UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

SUSTAINABLE BUILDING PRACTICE: ASSESSMENT TOOL FOR GHANA

JAMES TITO AKO-ADJEI

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A Thesis in the Department of CONSTRUCTION AND WOOD TECHNOLOGY EDUCATION, Faculty of TECHNICAL EDUCATION, submitted to the School of Graduate Studies, University of Education, Winneba, in partial fulfillment of the requirements for the award of Master of Philosophy (Construction Technology) degree.

SEPTEMBER, 2018

DECLARATION

STUDENT'S DECLARATION

I, **JAMES TITO AKO-ADJEI,** declare that this Thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE: ....

DATE: ....

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of Thesis as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: **DR. HUMPHREY DANSO**

SIGNATURE: ....

DATE: ....

ACKNOWLEDGMENTS

I wish to express my sincere thanks to the Lord Almighty God for His goodness and mercies that endures forever; and for seeing me through this programme successfully.

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DEDICATION

I dedicate this piece of work to my lovely wife Mrs. Augustina Adei Ako-Adjei and my dearly loved children, Cheryl Naa Anyeley Ako-Adjei & Irina Awula Anyorkor Ako-Adjei.

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GLOSSARY

AHP	:	Analytic Hierarchy Process
ASBC	:	American Sustainable Business Council
BEE	:	Building Environmental Efficiency
BMP	:	Benchmark Point
BREEAM	:	Building Research Establishment Environmental Assessment Methods
CASBEE	:	Comprehensive Assessment System for Building Environmental Efficiency
EPA	:	Environmental Protection Agency
ECA	:	Economic Commission of Africa
GGGC	:	Governor's Green Government Council
GBCS	:	Green Building Certification System
GhGBC	:	Ghana Green Building Council
GhIE	:	Ghana Institution of Engineers
GhIS	:	Ghana Institution of Surveyor
GhIA	:	Ghana Institution of Architects
GBCA	:	Green Building Council of Australia
GBCSA	:	Green Building Council of South Africa
GS SA	:	Green Star South Africa
HVAC	:	Heating, Ventilating, and Air-Conditioning
LEED	:	Leadership in Energy and Environmental Design
MEST	:	Ministry of Environment Science and Technology

MMDAs	:	Metropolitan Municipal and District Assemblies
NEP	:	National Energy Policy
NDPC	:	National Development Planning Commission
RII	:	Relative Importance Index
SD	:	Sustainable Development
TW	:	Total Weighting
WCED	:	World Commission on the Environment and Development

ABSTRACT

The built environment uses large amounts of scarce resources and contributes significantly to the production of global emissions and waste. It is of importance to adopt sustainable means to curb the dire consequences of the built environment. The purpose of this research is to analyze the existing sustainable building assessment tools and develop one for the Ghanaian construction industry. The study employed the mixed research method approach including literature review, and questionnaire survey. Data collected were analyzed using mean score, frequencies and relative importance index (RII) ranking and analytic hierarchy process method (AHP). The results of the study revealed that policies backing sustainable building construction in Ghana is inadequate and scattered around many departments and agencies and that the practice is likely to flourish to make the needed impact if it is backed by government in a centralized manner to guide the practice. It was also revealed that sustainable building practice can be fully embraced if the legislation backing it makes it mandatory for at least some forms of buildings especially in the city centers. It was also found that the absence of direction and uniformity in government strategy frameworks hinders the development of sustainable building constructions in the country. From the study it was also observed that most of the practitioners in Ghana did not know the exact name and functions of the existing rating tools. Most of them cited its complexity and the fact that it wasn't designed for the use in the conditions of Ghana as the reason of its inefficiency and ineffectiveness. Finally, based on careful study and review of existing rating tools used globally, this work developed a rating tool "Green Rating & Measurement System for Ghana" (GRMSG). The study recommended for existing policy guiding sustainable practice in Ghana to be amended and centralized in a single body for effective monitoring and supervision and further recommends that Ghana adopts the new rating tool developed in the study.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The built environment industry in Ghana is undeniably one of the most vibrant and significant sectors of the country's economy. According to the Ghana Statistical Service (2013) as cited by Addo (2015) it contributes an average of 12.6% of the Gross Domestic Product (GDP) and employs about 2.8% of the economically active population. Ahadzie, Proverb, Olomolaiye, and Ankrah, (2009) also opine that the building industry in Ghana contributes meaningfully to the national socio-economic development by providing significant employment opportunities. They further stated that beyond that, the industry provides the infrastructure and facilities required for other sectors of the economy to flourish such as; schools for education and training purposes, factories and shops for commercial and business activities, housing for basic human needs, hospitals for health care delivery, buildings for the national communications network and so on and so forth.

However, the industry put lots of stress on the environment due to the consumption of substantial natural resources such as non-renewable resources such as energy, timber, water, farmlands etc. thereby contributing to the phenomenon known as Climate change. Climate change arguably has become the greatest contemporary global threat and the risks associated with it will become more severe over time (Minia, 2004 as cited in Yaro, 2010). This phenomenon has given birth to the concept of sustainable development and this concept simply means the ability of the present generation meeting their needs without compromising the ability of the future generations to meet their own needs.

Sustainable building also known as high performance building or green building has been champion in the construction industry all over the world since the 1960s. This involves the kind of building that enhances the quality of life to the occupants as well as the environment, i.e. allowing people to live in a healthy environment, with improved social, economic and environmental conditions (Ortiz et al., 2009). A building is said to be sustainable if the processes of designing, construction, renovation or maintenance, operation or reuse conforms to environmental friendly and resource efficient manner. Sustainable projects should also meet a number of certain objectives. These objectives will include resource and energy efficiency; Carbon Dioxide ($CO_{2)}$ and Green House Gas (GHG) emission reduction; pollution prevention; mitigation of noise; improved indoor air quality; harmonization with the environment (Clements-Croome, 2005).

Buildings are certified as meeting sustainability principles through a rating system or with an assessment tool. The rating tool is a major part of the green building assessment process. According to Chehrzad, Pooshideh, Hosseini, and Majrouhi Sardroud (2016) it demonstrates the result of calculation and decision tools and also includes many criteria in different categories which reflect priorities in various regions. They further opined that rating tools can be adaptable and flexible, meaning that the criteria are able to be adjusted; changed or tailored depending on the conditions which the rating tool is being utilized for. Projects earn points for satisfying specific green building criteria set under the assessment tool, the number of points the project earns, determines whether the project will be certified as being sustainable or meeting sustainability principle.

Rating systems or tools of various kinds have been developed in some advanced countries to measure the application of sustainable principles in buildings based on the economic, environmental and social situations of those countries. Popular amongst them is the Leadership in Energy and Environmental Design (LEED) for the United States of America, the Building Research Establishment Environmental Assessment Method (BREEAM) for the United Kingdom, also there is the Compressive Assessment System for Built Environment Efficiency (CASBEE) for Japan as well as a host of others.

1.2 Statement of the Problem

Sustainable building, also known as ‘‘Green Building’’ is a sub-set of sustainable development and it is about meeting the needs and aspirations of people in a manner that does not impede future generations from being able to meet their own needs. Conventional construction of buildings is a major consumer of non-renewable resources, a substantial source of waste, a polluter of air and water, and an important contributor to land and environmental degradation (Wallbaum & Buerkin, 2003 as cited in Djokoto, Dadzie & Ohemeng-Ababio. 2014, Danso, 2018a).

According to Umar and Khamidi (2012), the construction of buildings, directly or indirectly causes a considerable portion of the annual environmental deterioration, and should therefore take up the obligation to go the sustainable development way by finding more environmentally benign technologies of building. Bossink and Brouwers (1996), Crawley and Aho (1999) also stated that the negative impacts on the environment caused by construction activities are serious and need to be controlled as soon as practicable in order to avoid its repercussions.

Several studies have been conducted indicating that sustainable development is therefore the surest way in minimizing, if not eradicating the effects or impacts construction activities has on the environment. To ascertain the sustainability of a building, there is a need for what is known as a rating system or assessment tool for this purpose. According to Chehrzad et al. (2016) rating systems are developed to assess the sustainability of a building in accordance with the economic, cultural and ecological environment they are being used in. Therefore, rating systems may define sustainability differently based on the economic, cultural or social and ecological as well as the environmental situations and allocate diverse weight factors or scores to each category. Rating systems are the interface of green or sustainable buildings. They include different categories and criteria for allocation of point and assessment which are based on the prevailing conditions of its application geography (Chehrzad et al., 2016).

However according to Osae-Akonnor (2014) as cited by Ahmed, Hatira and Valva (2014) the Ghana Green Building Council (GHGBC) does not have its own building rating system but has however, adopted a building rating system in South Africa called the GS SA-v1 Building Rating System, which was adapted from the GS-v1 Building Rating Tool in Australia which was initially a system designed for South Africa. This therefore calls for thorough examination in the Ghanaian point of view to derive a suitable rating system based on the social, environmental, and economic situation of the country. This study therefore, seeks to analyze the various assessment tools available and to determine the most suitable and efficient for Ghana. It also seeks to assess sustainability policies and its coordination for effective delivering of sustainable buildings in Ghana.

1.3 Purpose of the Study

The purpose of this research is to analyze the existing sustainable building assessment tools and develop one for the Ghanaian construction industry.

1.4 Objectives of the Study

To achieve the above mentioned purpose, the following specific objectives were advanced.

- To examine existing polices on sustainable development in Ghana.
- To identify possible challenges or limitations that building practitioners face in applying building sustainability modules.
- To examine the existing sustainable assessment tool used in Ghana.
- To develop a sustainable building assessment tool or rating system for Ghana.

1.5 Research Questions

The following research questions were formulated to enable the researcher to achieve the specific objectives set out.

- To what extent does existing polices on sustainable development impact on green building construction in Ghana?
- What are the possible challenges or limitations that building practitioners face in applying building sustainability modules?
- What are the existing sustainable assessment tools used in Ghana?
- What is the sustainable building assessment tool or rating system for Ghana to enhance the delivery of sustainable buildings?

1.6 Significance of the Study

This study is expected to come out with rating systems that can categorize building as to whether or not it is meeting sustainability principles and also to contribute to sustainable building practices policies as well as informing policy makers when formulating or amending policies on building and construction. The research outcome is also expected to influence construction practitioners to fully accept and practice sustainability modules knowing very well the availability of a Ghanaian centered rating tool to assess their work. It will also contribute to literature in the field of construction and housing delivery in conformity to environmental sustainability and enhance further studies by educationalist.

1.7 Scope of the Study

The research work was limited to sustainable building practice; assessment tool and policy framework for Ghana in the view point of Architects, Quantity Surveyors and Construction Managers/Engineers practicing in the Greater Accra, Central, Ashanti and the Brong Ahafo regions of Ghana. The study was also limited to only the environmental aspect of sustainable building construction.

1.8 Organization of the Study

The study will be organized under five main chapters and they are as follows;

Chapter one, covers the introduction comprising of background of the study, statement of problem, purpose of the study, objectives as well as the research questions. It also includes the significance of the study, the scope and the limitations. The second chapter will focus on the review of relevant literature on the topic. i.e. ideas and opinions of some researchers and authors on the subject will be reviewed to establish theories and facts on the subject. Chapter three will look at the methodology that will be adopted in undertaking the research. The data gathered will be analyzed in chapter four, whereas results will be presented in chapter five and summary of key findings, recommendations and conclusion will be presented in chapter six.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents to readers' review of existing relevant literature of previous studies that has been done on sustainable building practice. It considered the environmental, economic and social impacts of construction activities, it also took the concept and categories of sustainable development as well as the components, cost and value of sustainable building practices into consideration. The literature review, again touched on some of the assessment tools being used in the industry as well as some policies and a conceptual framework of the study.

2.2 Impacts of Construction Activities

The activities of our daily lives are mostly dependent on the construction industry of one sort or the other, without which will render a daunting task for us daily. We dwell in houses, travel on roads, work and socialize in buildings of all kinds. Human existence has actually become very much dependent on buildings and what they contain for its continued survival and yet our planet earth which we habit cannot support the high level of resource consumption associated with them (Dixon, 2010 as cited by Ahmed et al., 2014). Roodman and Lensen (1995); Pulselli, Simoncini, Pulselli and Bastianoni (2007) also stated that the construction industry consumes over 3 billion tons of raw materials each year, which accounts to about 40% of total global use.

The building and construction industry has a major impact on the economic and social aspects of human activities, as well as on the natural and built environment. Over the years, it has contributed significantly to global warming and climate change. McCormack, Treloar, Palmowski and Crawford (2007) indicated that in the last hundred years the Earth has warmed by about 0.5^{O}C, they further stated that there is a strong evidence that the warming is due to an increase in the concentrations of certain traces of greenhouse gases and principal amongst these is carbon dioxide (CO_2) which is produced whenever fossil fuels are burnt to obtain energy. The use of fossil-fuel-derived energy in the production of materials, during the construction process, and by the occupants or users of the building or structure throughout its lifetime is a source of significant quantities of carbon dioxide, and around half of all non-renewable resources mankind consumes are used in the construction industry, making it one of the least sustainable industries in the world (Dixon, 2010 as cited by Ahmed et al., 2014).

A report titled “our common future” by the World Commission on the Environment and Development noted the increasing strain between the environment and economic development and calls for sustainable development as a reasonable means to achieve political, social and economic stability (WCED, 1987). Table 1 indicates the average global resources utilization by the building industry (Hawken, Lovins & Lovins 1999).

Table 1: Estimate of Global Resources Used in Buildings

Resource	**Percentage (%)**
Energy	45–50
Water	50
Materials for buildings and roads (by bulk)	60
Agricultural land loss to buildings	80
Timber products for construction	60 (90% of hardwoods)
Coral reef destruction	50 (indirect)
Rainforest destruction	25 (indirect)

Source: Hawken, Lovins and Lovins (1999)

Construction activities consume raw materials and cause monumental waste: the product which it delivers requires resources such as energy and water to operate over its entire life-cycle. Throughout this process, construction activities often result in environmental degradation, economic activities restrain and social dislocation.

2.2.1 Environmental Impacts

According to Tolluch (1994) as cited by Muhwezi and Kyakula (2012) environment is defined as "physical surroundings and conditions, especially as affecting people's lives; conditions or circumstances of living; external conditions affecting the growth of plants and animals". Other terms to describe environment are surroundings, atmosphere, climate, habitat, territory, biosphere, ecosystem, and nature. The term also may include aspects such as cities, towns and villages (the urban or built environment), culture in all its manifestations, history, lifestyle and quality of life

The human race has spent the majority of its existence trying to manipulate the natural environment to better suit its needs and to harvest resources to produce necessary essentials for it continuance existence (Ofori, Briffed, Gay & Ranasingle, 2000). Bulk portions of primary resources extracted and used in the Ghanaian construction industry are stone, sand, gravel, and cement, all of these resource extractions applies major environmental impact. Wallbaum and Buerkin (2003) as cited in Djokoto, Dadzie, and Ohemeng-Ababio (2014) also opined that the construction industry is a major consumer of non-renewable resources, a substantial source of waste, a polluter of air and water, and an important contributor to land and environmental degradation. Construction industry related impacts on the environment expatiated by Muhwezi and Kyakula (2012) includes the following:

i. Consumption of large amounts of energy during the processing of materials, construction processes and in the use of constructed structures;
ii. Dust and gas emission released during the production and transportation of materials and in some construction operations;
iii. Disruption of people living in the vicinity of construction projects through traffic diversion, noise pollution and others;
iv. Production of substantial volumes of waste;
v. Waste water discharge;
vi. Use of water resources;
vii. Pollution from building materials;
viii. Land use and
ix. Substantial consumption of both renewable and non-renewable resources

2.2.2 Economic Impacts

According to Kats (2004) a recent study conducted on 33 green buildings in California found that the average cost of building green over traditional methods (the "premium") was about 2%, which equals about $4 per square foot and that the average energy reduction from the 33 buildings was 30 percent. It there suggests that, this alone provides savings sufficient to pay back the initial 2% premium in less than 9 years of the life of the building. The same study found that, over a twenty-year period, the overall net savings for a green building is between $48.87 - $67.31 per square foot, depending on the LEED rating of the building. Therefore, an initial investment of only 2% of the first costs results in savings worth more than ten times the added premium (Kats, 2004).

A report by the U.S. Department of Energy and the Rocky Mountain Institute documents eight case studies, in which efficient lighting, heating, and cooling measurably increased worker productivity, decreased absenteeism, and/or improved the quality of work performed (Rom & Browning, 1994).

2.2.3 Social Impacts

Buildings and infrastructures are an inseparable piece of society; it defines the spots where we live, play, learn and work. The World Commission on the Environment and Development propagates for a healthy and peaceful society (WCED, 1987). The construction of high rise buildings and recreational facilities such as hotels has often been in direct conflict with the interests of many local residents who are wary of change and the effects it will have on their livelihood. For instance, the Accra marine drive project has encountered some challenges with the indigenes and residents due to their inability to relocate despite the huge benefit of this project to the nation, these people would wish to preserve their culture and lifestyle which they see as threatened by the development of the area and population growth that comes with it (Matsuoka & Kelly, 1988).

2.3 Sustainability Concept

In an era in which mitigating climate change and global warming have become the greatest environmental challenges faced by the human kind, there is a growing interest in developing environmentally sustainable buildings (Ling & Gunawansa, 2011). Sustainable building concept is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction (Clements-Croome, John, & Jeronimidis, 2005). Kibert (1994) also defined it as ‘the creation and responsible management of a healthy built environment based on the prudent use of resources and ecological principles’ and the world commission on the environment and development describe it as the kind of development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987). This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. The concept of sustainable development has become imperative due to its emphasis on moderate consumption vis-à-vis wastefulness, thus construction designers advocate for its adoption (Keitsch, 2012).

Sustainable development involves the kind of development that enhances the quality of life, hence allowing people to live in a healthy environment, with improved social, economic and environmental conditions (Ortiz, Castells & Sonnemann, 2009; Danso, 2018b).

A project is said to be sustainable if the processes of designing, building, renovation or maintenance, operation or reuse conforms environmental friendly and resource efficient manner. Sustainable projects should also meet a number of certain objectives. These objectives will include resource and energy efficiency; CO_2 and GHG emissions reduction; pollution prevention; mitigation of noise; improved indoor air quality; harmonization with the environment (Clements-Croome et al., 2005).

According to Gilbert, Stevenson, Girardet and Stren (1996) in their book titled “making cities work”, the concept of sustainability relates to the maintenace and enhancement of the environment, social and economic resoures, in order to meet the needs of current and future generations (Morelli, 2011); Gilbert et al., (1996); Pitt, Tucker, Riley and Longden (2009); Ikediashi, Ogunlana and Ujene (2014) all opine the following as the three main concept of sustainability.

2.3.1 Environmental Sustainability

Which requires the natural capital remains intact. Environmental sustainable design describes the design process which takes into consideration the environmental implication of a design process by using various approaches to eliminate undesirable or potentially hazardous effects on the environment (Irad, Roni & Yossi, 2007). This means that the source and sink functions of the environment should not be dedgraded. Therefore, the extraction of renewable resources should not exceed the rate at which they are renewed, and the absorptive capacity to the environment to assimilate waste should not be exceeded. Furthermore, the extraction of non-renewable resources should be minimised and should not exceed agreed minimum strategic levels.

