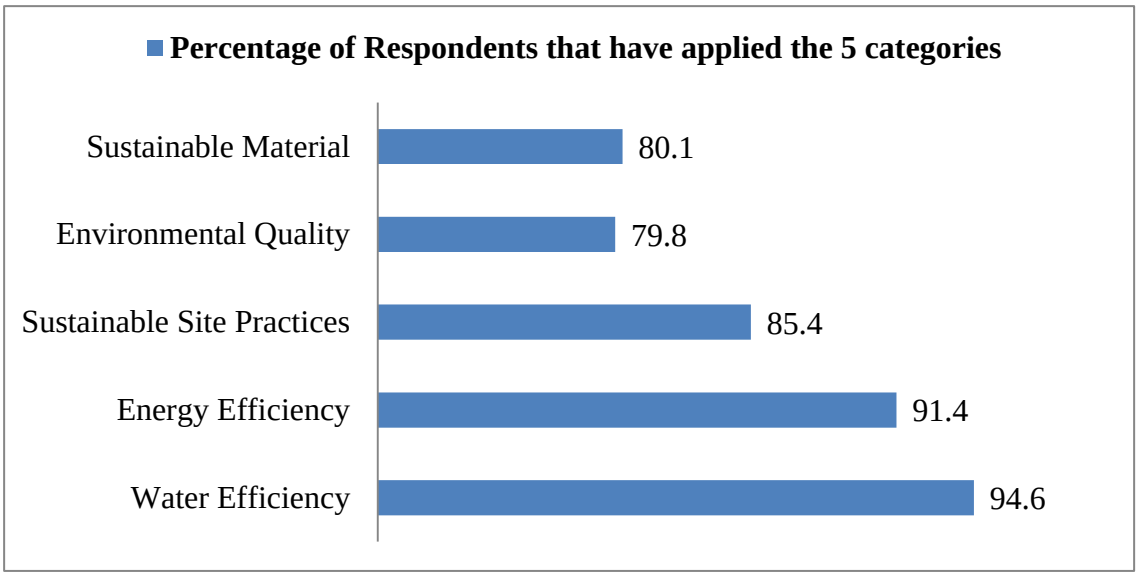


Figure 4.2: Percentage of respondents applied five environmental categories

Source: Author (2014)

4.1.4 Extent of adoption – Water efficiency and conservation concepts

The study sought to find out the extent to which water efficiency and conservation concepts had been incorporated in commercial buildings, it was revealed that water and conservation concepts had been applied to a moderate extent. 46% of the respondents

indicated that the concept had been applied to a little extent, 52% to a moderate extent while only 2% indicated a great extent.

These results indicate that the level of incorporation of efficiency and conservation concept in the sampled buildings was 46%. Ezilondo et al (2010) as observed in the literature review indicate that new and more efficient products are one of the choices to reduce water consumption. It was also observed that all the 38 buildings had installed water sub meters. Figure 4.3 shows the extent to which this concept had been incorporated in the commercial buildings.

Among the water efficiency and conversation concepts in Figure 4.4 and table 4.1, it was revealed that the use of water sub meters had been incorporated to a great extent (with mean of 2.6), rain water harvesting had been incorporated to a moderate extent (with mean of 2.9), whereas water recycling was to a little extent (with mean of 4.0). 60% of the respondents included use of bore holes as alternative source of water; this was observed during inspections of the buildings and it was noted that boreholes had been sunk in 12 buildings.

One possible reason why the use of water sub meters had been incorporated to a great extent is that tenants prefer to have their own water bills for purposes of monitoring and control than paying a fixed amount incorporated in service charge. AFED (2005) indicate in their study that sub metering is one of the ways that are used to monitor use of water in commercial buildings. The study suggest that sub metering offer incentive for cost savings that can only be realized by making water users aware of their consumption habits and linking their water bills to actual rates of consumption (AFED, 2005).

Davidson (Water conservation Group, 2010) observes that waste water in most cases is used for landscaping, irrigation, cleaning among other uses. In this study however it was observed that commercial buildings did not leave open spaces for landscaping. One of reason therefore why recycling of water was incorporated to a little extent was because

there was probably no landscaping that triggered the thought of users to recycle, however, Studies suggest that most efficiency measures are in attitude rather than in the incorporation of the concepts (Ezilondo, Maria, Lofthouse, & Victoria, 2010).

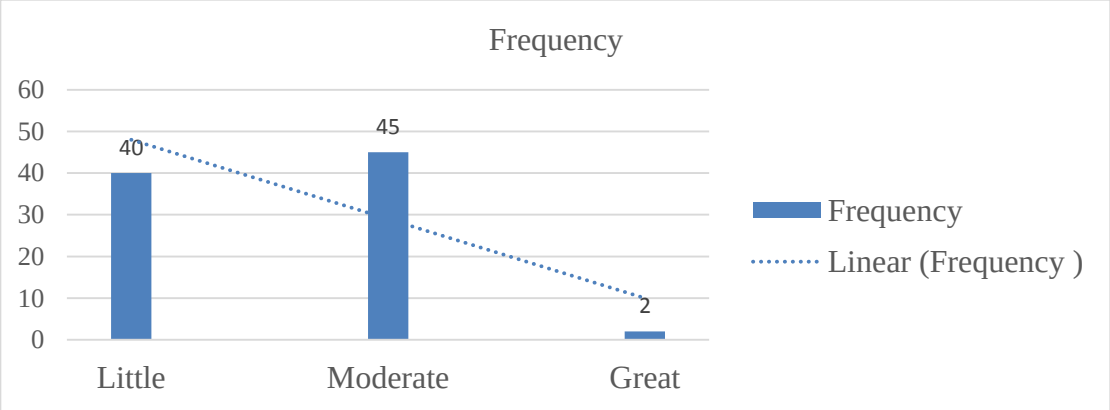


Figure 4.3: Extent of adoption of water efficiency and Conservation

Source: Author (2014)

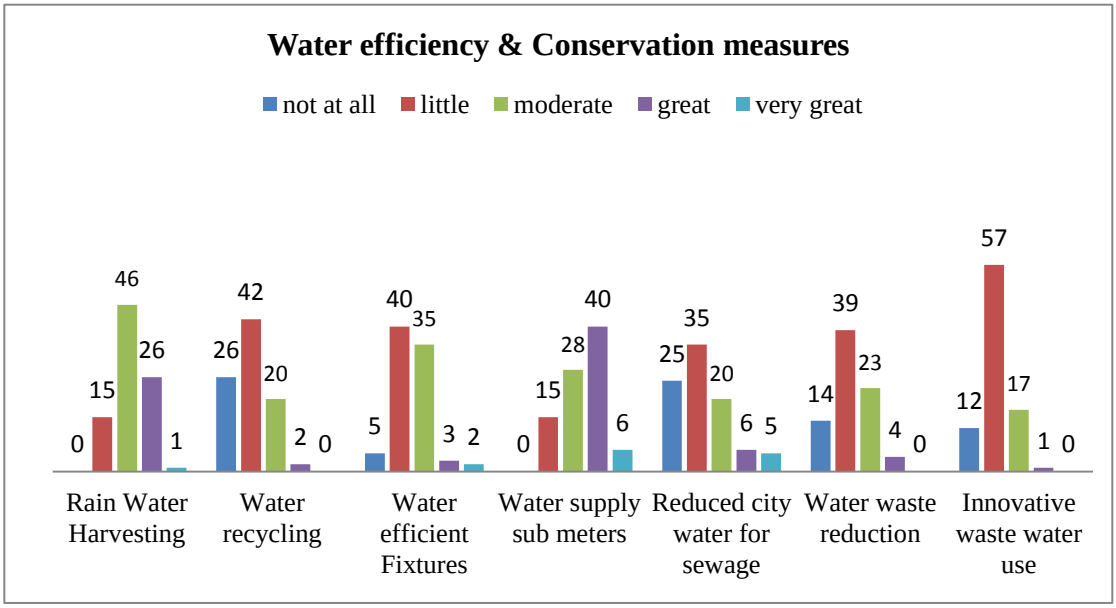


Figure 4.4: Extent of Incorporation of Water efficiency & Conservation concepts

Source: Author (2014)

Table 4.1: Mean Scores for Water efficiency & Conservation Concepts

Water efficiency and conservation concepts	Mean
Water supply sub meters	2.59
Rain Water Harvesting	2.85
Use of Water efficient Fixtures e.g. Sensor taps	3.5
Reduced City Water for sewage, (use of alternative source e.g. rain water for flushing wcs)	3.76
Water waste Reduction e.g. Planned maintenance for fixtures, pipes etc.	3.79
Innovative water use e.g. recycling waste water for reuse.	3.92
Water Recycling	4.02

Source: Author (2014)

4.1.5 Extent of Adoption - Energy Efficiency

The study sought to establish the extent to which energy efficiency concepts had been incorporated in commercial buildings, it was revealed that energy efficiency concepts had been applied to a little extent. 44% of the respondents indicated that they had applied the concept to a little extent, 38% to a moderate extent whereas only 16% had adopted this concept to a great extent. Figure 4.5 shows the extent to which the energy efficiency had been incorporated in the commercial buildings.

