

**INVESTIGATING KNOWLEDGE AND AWARENESS LEVEL OF
SUSTAINABLE CONSTRUCTION PRACTICES ON UNIVERSITY
CAMPUSES IN GHANA**

By
KNUST

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DECLARATION

I hereby declare that this thesis is my own work towards the award of MSc Construction Management, and that to the best of my knowledge does not contain materials that have been published or presented wholly or partially to this University or elsewhere except where due acknowledgement has been made.

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ABSTRACT

The principle of sustainability is rooted in the objective that the community or society should consume resources available in the environment in a steady way that will still make it readily available for future generations to use. This notion is important to ensure the aim of sustainable construction is achieved in the construction industry. The stumbling block of awareness and knowledge must first be eliminated before a capable and viable sustainable construction is achieved. This study therefore aimed at investigating the awareness and knowledge level of construction professionals in Universities in Ghana. To achieve this, a quantitative cross-section approach was adopted. A structured questionnaire was administered as the tool for collecting data for analysis. The technique for the data analysis was descriptive in nature focusing mainly on mean scores, standard errors and percentages. This study has brought to light that 70% of construction stakeholders in public universities indicated that they had high awareness, with majority (64%) of the respondents indicated that they had high knowledge on sustainable construction. The findings of the study revealed that high percentage of the respondents had heard about sustainability and had high knowledge of the sustainable concept. The commonest sustainable construction practices according to the respondents were, using alternative energy supplies (such as solar) and installing water efficient fixtures. Respondents were however not familiar with some of the practices considered in achieving sustainable construction. It is recommended for the continual education of professionals in charge of construction activities in the various universities on the concept and practices of sustainability and sustainable construction.

Keyword; Knowledge and Awareness, sustainable construction practices, Campuses

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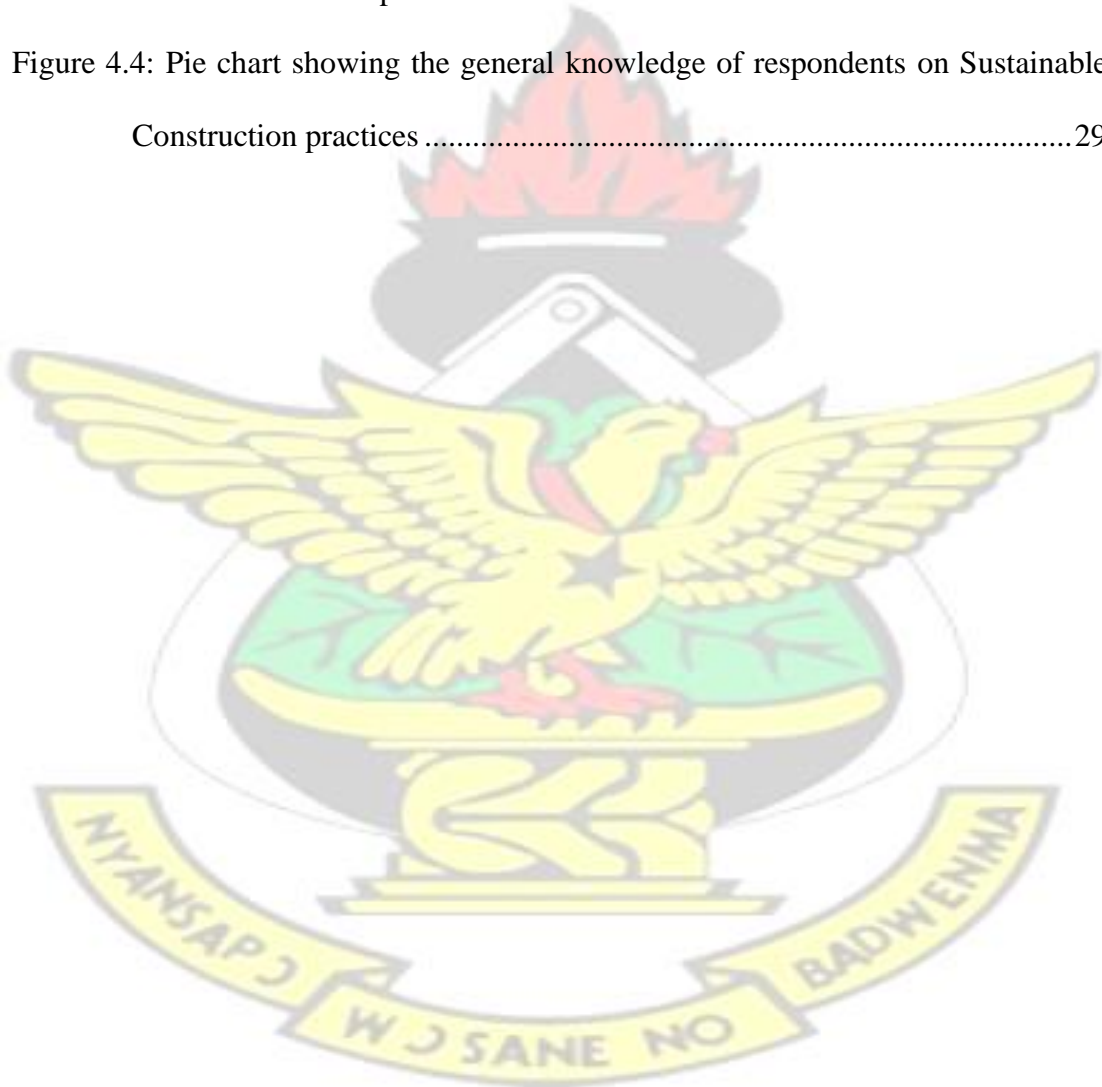
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LIST OF ABBREVIATIONS

VOC Volatile Organic Compounds

PM Project Manager

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DEDICATION

I dedicate this work to the Almighty GOD and the entire Owusu-Mensah family for their continuous support and encouragement. To all loved ones who supported one way or the other. I say a big thank you to you all.