According to Bawa, Rai and Sodhi (2009) this includes maintenance of biodiversity, atmospheric stability and other ecological functions not ordinarily classed as economic resource. Sustainability provides some benefits to the environment, these include the following;

i. Enhance and protect the eco-system
ii. Improve air and water quality
iii. Conserve natural resources

2.3.2 Social Sustainability

Oyebanji (2014); Ikediashi et al. (2014) defined social sustainability as effects of buildings and infrastructural projects on the rights and privileges of the people, health and safety well-being and other societal needs. The objectives of social sustainability are to reduce poverty, promote cultural differences, create jobs and improve the interaction between human and the environment and these are embedded in the corporate social responsibility of the owner/client of the building and the infrastructure projects, this requires that the cohesion of society and its ability to work towards common goals be maintained. Individuals needs, such as those for health and wellbeing, nutrition, shelter, education and cultural expression should be met. A socially sustainable system must achieve distribution fairness, satisfactory delivery of social amenities within the ecosystem (Bawa et al., 2009). Benefits of social sustainability may include the following;

i. Enhance occupants comfort and health
ii. Heighten aesthetic quality
iii. Improve overall quality of life

2.3.3 Economic Sustainability

Which occurs when development, which moves towards social and environmental sustainability, is financially feasible. Ikediashi et al. (2014) defined economic sustainability as the "degree to which an organization actively and constructively deploys its resources to support the socio-economic well-being of its surrounding community through job creation, education and provision of social amenities without comprising the continued existence and profitability of the organization and the ecosystem of the environment within which it operates."

An economically sustainable system must be able to give profits on ongoing basis, to maintain controllable levels of economic imbalance. That is the economic benefits of today's choice of building sustainable, must not have a detrimental effect on the economy of the user in the future (Bawa et al., 2009). According to Ikediashi et al. (2014), also the Department of Environment, Transport and Regions (DETR) has set five ways in achieving economic sustainability. These includes, a building and infrastructure projects being viable and competitive, providing greater satisfaction, well-being and value to its customers, improving and safeguarding the natural resources and reducing the impact of energy and natural resource consumption thus attracting investment, improving company's profile and improving its relationship with its stakeholders.

Sustainability provides some benefits to the economy as well, these benefits may include the following;

i. Reduction of operation cost
ii. Improve occupants' productivity
iii. Optimize life-cycle performance

2.3.4 Element of Sustainable Building

2.3.4.1 Siting

Generally, it is advisable that buildings are positioned in such a way that exposes it to appreciable sunlight and wind, water and nearness of trees, nearby buildings, fences and pavement. Thus, it is generally recommended for buildings to be suited on the east-west of the site bearing in mind the solar energy in order to maximize day light penetration and heating. The under listed points broadly shows how to achieve material efficiency and conservation for sustainable development.

i. Select a site well situated to take advantage of public and mass tarnsit opportunities as well as walking and biking access and trails.
ii. Protect, retain and utilised existing landscaping and natural features including the sun.

iii. In utilising an in-fill site, recycle paving materials, furnishing and other building materials for salvaging and reuse on site.

2.3.4.2 Material Efficiency and Conservation

Material efficiency and conservation deals with the choices made in selecting materials for construction projects. These materials must be selected conforming to the design and is associated with green buildings. Materials specified to be used for construction should be renewable and have a low embodied energy. Ljungberg (2007) defines renewable materials as materials which are formed again in a short time and give no or very little impact on the environment. He expressed that wood should be selected more often to plastic since it can be renewed in a short time than plastic. A building is said to be sustainable or “Green” when it is constructed with recyclable, renewable, reusable and nontoxic materials that have zero or low volatile organic compounds (US Department of Energy, 2008).

Sources of renewable materials are varied and could be in the form of strawboard made from wheat, linoleum flooring made from jute and linseed oil, acoustic ceiling tiles made from recycled materials and materials like recycled carpets and heavy steel (Lockwood, 2006). Locally, materials like straw, laterite, mud, bamboo, wood, etc. are renewable materials that if used helps to create a healthier and safer environment. Aside this, the use of local materials saves on transportation cost and energy (Kim & Rigdon, 1998).

The under listed points broadly shows how to achieve material efficiency and conservation for sustainable development.

i. Use of sustainable construction material including locally produced, durable, recyclable and non-toxic.

ii. Use of dimensional design planning to minimise cutting and waste, for example you design a room in multiples of 4feet to conform with wall and ply wood standard measurements.

iii. Reuse and recycle construction and demolition materials.

2.3.4.3 Energy Efficiency and Conservation

Gillingham et al. (2009) explained Energy efficiency as the energy services provided per unit of energy input and Energy conservation as the total reduction in the amount of energy consumed. Buildings consume huge chunk of energy at every stage of the construction process, from the design and construction through to operation and demolition (Schimschar, Blok, Boermans & Hermelink, 2011). It is therefore imperative to improve the energy efficiency and conserve energy during construction projects in order to reduce greenhouse gas emissions usually generated from electricity usage for Manufacturing, Fabrications, Heating, Ventilating, and Air-Conditioning (HVAC). The under listed points broadly shows how to achieve energy efficiency and conservation for sustainable development.

i. Use passive design strategies including building shape and orientation to improve energy performance.

ii. Utilize natural light where possible.

iii. Install efficient lighting system including motion activators, dimmers and track lighting.

iv. Install proper size heating and cooling units for the building size.

v. Install alternative energy sources including wing turbines and solar panels.

vi. Install geo-thermal heating systems.

2.3.4.4 Water Efficiency and Conservation

Water resources worldwide is becoming very scarce and an environmental challenge as a result to fast development of global economies since water is an indispensable resource for quality living and growth of varied economic sectors (Akadiri, Chinyio, & Olomolaiye, 2012). Rodrigues, Afonso, & Mariano (2012) however, opined that with water consumption rate tripling in the last 6 decades, it is very important to find viable approaches to conserve water and use it efficiently. Efficient use of water resource in buildings will have a direct economic impact on the structure as the water and waste water systems of buildings are powered by energy. It results in a reduction of cost arising from the more efficient water processes of distribution, treatment and abstraction (Rodrigues et al., 2012). Increasing efficiency of water usage will also add to the decrease in waste production arising from their treatment, thus improving environmental sustainability.

The under listed points broadly shows how to achieve water efficiency and conservation for sustainable development.

i. Design for dual plumbing to use recycled gray water for site irrigation.

ii. Install low flow toilets, low flow showerheads and other water conserving features.

iii. Install point-of-use water heating systems for distant locations.

iv. Install native plants and mulch in landscaping to save water.

v. Install rain barrels for water.

Akadiri et al. (2012) in Figure 1 explains some strategies and methods in achieving efficient resource conservation in the construction industry.

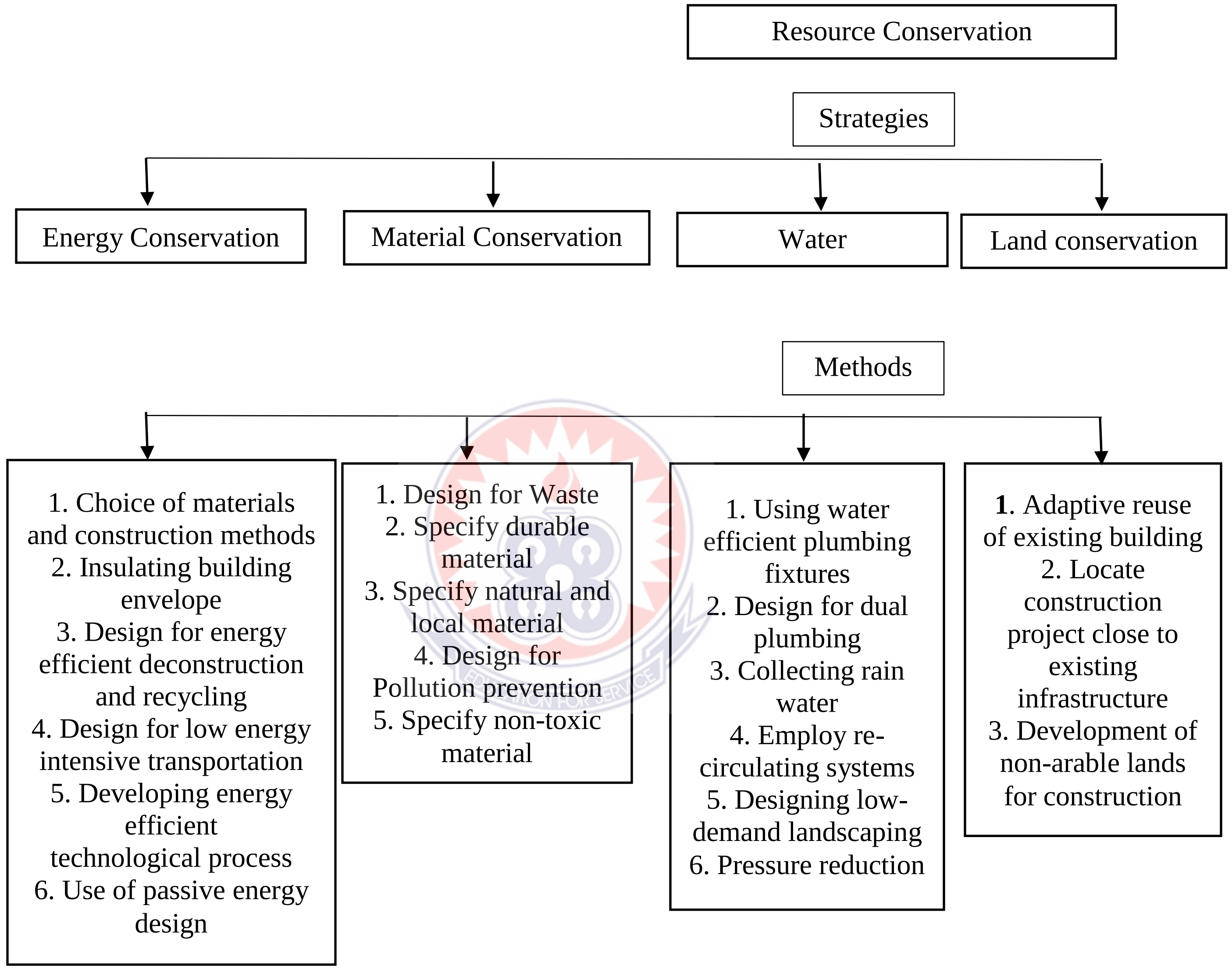

Figure 1: Strategies and Methods to achieve Resource Conservation
Source: Akadiri, et al. (2012)

2.4 Sustainability Models

The three main concept of sustainability has resulted in the creation of sustainability models, these models includes the following;

i. Three - legged Stool Model
ii. Three - Overlapping – Circle Model
iii. Three - Nested – Dependencies Model

2.4.1 Three-Legged Stool Model

The 3-legged stool model depicts the three dimensions of sustainability that are crucial for us to enjoy a high quality of life and shows that society is unbalanced if one of them is feeble. This model however draws the analogy that economic, environmental, and social dimensions are treated separately as shown in the Figure 2.

Figure 2: The Three (3) Legged Model of Sustainability

Source: World Conservation Union (IUCN, 2006)

2.4.2 Three - Overlapping – Circle Model

The overlapping-circles model of sustainability overlaps the economic, environmental, and social aspects of Sustainability. With this model, the circles can be resized to indicate one of the dimensions more prevailing than the other depending on the interest. This model seeks to communicate that some parts of the dimensions can exist on their own as shown in Figure 3.

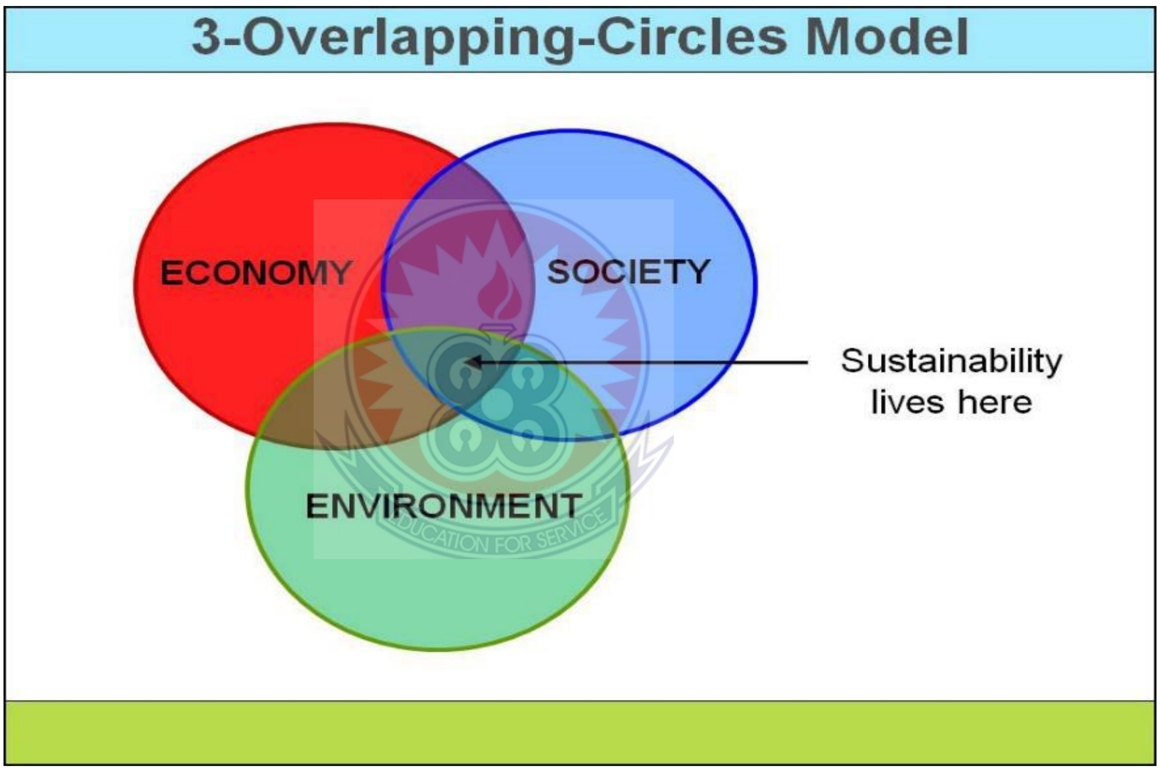

Figure 3: Three – Overlapping – Circle Model
Source: Newman and Kenworthy (1999) as cited by Kats (2004)

2.4.3 Three - Nested – Dependencies Model

The 3-nested-dependencies model has resulted under the premise that there is a co-reliant reality. This indicates that the economy is a subset to the society and the society is a complete subset of the environment; this is to say that we cannot live without fresh clean air, a balance meal, portable water, productive soil, and other resources that nature provides and the society on the other hand created it economy as shown in Figure 4.

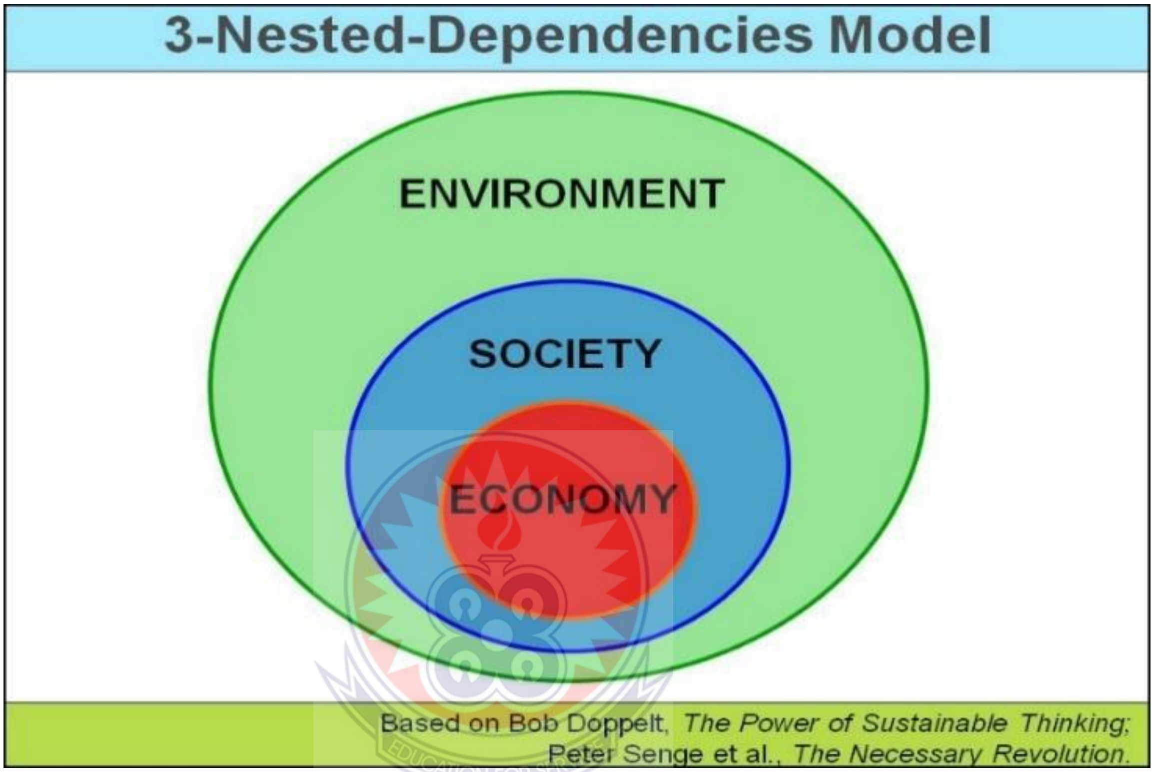

Figure 4: Three (3) –Nested – Dependencies Model

Source: Giannetti (1993)

2.5 Components of Sustainability

Creating sustainable buildings starts with proper site selection, which includes the orientation of the building to maximize the use of natural light and air, reuse or rehabilitation of existing buildings must also be considered. A sustainable building should also use water efficiently, and reuse or recycle water for on-site use, when feasible. Sustainable buildings are also constructed with materials that minimize life-cycle environmental impacts such as global warming, resource depletion, and human toxicity. Environmentally friendly materials have a reduced effect on human health and contribute to improved worker safety and health, reduced liabilities, reduced disposal costs, and achievement of environmental goals (Muhwezi & Kyakula, 2012).

Bainbridge (2004) also stated that an ideal sustainable project should be inexpensive to build, last forever with modest maintenance, but return completely to the earth when abandoned. Sustainable construction ethos requires what is known as a 'cradle to grave' appraisal of project, this involves the management of serviceability of the project during its life-time and eventual deconstruction focusing on the economic aspect of sustainability (Wyatt, 1994 as cited by Dzokoto et al., 2014). Thus a sustainable construction will aim at achieving set down principles.

According to Miyakate (1996); CIB (1996) as cited by Dzokoto et al., (2014), there are six principles for sustainable construction and these includes the following;

- Minimization of resource consumption;
- Maximization of resource reuse;
- Use renewable and recyclable resources;
- Protect the natural environment;
- Create a healthy and non-toxic environment; and
- Pursue quality in creating the built environment.

Kim, Houn and Jout (1998) mentioned that certain measures centered on the material life cycle can be used in defining sustainability of both structural and construction materials. The presence of some of these features in building materials make it sustainable, a production process that avoids pollution, materials that have high tendencies of being recycled, effort towards the reduction of embedded energy, the use of natural materials, materials that have the ability to prevent creation of a lot of waste during its installation, material that are locally available, energy efficient and renewable energy systems that can serve longer life spans and the like. The issue of reusability, recyclability and biodegradability is also important in determining the sustainability of a building.

According to Kim et al., (1998) the University of Michigan in a survey also came out with three main groupings of sustainable components or features of buildings and building materials. This illustrated in the Figure 5.