These results suggest that alternative sources of energy were not used or were used to a little extent (44%) in the sampled buildings. In the concepts, the study revealed that the use of alternative sources of energy such petrol, gas, charcoal, etc. was applied to a little extent; whereas the incorporation of energy conservation measures was applied to a moderate extent. Figure 4.6 and table 4.2 shows the extent of application of the energy conservation concepts.

The little extent (higher mean of 4.3) of adoption of use alternative energy sources could possibly be attributed to lack of other stable sources of electricity supply other than the supply from the national grid; this is coupled with the fact that the initial cost of

installing alternatives like solar panels and photovoltaic technology are very high except with increased volume of installed capacity (Bandari & Stadler, 2009). Reports from Kenya power indicate that electric energy is still the most reliable source of energy compared to other sources (KPLC, 2012).

Other studies indicate that standby generation using generators are only used during black outs to avoid extra 'peak demand' whereas charcoal and gas are commonly used in homes and hotels. The findings that the use of alternative sources of energy is applied to a little extent therefore concurs with other previous studies that commercial buildings rarely use other alternative sources of energy other than electricity especially because of complex demand for cooling, heating and lighting (Brown, 2000).

The lowest mean (3.2) of Energy Conservation measures suggest that this concept was the most applied among the other concepts. One possible suggestion for this result just like the water conservation measures is that individual offices monitor their consumptions, more so when the bills are not included in the service charge to lower their consumption and bills. Past studies suggest that conservation measures like smart meter that monitor how energy is used and light control sensors are measures that can go a long way to conserve energy (Scott, 2009).

Even though the study revealed the use of meters in the buildings was to a moderate extent, it was noted that there was no particular metering on the equipment and other electronic gadgets in the buildings. Metering equipment provides users with information on real time consumptions and has proved effective at reducing overall electricity consumption.

These findings are also in line with the observation made during the study where it was noted that there was use of compact fluorescent lamps (CFLs) for lighting spaces as opposed to incandescent lamps. CFLs as noted in the literature review are known to consume less electricity than the ordinary lamps.

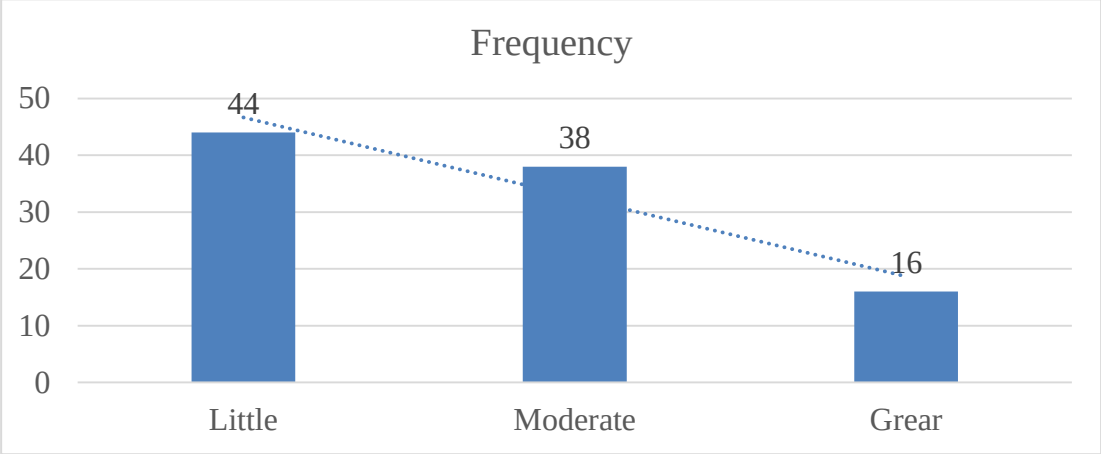


Figure 4.5: Extent of Adoption of Energy efficiency

Source: Author (2014)

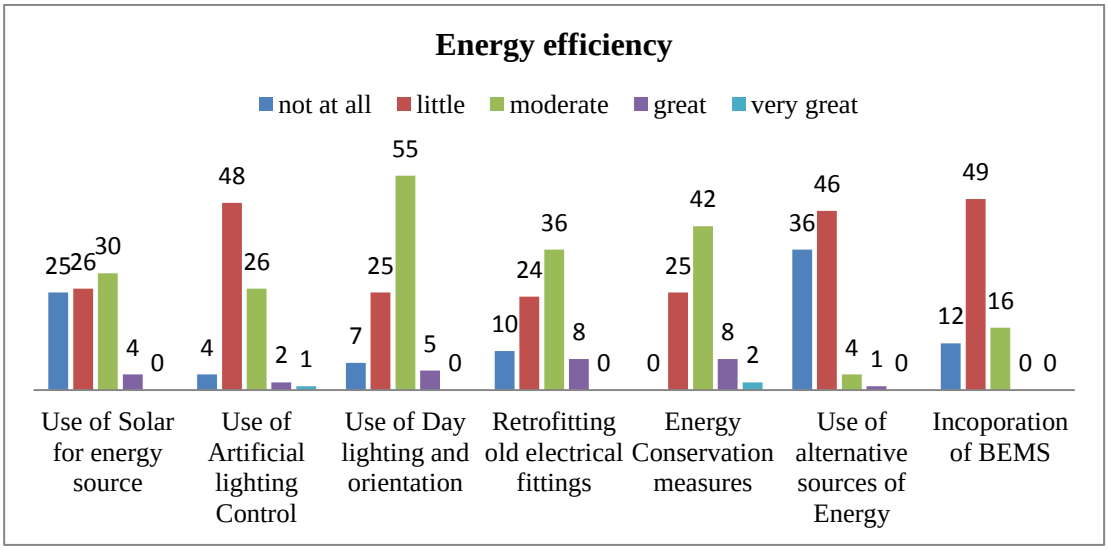


Figure 4.6: Extent of application of the energy conservation concepts.

Source: Author (2014)

Table 4.2: Mean score for concepts in energy efficiencies

Energy efficiency concepts	Mean
Energy Conservation measures e.g. installation of meters, light sensors etc.	3.2
Use of Day lighting	3.4
Retrofitting Old electrical fittings	3.5
Use of artificial light control	3.7
Use of solar as alternative source of energy	3.8
Building Energy Management System	4
Use of other sources of Energy e.g. charcoal, gas etc.	4.3

Source: Author (2014)

4.1.6 Extent of adoption – Sustainable sites

The study sought to establish the extent to which the concept of sustainable site had been incorporated in commercial buildings; it was revealed that the concepts had been applied to a little extent. 59% of the respondents indicated that they had applied the concept to a little extent, 36% to a moderate extent whereas only 5% had applied the concept to a great extent. Figure 4.7 and table 4.3 shows the extent to which the concept of sustainable site had been incorporated in the commercial buildings.

These findings indicate that adherence to the local zoning requirements, site landscaping, and preservation of existing vegetation and management of storm water are concepts which are not considered at either during design and construction or during building occupation and concurs with findings by Tessema, et al (2010) and Adebayo (2000). Adebayo (2000) argues that many urban areas of Africa especially in cities the construction of buildings occupy the entire site with total disregard to natural environment.

In the four concepts of sustainable site, the study revealed that adherence to local zoning was the most incorporated concept with the least mean of 3.1 whereas site

landscaping and preservation of existing vegetation were the least incorporated concepts with a mean of 3.7 and 3.6 respectively.

Incorporation of the concept of adherence to local zoning requirements to a great extent can be attributed local authority strict enforcement requirements for Upper Hill and Westlands areas. According to the Nairobi City County government, approvals cannot be granted if a plot has not been developed according to its intended use in the title.

The approval manual indicates plot ratios to be observed among other requirements. Even though this finding concurs with the reviewed literature that strict enforcement can improve sustainability requirements, interviewees, however, indicated that normally the approved plans are not the same as the constructed facility because once the approvals are obtained the council in most cases do not adhere to the very strict approval conditions during construction.

The study revealed that site landscaping was the least applied concept under the concept of choice of site with the highest mean of 3.7 followed closely with the concept of preservation of existing vegetation with a mean of 3.6 as indicated in Figure 4. 8. In an attempt to probably maximize the site for perceived 'higher returns' the practitioners found themselves with no open spaces to landscape nor to preserve existing vegetation.