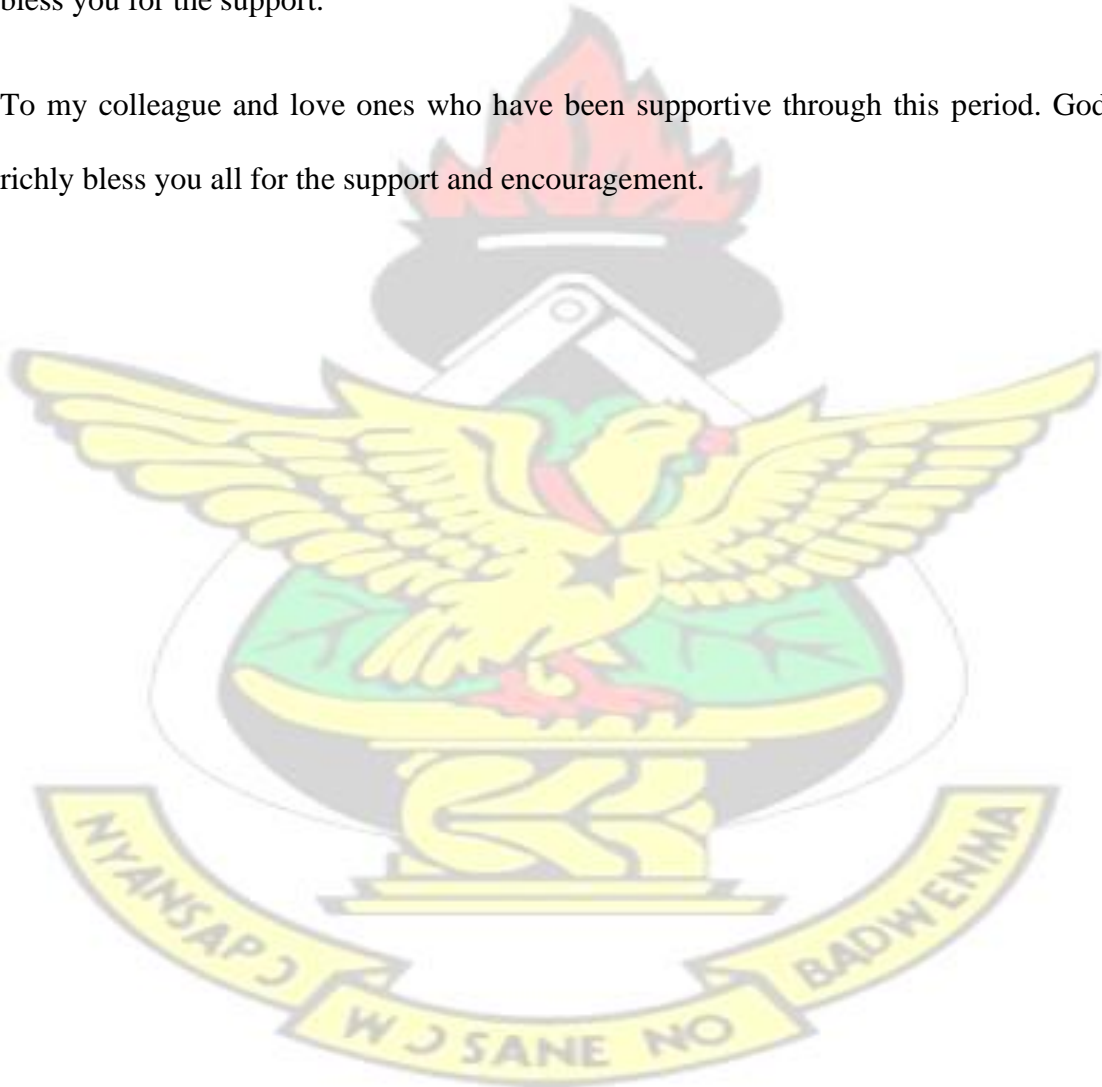
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CHAPTER ONE

INTRODUCTION

1.1 Background

The idea of sustainable construction still remains an emerging topic that seeks to integrate the principles of sustainability in contemporary practice of the construction industry (UNEP, 2002). It is widely accepted in recent times that sustainability cannot be accomplished in isolation but must involve all the stakeholders in the supply chain of the industry (Petersen, Ragatz & Monczka, 2005; Varsei *et al.*, 2014).

The principle of sustainability is rooted in the objective that the community or society should consume resources available in the environment in a steady way that will still make it readily available for future generations to use. This notion is important to ensure the aim of sustainable construction is achieved in the construction industry (World Commission on Environment and Developments, 1987).

The construction industry forms important part of the economic sector of every country because of its provision of infrastructures, this implies that the construction industry has an indirect impact on all other industries through the array of demand and supply (Halliday, 2008), this patterns of demand and supply may lead to expansion of construction industries which comes with a number of sustainable development challenges (Pero *et al.*, 2017).

These construction industry challenges and their impact on the environment are obvious, for instance during the construction and use of buildings, various waste are produced that destabilize and pollute the natural environment (Albino and Berardi,

2012). These natural environments may include our water bodies, land, air, which are very essential for the survival of all living things including humans.

According to Chu (2016), construction materials are manufactured through the consumption of large quantity of natural sources and energy. A usual instance is the Portland cement, which is produced from a natural resource such as limestone and high amount of energy. This is not sustainable since it requires continuous depletion of the resources in the environment.

The production of cement is known to produce environmentally unfriendly toxic substances such as carbon dioxide and dust which are key components in the pollution of the air (Chu, 2016). The cutting down of trees to provide wood for construction has also been linked to increase in the production of carbon dioxide in the atmosphere and subsequently may lead to various respiratory diseases among living organisms.