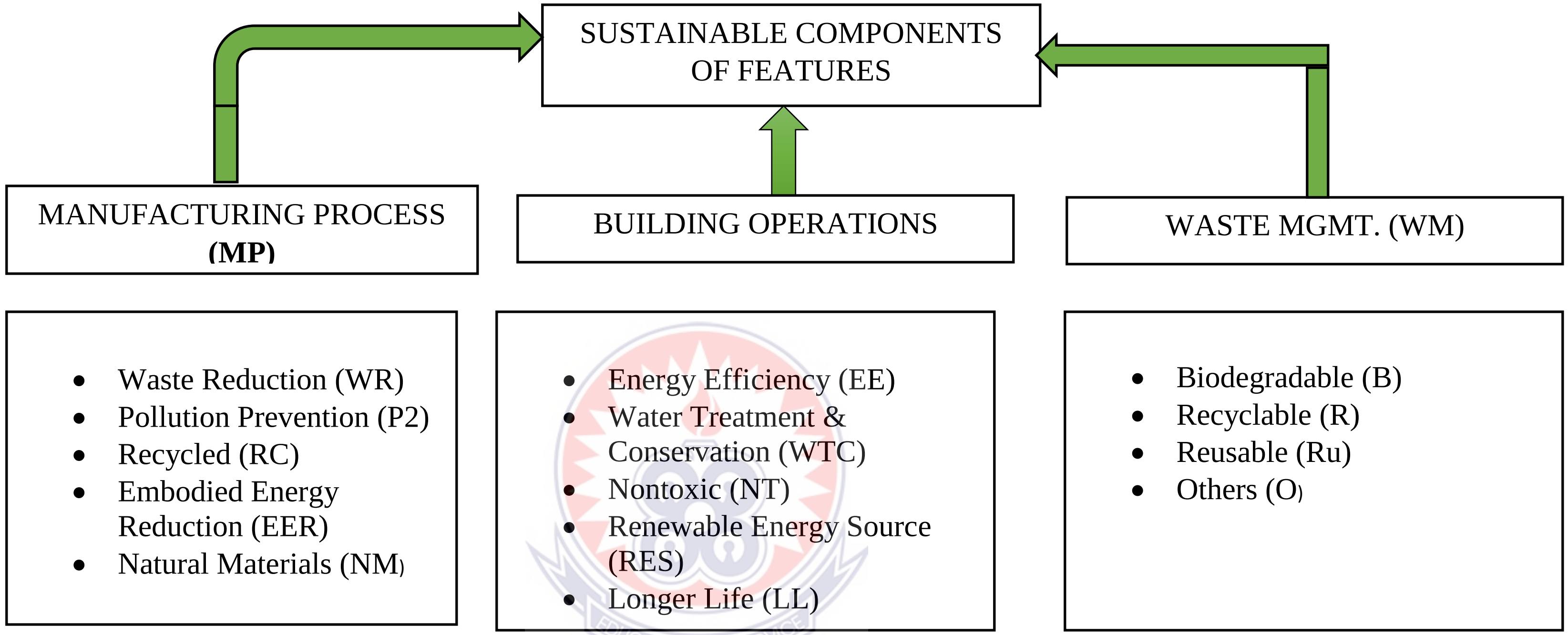

Figure 5: Sustainable components/features

Source: Kim et al., (1998)

2.6 Significance of Sustainable Building

Developing environmentally sustainable (green) buildings is extremely imperative in the efforts to mitigate climate change and adapt to changing climate conditions. Ofori-Boadu, Owusu-Manu, Edwards and Holt (2012) made mentioned that projects Certified by LEED are believed to considerably reduce the negative impacts of climatic change; they said this is possible because these buildings have been designed to work in harmony with the natural environment, natural resources and human health. In addition, living in environmentally sustainable buildings have other benefits such as improved health of occupants. According to Fisk and Rosenfeld (1998), buildings with good overall environmental quality can reduce the rate of respiratory disease, allergy, asthma, sick building symptoms, and enhance worker performance. By adopting green building strategies, we can maximize both economic and environmental performance.

The result is that a green building has a comparable or perhaps even a lower first cost, a higher comfort level, lower energy use, and lower energy bills and operating cost for the life of the building (GGGC n.d). Green construction methods can be integrated into buildings at any stage, from design and construction, to renovation and deconstruction. According to Richardson and Lynes (2007) as cited in Orr (2004) Green buildings have three key benefits over the design and construction of standard buildings. The benefits can be obtained if the design and construction team takes an integrated approach from the earliest stages of a building project. The benefits of green buildings can be categorized as follows;

Environmental benefits (Richardson & Lynes, 2007 as cited in Orr, 2004)

i. Enhance and protect biodiversity and ecosystems
ii. Improve air and water quality
iii. Reduce waste streams
iv. Conserve and restore natural resources

Economic benefits (Richardson & Lynes, 2007 as cited in Johnson, 2000; Von Paumgartten, 2003).

i. Reduce operating costs
ii. Create, expand, and shape markets for green product and services
iii. Improve occupant productivity
iv. Optimize life-cycle economic performance

Social benefits (Richardson & Lynes, 2007 as cited in Heerwagen, 2000; Scofield, 2002).

i. Enhance occupant comfort and health
ii. Heighten aesthetic qualities
iii. Minimize strain on local infrastructure
iv. Improve overall quality of life

2.7 Cost of Sustainable Building

There are diverse views in the literature regarding whether sustainable or green buildings have higher initial capital costs than traditional buildings. For example, in contrast to the view held by Johnson (2000) and Orr (2004), who contend that the initial capital cost of a green building is higher, several other researchers maintain that green buildings do not necessarily result in higher initial capital costs for design and construction (Richardson & Lynes, 2007; Hydes & Creech, 2000; Intrachooto & Arons, 2002; Scofield, 2002). Lockwood (2006) argued that the cost of green buildings could be inexpensive or equivalent to the costs of building traditionally, if the green technologies are included in the early stages of the design and construction. Although green materials and technologies incorporated in green buildings do cost more, it has been demonstrated that many green technologies in fact cost the same and some even costing lesser than traditional or conventional building technologies (GGGC n.d). Gunawansa and Ling (2011) concluded that green or sustainable buildings will cost about 5 percent to 10 percent more upfront. This could be achieved by blending the right mix of green technologies that cost less with green technologies that cost almost the same or slightly more, it is possible to have a very green building project that costs the same as a conventional or a traditional building (Keeping & Shiers, 1996).

Usually the answer to a cost effective green building and site design lies within the associated cost and performance trade-offs that exist between different building systems (GGGC, n.d). For example, the use of high performance windows and window frames increases the first cost of the building envelope, however the resulting reduction in the size and cost of the buildings heating and cooling system more than offsets the added cost of the better glazing system. Under the right circumstances, green or high efficiency buildings have both an equal capital cost and lower operating costs when compared to conventional buildings (Bartlett & Howard, 2000; Johnson, 2000). Akadiri et al., (2012) illustrated in Figure 6 as shown the strategies and methods to achieve Cost Efficiency in the construction industry.

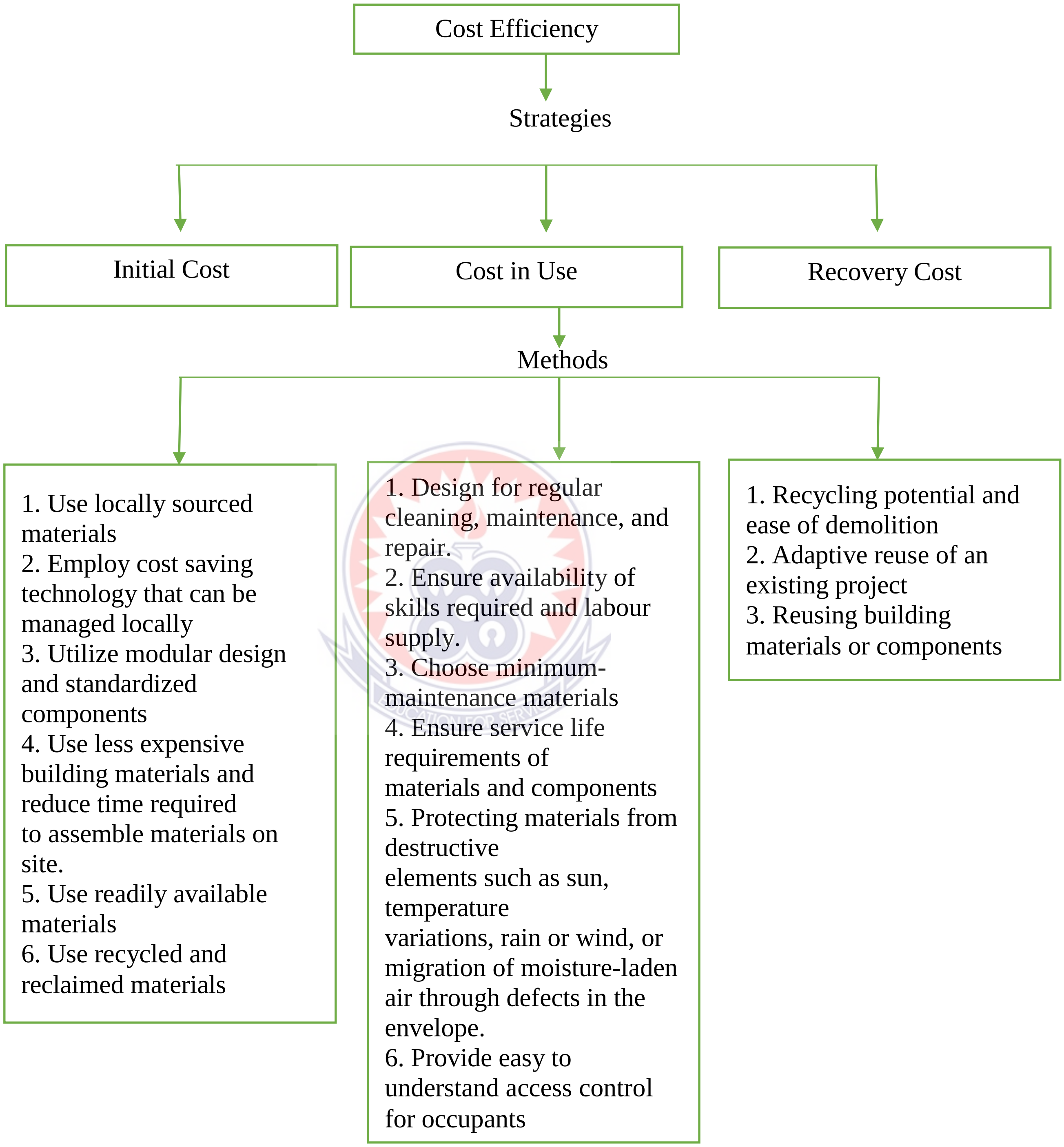

Figure 6: Strategies and Methods to achieve Cost Efficiency

Source: Akadiri, et al., (2012)

2.8 Value of Sustainable Building

There is a strong debate whether Green buildings are more valuable than conventional buildings; however, there is a growing evidence to support the fact that there is indeed a premium to be had whether you're in the business of leasing buildings or selling them (White & Smithing n.d.). Green buildings are expected to decrease operating costs between 8 and 9 percent increase total building value by about 7.5 percent and increase occupancy rates by 3.5 percent (Liu, Low & He, 2012 as cited in Braham, 2006) thereby adding value to it. Initially only a few high profile corporate clients and public agencies were interested in green building, of late, demand for green projects has increased significantly (Ofori-Boadu et al., 2012).

Given society's demand for sustainability, Ofori-Boadu et al. (2012) said that a LEED certified building will normally hold increased market value because of its intrinsic lower in-use operating costs and healthier indoor environment. While the direct financial benefits, such as energy savings, provide clearly measurable improvements, indirect benefits such as improvement of an institution's image, gains in competitive advantage and increased productivity as a result of employee or student pride can result in financial gains that are more difficult to assess. Other savings may be achieved principally as a result of lower operations and maintenance costs. Lower utilities costs such as electricity, water and waste disposal as evidence has also painted a picture of how green buildings improve the productivity and health of occupants (Kozlowski, 2003; Nelson & Rakau, 2010).

2.9 Barriers to Sustainable Building

According to Ahmed, Hatira and Valva (2014) as cited in Dzokoto et al. (2013) sustainable construction practice in the Ghana is considered a robust business but highly reliant and dependent, on traditional methods of construction. The industry has favored the use of traditional materials like blocks and concrete, has made the entry of other alternative or sustainable building material and services difficult to be adapted.

Despite a purported desire to adopt sustainable construction practices, the industry is further hampered by a lack of capacity to actually implement sustainable practices (Ahmed et al., 2014).

Djokoto et al. (2014) identified and grouped the lack of capacity to implement sustainable building construction into four main primary categories, and these include

- Cultural barriers,
- Financial barriers,
- Steering barriers and
- Professional barriers.

They further expatiated these barriers into lack of demand (by property owners) due to culturally and traditionally accepted way of construction, it's very difficult to change especially with respect to construction methods practiced and building materials used. Djokoto et al. (2014) stated that Construction in Ghana favours the use of blocks and reinforced concrete and discourages any other alternative to these building materials and services. They also mentioned lack of strategy to move towards sustainable development, higher development costs, lack of public awareness, lack of government support, lack of cooperation, risk of investment, lack of building codes and regulations, higher investment costs and lack of a measurement tool as challenges of sustainable construction practice in Ghana.

Professionals within the built environment are not yet fully trained in sustainable construction principles and thus lack the know-how to properly carry out such practices. In addition to forming an appropriate knowledge basis, these professionals would benefit from trainings in how to engage with owners'/end users, investors, developers, designers, and contractors (Djokoto et al. 2014 as cited by Ahmed et al., 2014). The Figure 7 illustrates the barriers of sustainable construction practice in Ghana as identified by (Djokoto et al, 2014).

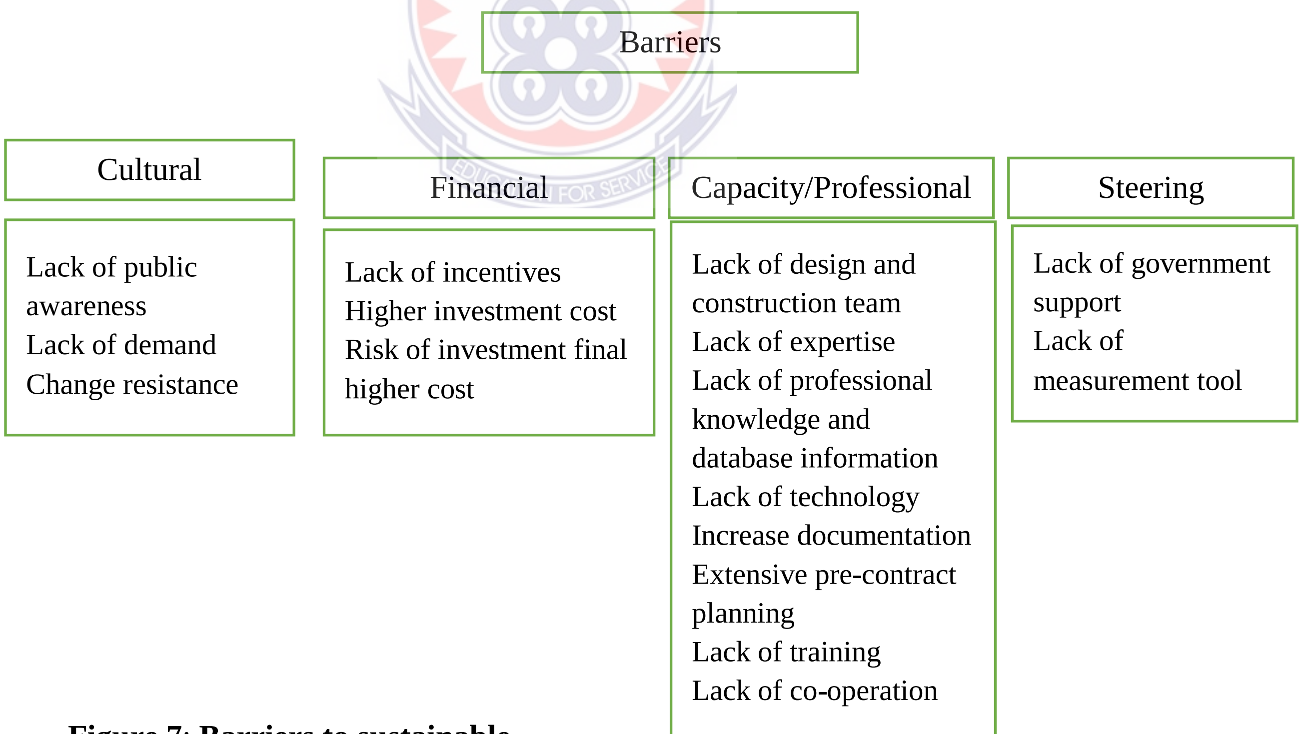

Figure 7: **Barriers to sustainable**

Source: Djokoto et al. (2014)

2.10 Sustainability Assessment Tools

Sustainable developments have been a major issue and subject of debates and arguments among the several practitioners in the building industry. The question arises when to compare a green or sustainable building and a normal or conventional building. The emergence of green building assessment tools has somehow given the guidelines and foundation for a building to be certified as being sustainable. Ahmed et al. (2014) defined Sustainable building rating systems as tools that examine the performance or expected performance of a 'whole building' and translate that examination into an overall assessment that allows for comparison against other buildings. They also cited from Fowler and Rauch (n.d) that for a rating system or tool to add value to the sustainable design and/or operation of a building, it must offer a credible and consistent basis for comparison, evaluate relevant technical aspects of sustainable design, and not be over-burdensome to implement and communicate.

In the last couple of decades, with the objective to enhance sustainable buildings has led several governmental agencies and departments as well as non-profit organizations to the emergence of green building assessment tools. Reed, Bilos and Wilkinson (2009) observed that the emergence of sustainable building assessment tools had helped the development of sustainable building assessment to compare to a normal traditional building and the method to compare and distinguish between the green features between them.

2.11 Types of Sustainability Assessment Tools

The last couple of decade had seen tremendous growth of building sustainability assessment tools. The first recognized assessment tool emerged in the year 1990 and several others have emerged subsequently from different countries and backgrounds. Sinou and Kyvelou (2006) mentioned that the availability of assessment tool tends to differ from developers due to principles and concept of one tool developed and also it considers the criteria, items evaluation and data.

2.11.1 Building Research Establishment Environment Assessment Method (BREEAM)

One of the earliest and most profound assessment tools is the UK's Building Research Establishment Environment Assessment Method (BREEAM) developed in the year 1990. The main function of this assessment tools are primary on building specification evaluation including the design, construction and use. According to Ding (2008) the vast experience of BREAAM in building assessment has lead its methodology to be adopted as the foundation of the development of other building assessment tools in Canada, Hong Kong, Australia and many other countries.

The BREEM comprehensive assessment includes all criteria from energy to ecology, the main aspect of management processes, water use, health and wellbeing, transport, pollution and waste. Table 2 shows the rating benchmark of buildings for BREEAM certification. The rating has been identified as outstanding, a building has to obtain score of 85% and the lowest rated as unclassified, at below 30% of scores.

Table 2: BREEAM rating benchmarks

Rating	Score in percentage (%)
Outstanding	≥ 85
Excellent	≥ 70
Very Good	≥ 55
Good	≥ 45
Pass	≥ 30
Unclassified	< 30

The BREEAM weighting criteria for certification is up to 100 percent (100%) and it consist of nine (9) benchmark points of environmental aspect, energy, health and wellbeing, management, and materials aspects. It has also an additional slot for innovation which gives extra ten percent (10%). Table 3 presents the weighting of the criteria in BREEAM assessment system.