Adebayo (Sustainable Construction In Africa, 2000) argues that in many urban areas of Africa and especially in the cities, construction of buildings generally, but especially residential buildings has been carried out to occupy the entire site. These findings and observations are similar to studies undertaken by Tessema, et al.(2010) who argue that the occupation of entire site other than limiting landscaping, also interfere with ventilation and air movement.

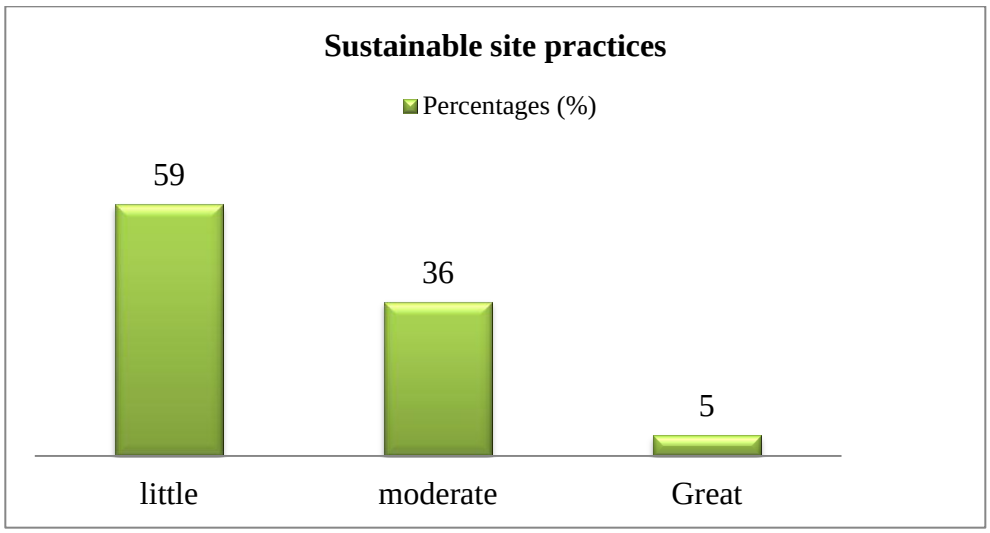


Figure 4.7: Incorporation of Sustainable site practices

Source: Author (2014

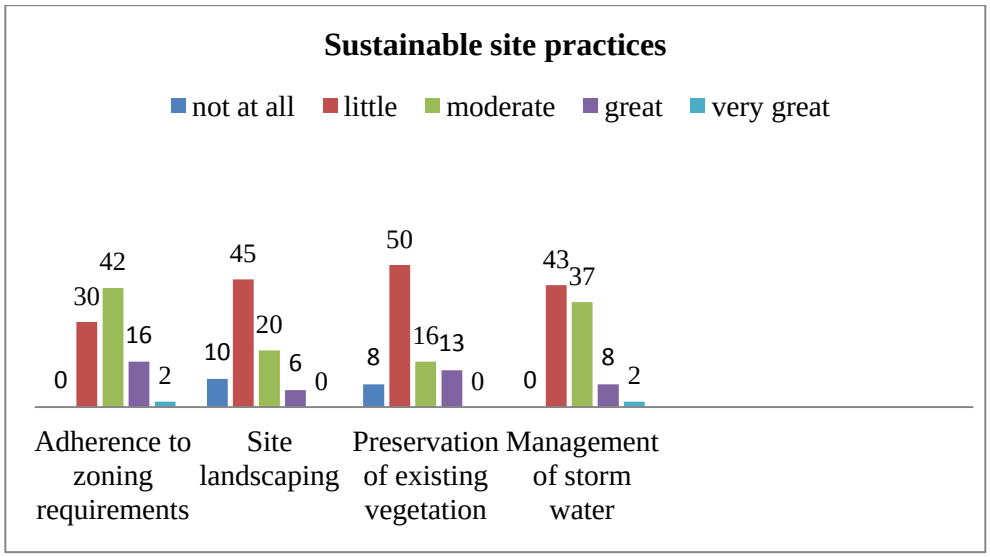


Figure 4.8: Sustainable site practices

Source: Author (2014

Table 4.3: Mean score for Concepts under choice of site

Sustainable Site Practices	Mean
Adherence to Local zoning requirements	3.1
Management of storm water	3.3
Preservation existing vegetation	3.6
Site Landscaping	3.7

Source: Author (2014

4.1.7 Extent of adoption – Sustainable Materials

The study revealed that the concept of sustainable materials had been applied to a little extent with 49% of respondents indicating that they had applied the concept to a little extent, 43% to a moderate extent and 8% to a great extent. Figure 4.9 shows the extent to which the concept of sustainable site had been incorporated in the commercial buildings.

The results indicate that practitioners do not consider (only 8% had applied sustainable materials to a great extent) the use of sustainable materials in their projects. The concepts under sustainable materials which were considered in the study included the use of Local materials and components, use of recycled materials and the use of materials with low environmental impact.

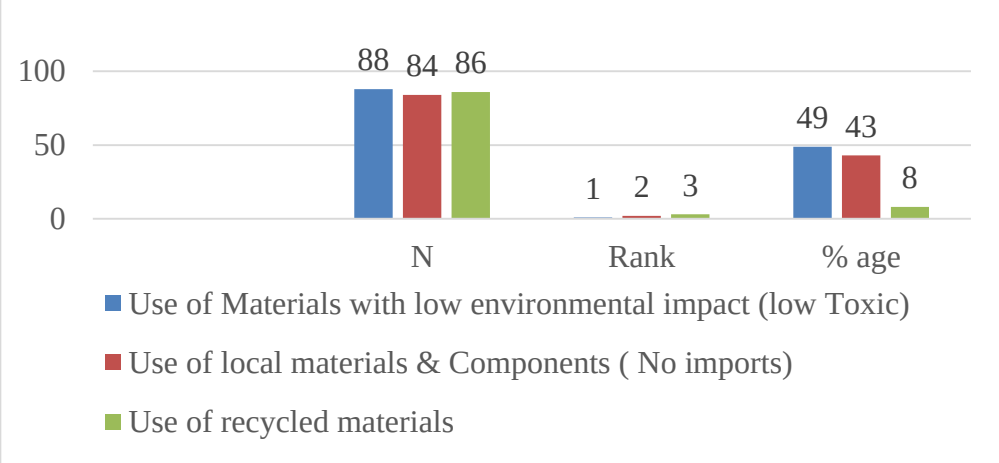
Figure 4.9 and table 4.4 indicate that the use of materials with low environmental impact was the most incorporated concept under sustainable materials with a mean score of 2.6 followed by use of local materials and components with a mean of 2.9. The use of recycled materials had the highest mean of 3.0 indicating that this concept was least applied.

The incorporation of materials with low environmental impact could be attributed to the fact that there has been introduction of various environmental laws under authorities like NEMA that require practitioners to conduct project environmental impact assessments

before execution as revealed during the interviews. Other than such organizations, the ban on certain material like asbestos for roofing restricts the practitioners to use only acceptable materials for the projects to be approved by both the local authority and NEMA.

This study revealed that the use of recycled material was least applied in the commercial buildings and therefore concurs with previous studies reviewed in the literature that recycling of building materials is a relatively new concept and has only been assessed in a few studies (Rode, 2011). Despite these findings however, it was observed that a number of recyclable materials such as aluminum, and timber were used in the construction of these buildings.

Figure 4.9: Incorporation of Sustainable material concepts



Source: Author (2014)

Table 4.4: Mean score for Concepts under Sustainable materials

Sustainable Materials	Mean
Use of Materials with low environmental impact (low Toxic)	2.6
Use of local materials & Components (No imports)	2.9
Use of recycled materials	3

Source: Author (2014)

4.1.8 Extent of adoption – Environmental Quality

Six concepts under environmental quality which included ventilation to spaces, use of thermal control units, noise control, and provision of smoking areas, use of low emitting paints and use of low emitting finishes were considered in this study.

It was revealed that the concept of environmental quality been applied to a little extent. Figure 4.10 shows that 57% of the respondents indicated that they had applied the concept to a little extent, 40% to a moderate extent whereas 2% out of 89 to a great extent. These results indicate that only concepts which had adverse effect like paint (1.7 mean) were adopted by the stakeholders.

In the six concepts under environmental quality the study revealed that provision of smoking areas was the least applied concept with the a mean of 3.6 whereas use of low emitting paints and adhesive was incorporated the most with a mean of 1.7. The incorporation of smoking areas in buildings is by and large a new concept and legislation that was introduced in the year 2007 by the county government of Nairobi, perhaps this could probably be one of the reasons for a high mean.