Even though, sustainable construction has received much recognition among customers, contractors, consultants, researchers, social enterprises, governmental regulatory bodies in countries such as United Kingdom, United States, New Zealand and other developed others (Bond and Perrett, 2012; Upstill-Goddard *et al.*, 2016), the situation is different in developing countries such as Nigeria (Dania, Larsen and Ewart, 2014).

In a recent study by Daniel, Oshineye, & Oshodi, (2018) in Nigeria, some bottlenecks were associated with the unpopular conception of sustainable constructions. They identified some of these barriers as lack of knowledge, experts, tactics, and demands

in the field. It was also identified the culture of short terms being considered over the issues of cost and the idea of sustainable construction in the industry.

Experts in the field of sustainable construction who are conversant with the concept are therefore needed in the drive of calling for sustainable construction and consequently sustainable development. These experts may include some stakeholders, researchers and consultants in the building construction industry, these same professionals are sometimes employed either permanently or part time by public universities for their building construction projects.

This study therefore seeks to ascertain the level of awareness and knowledge of sustainable construction among these professionals or key stakeholders contracted by public universities and also identifies practices of sustainable construction that are implemented by them in the course of discharging their duties such as erecting of a building facility right from the materials used to the completion of such projects.

1.2 Problem Statement

Many substantial changes in the construction industry seeks to promote construction activities that makes little or no use of the resources in the ecosystem, this has led to the ability of the environment to support the essentials of the current generations without compromising the anticipated needs of future generations, these developments have been made possible through the concept of sustainable construction (Kibert, 2008).

Although, the challenges of construction industries to a large extent have been addressed by the recent call for sustainable construction in high-income countries (Bond and Perrett, 2012; Upstill-Goddard *et al.*, 2016), the story is, however, different

in low-income countries such as Nigeria and Ghana (Dania, Larsen and Ewart, 2014) where barriers to sustainable construction such as lack of experts, demand and tactics of sustainable construction are dominant (Daniel, Oshineye and Oshodi, 2018).

In addition, numerous reasons have been associated with unnoticeable concept of sustainable construction in African Countries which includes lack of knowledge and awareness about the subject among key stakeholders. In a recent study conducted in Ghana, only 3% and 2% of respondents indicated their level of awareness and knowledge was good and excellent respectively (Ametepey and Aigbavboa, 2014).

Furthermore, this lack of knowledge has led to a gap in development between developed and underdeveloped countries. This can be seen in the frequent collapse of buildings in developing countries (Olajumoke *et al.*, 2009) the frequent pollution of the environment through construction materials, depletion of our natural resources and the inability of the ecosystem to support present and future generations (Chu, 2016).

1.3 Aim and Objectives

1.1.1 Aim

To determine level of knowledge and awareness of sustainable construction practices among stakeholders on university campuses in Ghana.

1.3.2 Objectives

- 1 To ascertain the level of awareness on sustainable construction concept among stakeholders in universities in Ghana.
2. To assess the level of knowledge on sustainable construction practices among stakeholders in universities in Ghana.
3. To suggest effective methods for achieving sustainable construction among stakeholders in universities in Ghana.

1.4 Research Questions

1. What is the level of awareness of sustainable construction concept among stakeholders in universities in Ghana?
2. What is the level of knowledge of sustainable construction practices among stakeholders in universities in Ghana?
3. What are the effective methods to consider in achieving sustainable construction among stakeholders in universities in Ghana?

1.5 Significance

The concept of sustainable construction appears to be popular among developed countries compared to developing countries especially nations in the African continent (Bond and Perrett, 2012; Upstill-Goddard *et al.*, 2016). This has been linked to many barriers such as awareness, knowledge and expertise about the subject among stakeholders in low and middle income countries (Dania, Larsen and Ewart, 2014; Ametepey, Gyadu-asiedu and Assah-kissiedu, 2015).

The call for sustainable development and for that matter, sustainable construction has become an imperative topic for discussion since it is a sure way to reduce the

emission of greenhouse gases, conservation of natural resources and support efficient use of energy resources which subsequently reduces the impact of construction industry in our environment, so that the planet can cater for the needs of the present and future generation (Ofori, 2001).

Most Studies conducted in developing countries have focused on barriers and implementation of sustainable construction (Dania, Larsen and Ewart, 2014; Djokoto, Dadzie and Chemang-Ababio, 2014; Oni, 2015), while a few also focused on the knowledge of the subject matter (Ofori, 2001; Obia and Obot, 2016). This present study therefore seeks to ascertain the level of knowledge and awareness on the concept and practices of sustainability and sustainable construction by construction professionals/developers employed by universities in Ghana to undertake construction projects.

1.6 Scope of the Study

This research was determined to predict the level of knowledge and awareness of construction professionals/developers who are usually employed by universities in Ghana. The study also looked out for the level of understanding of the concept and practices of sustainable construction that are being implemented by these experts in the construction and building of projects on universities campuses. At the end, based on the findings of the project, it was to be used to create awareness of sustainability and sustainable construction as well as promoting the concept and practices.

1.7 Summary of methodology

A cross-sectional survey study design was employed to recruit participants from some selected public universities in Ghana. A close-ended structured questionnaire was used to gather information from participants. This information included demographic characteristics of respondents, level of knowledge, awareness and practices of sustainable construction. The data was cleaned and entered into Microsoft Excel and then analyzed with the Statistical software Stata.

1.8 Limitations

The study was not be able to incorporate construction professionals from all Universities in Ghana, Also the time frame of the study did not allow all stakeholders especially contractors, developers and consultants who are contracted on projects of the universities to be included which means only professionals who are employed to work at the various development offices of the Universities, from inception stage to the completion were considered.