Table 3: BREEAM Environmental section weightings

Environmental Section	Weighting
Management	12%
Health & Wellbeing	15%
Energy	19%
Transport	8%
Water	6%
Material	12.5%
Waste	7.5%
Land Use & Ecology	10%
Pollution	10%
Total	100%
Innovation (additional)	10%

2.11.2 Leadership in Energy and Environmental Design (LEED)

Leadership in Energy and Environmental Design (LEED), is the second oldest assessment tool developed, it has been available since the year 1998. This tool was developed by the United States Green Building Council (USGBC). LEED also one of the earliest assessment tool has served as a model that is being adopted and modified according to one's country's environmental, social and economic nature (Reed et al., 2009). LEED is a third-party certification program and an internationally accepted benchmark for the design, construction and operation of high performance green buildings. LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health:

- Sustainable site development
- Water efficiency
- Energy efficiency
- Materials selection
- Indoor environmental quality

Certification is based on the total point score achieved, following an independent review. With four possible levels of certification (certified, silver, gold and platinum), LEED is flexible enough to accommodate a wide range of green building strategies that best fit the constraints and goals of particular projects. This tool has a wide range of coverage which include major renovation projects (LEED-NC), existing building operations (LEED-EB), commercial interiors projects (LEED-CI), core and shell projects (LEED-CS), homes (LEED-H) and neighborhood development (LEED-ND) (LEED, 2013 as cited by Sinou & Kyvelou, 2006). The required points for a building to be certified is 40 points and the highest rating would be 80 or more to obtain platinum rated. Table 4 present the rating and points and Table 5 presents the criteria points for LEED tools.

Table 4: LEED rating system

Rating	Point
Platinum	80 Points and above
Gold	79 - 60
Silver	59 - 50
Certified	49 - 40

Table 5: LEED criteria points

Criteria	Points
Sustainable sites	26
Water efficiency	10
Energy & atmosphere	35
Materials & resources	14
Indoor environmental quality credits	15
Innovation in Design	6
Regional Priority	4
Total	**110**

2.11.3 Comprehensive Assessment System for Building Environment Efficiency (CASBEE)

Japan has one of the most developed assessment tool in Asia, this is known as the Comprehensive Assessment System for Building Environment Efficiency (CASBEE) and it was developed in the year 2001. One of the first tools to emerged in the continent of Asia. The reliability of the tool has gained reputable status as the BREEAM of UK and LEED of the USA. The rating tool is mainly focused in green building certification in Japan and Asia.

The methodology which is applied during the CASBEE assessment tool usage differs greatly from other tools in existence. It applies the Building environmental efficiency (BEE) model. The scores will be resulting from the BEE values depending on the environmental load (L) and quality of building performance (Q). The environmental load (L) is divided into L_1 which is energy, L_2 which is resources and materials and L_3 which is off-site environment. The quality of building performance (Q) is also divided into Q_1 which is indoor environment, Q_2 which is quality of services and Q_3 which is outdoor environment on site.

The calculation of a building according to BEE is as follows;

$$\text{BEE} = \frac{\text{Quality of Building Performance (Q)}}{\text{Environmental Load (L)}}$$

BEE values from the equation are then represented by plotting on a graph. A building is considered sustainable when a steeper slope is achieved, this is achieved by getting higher values of Q and lower value of L.

The certification buildings by the CASBEE are given as S for Excellent, A for Very good, B+ for Good, B- for Fairly poor and C for Poor.

Table 6 the level of certification of buildings under the CASBEE assessment scheme and Table 7 and Table 8 presents the assessment items under the CASBEE system.

Table 6: Rating for CASBEE building scheme

Ranks	Assessment	BEE value	Expression
S	Excellent	BEE= 3.0 or more and Q=50 or more	*****
A	Very good	BEE=1.5-3.0 BEE=3.0 or more and Q is less than 50	****
B+	Good	BEE=1.0-1.5	***
B-	Fairy Poor	BEE=0.5-1.0	**
C	Poor	BEE=less than 0.5	*

Table 7: Assessment items for CASBEE rating

Q	Built environment quality	Weighting	
		Non factory	**Factory**
Q1	Indoor environment	0.4	0.3
Q2	Quality of service	0.3	0.3
Q3	Outdoor environment on site	0.3	0.4

Table 8: Assessment items for CASBEE rating

L	Built environment Load	Weighting
L1	Energy	0.4
L2	Resources and material	0.3
L3	Off-site environment	0.3

2.11.4 Green Star (Australia, South Africa & Ghana)

The Green Star is a sustainable rating tool for an environmental certification scheme. This tool was originally developed by the Green Building Council of Australia (GBCA). Green Star was then adopted by the Green Building Council of South Africa (GBCSA) for use in South Africa (Green Star SA) and has been adopted also by the Ghana green building council (GhGBC) for use in Ghana (Alfris & Braune, n.d).

This rating tool consist of some common categories such as management, emissions, land use and ecology etc., each category covers a certain number of credits which has some points available for project to apply. The Green Star has got more than 87% of points available (unweighted) to be environmentally sustainable related, e.g. indoor environmental quality, emissions, energy, etc. The credit with highest points available is Materials (M_1) with 35 points (unweighted). The total number of points achieved will be weighted to a maximum of 105 points (i.e. 100 points plus 5 points for Innovation) (GBCA, 2003 as cited by Zuo, Xia, Zillante & Zhao, 2014).

Table 9: Categories, credits and points available in the Green Star Healthcare V1 rating tool

Categories	Credits	Points available
Management	11	17
Indoor Environment Quality	19	32
Energy	6	29
Transport	5	12
Water	6	14
Materials	13	35
Land Use & Ecology	4	8
Emissions	9	20
Innovation	3	5

The Green Building Council Australia certifies three levels of green building depending on the points a project achieved during the certification process. The three levels are: 4 Star, 5 Star and 6 Star, indicating "Best Practice", "Australian excellence" and "World leader" respectively (see Figure 8).

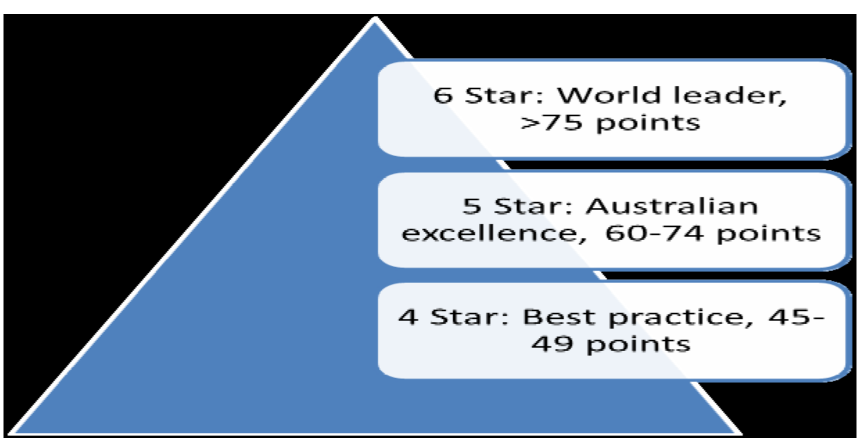

Figure 8: Three levels of GBCA Green Star certification

Source: GBCA (2003) as cited by Zuo et al., (2014)

2.12 Policies and Guidelines

There has been a significant increase in interest as well as research activity related to the development and promotion of green building guidelines in the last 10-20 years (Potbhare, Syal, Arif, Khalfan & Egbu, 2009). Low and Goh (2010); Arif, Bendi, Toma-Sabbagh and Sutrisna, (2012) also noted that Green Building Guidelines have gained prominence worldwide in the last decade and several countries across the globe have developed different rating systems. According to Potbhare et al. (2009) there has been a rapid growth in the number of green building guidelines in the world, and that within a span of 17 years; more than 23 countries developed green building guidelines.

Green building guidelines acceptance in the developed nations can be attributed to their relatively long history of green building movements whilst the acceptance level in the developing countries can be attributed to the public awareness, as well as, international pressure to reduce the environmental impacts such as increase in CO_2 emissions, water and soil pollution occurring due to the exponential growth in the built environment (Potbhare et al., 2009).

Sustainability development can effectively be championed by governments through its laws and policy directives. According to Kibert (2005), the absence of coordination and consistency in government policies directives and strategies can go about as a challenge to sustainable building developments. The American Sustainable Business Council (ASBC) posited that what is needed now for sustainable construction to flourish is for policymakers at all levels of government, from state capitals to national capitals, to fully support this movement and make it easier for consumers and businesses to take advantage of green building. They further stated that government incentives can provide a path that states and localities can take to support the green building economy. The use of a financing mechanisms that allow homeowners to take advantage of energy-saving building projects at lower or no cost and structural incentives that provide density bonuses or expedited permit regimes for potential home owners can be encouraged. Also direct tax credits and abatements, or technical or marketing assistance can go a long way in encouraging green or sustainable construction.

Ikediashi et al. (2014) also stated that for example in the UK, they have the climate change levy on the use of energy and also the landfill tax and also the sustainability agenda in Nigeria is set in section 20 of its 1990 constitution which mandates the Federal Republic to protect and improve the environment and safeguard the water, air, land, forest, and wild life and they also have the National Energy Policy (NEP) which was enacted in 2003. Applying the concept of sustainability to buildings and other construction works requires a holistic approach bringing together the global and local concerns and goals of sustainable development and the demands and requirements for product functionality, efficiency and economy. Different target audience will have a different perspective on these challenges and the preferred solutions.

2.12.1 Policies and Guidelines in Ghana

The Environmental Protection Agency (EPA) Act 490 of 1994 of Ghana is mandated to coordinate practices that will protect the environment. It provides environmental assessments to construction, oil and gas and mining firms among others before commencement of their operations in the country. There are a number of challenges that faces Ghana in its quest to develop strong institutions for sustainable development strategy formulation and implementation. A study by ECA (2007) as cited in a report by MEST (2012) documented the challenges to include inadequate ownership, commitments, governance and participation; poor integration and coordination; weak technical, institutional and financial capacity, among others.

While the challenges of sustainable building development are global, the strategies for addressing it are local. These strategies must reflect the context not only in the built and natural environment, but also in the social environment. This social environment includes cultural issues, legislation and regulation as well as the needs and concerns of all the users and the interested and affected parties involved. According to MEST (2012) In Ghana, there exists no legal mandate for the implementation of NSSD but the report however, stated that the 1992 Constitution indirectly covers issues pertaining to the economic, social, environmental and institutional development. Specific articles that indirectly touch on SD include articles 36 (1) and 36 (9). The report further mentioned that the NDPC, MEST and the EPA are the main governmental organisations that are responsible for SD planning and implementation. The NDPC has oversight responsibilities for the preparation, coordination, implementation and monitoring of medium-term strategic plans prepared by the MMDAs and the MDAs. MEST is responsible for policy issues and exercises supervisory authority over six statutory bodies - EPA, Town and Country Planning Department, Council for Scientific and Industrial Research, Ghana Atomic Energy

Commission, Rural Enterprises Project and the Environmental Resources Management Project charged with the responsibility of implementing policies in the areas of environment and science. MEST also coordinates government's activities on SD under the UNCSD framework (MEST, 2012).

According to MEST (2012) report Ghana has made headway in establishing institutions, policies and strategies formulation, coordinating and collaborating mechanisms and other relevant processes to facilitate the implementation of the SD agenda but stated however that these institutions are weak and have not been able to make the requisite impacts and that a lot remains to be done to strengthen them, particularly with regard to eliminating the environmental bias and addressing the three dimensions of sustainable development in a holistic and integrated manner.

Applying the principles of sustainability in building development, including all related processes and activities, requires the direct and responsible involvement of all interested parties. While their legal responsibility and liability is subject to national regulation. A national policy framework for sustainable or green building development in Ghana will create a collaborative enabling environment for the construction and operation of sustainable building construction activities by the public and private sectors in Ghana.

2.13 Framework of the Research

Research framework are concept or theories developed for the study, these concepts and theories must be related to the study area and also must provide unambiguous explanation as to why the problem under study is essential, by showing how the variables relate to each other. It guides the researcher to decide which path to take in the study Conceptual and theoretical frameworks are important elements of research studies (Miles & Huberman, 1994).

2.13.1 Conceptual Framework

Miles and Huberman (1994) explained a conceptual framework as either graphically or in a narrative form depicting the main ideas to be studied together with the key factors, variables or concepts and the supposed relationship among them. Establishing a conceptual framework for this study is very crucial and key as it will help in exploring ideas on how the research problem will be tackled.

From literature, four main concepts were identified for the application of sustainable building practices. These include Belief in Sustainable Practice, Certification or Assessment Levels, Personal Experience in Sustainable building and lastly Schema Congruity (Mansour & Radford, 2014). Figure 9 shows these concepts and its relationship to Environmental, Economic and social Sustainability.

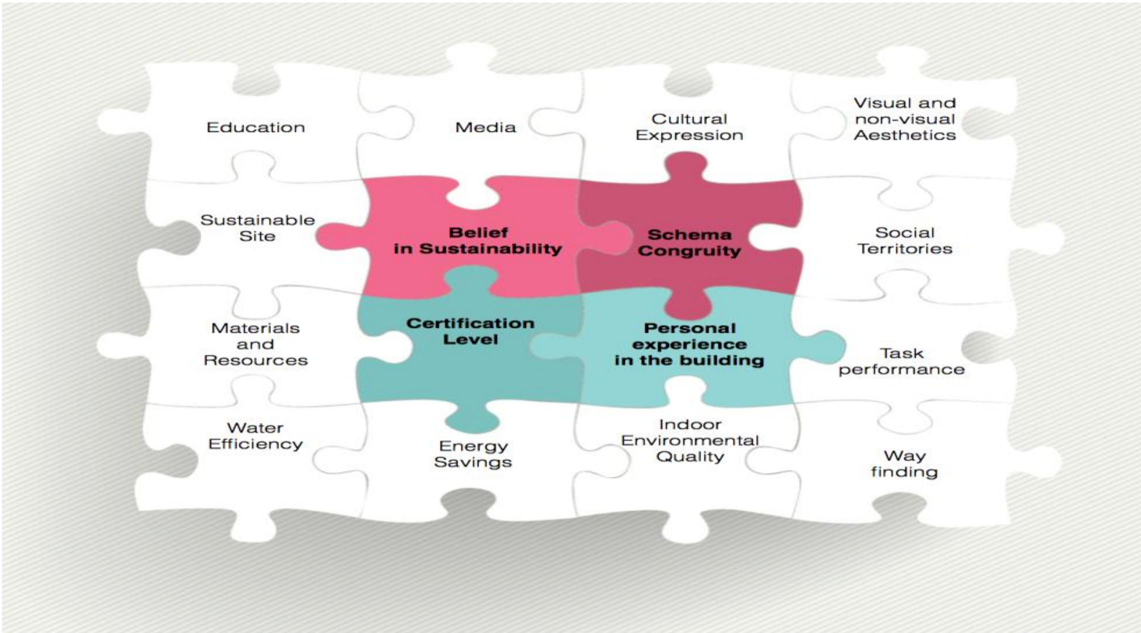

Figure 9: Concepts of Sustainable building practice

Source: Mansour and Radford (2014).

The Conceptual framework above shows belief in sustainability located at the upper left surrounded by sustainable site as an environmental category of green building evaluation, education and media as these form peoples understanding and beliefs in the practice. On the upper and lower right hand side of the puzzle, schema congruity and users' experience of the building are surrounded by cultural expression, way finding, task performance, social territories, and visual and non-visual aesthetics. These five environmental categories are experiential categories that indicate the users' experience of a building. By looking at the sub factors that surround the four core factors, one can easily notice that five of them are the main five environmental categories commonly used in green building rating systems, and five of them are experiential categories that are rarely considered in green building rating systems, in addition the other two sub factors education and media commonly affect the perception of any object in the world. By reflecting the S-O-R model, schema congruity concept, and Peattie's concept of confidence and compromise, on these factors, a conceptual framework has been generated for the perception of green buildings at the initial perception stage that eventually evolves to an evaluative judgment for green buildings in a later stage.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter discusses the research methodology adopted for the study to enable the researcher to achieve its aim and objectives. The chapter presents the study population and sample as well as the sampling technique adopted. It also deals with the methods used to analyze the data gathered. The chapter also deals with the presentation of data gathered, instruments for data collection and sources of data, as well as scope and limitations of the methodology.

3.2 Research Design

Adams and Schvaneveldt (1991) defined a research design as a plan or a framework for guiding a study. This, they said deals with the organization, collecting and analyzing of data; the structure that influences the technique for collection and analysis of data and provides the connection between empirical data as well as its conclusion in a logical sequence to the initial research question of the study (Baiden 2006; Bryman, 2004; Yin, 2003).

The research design employed is the Cross Sectional Survey, the purpose of this form of research approach was to provide a better understanding of the research problem and also since surveys are appropriate for research about self-reported beliefs and understandings or behaviors and when the answers people give to questions measure variables (Neuman, 2007). Both Quantitative and Qualitative otherwise known as mixed Method Approach thus was adopted. The data was collected using open-ended and close-ended questionnaire to enquire the views of practicing building industry professional on the various modules and workings of sustainable building practice in Ghana. This method thus enabled the researcher to use smaller groups of people to make inferences about larger groups which was prohibitively expensive to study (Holton & Burnett, 1997).

3.3 Research Area

Even though the research seeks to study sustainable buildings assessment tools and policy in Ghana, the study was carried out in four (4) regions out of the ten (10) administrative regions in the country at the time of study. These regions include the Greater Accra, Central, Ashanti and the Brong Ahafo Regions. The above mentioned regions were considered and selected because the target respondents are largely registered and practicing in those regions.

3.4 Population

The Population of a research is the total number of individuals or entities with common features, who are of interest to the research and the researcher. According to Mason *et al*. (1997) the population of a study is the collection of all possible individuals, objects or measurements of interest. Cooper *et al*., (2001) also opined that the population consists of all the individuals whom the measurement is being taken. This research work took the population of all practicing Architects, Quantity Surveyors and Construction Managers/Engineers in Ghana, as defined in the study area.

3.5 Sample and Sampling Techniques

The sampling technique adopted for the study involved a combination of purposive and convenience sampling which are non-probability sampling techniques. These techniques were used to select Architects, Quantity Surveyors and Construction Managers/Engineers from the population, who were thought to be relevant to the data needed (Lewis & Sheppard, 2006; Bernard, 2002; Tongco, 2007).

Purposive sampling deals with choosing samples that are available with a condition of being relevant to the subject under study. Bernard (2002) described purposive sampling as a form of nonprobability sampling in which decisions concerning the individuals to be included in the sample are taken by the researcher, based upon a variety of criteria which may include specialist knowledge of the research issue, or capacity and willingness to participate in the research. Some professionals such as Architects, Construction managers and Engineers were purposively selected within the four regions under study and were interviewed based on the existing rating tool in Ghana as well as the criteria and weighting points of the new tool to be developed. These professionals were contacted based on their background and experience in sustainable or green building practice in Ghana. Some of the criteria for their selection are extensive research experience in sustainable building construction in Ghana as well as has previously designed or worked on a sustainable building in Ghana.

Teddlie and Yu (2007) as cited by Muhwezi and Kyakula, (2012) defined convenience sampling as involving the drawing of samples that are accessible and also willing to partake in the research. Practicing professionals relevant to the data needed across the four regions under study who are readily accessible and willing to participate were contacted and questionnaires were administered to for their responses. A total of 195 practicing professionals were purposively and conveniently sampled from across the four regions and data collected.

3.6 Data Collection Instrument

Data gathering forms an integral part and very crucial in any research work (Bernard *et al.,* 1986). Proper and better understanding of a theoretical background of any research, depends on proper data gathered (Bernard, 2002). It then turns out to be imperative that selecting the method of obtaining data and from whom the data will be acquired be done with sound judgment, especially since no amount of analysis can make up for improperly collected data (Tongco, 2007; Bernard et al., 1986). Data collection instruments, methods, and procedures is addressed in this part of the study. The study focuses on primary data sources from the field survey as well as review of existing literature.

3.6.1 Instrument for Data Collection

Basically, primary sources of data were gathered for this research. Primary data are data that were previously unknown and which have been obtained directly by the researcher for a particular research project (Currie, 2005). This primary source of data is primarily gathered from the respondents from the various membership of the institutions under study i.e. Ghana Institute of Architects (GIA), Ghana Institute of Engineers (GhIE) and the Ghana Institution of Surveyors (GhIS). The tool or instruments used for the collection of data from respondents was a structured questionnaire and a semi-structured interview. A detailed survey questionnaire was designed and developed on the basis of a comprehensive literature review in the research area. The questionnaire consisted of both closed-ended and opened-ended questions.