In regard to paint, it is a commonly used finish in commercial buildings especially the internal surfaces as observed during the study and therefore practitioners would be slow to use products which are harmful to users. Other than being a common finish, manufacturers would lose out in the market with products that do not meet the standards.

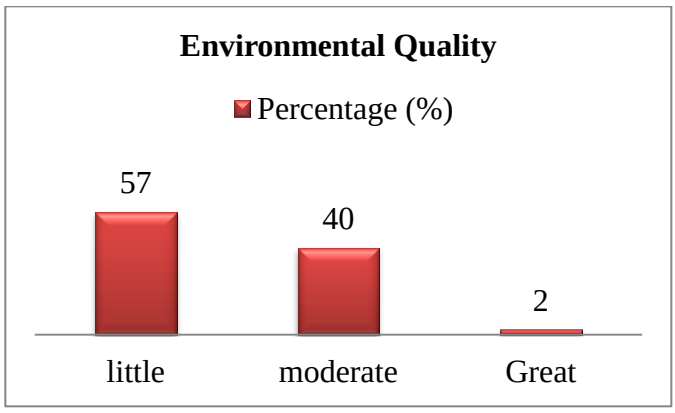


Figure 4.10: Extent of adoption – Environmental Quality

Source: Author

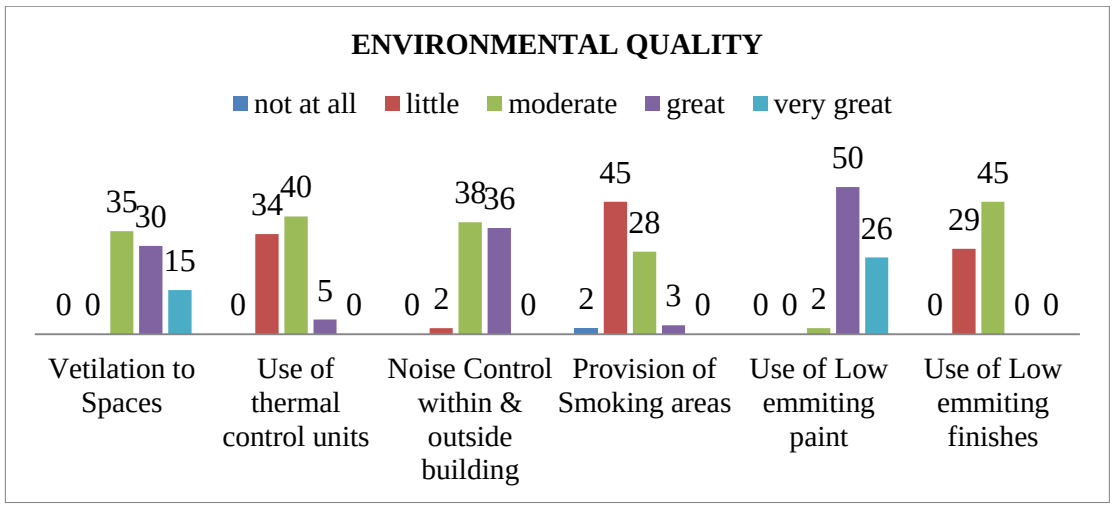


Figure 4.11: Extent of adoption – Environmental Quality concepts

Source: Author (2014)

Table 4.5: Mean score for Environmental Quality Concepts

Environmental Quality	Mean
Use of low emitting Paints and adhesives	1.7
Ventilation to spaces	2.3
Prevention of Noise within and outside the building	2.5
Use of thermal control units	3.3
Use of low emitting finishes (carpet and flooring system)	3.4
Provision of smoking areas	3.6

Source: Author (2014)

4.2 Adoption of Green building concepts in commercial buildings in Nairobi

One of the specific objectives of the study was to establish which green building concepts commercial buildings in Nairobi have adopted within the last five years. To establish these concepts, the green building concepts in each of the environmental categories were ranked after calculating the mean score for the concepts. A lower mean meant that the concept was most adopted whereas a higher mean meant that the concept was least adopted.

Table 4.6 indicates the ranking of the adopted concepts in each of the environmental categories. Water, Energy efficiencies and environmental quality had the most number of concepts adopted within the five years whereas choice of site and use of sustainable materials had a few concepts adopted.

Under water efficiency and conservation concepts, the results indicate that the most adopted concept is installation of water supply sub meters (2.56 mean), followed by rain water harvesting (2.85 mean) and installation of water efficient fixtures (3.50 mean). In regard to energy efficiency the adopted concepts as revealed by the study included among other concepts installation of sub meters (3.2 mean), use of day lighting (3.4 mean) and retrofitting old electrical fittings (32 mean).

The findings that Energy and Water efficiencies are the most adopted concepts strongly suggest that resources that are pegged to some kind of fee/charges are easily adopted than the once which do not attract charges. This argument is supported by the fact that sub metering for both water and energy efficiencies as a concept had the lowest mean (2.56 & 3.2) as indicated in figure 4.5-1 revealing that the concept was mostly adopted in the sample under the study.

This argument can also be advanced further for the concepts under choice of site, sustainable materials and environmental quality. It is evident that the concepts adopted in these categories which are subjected to regulations are mostly adopted than those that are not subjected to regulations. Adherence to local zoning under choice of site had the lowest mean (3.1) perhaps because of local authority regulatory requirements.

Use of materials with low environmental impact as a concept under sustainable materials (2.6 mean) and use of low emitting paint as a concept under environmental quality (1.7 mean) also emerged as top ranking concepts that are adopted in commercial buildings. These concepts are part of requirements that are fulfilled under NEMA before approvals are granted.

Table 4.6: Green building concepts adopted in commercial buildings

Water efficiency and conservation concepts	**Mean**	**N**	**Rank**
Water supply sub meters	2.59	90	1
Rain Water Harvesting	2.85	88	2
Use of Water efficient Fixtures e.g. Sensor taps	3.5	85	3
Reduced City Water for sewage, (use of alternative source e.g. rain water for flushing wcs)	3.76	91	4
Water waste Reduction e.g. Planned maintenance for fixtures, pipes etc.	3.79	80	5
Innovative water use e.g. recycling waste water for reuse.	3.92	87	6
Water Recycling	4.02	90	7
Energy efficiency concepts	**Mean**	**N**	**Rank**
Energy Conservation measures e.g. installation of meters, light sensors etc.	3.2	77	1
Use of Day lighting	3.4	92	2
Retrofitting Old electrical fittings	3.5	78	3
Use of artificial light control	3.7	80	4
Use of solar as alternative source of energy	3.8	85	5
Building Energy Management System	4	77	6
Use of other sources of Energy e.g. charcoal, gas etc.	4.3	87	7
Sustainable Site Practices	**Mean**	**N**	**Rank**
Adherence to Local zoning requirements	3.1	90	1
Management of storm water	3.3	90	2
Preservation existing vegetation	3.6	87	3
Site Landscaping	3.7	81	4

Source: Author (2014)

Table 4.6: Continued: Green building concepts adopted in commercial buildings.

Sustainable Materials	**Mean**	**N**	**Rank**
Use of Materials with low environmental impact (low Toxic)	2.6	88	1
Use of local materials & Components (No imports)	2.9	84	2
Use of recycled materials	3	86	3
Environmental Quality	**Mean**	**N**	**Rank**
Use of low emitting Paints and adhesives	1.7	78	1
Ventilation to spaces	2.3	80	2
Prevention of Noise within and outside the building	2.5	77	3
Use of thermal control units	3.3	75	4
Use of low emitting finishes (carpet and flooring system)	3.4	74	5
Provision of smoking areas	3.6	80	6

Source: Author (2014)

4.3 Hindrances to the Adoption of Green building concepts

To determine the challenges faced by practitioners in the adoption of green building concepts, respondents were asked to use a 5 point scale to determine the extent the identified challenges in the literature review hinder increased adoption. A mean score was calculated where a lower mean meant that the factor posed a high challenge whereas a higher mean was interpreted as a less challenge in adopting the concept.

Figure 4.12 and Table 4.7 indicate the responses and the mean score for the challenges in the adoption of the concepts.