1.9 Structure of the study

The write up of the study was organized into five chapters. The first chapter gives an introduction to the study which includes background, problem statement, study objectives, research questions, methodology, justification and organization of write up for the study. The second chapter reviewed literature on the awareness, knowledge, principles and practices of sustainable construction. The next chapter dealt with the methods and materials employed in carrying out the study, the chapter four presented results of the analyzed data and information gathering during the data collection stages as well as discussion of the results as compared to other studies. The final

chapter was then used to conclude the study by summarizing significant findings and making the necessary recommendations.

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CHAPTER TWO

LITERATURE REVIEW

2.1 Sustainability concept

The ability of the earth to support and absorb the impact of human activities for a life time is not guaranteed and this development has gained an increased recognition among both developed and developing countries. It has been observed in the high consumption of the earth natural resources beyond repair. This has initiated the debate on sustainability across the globe (Sev, 2009).

The idea of sustainability incorporates the interactions, integrations and substantial relations among the ecological, social and economic systems in the biosphere (Hutchins and Sutherland, 2008; Tam, 2008). Sustainability can be defined as meeting the fundamental needs of the community and creating opportunities for a better life without compromising the capacity to meet the needs of future generations (World Commission on Environment and Developments, 1987).

2.2 Dimensions of sustainability

Sustainability has been grouped and identified in three main dimensions, namely; social, economic and environment (Pitt *et al.*, 2009; Ikediashi, Ogunlana and Ujene, 2014). Environmental sustainability concerns how the rate of population, energy consumption and technology can impact on our environment. These effects can be negative or positive. Nevertheless, in sustainability we expect this impact to be a good one and serve both the present and future generations. Economic sustainability is also defined as the extent to which an organization can gather its resources to support the socio-economic well-being of its immediate surroundings and beyond (Ikediashi,

Ogunlana and Ujene, 2014). This can be experienced through education, employment, provision of social amenities. Social sustainability is seen as the impacts of buildings and infrastructure on the rights and privileges, health and societal needs of the people. However, these dimensions of sustainability can be viewed together based on the project one may be undertaking. For instance, sustainable environment is essential to achieve a balanced socio-economic system (Morelli, 2011) and therefore it is necessary to treat them together when considering sustainability in every project under consideration.

2.3 Concept of sustainable construction

Sustainable construction (SC) forms part of the agenda of broad concept of sustainable development where both social and economic growth are pooled for effective protection of the environment and cautious use of available resources. The goals of concept of sustainability are achieved through three main routes, namely; (1) economic sustainability, (2) environmental sustainability and (3) social sustainability (Sev, 2009).

1. **Economic sustainability:** the area of sustainable construction that maximizes profit by making efficient use of resources that may include materials, water, energy and labor (Vanegas and Pearce, 2016). Aspects of environmental sustainability includes; development on environmentally appropriate area, maintenance of biodiversity and ecology of life, conservation of building water and cooling power consumption, usage of effective energy source with low environmental effects, provision of clean and healthy environment, usage of products and materials that can be recycled or biodegradable.

2. Environmental sustainability: is the prevention of potentially irreversible harmful effects on the environment or surroundings by careful use of natural resources, reducing production of waste, protecting and enhancing safety of the environment. This area also consists of usage of materials from recycled sources, locally manufactured material, durable materials, implementation of cost-effective measures, designs to attract investors, design for less material usage.
3. Social sustainability: this type of sustainability responds to the needs and involvement of the people in the construction process – commissioning to demolition. It also addresses customer satisfaction and working closely with suppliers, employees, local communities and clients. This comprises of respect for people and local environment, consideration of occupant health and safety, analysis of building density in an area, minimizing pollution.

Sustainable construction has become an important subject since it has become vivid that the industry is of high economic significance and its impact on the environment and society is enormous (Burgan and Sansom, 2006; Sev, 2009).

The notion of sustainable construction is about the construction industry contributing to better-quality environment and an advanced society while at the same time attaining reasonable returns and economic gains in the industry (Vachon and Mao, 2008; Hueting, 2009). In a simple standpoint, sustainable construction is a process of executing good construction projects for both domestic and commercial purposes without destroying or misusing the resources in the ecosystem (Ruggieri *et al.*, 2009).

The construction industry produces huge amount of wastes that ranges from 15 to 50% depending on the province of the world (Roberts, 1994). A typical initiative of

sustainable construction may include recycling huge wastes that are produced in the process of manufacturing construction materials. This particular initiative will be beneficial to both the construction industry and the environment – less wastes will be deposited in the environment while cost of construction materials will be reduced. This will consequently result in cost reduction of construction projects (Tam and Tam, 2006; Asokan and Osmani, 2009).

The issue of sustainable construction has been linked with corporate social responsibility of the industry to their immediate communities, this is because these responsibilities are mostly related to the environment, society and the economy and also serves as a driving force for achieving sustainable construction (Hutchins and Sutherland, 2008). The implementation of sustainable construction practice will then come into play if the environment, society and the economy are given equal attention and this can be achieved by promoting sustainability in the construction industry (Shen *et al.*, 2010).

Sustainable construction is usually explained as an environmental oriented idea and this has often trigger implementation conflicts between long-term environmental gains and short-term economic operational goals in the construction industry (Lilja, 2009). These consequences result because protection of the environment requires a long-term plan which is always likely to impede economic gains, besides, investors also want their returns within a short period after they are invested in numerous areas which may include also include construction industry.

2.4 Principles of sustainable construction

Sustainable construction in other terms is the application of the principles of sustainable development to the construction industry through the various stages that

includes; manufacturing of raw materials, planning, designing, construction of buildings and infrastructure and finally the management of the resulting wastes (Pitt *et al.*, 2009).

Numerous efforts have been made on sustainable construction principles in an attempt to define the concept of sustainability into the construction industry. Sustainable construction principle concentrates on six thematic areas; 1) Minimizing resource consumption 2) Maximizing resource reuse 3) usage of renewable or recyclable resources 4) Protection of natural environment 5) Creation of a healthy, non-toxic environment and 6) Pursuance of quality in the creation of built environment (Kibert, 1994; Miyatake, 1996).