A Likert scale of 4-point was used since it was deemed to be an excellent method of measuring the attitude of respondents towards an attribute. The 4-point Likert scale measuring from “Strongly Disagree to Strongly Agree” was adopted. According to Yin (2003), the Likert scale is easy to use and also decreases doubt, misunderstanding and error. He also stated the merits of the Likert scale as the promotion in lessening non-response and reducing respondents’ fatigue.

The questionnaire was structured into five (5) main sections, which includes the following; Section A, examined the respondents’ background or personal information such as highest educational qualification, years of practice, professional affiliations and involvement in sustainable construction projects as well as the region of practice. These questions were included in order to assess each respondent’s involvement in the construction industry and more specifically in sustainable construction.

Sections B and C enquire from the respondents to state policy level and application on sustainable construction in Ghana and also to identify challenges that building practitioners face in applying sustainability modules in Ghana respectively. They are expected to indicate this using a 4-point Likert scale. Here respondents were asked to indicate their degree of agreement or disagreement on the Likert scale of 4 i.e. "Strongly Agree = 4; Agree = 3; Disagree = 2; Strongly Disagree = 1".

The Section D of the questionnaire asked respondent to give their opinions on the functionality of sustainable assessment or rating tools in Ghana on a 4-point Likert scale in the same manner as described above. While the Section E sought the respondents to display their level of familiarity and functionality of other assessment or rating tools of sustainability used globally. Responses were collected within a period of Eight (8) weeks with several instances of phone call reminders. Attached in Appendix one (1) is the questionnaire. A semi-structured interview was also used to gather information from practicing professionals who are abreast with the sustainability concept or modules. An interview guide was used to engage the practicing professionals in a formal interview. The interview guide was prepared based on the main themes that contributed to the developing of a new rating tool. These themes include the nine main categories, the criteria that that makes up each category that was shortlisted after the study and comparison of some existing rating tools from literature. The interview was conducted at the convenience of the selected professionals due to their busy schedules and it was cordial. A total of thirty eight (38) of these professionals were interviewed across the study area.

3.6.2 Weighting, Category and Criteria for Rating Tool Development

To generate the weights for the proposed rating tool, first the categories and criteria have to be decided. In order to do that, existing rating tools were studied and comparison were made and then, the categories and criteria which are suitable for Ghana were short listed. This then form the basis of the interview with the professionals, the interview was for the professionals to verify the suitability of each category and its criteria. Once the criteria have been verified, comparison between these criteria were made to generate weights according to the relative importance. In order to do that, the use the Analytic Hierarchy Process (AHP) technique was employed to make comparison between the criteria to form the basis for the development of a new rating tool for Ghana. The semi-structured interviews allowed the respondents freedom to express their views in their own terms and this provided reliable and comparative qualitative data (Malhotra & Birks, 2007; Burns, 2000). This method was adopted to permit the researcher to debate the interviewees' opinions on the criteria and benchmark points for the rating tool to be developed. Find attached as Appendix 2 categories and criteria as shortlisted and the AHP comparison scale.

3.6.3 Pre-Testing

Pre-testing is generally defined as the testing of a set of questions on the target population. It usually involves the use of few of the designed questionnaire to test the appropriateness of the questions and the understanding of the targeted respondents. The questionnaire was pre-tested before using it to collect data. A total of fifteen (15) questionnaires were given out to some of the targeted professionals to fill at this level. The pre-testing aided in the improvement of the questions, i.e. improving the wording, check accuracy, eliminate unnecessary questions and estimate the time required for answering the questions based on the pre-test results.

3.7 Data Collection

A total of one hundred and ninety-five (195) practicing professionals from across the four regions were contacted and questionnaires were administered. Several reminders via phone calls were sent. A total of one hundred and forty-six (146) questionnaires were retrieved making a retrieval rate of seventy-four percent (74%). The total number of questionnaires distributed vis-a-vis the number responded to are summarized in the Tables 10 and 11.

Table 10: Total number of Questionnaire by Region

Respondents Region	Questionnaire Sent	Questionnaire Returned
Greater Accra Region	85	67
Central Region	30	23
Ashanti Region	50	42
Brong Ahafo Region	30	14
Total	**195**	**146**
Percentage	**100%**	**74%**

Source: Researcher's database

Table 11: Total number of respondents by Professionals

Respondents Profession	Questionnaire Returned
Architects	49
Quantity Surveyors	41
Construction Managers/Engineers	56
Total	**146**

Source: Researcher's database

3.8 Data Analysis

Analysis of data is a process of editing, cleaning, transforming, and modeling data with the goal of highlighting useful information, suggestion, conclusions, and supporting decision making, (Adèr, 2008). And according to Strydom *et al.* (2005) as cited by Umar and Khamidi (2012) data analysis is simply a means of finding answers by way of interpreting the data gathered, they further stated that to interpret is also simply to explain and find meaning.

Data from the field were coded appropriately to make meaning out of them. Coding was done to facilitate data entering and ensure comprehensive analysis. Editing was also done with the aim of detecting and eliminating errors to ensure clean and reliable data. The Statistical Package for Social Science (SPSS) software version 20 was used for the data analysis. Descriptive statistical analysis factors like frequency tables, and percentages were generated to describe the data obtained on the field.

3.9 Ethical Considerations

Informed consent: The researcher ensured to provide all relevant information about the research that participants needed to know which included the purpose and aim of the research as well as what is expected of them during the data collection process. No form of deception was used during the process.

Anonymity and confidentiality: To ensure anonymity, respondents were not required to provide any form of identification such as their name, the name of their firm or address. All responses were duly kept confidential and used only for the purpose of this research.

Presented findings were solely as a result of the objective analysis of the data gathered.

3.10 Chapter Summary

This chapter presented an overview of the research methodology with regards to the appropriate and pertinent application of the research design or approach, sample technique and procedures in dealing with the research problem. A cross sectional survey Quantitative Method Approach thus was adopted. The purpose of this form of research approach was to provide a better understanding of the research problem. A variety of analytical techniques were also employed to aid in the analysis of the various data that was collected the structured questionnaire administered. The chapter preceding this chapter will present the analysis and findings of the research.

CHAPTER FOUR

ANALYSIS AND RESULTS

4.1 Introduction

This Chapter presents in details, critically analyzed data collected from respondents. The presentation of the results commensurate with the order of arrangement of the objectives of the study. The first part dwelt with the profile and characteristics of the respondents. Next, descriptive statistics was performed on the data collected on existing polices on sustainable development in Ghana as well as to show the possible challenges or limitations that building practitioners face in applying building sustainability modules as identified from available literature.

Analysis was also conducted to assess the magnitude of agreement among respondent of the effectiveness and efficiency of sustainable assessment tools used in Ghana. Lastly review and comparison was made on existing rating tools used globally to form the basis for the development of a rating tool for Ghana. The results were presented under themes in accordance with the objectives formulated for the study and presented in frequencies, percentages, mean & standard deviation and tables.

4.2 Characteristics of Respondents

Respondents' characteristics information was analyzed by descriptive statistics employing the IBM SPSS version 20. Probing the background of the respondents gives more relevance and also places more weight to the results of the study. The

Characteristic of the respondent were examined to ascertain; their highest educational level, professional role and affiliations, years of professional practice as well as the number of works related to sustainable buildings they have worked on over the years.

From the analysis, it is observed from Table 12 that the number of male respondent largely outnumbers female respondents. The male respondent forms (77.4%) while the female respondents represent (22.6%). The probable large difference between the male and female respondents maybe due to the high interest of males in the construction industry as to their female counterpart, as was also found by Danso (2012).

Respondents holding bachelor's degree (BSc.) greatly dominates the other academic qualifications holders, this is represented by (63.7%). This is followed by masters' degree holders *i.e.* MPhil/MSc/MEng/MTech which is represented by (28.1%) and other academic qualifications including P. G. Diploma, HND and CTC holders are represented by (8.2%).

From the analysis it is observed that majority of the respondents have worked in the industry for a substantive period between 6 years to 10 years, this is represented by (58.9%), followed by those that have worked between 2 years to 5 years represented by (25.3%). (10.3%) represents those who have worked above the 10 years and a percentage of (5.5) represent those with experience 1 year and below.

All the respondents are affiliated to one professional body or the other, the analysis shows that most of the respondents (34.2%) belonged to the Ghana Institute of

Architects (GIA), with (26.7%) belonging to the Ghana Institution of Engineers (GhIE). A little over a quarter (25.3%) are affiliated to the Ghana Institution of Surveyors (GhIS). Few of the respondents representing (13.7%) belongs to other professional bodies such as the Ghana Institute of Construction (GIOC) and the Institute of Engineering and Technology Ghana (IETG).

Majority of the respondents have worked on sustainable buildings over the period of their practice in the industry with just a few, less than a quarter who have not had any practical experience on sustainable building works. The breakdown is as follows; (42.5%) being respondents who have worked on between 1 to 10 sustainable buildings, whiles (24.0%) represents those who have worked on more than 20 sustainable buildings, this is followed by those who have worked on between 11 to 20 sustainable buildings represented by (17.8%), and a percentage of (15.8) represents those with no practical experience at all with sustainable building practice.

Majority of the respondents (45.2%) practiced professionally in the greater Accra region, with (28.87%) practicing in the Ashanti region. (15.8%) and (9.6%) practice in the Central and Brong Ahafo regions respectively.

Table 12: Characteristics of Respondents (N=146)

Characteristic	Responses	Frequency	Percent (%)
Gender	Male	113	77.4%
	Female	33	22.6%
Highest Educational Qualification	Bachelor's degree	93	63.7%
	Master's degree	41	28.1%
	Others	12	8.2%
Years of Work Experience	Less than 2 years	8	5.5%
	2 – 5 years	37	25.3%
	6 – 10 years	86	58.9%
	Above 10 years	15	10.3%
Affiliation to Professional body or Association	GIA	50	34.2%
	GhIS	37	25.3%
	GhIE	39	26.7%
	Others	20	13.7%
Number of works on Sustainable building	Never	23	15.8%
	1 - 10	62	42.5%
	11 - 20	26	17.8%
	More than 20	35	23.9%
Region of practice in Ghana	Greater Accra	67	45.8%
	Central	23	15.8%
	Ashanti	42	28.8%
	Brong Ahafo	14	9.6%

Source: Researcher's survey (2018)

4.3 Policy on Sustainable Development in Ghana

This section deals with the analysis on the Policies on sustainable development in Ghana. Cronbach alpha scale reliability is used to measure the internal consistencies and frequency of responses was use for discussion.

This construct seeks to determine from the respondents the relevance in employing policies and codes to regulate sustainable building practice in Ghana. Successively respondents were asked to indicate their level of agreement from scale of 1 to 4, the need to have and apply formulated policies from government to guide sustainable building practice. Where 1=strongly disagree, 2 = disagree, 3=agree, and 4=strongly agree. Respondents were asked varied of questions ranging from Sustainable development dependence on Government policies to application of the policies in the construction industry as far as sustainable building projects are concerned.

Majority of the respondent i.e. (37% strongly agree) and (35.6% agree) agrees with the assertion that sustainable development solely is depended on government policies to flourish while (11.6% strongly disagree) and (15.8% disagree) to that assertion. However, some of the respondents highly disagree that policies in Ghana encourages sustainable construction practice (30.1% strongly disagree) and (31.5% disagree) while a few also agreeing that policies encourages sustainable construction practice in Ghana (37% strongly agree) and (1.4% agree). On the issue of policies in Ghana being adequate in addressing sustainability development in the construction industry, overwhelming majority of the respondents i.e. (19.2%) and (61.6%) strongly disagree and disagree respectively and only (15.8%) and (3.4%) agrees to sustainable development policies being adequate in Ghana.

On the basis of the above, it was therefore no surprise that a huge majority of the respondents are of the view that policies on sustainable construction practice should be amended. A total of 94.5 percent (35.6% responded in agreement and 58.9% strongly agreed). Only 1.4% and 4.1% responded otherwise. Majority of the respondents also believe sustainable construction can be fully embraced in Ghana when its practice is made mandatory through legislations in the construction industry. 63.0% of the respondents strongly agreed to this whiles 24.0% agree to it with just a few of the respondents i.e. 1.4% and 11.6% responded in the negative. They also believe policies and legislation to regulate the practice should be centralized in a single body or organization in order for effective monitoring and rating. 74.6% responded in the affirmative whiles 25.3% responded in the negative. The respondents also fairly agreed that policies regulating the practice should apply to existing buildings during renovations as well as all kinds of construction works in order to fully achieve the benefits of sustainable construction. A total of 34.9% and 28.1% agreed and strongly agreed respectively to renovations of old buildings and massive percentage of 94.5 affirm to policies applying to all kinds of construction projects while 37% did not agree to policies applying to existing buildings during renovation and just 5.5% did not agree to policies applying to all constructions works. Similarly, to the belief of the respondents that policies should apply to all kinds of construction projects, they also uphold that policies should factor in (Environmental, Economic and Social Dimensions) of sustainability for the full balance of sustainable principles and also they demonstrated through their responses that professionalism is essential towards suitable sustainable practice so therefore professional selection should include demonstrated knowledge of green building practices. 96.5% agree while only 3.5 disagree to inculcating sustainability practice in environmental, economic and social Dimensions. Furthermore, a large majority of 93.2% also encouraged professionals in the construction industry demonstrating knowledge of sustainable construction before being selected. A few of the respondents representing 6.8% argued otherwise. Refer to table 13.

Table 13: Policy on sustainable development in Ghana (No. = 146)

Sustainable Policy	**Frequency and Percentage**				**Mean**	**SD(□)**
	SD	**D**	**A**	**SA**		
Policy Phrase 1	17(11.6%)	23(15.8%)	54(37.0%)	52(35.6%)	2.96	0.99
Policy Phrase 2	44(30.1%)	46(31.5%)	54(37.0%)	2(1.4%)	2.09	0.84
Policy Phrase 3	28(19.2%)	90(61.6%)	23(15.8%)	5(3.4%)	2.03	0.69
Policy Phrase 4	2(1.4%)	6(4.1%)	52(35.6%)	86(58.9%)	3.52	0.64
Policy Phrase 5	2(1.4%)	17(11.6%)	35(24.0%)	92(63.0%)	3.48	0.75
Policy Phrase 6	0(0.0%)	37(25.3%)	71(48.6%)	38(26.0%)	3.00	0.71
Policy Phrase 7	7(4.8%)	47(32.2%)	51(34.9%)	41(28.1%)	2.86	0.88
Policy Phrase 8	0(0.0%)	8(5.5%)	53(36.3%)	85(58.2%)	3.52	0.60
Policy Phrase 9	2(1.4%)	3(2.1%)	52(35.6%)	89(61.0%)	3.56	0.60
Policy Phrase 10	6(4.1%)	4(2.7%)	88(60.3%)	48(32.9%)	3.21	0.68

NOTE: Policy Phrase 1=Sustainable development depends on Government policies, Policy Phrase 2= Policies in Ghana encourages sustainable practice, Policy Phrase 3= Policies are sufficient in building sustainable in Ghana, Policy Phrase 4= Policies should be amended, Policy Phrase 5= Policies should be obligatory, Policy Phrase 6= Policy co-ordination and regulations should be centralized in one body, Policy Phrase 7= Policies should regulate new buildings, Policy Phrase 8= Policies should apply to all kinds of structural development, Policy Phrase 9= Policies should factor in (Environmental, Economic and Social Dimensions), Policy Phrase 10= Criteria for professional selection should include demonstrated knowledge of green building practices.

SD=Strongly Disagree, D=Disagree, A=Agree, SA=Strongly Agree
Research Survey (2018)

4.3.1 Scale Reliability on Policies of Sustainability in Ghana

Cronbach Alpha was performed to establish the internal consistency of measurement items in the study to measure the reliability. A low coefficient alpha indicates that the scaled item is not consistent with the variable component whiles a higher coefficient alpha indicates otherwise. Table 17 presents the measured items as follows; Sustainable development is solely depended on Government policies to flourish, The policies on sustainable development in Ghana encourages sustainable practice, Government policies on sustainable development is adequately sufficient in building sustainable in Ghana, There is the need for amendments of existing policies or more policies should be formulated for the industry, Government policies should be obligatory to industry players, Co-ordinations of policies and regulations should be centralized in one body, Policies and guidelines to be formulated should apply to only new buildings to be constructed, Policies on sustainable construction should apply to all kinds of structural development, Policies on sustainable construction should factor in all forms of sustainability (Environmental, Economic and Social Dimensions), We need a policy to propose that criteria for choosing Architects, Quantity Surveyors, Construction Managers, and Construction Consultants shall include demonstrated knowledge of green building practices and a Cronbach alpha value of .783 was obtained, such a Cronbach alpha co efficient is deem reliable.

Table 14: Reliability statistics of policies on SB in Ghana

Cronbach Alpha	**Number of Items**
.783	10

4.4 Challenges or Limitations that Building Practitioners Face in Applying Building Sustainability Modules in Ghana

This section deal with the analysis on the challenges or limitations that practitioners face in applying sustainable building modules in Ghana. The respondents were therefore asked to indicate their views by ranking the challenges or limitations items on a Likert scale of 1 to 4, where 1= Strongly Disagree, 2= Disagree, 3=Agree and 4= Strongly Agree. A descriptive statistics was then conducted on all the variables under the construct challenges or limitations building practitioners face in applying sustainability building model in Ghana in order to determine the mean values and standard deviations of all the variables. A mean value greater than 2.0 is deemed to be a level of agreement.

All of the variables or items analyzed had a mean value 2.0 or more as can be seen in Table 15, this therefore indicate that respondents largely agreed with the challenges or limitation variables in the construction industry in Ghana. Standard deviation was used to check the internal consistencies in the data collected in order to be able to generalize the results. All the standard deviation values were less than 1.0 which indicates consistency in agreement among respondents.

The summary of items and mean values as analyzed are as follows; C&L1 =3.19, "C&L2 = 2.00, C&L3 =2.35, C&L4 =2.47, C&L5 =3.07, C&L6 =3.08, C&L7 =3.10, C&L8 =2.84, C&L9 =3.06 and C&L10 =3.13 displayed mean scores over 2.0. The results from the analysis indicates that "Initial and operational cost of sustainable buildings are very high as compare to the conventional buildings", ranked the highest. The variable had a mean score of 3.19 with a SD value of 0.65<1.0, it can be interpreted that, there is little variability in the data gathered and consistency in agreement among the respondents.

"Lack of Government support and financial incentives in the industry" ranked second with a mean value of 3.13 and SD value 0.78<1.0. On the variable that suggest buildings that attain sustainable certification should be embossed with the certificate to encourage other building owners ranked third with a mean value of 3.10 and SD value of 0.70 <1.0, the respondents generally concur to this variable.

Learning and Skills training on sustainable construction is inadequate with a mean value of 3.08 and SD value of 0.79, Commitment level of stakeholders in the industry is very minimal (Building owners, Construction professionals, Government) with a mean value of 3.07 and SD value of 0.86, as well as Not enough research has been carried out on sustainable development to ascertain its viability and practicality in the country with a mean value of 3.06 and SD value of 0.74, followed in rank of four, five and six respectively. This therefore means respondents share similar views with the variables that learning and training on sustainability development in Ghana is very limited or inadequate and that there is generally lack of commitment among key stakeholders in the industry so therefore research interest on sustainability development is limited.

There are no clear and consistent guidelines for measuring sustainable construction ranked 7th with a mean value of 2.84 and SD value 0.47 and Material and Technology know-how are not readily available in Ghana ranked 8th with a mean value of 2.47 and SD value 0.89. On this variable, the disparity among respondents for this variable is not so wide, this may be due new trend of materials and technologies for sustainable construction being discovered by the day as opined by (Danso, 2012).