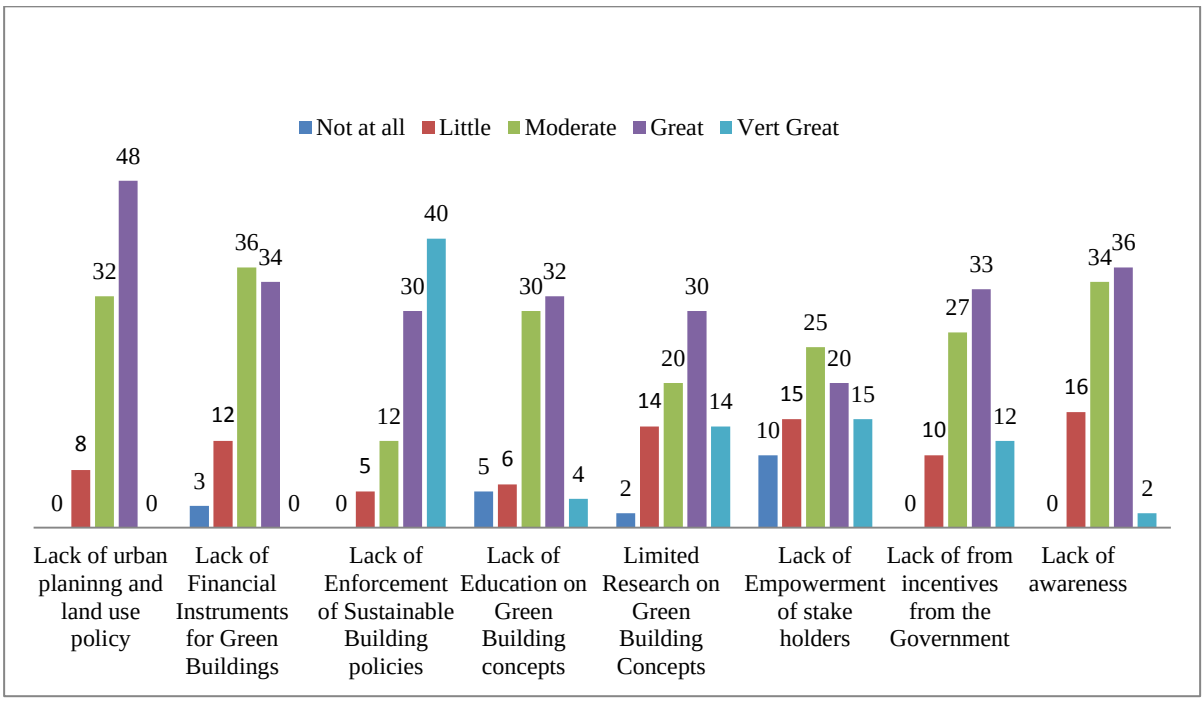


Figure 4.12: Responses to challenges in the adoption of the green building concepts.

Source: Author (2014)

Table 4.7: Mean score for uptake challenges

	Uptake Challenges	Mean
1	Lack of enforcement of sustainable building policies	1.81
2	Lack of incentives from the govt. e.g. Tax holiday, green loans etc.	2.43
3	Limited research on GBC	2.50
4	Lack of urban planning and land use policy	2.56
5	Investment in Green Building related research	2.69
6	Lack of financial instruments for green buildings	2.81
7	Lack of empowerment of stake holders	2.82
8	Lack of awareness	3.74

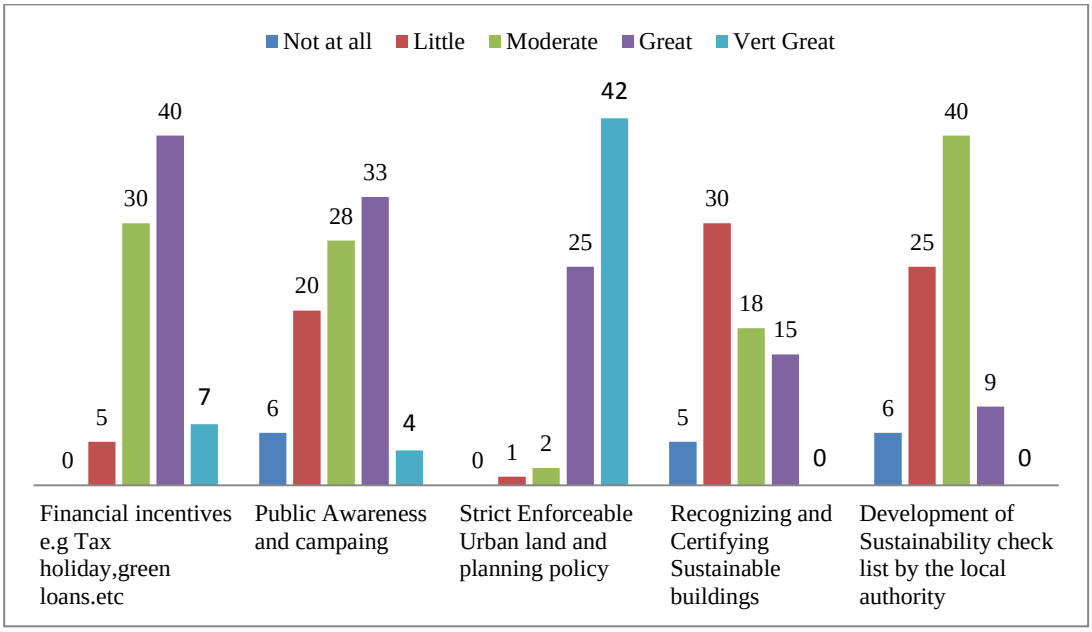
Source: Author (2014)

The study revealed that lack of enforcement on sustainable building policies posed a greater challenge to adoption of the concept with the lowest mean of 1.81. Lack of awareness had the highest mean of 3.74. The mean of 1.81 on lack of enforcement of sustainable building policies suggests that enforcement is the foremost challenge in adopting the concepts. Studies suggest that it is difficult to enforce sustainable building policies as enforcement requires adequate education and training of building inspection teams (Anderson, Lyer, & Huang, 2004). They suggest that improved enforcement can be laid through starting with voluntary schemes and use of incentives to overcome the challenge.

Findings by McGraw- Hill construction smart market report (McGraw, 2013) differs with these findings and indicate that higher first costs for green building efforts is viewed as the most significant obstacle between current levels of adoption and the future growth, however, the report also indicate that the second most important challenge is lack of enforcement which varies from region to region. In our context, Africa and Kenya generally, lack of enforcement take lead as a challenge to adoption because of the inability and inefficiency of the county governments who are charged with responsibility of enforcement (Ringera, 2007). These findings therefore are in line with both the McGraw – Hill report and Anderson Lyer and Huang (2004).

4.4 Green Building Concepts Strategies

The last objective of the study was to determine appropriate strategies for implementing green building concepts in commercial building in Nairobi. In this objective respondents were asked to use a 5 point scale to determine appropriate strategies that can be used to promote uptake of green building concepts. A mean score for the strategies was calculated where a lower mean meant that the strategy promoted uptake whereas a higher mean was interpreted not to be the fastest way to promote uptake of the concepts. Figure 4.13 and Table 4.8 indicate the responses and the mean item score on the factors that are considered to promote uptake of green building concepts.



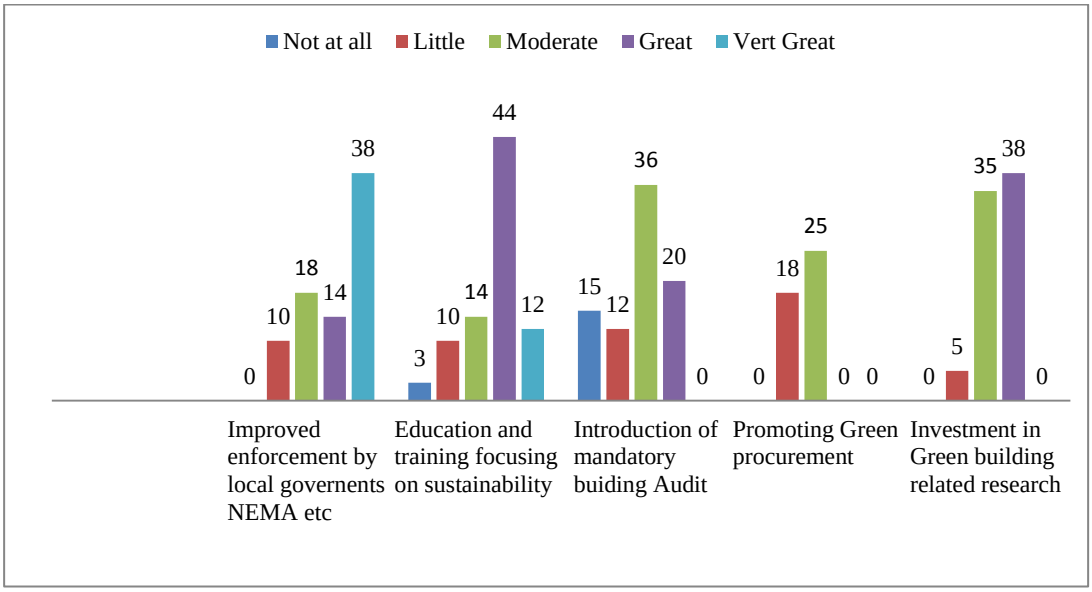


Figure 4.13:Factors promoting uptake of uptake of Green building concepts

Source: Author (2014)