In 1997, Hill and Bowen, summarized the principles of sustainable construction and grouped them into four pillars; social, economic, environmental and technical principles, also accompanying these pillars are set of process oriented principles (Hill and Bowen, 1997). The principles of social pillar consist of improvement in quality of life, provision for social determination and cultural diversity, protection and protection of health through healthy and safe working environment. Economic pillar includes ensuring financial affordability, employment creation, adoption of full cost accounting, enhancement of completeness. Technical pillar also comprised of construction of durable, functional and quality infrastructure. (Holm, 2014)

With regards to DETR study, sustainable construction principles are profitability and competitiveness, customers and client's satisfaction and best value, fair treatment and respect for stakeholders, enhancement and protection of the natural environment and minimizing the impact on energy consumption and natural resources (DETR, 2000).

In recent times, sustainable construction principles was again regrouped into three main pillars; environmental protection, social well-being and economic prosperity (Shellbourn *et al.*, 2006). The environmental protection dwells on both the built and natural environment. The built environment are the activities that are carried during the construction projects itself and if they are not well handled, they might results in detrimental impacts on the environment whiles the natural environment deals with the extraction of the natural resources (Addis and Talbot, 2001). Social well-being also points out the human feelings, health, security, satisfaction, safety and comfort and human contributions such as skills, knowledge and motivation. The economic prosperity are the economic gains from the projects that are beneficial to customers, players in the industry as well as the government (Parkin, 2000; Lombardi, 2001). All classifications of sustainable construction seem to achieve the goal of bringing the social, economic and environment components to achieve sustainability.

2.5 Practices of sustainable construction

Many studies have classified practices of sustainable construction in different ways. However, different organizational features may lead to different choices in sustainable construction practices. Choice of sustainable practices are usually made after a clear sustainability strategy has been outlined. According to HMG (2008), sustainable construction practices can be viewed in five major areas namely; 1) compliance with sustainability legislation 2) design and procurement technology and innovation 3) organizational structure and process 4) education and training and 5) measurement and reporting.

Conformity with sustainable construction practice usually yield company profit. Though, better regulation will also create the correct balance between regulation and

environmental protection without exceedingly increasing cost. Sustainable procurement helps to provide greener supply chain system in which all materials and equipment are delivered in a green manner (Vanegas, 2003). Technology research and development also helps in improving the performance of sustainability (Miyatake, 1996). Organizational structures are also known to help to determine responsibilities, authority, lines of communication, process and resources needed to implement sustainable management systems (Hill and Bowen, 1997). Educating stakeholders on sustainability changes their thoughts on nature and keeps construction sustainable practices on course.

A process whereby organizations meet their needs for goods, services, works and utilities in a way that achieves value for money on a whole life basis in terms of generating benefits not only to the organization, but also to society and the economy, whilst minimizing damage to the environment (Rajeev and Hewage, 2015).

Sustainable construction practices should consider the environmental, social and economic consequences of design; manufacture and production methods; non-renewable material use; logistics; recycling options; operations; maintenance; reuse; suppliers capabilities and service delivery and disposal (Perera, Chowdhury and Goswami, 2007). A study by DTI (2006), outlined fundamental sustainable construction practices, namely: establishing effective construction programs, developing and supporting well focused and capable public sector clients; designing and decision-making based on 'whole-life value'; using the appropriate procurement and contracting strategies; working collaboratively with fully integrated teams; evaluating performance and embedding project learning. Some sustainable activities includes the following; protection of the environment, specify and use local materials

sourced, energy efficiency, using Alternative energy supplies (solar panels e.tc), install whole house ventilation systems, appropriately dispose of waste water on site, waste water management, conduct frequent materials audits, indoor Air quality control, waste management, install water efficient fixtures, water conservation/ efficiency using recycled content materials, use products or materials with recycled content, restore ecosystems native plants, use bio-based products or materials, minimize use of PVC based products or materials, use of low or no VOC emitting paints & adhesives.

2.6 Features of sustainable construction

Guiding principles of building construction are based on the concept of sustainability. According to Council on Environmental Quality (2016), these guiding principles are factors that considered in sustainable construction. These principles include employment of integrated design principles, optimization of energy performance, protection and conservation of water, enhancement of indoor environmental quality, reducing environmental impact of materials, assessment and consideration of climate change risks.

Sustainable construction is done in sustainable location, minimizes energy usage, implements life-cycle cost-effective renewable energy, tracks and continuously optimize energy performance, employ strategies that minimize water use and waste, purchases water conserving products, provides safe and healthy ventilation and thermal comfort, maximizes opportunities for daylighting in a regular occupied space, ensures optimal indoor air quality, uses materials and building supplies that have lesser or reduced effect on human health and the environment, incorporates appropriate space, equipment and finally assesses potential impacts and vulnerabilities

from both weather events and climate changes (Council on Environmental Quality, 2016).