Ghanaian construction professionals are not well versed in sustainability construction practice, this placed 9th on the ranking with a mean value of 2.35 and SD value of 0.84. With the variable green buildings do not ensure value for money, ranking 10th with a mean value of 2.00 and SD value of 0.69.

Table 15: Challenges or Limitation of sustainable development in Ghana (No. =146)

Item	Sustainable practice policies	Mean	SD	Ranking
C&L1	Initial and operational cost of sustainable buildings are very high as compare to the conventional buildings	3.19	0.65	1
C&L10	Lack of Government support and financial incentives in the industry	3.13	0.78	2
C&L7	Buildings that attain sustainable certification should be embossed with the certificate to encourage other building owners	3.10	0.70	3
C&L6	Learning and Skills training on sustainable construction is inadequate in the country	3.08	0.79	4
C&L5	Commitment level of stakeholders in the industry is very minimal (Building owners, Construction professionals, Government)	3.07	0.86	5
C&L9	Not enough research has been carried out on sustainable development to ascertain its viability and practicality	3.06	0.74	6
C&L8	No clear and consistent guidelines or framework for measuring sustainable construction	2.84	0.47	7
C&L4	Materials and Technologies know-how are not readily available in Ghana	2.47	0.89	8
C&L3	Professionals in the Ghanaian industry are not well versed sustainable building practices	2.35	0.84	9
C&L2	Sustainable buildings do not ensure value for money	2.00	0.69	10

Note: C & L= Challenges or Limitations

Source: Research Survey (2018)

4.4.1 Scale Reliability on Challenges of Sustainability Practice in Ghana

Analyses were performed to observe the reliability of the challenges and limitations variables. Reliability is concerned with the degree to which scores on a scale can be replicated i.e. internal consistency reliability measures the reciprocal relation of an item set. Cronbach's Alpha coefficient (α) was employed, an alpha (α) value of .70 or higher is largely considered by researchers as demonstrating a reliable measurement. Table 11 shows the reliability coefficients of the study obtained. Alpha (α) value of .725 obtained revealed that the internal consistency of the measurements was satisfactory.

Table 16: Reliability statistics of challenges of GB in Ghana

Cronbach Alpha	Number of Items
.817	10

4.5 Sustainable Building Assessment Tool Existence in Ghana

This section presents the analysis and results on sustainable assessment tools used in Ghana. The respondents were therefore asked to indicate their views on the existence and functions of assessment tools in Ghana by ranking items on a Likert scale of 1 to 4, where 1= Strongly Disagree, 2= Disagree, 3=Agree and 4= Strongly Agree. The results obtained are presented in Table 18.

Respondents were asked to acknowledge whether or not they know or have heard of any sustainable building assessment tool used in Ghana and to name it. Out of the 146 respondents, 83 representing 56.8% said YES indicating they are aware of sustainability assessment tools in Ghana while 63 representing 43.2% said NO to the same question. All the 43.2% that answered NO did not give any name thereby filling NOT APPLICABLE representing 43.2% as well, whereas 6.2% out of those that answered YES indicated NOT SURE of the name of the tool used in Ghana.19.1% of the respondents provided GREEN STAR (ECO HOMES) GHANA as the tool used in Ghana and 31.5% wrote OTHERS ranging from LEED, BREEAM, EPA, Building Code etc. as the building assessment or rating they know of being used in Ghana.

The respondents then went further and responded to the other variables as follows; majority of the respondents thought that the tool used in assessing the sustainability of buildings in Ghana is not very efficient and effective in measuring sustainability status of buildings, 73.2% of the respondents were of that view, with only 26.7% which held an alternative view and majority of the respondents also held the view that the tool used in assessing sustainability of buildings in Ghana needs to be updated or changed because it's not being efficient and effective. A huge majority of the respondents representing 98.6% were in agreement, however 1.4% of the respondents did not share same view, they believe the existing rating tool is satisfactory for sustainability status measurement in the country.

Furthermore, a little over half of the respondents disagree to a single tool being used to rate the sustainability status of all kinds of buildings, a response rate of 54.9% of the respondents disagreeing to that view, whilst 45.1% agreed to using a single tool to rate all kinds of buildings since numerous tools rating different kinds of building will not be appropriate and probably can create some sort of duplication.

On whether the tool used to assess sustainability of buildings in Ghana considers all aspects of sustainability *i.e.* Environmental, Economic and Social dimensions, 43.8% of the respondents were in disagreement, however a 56.2% of the respondents did agreed to the variable's suggestion. And also all of the respondents agreed with the assertion that a rating tool for office and commercial buildings should be different from a rating tool for a residential facility. Additionally, most of the respondents were in agreement with the assertion that a rating criteria for office and commercial buildings should be different from a rating criteria for a residential facility. Only 4.8% of the entire respondents disagreed whereas a huge majority of 95.8% were in agreement.

A few of the respondent held the view that sustainable construction practice is not relatively new in Ghana so they disagreed with the view that it lacks commonly accepted standard of practice. Only 27.4% of the respondent's held this view, however most of the respondent i.e. 72.6% thought otherwise, they believed the practice is relatively new in Ghana and therefore lacks commonly accepted standard practices. Some of the respondents were also in the view that the tool used in assessing the sustainability of buildings in Ghana is not very easy and simple to understand, they believe it's too complicated to understand and work with. 69.9% of the respondents held this view whereas a little over a quarter representing 30.1% were in disagreement. More so a little over half represented by 56.2% of the respondents believes there is lack of assessment of building performance during operation stage of the life cycle period of the building, however 43.8% of the respondents thought otherwise. As to whether the assessment tool used in Ghana focuses on social aspects of sustainability such as stakeholder engagement and health and safety performance, respondents were largely in favor of that assertion. A percentage of 67.8 believes those aspects are considered, however some 32.2% of the respondents believes otherwise and majority of the respondents i.e. 85% of the entire respondent also thought that the assessment tool used in Ghana should be modified to reflect the conditions in Ghana. However, a quarter of the respondent did not think so.

Table 17: Sustainable building assessment tool in Ghana

Responses	**Frequencies**	**Percentage (%)**
Yes	83	56.8
No	63	43.2
If "Yes" Kindly Names it		
Not Applicable	63	43.2
Not sure	9	6.2
Green star (Eco Homes) Ghana	28	19.1
Others	46	31.5
Total	146	100

Sustainable Policy	**Frequency and Percentage**				**Mean**	**Rank**
	SD	**D**	**A**	**SA**	**SD(□)**	
Tool used in assessing the sustainability of buildings in Ghana is very efficient and effective	17 11.6%	90 61.6%	34 23.3%	5 3.4%	2.18 0.67	10
Tool used in assessing the sustainability of buildings in Ghana needs to be updated or changed	0 0%	2 1.4%	73 50%	71 48.6%	3.47 0.52	1
A single tool to rate all kinds of buildings is appropriate	27 18.5%	53 36.3%	49 33.5%	17 11.6%	2.38 0.91	9

Tool used to assess sustainability of buildings in Ghana considers all aspects of sustainability i.e. Environmental, Economic and Social dimensions	2 1.4%	62 42.4%	74 50.7%	8 5.5%	2.60 0.61	7
A rating tool for office and commercial buildings should be different from the rating tool for a residential facility	0 0%	0 0%	94 64.4%	52 35.6%	3.35 0.48	2
The rating criteria for office and commercial buildings should be different from the rating of residential facility	0 0%	7 4.8%	107 73.3%	32 21.9%	3.17 0.48	4
Measuring sustainability is relatively new in Ghana and so there is a lack of commonly accepted standard	0 0%	40 27.4%	73 50%	33 22.6%	2.95 0.70	5
The tool used in assessing the sustainability of buildings in Ghana is very easy and simple to understand	21 14.4%	81 55.5%	44 30.1%	0 0%	2.15 0.65	11
There is lack of assessment of building performance during operating stage with the current assessment tool used in Ghana	20 13.7%	44 30.1%	62 42.5%	20 13.7%	2.56 0.89	8

The assessment tool focuses on social aspects of sustainability such as stakeholder engagement; health and safety performance	3 2.1%	44 30.1%	98 67.1%	1 0.7%	2.66 0.52	6
The assessment tool used in Ghana should be should or can be modified to reflect conditions in Ghana	0 0%	22 15%	62 42.5%	62 42.5%	3.27 0.70	3

Source: Research Survey (2018)

4.5.1 Scale Reliability on Existing Rating Tool in Ghana

Cronbach's Alpha coefficient (α) was employed, an alpha (α) value of .70 or higher is largely considered by researchers as demonstrating a reliable measurement. Table 12 shows the reliability coefficients of the study obtained. Alpha (α) value of .712 obtained revealed that the internal consistency of the measurements was satisfactory.

Table 18: Reliability statistics of existing rating tool in Ghana

Cronbach Alpha	Number of Items
.712	13

4.6 Development of Green Building Rating Tool for Ghana

4.6.1 A Comparison of Sustainable Rating Tools: Their Purposes and Measuring Criteria, Strength and Weakness

It is essential to compare some of the key Sustainable building rating systems available to better understand their standards, mechanisms and indicators for measuring sustainable development. Tables 19, 20, 21 and 22 presents elaborate comparison of the functions, strength and weaknesses, categories/ criteria, weighting points as well as the certification levels of the four main rating tools used globally that was reviewed to form the basis for the development of a rating tool for Ghana. This tools includes the BREEAM as used in the UK, LEED, used in the USA and Canada, GBCS used in Korea and Green Star used in Australia.

Table 10: General Comparison of other assessment methods

System	BREEAM, UK	LEED, USA	GBCS, Korea	Green Star
Year	1990	1998	2002	2003
Project scopes	4	9	7	7
	Commercial (offices, industrial, retail), Public (Non housing,- education, healthcare, prisons, law courts), Multi-residential accommodations (residential institutions), other (residential institutions, non residential institutions, assembly and leisure, other)	LEED-NC, LEED-EB, LEED-CS, LEED-CI, LEED-Retail, LEED-Schools, LEED-Homes, LEED-ND, LEED-H	Multi-family residential, Mixed-use (residential/ non-residential areas), Office, School, Retail, Accommodation	Offices Retail Schools (Industrial buildings) (Mixed use residential) (Mixed use) (Healthcare)
Evaluation scopes	Whole building assessment frameworks and rating systems	Whole building assessment frameworks and rating systems	Whole building assessment frameworks and rating systems	Whole building assessment frameworks and rating systems
Applying stage	Design, Construction and Operation	Design, Construction and Operation	Design, Construction and Operation	Design, Construction
System scope	New build Refurbishment Existing building	New build Refurbishment Existing building	New build Refurbishment Existing building	New build Refurbishment
Certification levels	5	4	4	6
	Outstanding, Excellent, Very good, Good, Pass	Platinum, Gold, Silver, Certified (Bronze)	Green I, II, III, and IV	Star 1, 2,3,4,5 and 6
No. of credit items	48	57	44	76
Total credit scores	155	110	136	172

Credit categories	10 Management, Health & Wellbeing, Energy, Transport, Water, Materials, Waste, Land Use & Ecology, Pollution, Innovation	7 Sustainable Sites, Water Efficiency, Energy & Atmosphere Materials & Resources, Indoor Environmental Quality, Innovation in Design or Innovation in Operations	9 Land Development, Transportation, Energy, Materials & Resources, Water Efficiency, Atmosphere, Maintenance, Ecological Environment, Indoor Environmental Quality	9 Energy Transport Water Ecology and Land use Emissions Materials, IEQ Management, Innovation

Source: Zuo et al., (2014)

Table 11: Category Comparison Chart

CATEGORY	BREEAM	LEAD	GBCS	GREEN STAR
Energy	√	√	√	√
Ecology	√	_	√	√
economic	_	_	_	_
Water efficiency	√	√	√	√
Waste management	√	√	√	√
Material	√	√	√	√
Indoor environment quality	√	√	√	√
Mobility and transportation	√	√	√	√
Emission and pollution	√	√	√	√
Land use	√	√	√	√
Cultural and social	_	_	√	_
Innovation	√	√	√	√

Source: Zuo et al., (2014)

Table 12: Criteria and Scoring for BREEAM, LEED, GBSC, GREEN STAR

System	BREEAM	LEED	GBSC	GREEN STAR
Criteria	Management, (12%)	Sustainable sites (22%)	Land Development 22points (15mad.+7rec.)	Energy 29points
	Health & Wellbeing (15%)	Water efficiency (10%)	Transportation, 8points (6mad.+ 2rec.)	Transport 12points
	Energy (19%)	Energy and atmosphere (30%)	Energy, 15points (12mad.+3rec.)	Water 14points
	Transport (8%)	Materials and resources (12%)	Materials & Resources, 15points (13mad.+3rec.)	Ecology and Land use 8points
	Water (6%)	Indoor environmental quality (17%)	Water Efficiency, 23points (14mad.+9rec.)	Emissions 20points
	Materials (12.5%)	Innovation (5%)	Atmosphere, 3points (3mad.+0rec.)	Materials, 35points
	Waste (7.5%)	Regional Priority (4%)	Maintenance, 7points (6mad.+1rec.)	IEQ 32points
	Land Use & Ecology (10%)		Ecological Environment, 18points (17mad.+1rec.)	Management, 17points
	Innovation (10%)		Indoor Environmental Quality27points (18mad.+9rec.)	Innovation 5points
	Pollution (10%)			
Scores	Pass : 0 to 44 Good: 45 to 54 Very Good: 55 to 69 Excellent:70 to 84 Outstanding: 85+	Platinum (52 +) Gold (39 to 51) Silver (33 to 38) Certified (26 to 32)	Green I (80) Green II (70-79) Green III (60-69) Green IV (50-59)	6Star:world leader (75 +) 5Star:Australian Excellence (60- 74) 4Star: Best practice (45-59)

Source: Zuo et. al., (2014)

Table 13: Strength and Weaknesses of BREEAM, LEED, GBSC, GREEN STAR

System	Strength	Weaknesses
BREEAM	Whole building assessment frameworks Strong Environmental assessment Applied during Design, Construction and Operation stages Applied to New build, Refurbishment & Existing building	Weak Social and Economic assessment
LEED	Whole building assessment frameworks Strong Environmental assessment Applied during Design, Construction and Operation stages Applied to New build, Refurbishment & Existing building	Weak Social and Economic assessment
GBSC	Holistic Approach In Assessment Applied during Design, Construction and Operation stages Strong in Environmental and social assessment Applied to New build, Refurbishment & Existing building	Weak Economic assessment
GREEN STAR	Strong Environmental assessment Holistic Approach In Assessment	Applied to only Design and Construction stages Weak Social and Economic assessment

Source: Zuo et al., (2014)

4.6.2 Analytic Hierarchy Process (AHP) Method

The Analytic Hierarchy Process (AHP) method is a multi-criteria decision-making approach permitting decision-makers to model a complicated challenge in a hierarchical structure (Brunelli, 2015). The AHP framework or (model) is usually developed to breakdown complex problems into manageable elements. This in turn established different hierarchal levels.

The AHP Method was employed to select a rating tool among the key ones analyzed in order to choose one that best measure indicators similar to the condition of Ghana. The categories and criteria were compared to each other by the professional through and interviewed session. The ability of the criteria to impact more in the Ghanaian set up as compared to the other were the main factors considered to allocate the weightings. These criteria is then modify to suit the prevailing conditions in Ghana. Table 14 presents the AHP analyses in details.

Table 14: Analytic Hierarchy Process (AHP) Method for the selection

	BREEAM	LEED	GBCS	GREEN STAR		
BREEAM	1.000	0.200	0.111	3.000		
LEED	5.000	1.000	0.142	5.000		
GBCS	9.000	7.000	1.000	0.111		
GREEN STAR	0.333	0.200	9.000	1.000		
SUM	15.333	8.400	10.253	9.111	WEIGHT	PERCENT
BREEAM	0.065	0.023	0.010	0.329	0.107	10.7%
LEED	0.326	0.119	0.013	0.548	0.251	25.2%
GBCS	0.586	0.833	0.097	0.012	0.382	38.3%
GREEN STAR	0.021	0.023	0.877	0.109	0.257	25.8%

Source: Research Survey (2018)

4.5.3 Propose Sustainable Building Rating Tool for Ghana [Green Rating & Measurement System for Ghana (GRMSG)]

A number of building practitioners within the four regions under study were interviewed based on their experience in the industry either through design, supervision works. The interview is based on the outcome of the AHP analyses which projected the Green Building Certification System (GBCS) as the rating tool preferably to be modify to suit Ghana's condition. From table 23, GBCS got the highest percentage (38.3%).

The interview focused on the nine (9) main categories which comprises of the following:

Land Development, containing of four (4) criteria, Transportation having three (3) criteria, and Energy Efficiency, Materials Resources Efficiency, Water Efficiency containing of four (4), eight (8), and five (5) criteria respectively. The rest are Carbon Emissions reduction which has just one (1) criteria, Maintenance/Innovation/ Management, having three (3) criteria, Environment ecology and Indoor Environmental Quality (IEQ) having four (4) and eight respectively. Almost all of the practitioners interviewed agreed to the above mentioned categories and its corresponding criteria as being able to adequately measure sustainability of buildings in Ghana.

These categories and criteria were obtained by shortlisting from the existing rating tool that the AHP suggested as the most suitable for the Ghanaian industry. The weightings are based on the magnitude of the category and criteria's ability to impact on sustainability, it is also based on readily availability and cost of procurement as well as installation of the component, for example installing bicycle rack is much cheaper than installing renewable source of energy such as solar systems or wind turbine, so the weight of the two varies in terms of the weighting points. Table 24 throws more highlight on the categories as well as the criteria with it respective weightings and possible points. The total weight (TW) is the sum of all the criteria weights whiles the Possible points of a category is obtained by multiplying the TW by the Benchmark point of three (3) for each category.

Table 15: Propose "Green Rating & Measurement System for Ghana (GRMSG)"

	Benchmark Point (BMP)		**3**	
Categories	**Criteria**	**Weight**	**TW**	**Possible Points**
Land Development	Ecological Value of Site	1	4	12
	Preservation of Existing Natural Resources	1		
	Interference with Daylight to Adjacent Properties	1		
	Provision of Community Center and/or Facilities	1		
Transportation	Accessibility to Public Transportation	1	2	6
	Installation of Bicycle Racks And Roads	0.5		
	Easy Accessibility to City centers	0.5		
Energy Efficiency	Reduction of Annual Energy Consumption	1.5	6.5	19.5
	Use of Alternative renewable Energy Sources such as solar etc.	2		
	Use of motion and daylight sensors	2		
	Daylight & natural ventilation	1		
Materials Resources Efficiency	Application of Environmentally Friendly Construction Methods/Materials	3	14	42
	Locally sourced materials	2		
	Built-In Furniture	1		
	Installation of Recycling Containers	2		
	Installation of Food Waste Containers	2		
	Reuse-Nonstructural Elements	1		
	Use of Recycled-Content Materials	2		
	Reuse-Structural Elements	1		

Water Efficiency	Water Efficient Landscaping	1		
	Water Use Reduction	1		
	Installation of Storm water Reuse Systems	1	5	15
	Installation of Gray water Reuse Systems	1		
	Rain water harvesting	1		
Atmosphere/ Emissions	Reduction of CO_2 Emissions	3	3	9
Maintenance/ Innovation/ Management	Waste Management and Reduction Planning	1		
	Health and safety management planning	0.5		
	Provision of a Building Manager's Manual	0.5	2.5	7.5
	Provision of an Occupant's Operations and Maintenance Manual	0.5		
Ecological Environment	Consistent Green Space in the Complex	2		
	Application of Planned Landscaping	1		
	Improving the Local Ecological Environment	1.5	5	15
	Topsoil Reuse	0.5		
Indoor Environmental Quality	Use of Low-Emitting Materials	3		
	Installation and Controllability of thermal and cooling System	1		24
	Noise Between Floors prevention	0.5	8	
	Noise Between Walls prevention	0.5		
	Noise from Outside prevention	0.5		
	Accessibility for The Disabled and Elderly	1		
	Increased natural Ventilation	1.5		
Categories = 9	Criteria = 40	50	50	150

Source: Research Survey (2018)

4.5.4 Certification Levels

There is benchmark point (BMP) of three (3) for each category, so therefore the weighting value accrued by a project by the BMP will form the accrued points for the project. The total possible accrued point is one hundred and fifty (150) and a minimum accrued points for a certification is forty (40). A project is required to earn the minimum to attain a certification. Projects earning higher scores will be rewarded with different certification levels depending on the specific thresholds they reach. In all there will be four certification levels which will include "Bronze" (40-59 points), "Silver" (60-79 points), "Gold" (80 -105 points), and "Diamond" (106 – 150 points) as shown in Table 16.