Table 4.8: Mean score implementation strategies

	Strategy	Mean
1	Strict enforceable urban land and planning policy	1.46
2	Improved enforcement by local government, NEMA etc.	2.00
3	Education and training focusing on sustainability	2.37
4	Financial incentives e.g. Tax holidays, green loans etc.	2.40
5	Investment in Green Building related research	2.58
6	Development of sustainability check list by local authority	2.65
7	Public awareness and campaign	2.91
8	Promoting green procurement	3.24
9	Introduction of mandatory building Audit	3.27
10	Recognizing and certifying sustainable buildings	3.38

Source: Author (2014)

The study revealed that strict enforceable urban land and planning policy was one of the fastest ways to promote uptake of green building concept. This strategy had a mean of 1.46 followed by improved enforcement of codes and regulation by other enforcement agencies like the local government, NEMA etc. which had a mean score of 2.00. Other strategies for promoting uptake in order of priority included Education and training focusing on sustainability 2.37, financial incentives such tax holiday and green loans had a mean of 2.40 as shown in table 4.7-1. Promoting green procurement as a strategy leased promoted uptake of the concepts with the highest mean of 3.42

Enforcements, whether in urban land and planning policies, building codes, energy efficiency obligation or procurement regulations fall under regulations and control mechanisms and studies have shown that enforcement of regulatory mechanisms can be a rapid way to implement effective technologies and best practices (Granade, Ostroki, Derkach, & Farese, 2009). Analyses in (UNEP SBCI, 2007) of cases conclude that regulatory and control measures are probably the most effective ways to implement

green strategies. Conclusively these findings concur with the studies as both the first and the second strategy for uptake of green building concepts revolved around enforcement.

A survey in the year 2009 by Price Water House (PwC) of European countries indicated that a number of developed countries are leading the way in green public procurement. The survey found out that where green procurement is applied, life cycle costs are reduced by 10 per cent (PwC, 2009). This survey, however, does not rank the green procurement strategy as driver to uptake. It can be argued that in our context green procurement is a relatively new concept which need to be understood through education and training for it to be a top strategy for enhancing uptake of the concepts.

4.5 Conclusion

Strict enforceable urban land and planning policy, improved enforcement of bylaws by local government as well as education and training focusing on sustainability are some of the appropriate strategies that this study concluded to be among the approaches that can be adopted to promote uptake. Strict enforcement of policies especially at the point of building plans approvals would drive the industry practitioners to embrace green construction in their practices.

Education training and research right from the lower school systems and to institutions of higher learning would produce environmentally focused graduates who will easily embrace sustainability concepts in their projects. The next chapter of the study is a summary of findings, recommendation and conclusions.

CHAPTER FIVE

SUMMARY OF FINDINGS, RECOMMENDATION AND CONCLUSION

5.0 Introduction

This chapter represents the summary of the research work undertaken and based on the study findings, draws conclusion and make recommendations on the aims and objectives.

5.1 Summary of Major findings

5.1.1 Awareness and Incorporation of Green Building Concepts in Projects

The study revealed that the professional and the practitioners in the sampled buildings were aware of the green building concepts under the five environmental categories. Water efficiency had the highest percentage of awareness at 98%, Energy efficiency 97%, Sustainable materials 92%, Environmental quality 95% and Sustainable materials at 91%, which was an average of 95%

5.1.2 Extent to which Green building concepts have been adopted in commercial buildings

The first objective of the study was to determine the extent to which green building concepts had been incorporated in the commercial buildings. Five green building environmental categories namely water efficiency and conservation, energy conservation, sustainable sites, sustainable materials and environmental quality were taken into consideration.

The study revealed that only 2% of the respondents had applied water and conservation concepts to a great extent, 16% had applied energy efficiency concepts to great extent and 5% had applied the concept of sustainable site to a great extent. Under sustainable materials, the study revealed that only 8% of the respondents had applied the concept to a great extent whereas 2% of the respondent had applied the concept of environmental quality to a great extent. The average extent to which the concepts had been incorporated was 7%.

5.1.3 Green building concepts adopted in commercial building in Nairobi

Objective two was to establish which green building concepts commercial buildings in Nairobi have adopted within the last five years. In order to establish the green building concepts adopted in the last five years, the study categorized the green building concepts in the five environmental categories and subjected them to a mean item rating scale. A lower mean meant that the concept was mostly adopted whereas a higher mean meant that the concept was least adopted.

The study revealed that use of water sub meters was the most incorporated concept with a mean of 2.59 whereas rain water harvesting was the second most incorporated concept (2.85) mean. The third most incorporated concept was use of water efficient fixtures (3.50) whereas the least incorporated concept was water recycling (4.02 mean). Under energy efficiency measures installation of sub meters was also the most adopted concept (3.2 mean) followed the use of day lighting with a mean of 3.4 whereas retrofitting of old electrical fitting was third with a mean of 3.5.

Adherence to local zoning requirements under sustainable site was the most adopted concept with a mean of 3.1 whereas use of materials with low environmental impact was most adopted with a mean of 2.6 under the concept of sustainable materials. In environmental quality, use of low emitting paint and adhesives was the most applied concept with a mean of 1.7. The study also revealed that water recycling (4.02), use of other sources of energy e.g. charcoal, gas, diesel, etc. (4.3)., site landscaping (3.7), use of recycled materials (3.0) and provision of smoking areas (3.6) were the least adopted concepts in commercial buildings.

5.1.4 Challenges hindering uptake of the concepts

Objective three was to determine the challenges faced by practitioners in the adoption of green building concepts in commercial building in Nairobi. The study revealed that lack of enforcement of sustainable building policies and incentives from the government

were the greatest hindrance facing practitioners in the adoption of green building concept with 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.

5.1.5 Appropriate Strategies to Promote uptake of Green building Concepts

Objective four was to determine appropriate strategies for implementing green building concepts in commercial building in Nairobi. The study through mean item rating scale ranked strict enforcement of urban land and planning policy (1.81), as the first strategy that would promote uptake of green building concepts. Recognizing and certifying buildings (3.38) least promoted the uptake of the concepts.

5.1.6 Methodology Adopted

This study adopted survey research design method. The population consisted of commercial buildings completed between 2008 and 2012. A total of 50 buildings were identified for this study in Nairobi Upper Hill and Westlands areas. The choice of these two areas was informed by the fact that over 80% of major commercial buildings had been constructed in these two locations between the periods of the study. To maintain uniformity, premises that were sampled were limited to at least five floors and above. This ensured that the composition of the accessible population had the same characteristics hence homogeneous.

Due to time and resource constraints, the study was restricted to a portion of the target population. It focused on 75% of the target population; Mugenda & Mugenda, (Research Methods, Quantitative & Qualitative approaches, 1999) recommend a minimum sample of 30 items. A bigger sample of 75% which translated to 38 commercial buildings was selected through simple random sampling. Questionnaires were sent out to consultants, who were involved in the design and implementation of the 38 sampled commercial buildings and a response rate of 62% was obtained. This response rate exceeds the

required threshold of 30-80% reported in preceding studies and can be generalized in order to arrive at an informed conclusion.

5.2 Conclusion

Despite 95% awareness of green building concepts among the practitioners, the extent of adoption of the concepts in commercial buildings is only 7%. Generally these findings are similar to other findings in the developing countries of Africa where only South Africa and Egypt have Green Building Councils. It is therefore imperative that project stakeholders adopt more green concepts in the projects.

The study also revealed that water and energy conservation concept of sub metering is ranked first in the adoption uptake with a mean of 2.59 and 3.2 respectively, this as discussed in the study is perhaps due to the fact that their consumption comes with a cost as opposed to the other environmental categories, i.e. sustainable sites, materials and indoor environmental quality.

Last but not least there is need to develop guild lines and policies for enforcement of sustainable building concepts and introduction of incentives from both local and national governments as lack of these factors were ranked first and second challenges practitioners faced in the adoption of the concepts. Consequently, the strategy would be to follow up on the enforcement of the policies as well as education and training focusing on sustainability as found out in the adoption strategies.

5.3 Contribution to Knowledge

This study has uncovered several Green building concepts that despite being known to practitioners in the built environment field are applied to a very little extent (7%). From this study therefore, the practitioners and players in the built environment have an opportunity to increase the levels of incorporation of the concepts that they already apply and further still incorporate the ones which have either been ignored or have never thought to incorporate.