2.7 Awareness and knowledge of sustainable construction

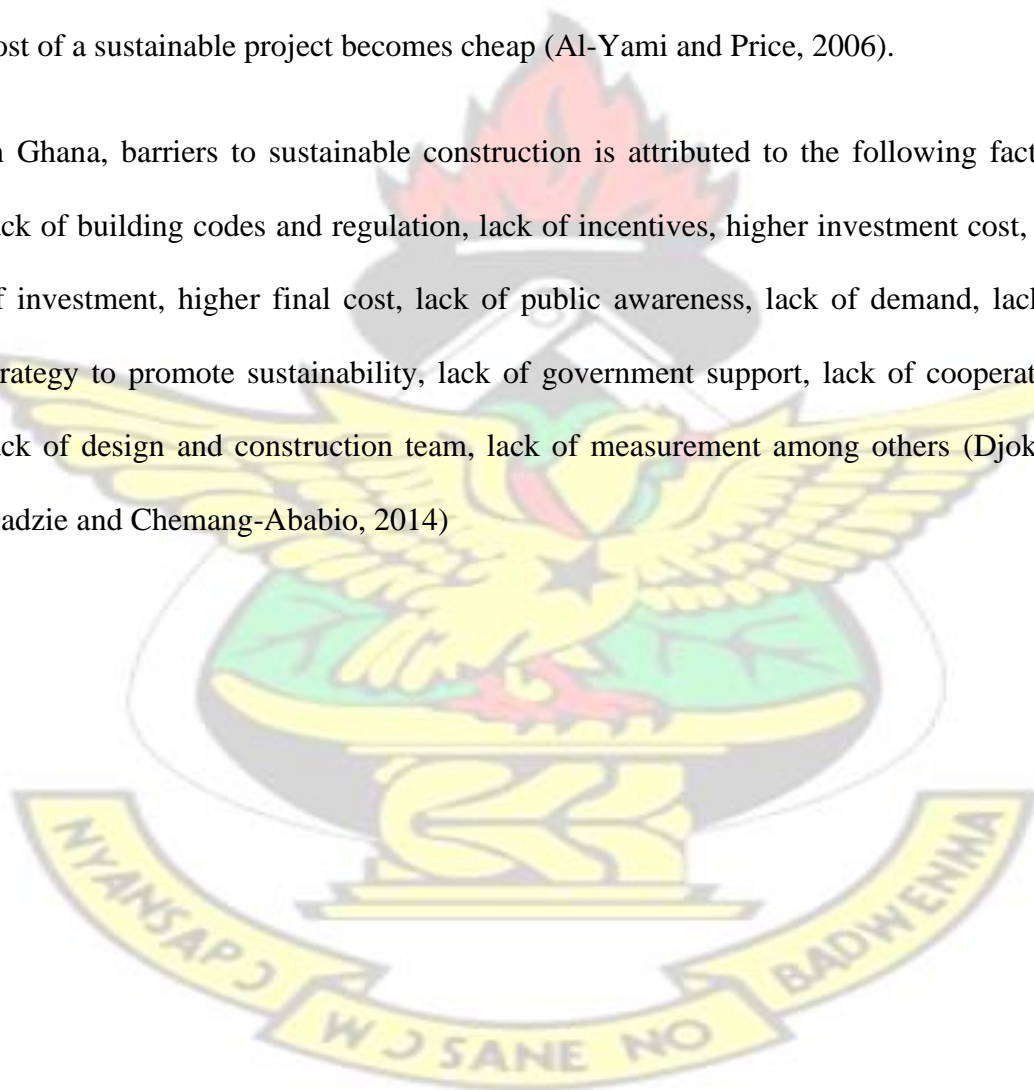
The awareness of sustainable construction appears is popular among developed countries compared to developing countries (Bond and Perrett, 2012; Upstill-Goddard *et al.*, 2016). A study in Ghana among practitioners with relatively high level of formal education showed awareness level of sustainable construction to be 83%. Majority, 71% of these participants got to know the concept through academic work (Ametepey and Aigbavboa, 2014). However, a study conducted among respondents in Kuwait showed a moderate level of awareness of sustainable construction. A similar study among polytechnic students showed that, 91 out of 100 people were aware construction sustainability issues (Zaki *et al.*, 2016).

2.8 Challenges to implementation of sustainable construction

The concept of sustainable construction is faced with many challenges as raised in different studies. The widespread agreement on sustainable construction does not translate into implementation (Ashley *et al.*, 2003). The notion of higher cost associated with sustainable construction is claimed as one of the major setbacks of implementing sustainable construction (Sodagar and Fieldson, 2008; Hakkinen and Belloni, 2011). However, another study outlined ignorance of sustainability economic benefits, and absence of right building regulations and planning policies as key challenges of sustainable construction (Zhou and Lowe, 2003). The ignorance and wrong perception reduce investors' interest in sustainable construction.

Williams & Dair (2007) identified some barriers such as perceived cost implications, insufficient experts in sustainable designs, lack of information of sustainability, lack of sustainable construction materials, insufficient capacity for executing sustainable construction projects and stakeholders' unwillingness to consider sustainability. The view of sustainable construction being expensive is not actually true. Cost is addressed with the acceptance of whole life cycle costing technique which make emphasis on long term perspective of cost rather the short and at the end the whole cost of a sustainable project becomes cheap (Al-Yami and Price, 2006).

In Ghana, barriers to sustainable construction is attributed to the following factors; lack of building codes and regulation, lack of incentives, higher investment cost, risk of investment, higher final cost, lack of public awareness, lack of demand, lack of strategy to promote sustainability, lack of government support, lack of cooperation, lack of design and construction team, lack of measurement among others (Djokoto, Dadzie and Chemang-Ababio, 2014)



CHAPTER THREE

METHODOLOGY

3.1 Introduction

According to (Oke *et al.*, 2019) the stumbling block of awareness and knowledge must first be conquered before a capable and viable sustainable construction can be created. There is therefore an absence of Ghanaian research into the areas of investigating awareness and knowledge of sustainable construction concepts and practices, hence the researcher aimed to carry out this study. Within this chapter, the researcher outlined and discussed the research design and the most appropriate sample selection, data collection procedure, data processing and analysis that were used.

3.2 Study Area

The study looked at some selected Public Universities in Ghana, namely; University of Health and Allied Sciences, University of Energy and Natural Resources, University of Education, Kwame Nkrumah University of Science and Technology and the University of Ghana.