Table 16: Certification Levels

Rating	**Score**
Diamond	106 - 150
Gold	80 - 105
Silver	60 - 79
Bronze	40 - 59

Source: Research Survey (2018)

CHAPTER FIVE

DISCUSSION

5.1 Introduction

This Chapter presents in details, critically analyzed data collected from respondents. The presentation of the results commensurate with the order of arrangement of the objectives of the study. The first part dwelt with the profile of respondents for the questionnaire issued. Next, descriptive statistics was performed to indicate existing polices on sustainable development as well as to show the possible challenges and limitations that building practitioners face in applying building sustainability modules as identified from available literature.

5.2 The Need to have and Apply Policies to Regulate Sustainable Development in Ghana

Sustainable construction cliché is fast becoming a widespread phenomenon globally and among industry players. However, Djokoto et al. (2014) identify the lack of policy and codes to regulate the practice as the major barrier to sustainable building practice in Ghana. This construct therefore seeks to determine from the respondents the relevance in employing policies and codes to regulate sustainable building practice in Ghana. Respondents were asked varied of questions ranging from sustainable development dependence on government policies to application of the policies in the construction industry as far as sustainable building projects are concerned. Majority of the respondent believes sustainable development is solely dependent on Government policies to flourish, Djokoto et al. (2014), believes this is the case because the

Ghanaian construction industry is a robust sector, which is heavily reliant and dependent, on traditional methods of construction and as such favors the use of blocks and concrete predominantly which has made the entry of other alternative and more sustainable building material and services difficult. Asamoah and Decardi-Nelson (2014) also believes clients and stakeholders do not demand innovative resources and solutions, relying instead on old and known material and construction methods so therefore a government deliberate policy on sustainability will encourage its practice in Ghana.

On the issue of policies in Ghana being adequate in addressing sustainability development in the construction industry, overwhelming majority of the respondents held an opposing view. Femenias (2005) as cited by Djokoto et al. (2013) highlighted the fragmented nature of the sector and the high number of actors involved that may contribute to this. However, they further stated that there must be a policy on sustainable construction which indicates clearly when, how and who enforces what in Ghana. A sustainable policy seeks to drive forward the sustainable construction by providing clarity around the existing policy framework, signaling the future direction of Government policy and showing what can be done towards making sure they are enforced. Häkkinen and Belloni (2011) also mentioned the lack of steering or the wrong type of steering may hinder sustainable construction. Furthermore, sustainable construction can also be promoted at least to a certain extent with the help of right policies and regulations. A combination of legislations or policies to enforce companies and market to sustainable development and incentive package for construction firms that practice sustainability in their projects is the best approach that can be applied as a strategy tailored towards sustainable construction (Samari, 2013). On the basis of the above, it was therefore no surprise that a huge majority of the respondents are of the view that policies on sustainable construction practice should be amended. Majority of the respondents also believe sustainable construction can be fully embraced in Ghana when its practice is made mandatory through legislations. They also believe policies and legislation to regulate the practice should be centralized in a single body or organization in order for effective monitoring and rating just as Aitken (1998) expressed that one of the real motivation behind great administration is to force singular performing artists to settle on all things considered insightful choices; in light of a legitimate concern for general wellbeing, security, or welfare, through administrative arrangement (obliging and restricting certain activities) or non-administrative strategy (making impetuses for or just reassuring and encouraging certain activities).

The respondents also fairly agreed that policies regulating the practice should apply to existing buildings during renovations as well as all kinds of construction works in order to fully achieve the benefits of sustainable construction. Similarly, to the belief of the respondents that policies should apply to all kinds of construction projects, they also uphold that policies should factor in (Environmental, Economic and Social Dimensions) of sustainability for the full balance of sustainable principles (Pitt, Tucker, Riley & Longden, 2009; Ikediashi, Ogunlana, & Ujene, 2014; Danso, 2018a). Schwartz and Raslan (2013) also concluded that rating systems are developed to assess the sustainability of a building in accordance with the economic, cultural and ecological environment they are being used in, it was therefore of no surprise when the respondents also indicated that all the dimensions should be factored in the policies.

Also they demonstrated through their responses that professionalism is essential towards suitable sustainable practice so therefore professional selection should include demonstrated knowledge of green building practices as architects educated in green design better serve their clients by designing buildings that cost less to occupy and maintain as Kats and Gregg (2003) propounded. Since most of the features that make a building sustainable are incorporated in the design phase, architects can play a pivotal role in determining how green a building is. Factors that determine a building's performance, such as site selection; orientation; foundation, walls, and roof; heating, cooling, and ventilation; and lighting, are either directly or indirectly influenced by the design decisions of the architect (Kats & Gregg, 2003).

5.3 Challenges or Limitations that Practitioners Face in Applying Building Sustainability Modules in Ghana

The results from the analysis indicates that "Initial and operational cost of sustainable buildings are very high as compare to the conventional buildings", ranked the highest, i.e. this variable had a higher number of respondents agreeing and strongly agreeing with just few disagreeing. None of the respondents strongly disagreed to this variable. The variable had a mean score of 3.19 with a SD value of 0.65<1.0, it can be interpreted that, there is little variability in the data gathered and consistency in agreement among the respondents. Rehm and Ade (2013); Dzokoto et al. (2014) emphasized that green building construction costs is higher on average. Most of the respondents perceived sustainable construction to be expensive due to the varied new ideas, systems and components emanating frequently and which are considered expensive to acquire, install and operate. This therefore leads to the general apathy attached to green building products in Ghana and worldwide (Kats et al., 2003). According to Dzokoto et al. (2014) the result of their research ranked higher initial cost as third on a list of twenty (20) barriers to green construction in Ghana.

"Lack of Government support and financial incentives in the industry" ranked second with a mean value of 3.13 and SD value 0.78<1.0 indicating there is little variability in the data gathered and consistency in agreement among the respondents. Majority of the respondents strongly agreed to this variable with just a few exceptions. According to Atsusaka (2003) and Samari (2012) as cited by Dzokoto et al., (2014) the role of governments in promoting green building is undeniable and very effective if it is done. Governments have important role to promote green building development. Naturally for a developing country like Ghana, the need to have a government ready to lead in the provision of sustainable construction is vital and critical (Ofori, 2006).

The result from Dzokoto et al., (2014) indicates that the lack of maximum support from government is a major challenge to the adoption and use of sustainable construction processes. They further stated that when Governments plays a key role in terms of promoting green building, the industry will advance. From the analysis, its clear huge majority of the respondents considers this assertion to be true and see the lack of it as a challenge.

Buildings that attain sustainable certification should be embossed with the certificate to encourage other building owners ranked third with a mean value of 3.10 and SD value of 0.70 <1.0, this shows there is little variability in the data gathered and consistency in agreement among the respondents. Ofori-Boadu et al. (2012) opine that while the direct financial benefits of sustainable building, such as energy savings, and clearly measurable improvements of the building, indirect benefits such as improvement of an institution's image, gains in competitive advantage and increased productivity as a result of employee or student pride can result in financial gains that are more difficult to assess. Physical visual inscription of sustainability status on buildings may serve as a big incentive and awareness creation of the subject. According to Dzokoto et al., (2014), the Toronto Green Development Standard (TGDS) indicated that public awareness about green building was the most important component that led to high demand in Canada. Majority of the respondents also hold same view as they strongly agreed to this variable with just a few disagreeing.

Learning and Skills training on sustainable construction is inadequate with a mean value of 3.08 and SD value of 0.79. Commitment level of stakeholders in the industry is very minimal (Building owners, Construction professionals, Government) with a mean value of 3.07 and SD value of 0.86, as well as Not enough research has been carried out on sustainable development to ascertain its viability and practicality in the country with a mean value of 3.06 and SD value of 0.74, followed in rank of four, five and six respectively. The mean and SD values obtained from the analysis indicate some variability in the data gathered and consistency in agreement among the respondents. Djokoto et al. (2013) also identified the lack of capacity to actually implement sustainable practices despite the purported desire to adopt sustainable construction practices in Ghana. They further observed that Professionals within the built environment are not yet fully trained in sustainable construction principles and thus lack the know-how to properly carry out such practices just as identified in this research. In addition to forming an appropriate knowledge base, these professionals would have to be trained on how to engage with owners/end users, investors, developers, designers, and contractors (Djokoto et al., 2014). The lack of a solid knowledge base in sustainability hampers its (Ampadu- Asiamah & Ampadu-Asiamah 2013).

Asamoah and Decardi-Nelson (2014) concluded that many of the construction projects in Ghana are becoming larger and more technical in sustainability and will require a higher quality of professional services and better control systems to meet the needs of the growing population, this therefore needs investment in training skills for the survival of the industry. Häkkinen and Belloni, (2011) posited that sustainable building practice can be hindered by ignorance or a lack of common understanding about sustainability, and this therefore calls for adequate training and continuance skills development which most of the respondents agreed as lacking in the Ghanaian green building industry. They also strongly agreed that the commitment level in achieving this is very low in the industry. Government and industry players' commitment to a successful green building practice is inevitable and for a developing country like Ghana with green development at its infancy stage the commitment level should be at it maximum, Sutherland (1991); Ofori (2006) also held the same view. Dzokoto et al. (2014) posited that lack of commitment is a major barrier in the Ghanaian green building industry. Kibert (2005) also mentioned that the expansion of green or sustainable projects relies heavily on the consistency and coordination in policy frameworks. The study mentioned for example inconsistencies in building codes to hamper the operation of different building resources and advanced strategies in the design.

There is no clear and consistent guidelines or framework for measuring sustainable construction ranked 7th with a mean value of 2.84 and SD value 0.47, most of the respondent agreed to this variable, however according to Osae-Akonnor (2012) as cited by Ahmed et. al., (2014), there is a measuring tool in Ghana, this was adopted from the Green Star South Africa which was originally adopted from the Green Star Australia.

The industry in Ghana has traditionally favored the use of blocks and concrete, it has therefore made the entry of other alternative building material and services difficult. As such, clients and stakeholders do not demand innovative resources and solutions, relying instead on outdated materials (Djokoto et al., 2013).

Material and technology challenge for buildings usually takes various forms (Umar & Khamidi, 2012). One should additionally consider the infrastructure use to support the built environment in material selection. There are lots of technological advances that need to be carried out to resolve the complications of resource depletion, corrosion, pollution, durability, lifespan, etc. related to building materials as opine by forms (Umar & Khamidi, 2012). Firstly, new construction needs to be constructed more sustainably so that it not just reduces negative aspects of construction and operations, but that it primarily boosts building lifespan, which can be carried out by eliminating design features that will be rapidly outdated.

Lastly, with regards to the end of lifetime of a building, there needs to be extremely careful consideration for the processing of the materials. This should be considered previously during the design stage of any building, where composites that are hard to handle are minimized. Materials should be used that can be immediately recycled without the need to remanufacture them. If they cannot be immediately reused, they can be recovered as raw materials. If they should be reused, they should be utilized at the same level of quality, thereby eradicating any down cycling or waste.

Professionals in the Ghanaian industry are not well versed sustainable building practices placed 9th with a mean value of 2.35 and SD value of 0.84. According to Langdon (2007), steep industry learning curve - general lack of knowledge is also major challenging factor to sustainable practice just as agreed by most of the respondents. Stang and Hawthorne (2005) also opine that a major hurdle to sustainable design was that there were architects who are not inclined alongside green design as they trust that power efficiency and architectural aesthetic are two contradictory agents and are watchful that the label of green architect could alter their area perception.

Sustainable buildings are expected to decrease operating costs between 8% and 9% and increase total building value by about 7.5 percent as well as increase occupancy rates by 3.5 percent (Liu, Low & He, 2012; Braham, 2006). Value drives demand for every product or service, and as such the green building industry will normally hold increased market value because of its intrinsic lower in-use operating costs and healthier indoor environment. This therefore highlight the mood of the respondents when they generally disagreed to this variable "Green buildings do not ensure value for money" with a mean value of 2.00 and SD value of 0.69 but Langdon (2007) argues that general lack of knowledge about the economic and environmental benefits of high performance buildings; and fiscal consideration – uncertainties on the rate of return or pay back of investments and other monetary consideration can be a major challenge.

5.4 Sustainable Assessment Tools Used in Ghana

The increasing demand for housing and other infrastructure developments has spurred the urgent need of creating and developing sustainable building. The construction industry had been identified as the main culprit in the deterioration of earth environment and being the major contributor to pollution (Ding, 2008). In the last couple of decades, with the objective to enhance sustainable building has led several government and non-profit organization to the emergence of green building assessment tools.

Respondents were asked to acknowledge whether or not they know or have heard of any sustainable building assessment tool used in Ghana and to name it. A sizeable majority disclosed that they are aware however could not mention the appropriate names. It can be observed that the knowledge does not match its practice as noted by Nduka and Sotumbo (2014) and Abidin (2010) and perhaps, the Ghana Green Building Council, needs to engage in more of educational programs which will translate the awareness into practice.

Majority of the respondents purported that the tool used in assessing the sustainability of buildings in Ghana is not very efficient and effective in measuring sustainability status of buildings. Suopajarvi (2011) identified an effective and efficient rating tool to include sustainability assessment indicators, "used for providing summaries and to focus and condense the complex surroundings into a form of manageable indicators. Building rating systems were developed as a means for the construction industry to meet the sustainability challenge. They enable architects and contractors to take sustainability into consideration when designing and constructing buildings and therefore should aid in the assessment with ease (Ahmed, Hatira & Valva, 2014). Building rating systems provide a 'road map' towards sustainability for the industry at a practical, everyday level. Systems outline what the industry must do to become sustainable. They function as guidelines in designing and constructing the building, as building codes and blue prints do in traditional construction projects. Clearer and more detailed blue prints and building codes will more likely result in the end product mirroring the envisioned concept. Similarly, clearer building rating systems will result in more sustainable buildings and practices as espouse by Ahmed, et al., (2014).

Ahmed, et al., (2014) agreed with the respondents that a single tool used to rate the sustainability status of all kinds of buildings is not appropriate, they identified a deficiency in the tool used in Ghana as failing to consider the interaction among different actions towards sustainability.

When sustainability principles are taken into consideration, construction then considers the impact of development on the environment, both ecologically and socially, and products are designed to meet the changing needs and desires. The extended enterprise is expanded to include not only the traditional stakeholders (property owner, architects, contractors, regulators, and property occupants), but additional stakeholders as well, such as commissioning agents, NGOs, and society at large. The range of stakeholders is increased because the impact on the environment and society is increased as well when sustainability is taken into consideration. The practice is relatively new in Ghana and therefore lacks commonly accepted standard practices.

5.5 The Proposed Rating Tool for Ghana [Green Rating & Measurement System for Ghana (GRMSG)]

Sustainable building rating systems are defined as tools that examine the performance or expected performance of a 'whole building' and translate that examination into an overall assessment that allows for comparison against other buildings. For a rating system to add value to the sustainable design and/or operation of a building, it must offer a credible, consistent basis for comparison, evaluate relevant technical aspects of sustainable design, and not be over-burdensome to implement and communicate" (Fowler & Rauch n.d.; Ahmed et al., 2014).

Green building primarily having energy efficient usage, water conserving, the use of recyclable materials, non-toxic and other features that contribute to environmental, social and economic sustainability (Ali & Al Nsairat, 2009). The question arises when to compare a green building and a normal building, therefore the emergence of green building assessment tools which has helped the development of green building assessment to compare to a normal traditional building and the method to compare and distinguish between the green features between them (Reed, Bilos & Wilkinson, 2009). The Ghana Green Building Council is an independent association registered with the Registrar General's Department in Accra (Ghana) as a member-based non-governmental organization with no private ownership (GHGBC Handbook, 2011 as cited by Ahmed et. al., 2014). The GHGBC is responsible for implementing the rating system in Ghana and according to Ahmed et al. (2014) the GHGBC does not have its own building rating system up to date.

There is, however, a building rating system in South Africa called the GS SA-v1 Building Rating System, which was adapted from the GS-v1 Building Rating Tool in Australia. In that rating system as elaborated by Osae-Akonnor (2014) each category consists of a series of credits describing criteria that represent a desired level of sustainability. Points are awarded for each credit achieved in the construction process. For example, under Indoor Air Quality, contractors can earn a point for installing ventilation systems that provide fresh air to a building. The more points a project earns, the higher the rating and the greater the degree of sustainability. Overall the use of the G.S. Tool is a move in the direction towards sustainability in the construction industry in Ghana. However, Ahmed et al. (2014) identified some deficiencies in the existing rating tool, and stated that this could result in a greater level of performance in terms of sustainability when it is improved. The first deficiency they identified is the tool is designed for the construction industry of South Africa and even though the basic categories are applicable in Ghana, the individual credits and the weightings for the credits are not equivalent for both countries. They noted for example the importance of water conservation having a different significance in the two countries. The second problem they identified with the existing tool is that it is insufficient to meet the sustainability challenge of our time because it fails to take changing market needs and desires into consideration. For example, there will be an increasingly greater need for access to public transportation as traffic from rapid urbanization and building construction increases. A third deficiency of the existing tool is its failure to consider emerging products in the market, such as technical innovations that are driving needs, desires and construction practices. Alternative energy sources such as solar arrays, windmills and geo-thermal power are becoming increasingly available, driving demand up and prices down. Their wide availability changes the weightings that will be assigned to each credit. Availability of solar panels, for example, puts more weight on the credits of the Energy category because contractors are expected to use and are rewarded for using innovative technology as it becomes available in the marketplace.

The fourth and final deficiency of the existing tool they identified is its failure to identify points of influence in the process to move towards sustainability - that is, stakeholders who can either facilitate or hinder progress towards sustainable actions. Contractors would benefit from understanding who has the power to assist or block an action towards sustainability (Ahmed et. al., 2014).

The proposed rating tool for Ghana consists of nine categories of sustainability-related issues: land development, transportation, energy efficiency, materials resources efficiency, water efficiency, carbon emissions reduction, maintenance/innovation/ management, environment ecology, and indoor environmental quality (IEQ). A description of each of the categories is listed below:

Land development: addresses the impact on the immediate ecosystem, encourages preservation and restoration of flora and fauna. it comprises of four (4) criteria which includes; preservation ecological value of site, preservation of existing natural resources, interference with daylight to adjacent properties and provision of community center and/or facilities, each with a weighting value of one (1). Land development is very essential in assessing sustainability status of a building (Ahmed et. al., 2014; Osae-Akonnor, 2014).

The second category considered is transportation which targets reduction of individual use of cars and encourages alternative forms of transport as well as mass transportation system. This has three (3) criteria which are; accessibility to public transportation having a weighting value of one (1), installation of bicycle backs &

roads and easy accessibility to city centers each having a weighting value of zero-point-five (0.5).

The third category focused on energy efficiency which targets an overall reduction in non-renewable energy consumption, to achieve an impact on greenhouse gas emissions. The criteria of this category comprises of reduction of annual energy consumption with weight of one-point-five (1.5), use of alternative renewable energy sources such as solar etc. with a weight of two (2), use of motion and daylight sensors with a weight of two (2) and daylight & natural ventilation optimization with a weight of one (1).