5.4 Recommendation

Based on the findings of this study in chapter four, the following recommendations are hereby made with a view of increasing the uptake and adoption of green building concepts in commercial buildings.

Table 5.1: Recommendation for uptake of Green Building Concepts

	Finding	Section	Recommendation
1	The extent of Adoption of green building concepts by practitioners is low (7%)	Section 5.21, 4.43 - 4.47	Practitioners need to explore and adopt concepts especially at project design stages.
2	The level of awareness of green building concepts by practitioners is high (95%)	Section 4.41 and Figure 4.1	Need to translate awareness into practice through introduction of incentives like tax holidays.
3	The study revealed that Water and Electricity sub meters, Adherence to local zoning, Use of materials with low environmental impact and Use of low emitting paint and adhesives were popular concepts adopted by practitioners	Section 4.43 - 4.47	Players to view green building as a system and incorporate the concepts holistically as opposed to adopting single concepts
4	Lack of enforcement of sustainable building policies and incentives from the government are the greatest hindrance facing practitioners in the adoption of green building concept	Section 5.23	Develop guild lines and policies for enforcement of sustainable building concepts and introduction of incentives from both local and national governments
5	Strict enforcement of urban land and planning policy, as a strategy would promote uptake of green building concepts.	Section 5.24	Follow up on the enforcement of the policies as well as education and training focusing on sustainability.

5.5 Areas for further research

This study recommends further research to be carried out on perception and knowledge of Green buildings in Kenya. This will help establish the extent of penetration of knowledge by professionals and practitioners in the built environment better understand the benefits and the salient features of Green buildings. The study also recommends further research on the direct environmental, social and financial benefits Green buildings can bring to Kenya as this will benefit local manufacturers to include green product lines in their production which will encourage a wider and faster acceptance of the Green building concepts.

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APPENDICES

Appendix 1: Letter of introduction

JOMO KENYATTA UNIVERSITY

OF

AGRICULTURE ANDTECHNOLOGY

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DEPARTMENT OF CONSTRUCTION MANAGEMENT

SCHOOL OF ARCHITECTURE AND BUILDING SCIENCES

Date: April 2014

Dear Sir/Madam,

RE: PERMISSION TO CONDUCT A STUDY ON ADOPTION OF GREEN BUILDING CONCEPTS.

I am a student at Jomo Kenyatta university of Agriculture and Technology undertaking a Master's degree of Construction Project Management. My research thesis is titled, '**Investigation into the adoption of Green Building concepts in commercial buildings: A case of Nairobi of city.**

The main objective of the study is to investigate the extent to which green building concepts have been adopted within Nairobi commercial buildings, and determine the challenges facing increased adoption of the concepts. All of the responses in the study will be recorded anonymously and with utmost confidentiality and the findings shall be

used for academic purposes only. Your participation and cooperation will be highly appreciated.

Thank you

For More Information Contact

Solomon W. Were

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Appendix 2: Population size

A.COMMERCIAL BUILDINGS, FIVE FLOORS AND ABOVE (UPPER HILL-NAIROBI)

1. CIC Plaza
2. KMA Centre
3. ACK Garden Annex
4. KCB Headquarters
5. Equity Centre
6. Solution Tech Place
7. Renaissance Corporate Park
8. Corporate Business Centre
9. Court of Appeal
10. Woodland Centre
11. Nairobi java
12. Khushee Tower

B.COMMERCIAL BUILDINGS, FIVE FLOORS AND ABOVE (WESTLANDS AREA)

1. Sky Park Plaza
2. Goodman Plaza
3. Safaricom Centre
4. KAM House
5. Brookside House
6. BBK West End
7. West end Towers
8. Delta Corner
9. Arundala Heights
10. Caital West
11. Medox House

12. VIP Plaza
13. Orbit Place
14. Autarc Building
15. Citadel Center
16. Royal Offices
17. Reliable towers
18. Westlands Business Park
19. Misha Tower
20. The Exchange
21. Harley`s
22. Prosperity House
23. 9 west
24. The Oval
25. Emress
26. Apollo Centre
27. Standard Chartered Bank Building
28. Peponi Plaza
29. Equatorial Fidelity Centre
30. Madima House
31. Back Field
32. Fortis Towers
33. Krishna Centre
34. Sound Centre
35. Reliance Centre
36. Arnold Plaza
37. Divan Plaza
38. MMID Studio

SUMMARY

Upper Hill - 12

Westlands - 38

TOTAL - 50

Appendix 3: Sample population

1. CIC Plaza
2. KMA Centre
3. KCB Headquarters
4. Equity Centre
5. Renaissance Corporate Park
6. Corporate Business Centre
7. Woodland Centre
8. Nairobi java
9. Khushee Tower
10. Sky Park Plaza
11. Safaricom Centre
12. KAM House
13. Brookside House
14. BBK West End
15. West end Towers
16. Capital West
17. Medox House
18. VIP Plaza
19. Orbit Place
20. Autarc Building
21. Citadel Center
22. Royal Offices
23. Reliable towers
24. Westlands Business Park
25. The Exchange
26. Prosperity House
27. 9 west
28. The Oval

29. Apollo Centre
30. Standard Chartered Bank Building
31. Equatorial Fidelity Centre
32. Back Field
33. Fortis Towers
34. Krishna Centre
35. Sound Centre
36. Reliance Centre
37. Arnold Plaza
38. Divan Plaza

TOTAL - 38

Appendix 4 A: Questionnaire for consultants involved in design and implementation.

Dear respondent,

This questionnaire aims to collect information related to extent of adoption of green building concepts in Nairobi. The information given is for academic purpose only and will be treated as very confidential.

Introduction

Green building concepts are based on the principles of resource efficiency, health and productivity. It involves an integrated approach in which a building project and its components are viewed on a full cycle basis. They use **less energy**, **water** and **natural resources** compared to the convectional buildings. They also create less waste and provide healthier living environment, further they incorporate features such as efficient use of water, energy efficient and eco-friendly environment. The buildings use renewable energy and recycled materials, embrace effective use of landscape and have improved indoor quality for health and comfort.

Section A: Information on respondent

1. Profession

Architect	Quantity Surveyor	Project Manager	Property Manager
☐	☐	☐	☐

Engineer – Electrical ☐

Structural / Civil ☐

Mechanical ☐

Others, specify……

2. Professional Experience

a) Below 5 ☐ 6 - 10 ☐ 11 - 15 ☐ 16 - 20 ☐ Over 20 ☐

Section B: Specific Questions

1. Adoption of Green Building Concepts

a) Are you aware of the following green building concepts? Tick **Yes / No.**

	Green Building Concept	**Example**	**Yes**	**No**
1	Water Efficiency	e.g. water conservation measures, water efficient fixtures etc.		
2	Energy Efficiency	e.g. Use of day lighting, use of renewable sources of energy e.g. solar etc.		
3	Use of Sustainable Material	e.g. use of recyclable and low toxic materials,		
4	Use of Sustainable Site Practices	e.g. landscaping , sticking to zoning requirements, etc.		
5	Indoor Environmental Quality	e.g. provision of adequate ventilation, thermal and sound control, etc.		

b) Among the Projects you have completed in the last 10 years, have you incorporated any of the Green Building Concepts?

Yes ☐

No ☐

c) If yes, Green Building Concepts encompass five environmental categories namely Water and Energy efficiency, Sustainable site, Materials and indoor environmental quality. Which concept did you apply in your commercial building project? **Please tick Yes or No.**

	Category	Yes	No
1	Water Efficiency		
2	Energy Efficiency		
3	Sustainable Materials		
4	Sustainable Site Practices		
5	Indoor Environmental Quality		
6	None		

d) To what extent did you incorporate the **five environmental categories**?