The University of Ghana (UG) is the premier university in Ghana, established in 1948 in the then Gold Coast with currently over 40,000 students studying various courses. The UG is situated in Legon, a suburb of Accra, the capital of Ghana. The University has a physical development department responsible for all the construction, renovation, maintenance, etc. activities of the university.

The Kwame Nkrumah University of Science and Technology (KNUST) is another the premier university in Ghana, established around 1961 in the Kumasi municipality. It has a similar student population of around 40,000 students studying various courses. The KNUST is situated right at Ayigya a suburb of Kumasi in the Ashanti region of Ghana. The KNUST has a development office that is responsible for all projects from inception to the completion stage.

University of Education was established as a full University in 1992 in Winneba, a suburb in the central region of Ghana. It has a student population of around 60,000 in four satellite campuses, namely Winneba, Kumasi, Mampong and Ajumako campus. There is a works and physical development department who are in charge of construction and project delivery in the various campuses of the University.

University of Health and Allied Sciences (UHAS) and the University of Energy and Natural Resources are two the young universities in Ghana. Both established in 2012 with the sole focus on training students in the health and environmental related issues. Infrastructural development is growing at fast rate in these institutions. And it been supervised by the various development offices of the university.

3.3 Study Type/Design

A cross-sectional quantitative study was employed to collect data on investigating the knowledge and awareness level of sustainable construction practices on university campuses in Ghana among construction professionals employed by these Universities. A cross-sectional study was used because it has the advantages of proving and/or disproving assumptions, less costly to perform and due to the time at hand the most appropriate because it does not require a lot of time. It also captures multiple variables as a data snapshot at a specific point in time.

A pre-tested, self-administered, structured questionnaire was used to elicit information from stakeholders in the construction sector currently on a university project.

The study purposively censured all construction professionals in the five public universities in Ghana. This was done by sending all the professionals a mail explaining the study with google document attached for them to complete the questionnaire online.

3.4 Study population

The targeted population of the study were all the construction professionals from Project managers (PM), Architects, Engineers, Quantity Surveyors who were employed by these universities and were present during the study and working or had worked on a school project. These professionals were purposively used in the study due to their knowledge and expertise in construction and they are the stakeholders in the construction industry based on these university campuses.

3.4.1 Dependent variables

Knowledge level of sustainable construction practices

Awareness level of sustainable construction practices

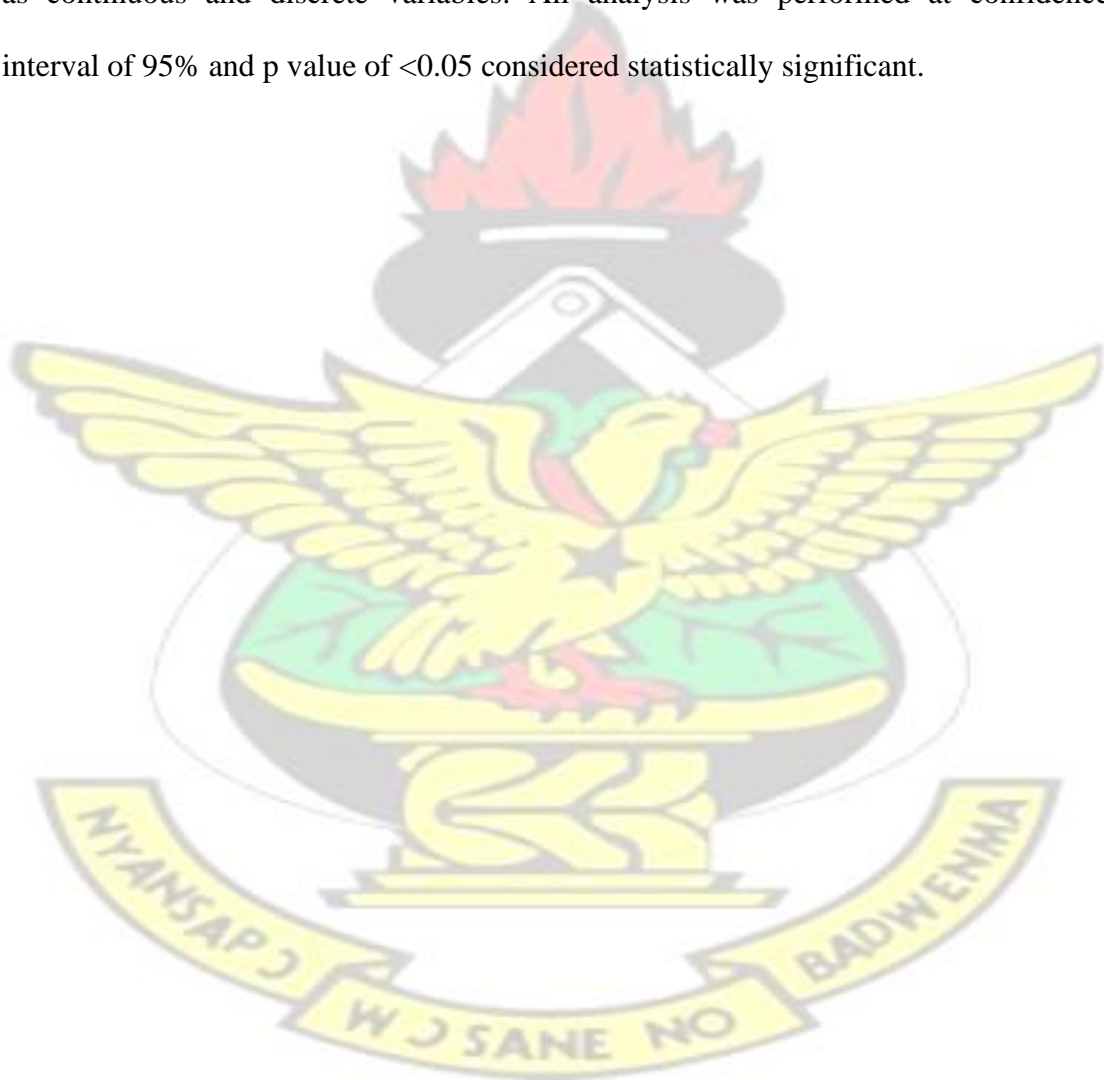
3.4.2 Independent variables

Socio-demographic characteristics such as Age, Academic qualification, Area of specialty, Years of experience in the current position, will be considered.