Materials resources efficiency is the fourth category considered, this targets the consumption of resources through selection and reuse of materials, and efficient management practices. Material efficiency has eight (8) criteria which comprises of application of environmentally friendly construction methods/materials with weight of three (3), locally sourced materials with a weight of two (2), built-in furniture with a weight of one (1), installation of recycling containers, & installation of food waste containers with weighting value of two (2) each, the rest of the criteria are reuse-nonstructural elements & reuse-structural elements with one (1) each weighting value, the use of recycled-content materials with two (2) weighting value.

The fifth is water efficiency which addresses the reduction of potable water consumption, and encourages the use of recycled and rain water. This has five (5) criteria which comprise of water efficient landscaping, water use reduction, installation of storm water reuse systems, installation of gray water reuse systems, and rain water harvesting with each having a weighting value of one (1). The sixth category concentrates on carbon emissions reduction, this addresses the negative emissions from development to the atmosphere, watercourses and local ecosystems. This has only one (1) criterion with a weighting value of three (3).

The seventh category is maintenance/innovation/management which will ensure that sustainable development principles from project conception through design, construction, commissioning, tuning and operation are met. This comprises of waste management and reduction planning with a weight of one (1), health and safety management planning, provision of a building manager's manual, provision of an occupant's operations and maintenance manual with zero-point-five (0.5) weighting value.

Ecological environment is the eighth category, it defines the greening and the landscaping of the surrounding environment of the building. It has four criteria which comprises of consistent green space in the complex with weight of two (2), application of planned landscaping with a weight of one (1), improving the local ecological environment with a weight of one-point-five (1.5) and topsoil reuse with a weight of zero-point-five (0.5).

Last but not the least, indoor environmental quality (IEQ) addresses occupant health, comfort, and productivity issues in terms of thermal and cooling comfort, lighting systems and contaminants as well as pollution. The criteria for this category includes the use of low-emitting lighting and other materials which has a weight value of three (3), installation of controllability of thermal and cooling system with a weighting value of one (1), noise between floors, noise between walls, noise from outside prevention having a weighting value of zero-point-five (0.5) respectively, accessibility for the disabled and elderly with a weight of one (1) and lastly increased in natural ventilation with a weighting value of two-point-five (2.5). The above mentioned categories and their corresponding criteria as being able to adequately measure sustainability of buildings in Ghana. (GHGBC handbook 2011; Commey 2014; Bukari Braimah 2014 as cited by Ahmed et. al., 2014).

There is benchmark point (BMP) of three (3) for each category, so therefore the weighting value accrued by a project by the BMP will form the accrued points for the project. The total possible accrued point is one hundred and fifty (150) and a minimum accrued points for a certification is forty (40). A project is required to earn the minimum to attain a certification. Projects earning higher scores will be rewarded with different certification levels depending on the specific thresholds they reach. In all there will be four certification levels which will include “Bronze” (40-59 points), “Silver” (60-79 points), “Gold” (80 -105 points), and “Diamond” (106 – 150 points). To earn a certification, the applicant project must acquire the minimum points which shall be a combination of points from all the nine categories.

The weighting benchmarks factored in the prevailing conditions of the country, the most demanding are weighted with much more value, and for example because of energy inconsistency energy efficiency is weighted much higher. CIA fact book (n.d.)

as cited by Ahmed et al. (2014) opine that energy inconsistency has stalled the completion of many construction projects in Ghana. The report further stated that the country depends on hydroelectric power energy for 59.40% of its electricity production as such, recent droughts have created water shortages as well, resulting in sporadic electricity fluctuation throughout the country, affecting the timely completion of construction projects. Additionally, the construction industry in Ghana as observed by Ofori (2012) and Djokoto et al. (2014) performs poorly in minimizing their environmental impact. Construction activities are linked to excessive resource consumption causing land degradation, loss of habitats, air and water pollution and high-energy usage.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

A study of the data collected and the examination of the outcome revealed certain significant concerns. The focus of this chapter is to highlight the major findings that the study discovered. These findings are outlined in direct response to the objectives of the study. Also captured in this chapter are some recommendations made. Some of these findings and recommendations are presented below.

6.2 Summary of Findings

The study revealed that policies backing sustainable building construction in Ghana is inadequate and scattered around many departments and agencies, that the practice is likely to flourish to make the needed impact if it is backed by government in a centralized manner and there exist coordinated policy to guide the practice. Also it was revealed that sustainable practice can be fully embraced if the legislation backing it makes it mandatory for at least some forms of buildings especially in the city centers. It was also found that the absence of direction and uniformity in government strategy frameworks hinders the development of sustainable building constructions in the country.

On the challenges or limitations to sustainable building practices, it was observed that perception of higher initial cost and lack of government support and financial incentives in the industry were some of the challenges to sustainable practices. There were also mention of the inadequate learning and skills training as well as lack of experienced workforce and the lack of research interest on sustainable construction as some challenges in the industry, there is generally the lack of commitment by key stakeholders in the industry so therefore research interest on sustainability development is limited. The study also revealed that materials and technologies for sustainable construction practice is readily available in Ghana and that the practice is not hindered by that, but by disinterest by stakeholders.

The study further revealed that the rating tool used in Ghana (GS SA-GH-v1) or Green Star Eco Homes is the adopted version from Green Star Australia (GS A-v1) which was designed for South Africa known as the Green Star South Africa (GS SA-v1). From the study it observed that most of the practitioners who responded did not know the exact name and functions of the existing rating tool used in Ghana. Most of them cited its complexity and the fact that it wasn't designed for the use in the conditions of Ghana as the reason of its inefficient and ineffectiveness. The rating tool apply in Ghana for assessment should be amended or modified to reflect prevailing conditions in Ghana was suggested by the respondents.

Lastly the "Green Rating & Measurement System for Ghana" (GRMSG) was proposed to be employed for the use in Ghana, this tool's development was based on careful scrutiny of four (4) major rating tools used globally. This was done by comparing their purposes and categories and measuring criteria, strength and weakness as well as points build ups methodologies.

6.3 Conclusion

In general, the study concludes among other things that policies on sustainable construction practices in Ghana is inadequate and has been scattered in several governmental departments and agencies making it very difficult for effective monitoring and supervision.

It further concludes that the perception of high initial cost as well as lack of governmental support and incentive, learning and skills training and proficient workforce are the biggest challenges facing sustainable construction practice in Ghana.

The study also concludes that the rating tool currently in use in Ghana does not precisely measure sustainability status of buildings due to difference in energy, water, source of construction materials etc. requirements in Ghana and the country of its origin.

Finally, the study concludes with the development of a rating tool for Ghana, known as the Green Assess & Measurement System for Ghana (GAMS).

6.4 Recommendations

The following recommendations have been made based on the findings and conclusions drawn as well as the discussions of the study.

1. It is recommended that the existing policy guiding sustainable practice in Ghana should be amended and centralized in a single body for effective monitoring and supervision.

2. It is also recommended that the Ghana Green Building Council should be embraced by the government and well-resourced so it can carry out its mandate more effectively by educating the populace about the benefits of green buildings.
3. To increase the awareness of sustainable practice, buildings that acquire certification should be published on the building.
4. It is again recommended that professional programs should be run at the universities on sustainable construction practice so as to equip professionals in the industry with the requisite knowledge.
5. It is further recommended that the existing adopted tool for rating sustainability status in Ghana should be amended to reflect the prevailing conditions in the country.
6. The Green Rating & Measurement System for Ghana (GRMSG) developed in this study is recommended to be adopted and trial to ascertain its efficiency and effectiveness in Ghana.

6.4.1 Recommendations for Future Research Work

For future research to increase knowledge and awareness of sustainable practice in Ghana, the following recommendations have been proposed;

1. The overall environmental, social and economic benefits of sustainable buildings as compared to conventional buildings in Ghana.
2. How a reliable, harmonized and effective government policy can enhance the delivery of sustainable buildings in Ghana.
3. Future research work can broaden the scope to all ten regions of Ghana.

4. It is also recommended for future studies to focus on the impacts of green rated or certified buildings on clients or end users in Ghana.

6.5 Limitations

Some limitations of the research deserve mention so that the study can be interpreted within its constraints. The research considers professionals located in only four regions in the country due to time restriction. It was also almost impossible to get direct access to the relevant professionals for responses. More time could have allowed for more extensive work on the current state of sustainable building practice in Ghana, paying particularly attention to the rating and certification of buildings.

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APPENDICES

APPENDIX I: RESEARCH QUESTIONNAIRE

DEPARTMENT OF CONSTRUCTION AND WOOD TECHNOLOGY

EDUCATION COLLEGE OF TECHNICAL EDUCATION

UNIVERSITY OF EDUCATION, WINNEBA-KUMASI

This research is being undertaken in partial fulfillment of the requirements for the awards of Master of Philosophy in Construction Technology by the University of Education, Winneba-Kumasi Campus. The author is an MPhil student offering Construction Technology at the Department of Construction and Wood Technology Education at the University of Education, Winneba-Kumasi.

Please note that responses given will be made confidential and be used strictly for academic purposes. For the sake of anonymity, please do not include your name and address, endeavor to answer all questions and ensure to offer honest and candid responses.

Please, answer the questions that follow by ticking the appropriate option (if provided) or writing unrestrictedly for open-ended questions. Please answer all questions freely but objectively.

SECTION A
Personal Information

Please tick (√) where appropriate

1. Please indicate your Gender
   a) Male [ ]
   b) Female [ ]

2. What is your highest level of education?
   a) Bachelor's Degree [ ]
   b) Master's Degree [ ]
   c) PhD [ ]
   d) Others [ ] (Please specify) ……………

3. How long have you been working as an Architect or Quantity Surveyor or Construction Manager/Engineer?
   a) A year and below [ ]
   b) 2-5years [ ]
   c) 6-10 years [ ]
   d) above 10 years [ ]

4. Which of the following professional bodies are you affiliated?
   a) Ghana Institute of Architects (GIA) [ ]
   b) Ghana Institution of Surveyors (GhIS) [ ]
   c) Ghana Institute of Engineers (GhIE) [ ]
   d) Others [ ] (Please specify): ……………

5. How many Sustainable Buildings/Structures have you worked on?
   a) 1 – 10 [ ]
   b) 11 – 20 [ ]
   c) 21 – 30 [ ]
   d) more than 30 [ ]

6. Which region do you mostly practice?

   ………………………………………………………………………………………

SECTION B

Please indicate your response by ticking (√) the option which best describes government policies on sustainable development in Ghana on the scale below, ranging from "strongly disagree" to "strongly agree".

Strongly Disagree	Disagree	Agree	Strongly Disagree
1	2	3	4

7	Sustainable development is solely depended on Government policies to flourish	1	2	3	4
8	The policies on sustainable development in Ghana encourages sustainable practice	1	2	3	4
9	Government policies on sustainable development is adequately sufficient in building sustainable in Ghana	1	2	3	4
10	There is the need for amendments of existing policies or more policies should be formulated for the industry	1	2	3	4
11	Government policies should be obligatory to industry players	1	2	3	4
12	Co-ordinations of policies and regulations should be centralized in one body	1	2	3	4
13	Policies and guidelines to be formulated should apply to only new buildings to be constructed	1	2	3	4
14	Policies on sustainable construction should apply to all kinds of structural development	1	2	3	3
15	Policies on sustainable construction should factor in all forms of sustainability (Environmental, Economic and Social Dimensions)	1	2	3	4
16	We need a policy to propose that criteria for choosing Architects, Quantity Surveyors, Construction Managers, and Construction Consultants shall include demonstrated knowledge of green building practices	1	2	3	4

SECTION C

Kindly indicate your response by ticking (√) the option which best describes your opinion the Challenges and Limitations that building practitioners face in applying building sustainability modules in Ghana on the scale below, ranging from "strongly disagree" to "strongly agree".

Strongly Disagree	Disagree	Agree	Strongly Disagree
1	2	3	4

17	The initial and operational cost of sustainable buildings are very high as compare to the conventional buildings	1	2	3	4
18	Sustainable buildings do not ensure value for money	1	2	3	4
19	Professionals in the Ghanaian industry are not well versed with sustainable building practices	1	2	3	4
20	Materials and Technologies know-how are not readily available in Ghana	1	2	3	4
21	Commitment level of stakeholders in the industry is very minimal (Building owners, Construction professionals, Government)	1	2	3	4
22	Learning and Skills training on sustainable construction is inadequate in the country	1	2	3	4
23	Buildings that attain sustainable certification should be embossed with the certificate to encourage other building owners	1	2	3	4
24	There is no clear and consistent guidelines or framework for measuring sustainable construction	1	2	3	3
25	Not enough research has been carried out on sustainable development to ascertain its viability and practicality in Ghana	1	2	3	4
26	There is lack of Government support and financial incentives in the industry	1	2	3	4

SECTION D

Sustainable Assessment tools used in Ghana

27. Do you know any tool used for sustainable building assessment in Ghana?

a) Yes [ ]
c) No [ ]

28. If "Yes" Kindly Names it…………………………………………………….

Please indicate your response by ticking (√) the option which best describes your opinion on Sustainable assessment tools used in Ghana on the scale below, ranging from "strongly disagree" to "strongly agree".

Strongly Disagree	Disagree	Agree	Strongly Disagree
1	2	3	4

29	The tool used in assessing the sustainability of buildings in Ghana is very efficient and effective	1	2	3	4
30	The tool used in assessing the sustainability of buildings in Ghana needs to be updated or changed	1	2	3	4
31	Using a single tool to rate all kinds of buildings is appropriate	1	2	3	4
32	The tool used to assess sustainability of buildings in Ghana considers all aspects of sustainability i.e. Environmental, Economic and Social dimensions	1	2	3	4
33	A rating tool for office and commercial buildings should be different from the rating tool for a residential facility	1	2	3	4
34	The rating criteria for office and commercial buildings should be different from the rating of residential facility	1	2	3	4
35	Measuring sustainability is relatively new in Ghana and so there is a lack of commonly accepted standard.	1	2	3	4

36	The tool used in assessing the sustainability of buildings in Ghana is very easy and simple to understand	1	2	3	3
37	There is lack of assessment of building performance during operating stage with the current assessment tool used in Ghana	1	2	3	4
38	The assessment tool focuses on social aspects of sustainability such as stakeholder engagement; health and safety performance	1	2	3	4
39	The assessment tool used in Ghana should be should or can be modified to reflect conditions in Ghana	1	2	3	4

SECTION E

Sustainable assessment tools used globally

40. Do you know of any tool used for sustainable building assessment in globally?

a) Yes [ ]

d) No [ ]

41. If "Yes" Kindly Name them

a)……………………………………………………………………………………

b) …………………………………………………………………………………..

c)……………………………………………………………………………………

d) …………………………………………………………………………………..

e) ……………………………………………………………...……………………

42. In your view, which of the above mentioned tools gives more credit in its assessment

…………………………………………………………………………………

Please give reasons ……………………………….……………………………

……………………………………….………………………………………….

43. In your opinion, which of the above mentioned tool is the most efficient and effective in measuring sustainability…………………………………………….. ………………………………………………………………………………………

Please give reasons…………………………………………………………………

………………………………………………………………………………………

44. In your estimation, which of the above mentioned tool is the most reliable in measuring sustainability……………………………………….…………………….

Please give reasons…………………………………………………………………..

………………………………………………………………………………………

45. Which of the assessment tool in your view is the most complex and difficult to understand……………………………………………………………………………

Please give reasons…………………………………………………………………..

………………………………………………………………………………………

46. Which of the assessment tool in your view is the easiest and simpler to understand

………………………………………………………………………………………

………………………………………………………………………………………

Please give reasons…………………………………………………………………

………………………………………………………………………………………

47. Which of the assessment tool used globally will you use when working on sustainable building? ……………………………………………...…………..

………………………………………………………………………………………

Please give reasons…………………………………………………………………

……………………………………………………………………………………..

APPENDIX II: CATEGORIES AND CRITERIA AS SHORTLISTED FOR INTERVIEW

Serial Number	Criterion Number	Details	Source
		Land Development (LD)	
1	**LD_1**	Ecological Value of Site	GBCS
2	**LD_2**	Preservation of Existing Natural Resources	
3	**LD_3**	Interference with Daylight to Adjacent Properties	
4	**LD_4**	Provision of Community Center and/or Facilities	
		Transportation (T)	
5	**T_1**	Accessibility to Public Transportation	
6	**T_2**	Installation of Bicycle Racks And Roads	
7	**T_3**	Easy Accessibility to City centers	
		Energy Efficiency (EE)	
8	**EE_1**	Reduction of Annual Energy Consumption	
9	**EE_2**	Use of Alternative renewable Energy Sources such as solar etc.	
10	**EE_3**	Use of motion and daylight sensors	
11	**EE_4**	Daylight & natural ventilation	
		Material Efficiency (ME)	
12	**ME_1**	Application of Environmentally Friendly Construction Methods/Materials	
13	**ME_2**	Locally sourced materials	
14	**ME_3**	Built-In Furniture	
15	**ME_4**	Installation of Recycling Containers	
16	**ME_5**	Installation of Food Waste Containers	

17	**ME_6**	Reuse-Nonstructural Elements	
18	**ME_7**	Use of Recycled-Content Materials	
19	**ME_8**	Reuse-Structural Elements	
Water Efficiency (WE)			
20	**WE_1**	Water Efficient Landscaping	
21	**WE_2**	Water Use Reduction	
22	**WE_3**	Installation of Storm water Reuse Systems	
23	**WE_4**	Installation of Gray water Reuse Systems	
24	**WE_5**	Rain water harvesting	
Atmosphere/Emissions (E)			
25	**E_1**	Reduction of CO_2 Emissions	
Maintenance/Innovation/Management (M)			
26	**M_1**	Waste Management and Reduction Planning	
27	**M_2**	Health and safety management planning	
28	**M_3**	Provision of a Building Manager's Manual	
29	**M_4**	Provision of an Occupant's Operations and Maintenance Manual	
Ecological Environment (Eco)			
30	**Eco_1**	Consistent Green Space in the Complex	
31	**Eco_2**	Application of Planned Landscaping	
32	**Eco_3**	Improving the Local Ecological Environment	
33	**Eco_4**	Topsoil Reuse	
Indoor Environmental Quality (IEQ)			
34	**IEQ_1**	Use of Low-Emitting Materials	
35	**IEQ_2**	Installation and Controllability of thermal and cooling System	

36	**IEQ_3**	Noise Between Floors prevention	
37	**IEQ_4**	Noise Between Walls prevention	
38	**IEQ_5**	Noise from Outside prevention	
39	**IEQ_6**	Accessibility for The Disabled and Elderly	
40	**IEQ_7**	Increased natural Ventilation	

APPENDIX III: THE AHP COMPARISON SCALE

Value	Meaning		Importance
1	Equal		
2	Between equal and moderate		
3	Moderate		
4	Between moderate and strong		
5	Strong		
6	Between strong and very strong		
7	Very strong		
8	Between very strong and extreme		
9	Extreme		

Appendix IV: Reliability Statistics

Scale: Policies on Sustainable Development in Ghana

Case Processing Summary

		N	%
Cases	Valid	15	100.0
	Excluded[a]	0	.0
	Total	15	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.783	10

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
30.1333	6.552	2.55976	10

Scale: Challenges or Limitations of Sustainable Development in Ghana

Case Processing Summary

		N	%
Cases	Valid	15	100.0
	Excluded[a]	0	.0
	Total	15	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.817	10

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
27.0667	13.924	3.73146	10

Scale: Sustainable Development rating tool in use in Ghana

Case Processing Summary

		N	%
Cases	Valid	15	100.0
	Excluded[a]	0	.0
	Total	15	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.712	13

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
34.4667	7.838	2.79966	13