Use a **5 point scale** where **5** Not at all; **4** Little Extent; **3** Moderate Extent; **2** Great Extent and **1** Very Great Extent,

	Category	5	4	3	2	1
1	Water Efficiency					
2	Energy Efficiency					
3	Sustainable Materials					
4	Sustainable site practices					
5	Indoor Environmental Quality					

e) The table below shows different Green building concepts under the environmental categories normally applied in Kenya, using a **5 point likert scale,** Rate the extent to which you have applied these concepts

f)

A	WATER EFFICIENCY AND CONSERVATION	Not at all	Littl e	Mod erate	Great	Very Great
		1	2	3	4	5
a	Rain Water Harvesting					
b	Water recycling					
c	Water efficient Fixtures					
d	Water supply sub meters					
e	Reduced city water for sewage					
f	Water waste reduction					
g	Innovative waste water use					
h	Others Specify……					

B	ENERGY EFFICIENCY	Not at all	Little	Moderate	Great	Very Great
		1	2	3	4	5
a	Use of renewable energy Sources					
b	Use of Day lighting					
c	Use of Artificial lighting Control					
d	Retrofitting old electrical fittings					
e	Building Energy Management system					
f	Energy Conservation measures					
g	Use of solar.					
h	Others Specify……					
C	**CHOICE OF SITE**					
		1	2	3	4	5
a	Adherence to Local zoning requirements					
b	Preservation existing vegetation.					
c	Site Landscaping					
d	Management of storm water					
e	Others Specify……					
D	**MATERIALS**					
		1	2	3	4	5
a	Use of local materials.(No imports)					
b	Use of materials that can be reused or recycled after the building life.					
d	Use of local components					
e	Use of materials with low environmental impact.					
f	Use of Low Toxic material					
E	**PERFORMANCE IN USE & ENVIRONMENTAL QUALITY**					
		1	2	3	4	5
a	Ventilation to public and circulation spaces					
b	Use low emitting carpet and flooring system.					
c	Use of low emitting paint and adhesive.					
d	Complaints arising from users					

e	Prevention of noise within and outside the building.					
f	Provision of smoking areas					
g	Use of thermal control units					
F	**WASTE REDUCTION & DISPOSAL**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
a	Provision of Waste management plan					
b	Provision of Maintenance services.					
c	Hazardous waste control and disposal					
d	Provision of different disposal methods					

2. Challenges hindering uptake of Green Building Concepts

a) From the table below please **Rank** in a **scale of 1 – 5** the factors you feel largely affect the adoption of Green Building Concepts in Kenya, where **1** is the lowest rank and **5** the highest.

	FACTORS HINDERING INCREASED ADOPTION	**1**	**2**	**3**	**4**	**5**
1	Lack of Urban planning and land use Policy					
2	Lack of Financial Instruments for Green Buildings					
3	Lack of Enforcement of Sustainable Building policies					
4	Lack of Education on Green Building Concepts					
5	Limited Research on Green Building Concepts					
6	Lack Empowerment of stake holders					
7	Lack of from incentives from the Government					
8	Lack of awareness					
9	Others, …….. ..Specify.					

b) From your experience to what extent do the following challenges hinder increased adoption of Green building concepts in Kenya. Use a **5 point scale** where **5** Not at all; **4** Little Extent; **3** Moderate Extent; **2** Great Extent and **1** Very Great Extent

	FACTORS HINDERING INCREASED ADOPTION	5	4	3	2	1
1	Lack of Urban planning and land use Policy					
2	Lack of Financial Instruments for Green Buildings					
3	Lack of Enforcement of Sustainable Building policies					
4	Lack of Education on Green Building Concepts					
5	Limited Research on Green Building Concepts					
6	Lack Empowerment of stake holders					
7	Lack of from incentives from the Government					
8	Lack of awareness					
9	Others, ……..Specify					

3. Strategies to increase / promote uptake of Green Building concepts

a) Which of the following strategies do you think would **promote uptake** of Green Building Concepts in commercial Buildings in Kenya? Use a **5 point scale** to **Rank** the strategies where **1** is the lowest and **5** the highest Rank

	STRATEGIES FOR UPTAKE OF GBCs	1	2	3	4	5
1	Development of sustainability check list by local Authority					
2	Improved enforcement by local governments, NEMA etc.					
3	Education and training focusing on sustainability					
4	Introduction of Mandatory building Audit					
5	Promoting Green Procurement					
6	Investment in Green Building related research					
7	Financial incentives e.g. Tax holidays, green loans etc.					
8	Public Awareness and campaign					
9	Strict Enforceable urban land and Planning Policy					
10	Recognizing and Certifying Sustainable buildings.					
11	Others, ……..Specify					

b) Use a **5 point scale where 5** Not at all; **4** Little Extent; **3** Moderate Extent; **2** Great Extent **1** Very Great Extent. To **what extent** can these strategies promote uptake of Green Building Concepts in Kenya?

	STRATEGIES FOR UPTAKE OF GBCs	**5**	**4**	**3**	**2**	**1**
1	Development of sustainability check list by local Authority					
2	Improved enforcement by local governments, NEMA etc.					
3	Education and training focusing on sustainability					
4	Introduction of Mandatory building Audit					
5	Promoting Green Procurement					
6	Investment in Green Building related research					
7	Financial incentives e.g. Tax holidays, green loans etc.					
8	Public Awareness and campaign					
9	Strict Enforceable urban land and Planning Policy					
10	Recognizing and Certifying Sustainable buildings.					

Any other additional information / comment you would like to make on this subject

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THANK YOU FOR FILLING THE QUESTIONNAIRE AND YOUR TIME.

Appendix 4 B: Interview schedule & guide questions

(For planning officers in Government Ministries and Parastatals)

ITEM	DESIGNATION OF THE INTERVIEWEE	INTERVIEW FOCUS	DATE	DURATION
1	Chief Engineer, Demand side management, Kenya Power and lighting company	Challenges hindering uptake and implementation of Energy related GBC. Strategies of implementing GBCs.	April 2014	1hour
2	Senior Principal Supt. Architect, Ministry of Lands Housing and Urban development. Senior Principal Supt. Quantity Surveyor, Ministry of Lands Housing and Urban development.	How to promote uptake of Green Building Concepts and their adoption. Strategies of implementing GBCs.	April 2014	1hour
3	Environmental Impact Assessment Expert, Ministry of Environment, Water and Natural Resources	GBCs adopted in commercial buildings Strategies of implementing GBCs.	May 2014	30 minutes

1. What are the challenges hindering uptake of solar Energy?
2. How successful has the retrofitting exercise by your company as a strategy for implementing uptake by your company been?
3. To what extent has urban planning and land Policy improved implementation of Green building concepts?

4. How does National Environmental Management Authority intend to promote implementation of green construction concepts?

Appendix 4 C: Inspection check list

1.1 Extent of adoption.

The checklist below will be used to determine the degree of adoption of the green building concepts incorporated in Nairobi's commercial buildings. Some of the green concepts will not be included in the observation checklist since the sample will be drawn from already existing buildings.

The checklist will be divided into five themes namely

- Water efficiency and conservation,
- Energy efficiency,
- Sustainable sites,
- Waste disposal and
- Internal performance of the building.

The themes for the checklist are based on the international rating systems which include LEED, USGBC among others. It is worth noting that not all the aspects of international systems were adopted in this checklist as they are only applicable in those countries.

The researcher after observation will through the questionnaires and interviews confirm the extent to which the green building concepts have been incorporated in the sampled buildings. During observation the researcher will tick and make remarks on the Green Concepts adopted in the sampled commercial buildings within Nairobi which were constructed in the last ten years in Upper hill and Westlands areas.

INSPECTION CHECK LIST

GBCs ADOPTED IN COMMERCIAL BUILDINGS IN NAIROBI

	WATER EFFICIENCY	**YES**	**NO**	**REMARKS**
a	Rain Water Harvesting			
b	Water recycling			
c	Water efficient Fixtures			
d	Water supply sub meters			
e	Reduced city water for sewage			
f	Water waste reduction			
g	Innovative waste water use			
h	Others			
	ENERGY EFFICIENCY			
a	Use of renewable energy Sources			
b	Use of Day lighting			
c	Use of Artificial lighting Control			
d	Retrofitting old electrical fittings			
e	Building Energy Management system			
f	Energy Conservation measures			
g	Use of solar.			
h	Others			
	CHOICE OF SITE			
a	Adherence to Local zoning requirements			
b	Preservation existing vegetation.			
c	Site Landscaping			
d	Management of storm water			
e	Others			
	MATERIALS			
a	Use of local materials.(No imports)			
b	Use of materials that can be reused or recycled after the building life.			
d	Use of local components			
e	Use of materials with low environmental impact.			

f	Use of Low Toxic material			
g	Others			

INSPECTION CHECK LIST

GBCs ADOPTED IN COMMERCIAL BUILDINGS IN NAIROBI

	PERFORMANCE IN USE & ENVIRONMENTAL QUALITY	**YES**	**NO**	**REMARKS**
a	Ventilation to public and circulation spaces			
b	Use low emitting carpet and flooring system.			
c	Use of low emitting paint and adhesive.			
d	Complaints arising from users			
e	Prevention of noise within and outside the building.			
f	Provision of smoking areas			
g	Use of thermal control units			
1.15	**WASTE REDUCTION & DISPOSAL**			
a	Provision of Waste management plan			
c	Provision of Maintenance services.			
d	Hazardous waste control and disposal			
e	Provision of different disposal methods			