3.5 Data collection and analysis

The Data was collected using a questionnaire to illicit information from study participants since the study is a quantitative one and looks at the work from the angle of the professionals. The collected data was further coded and entered into SPSS version 23 software for data analysis.

Descriptive statistics such as frequencies, means, ranges and standard deviation were used to summarize data. Socio-demographic characteristics was analysed and grouped as continuous and discrete variables. All analysis was performed at confidence interval of 95% and p value of <0.05 considered statistically significant.



CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

Data was analyzed and discussed in the chapter. The analysis was done based on the objectives of the research under study. In discussing the result emerging out of the data, thoughts as stated by authorities in the literature review of the chapter two (2) were considered for purposes of collaborating or opposing the thoughts. The results as presented covered demographic characteristics of respondents, Respondents level of awareness of sustainable construction concepts, as well as the knowledge level of respondents.

4.2 RESULTS

4.2.1 *Scio-Demographic characteristics of Respondents*

A total of 50 respondents in five (5) public Universities participated in the study. The ages of participants ranged from 20years to 60years, with majority (74%) of them been in the age bracket of 20-40 years. Most respondents were Master's (40%) and bachelor's (34%) degree holders with Quantity Surveyors been the majority. It was observed that the respondent years of work experience in the construction industry one-year to over 20 years, with most of the respondents (24%) having work experience between 6-10 years.

Table 4.1: Demographic characteristics of Respondent

Variable	Frequency (50)	Percentage (%)
Age (years)		
20-40	37	74
41 - 60	13	26
Educational level		
Bachelor's Degree	17	34
Certificate	8	16
HND	5	10
Master's Degree	20	40
Area of specialty		
Architects	11	22
Building Technician	5	10
Engineer	6	12
Estate	4	8
Quantity Surveyor	20	40
Draughtsman	4	8
Institution		
KNUST	9	18
UEW	13	26
UENR	8	16
UG	11	22
UHAS	9	18
Years of experience		
1-5	11	22
11-15	10	20
16-20	9	18
6-10	12	24
Over 20	8	16

4.2.2 Respondents Awareness of issues in Sustainable Construction

Respondents were asked if they were aware of the general sustainable construction issues in the construction. It was observed that (92%) of the respondents were acquainted with the issues on sustainable construction in the construction industry while as the remaining (8%) were not aware of sustainable construction.

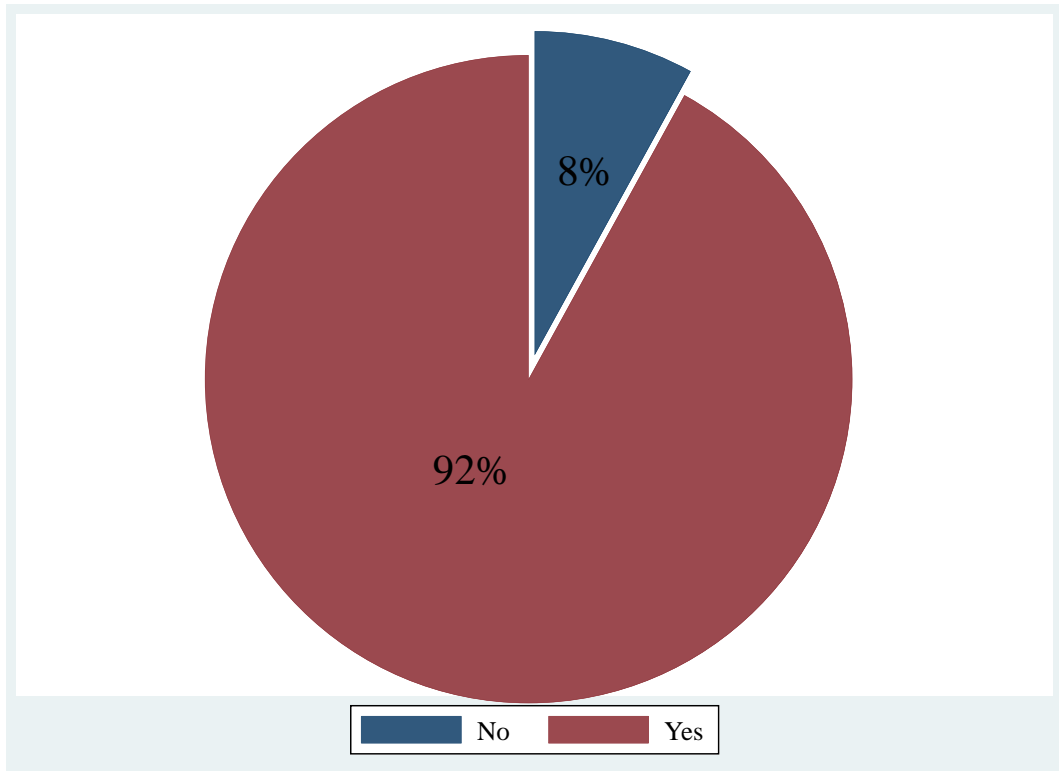


Figure 4.1: Pie chart showing Respondents Awareness of issues in Sustainable Construction

4.2.3 Respondents Source of Information on Sustainable Construction

On the sources of information on sustainable construction, respondents indicated that Courses and information of from colleagues were their major source of information respectively. However, some respondents also considered training/workshops and the media as how they got information on the subject matter. Personal research and articles were considered the least of the sources of information by respondents.

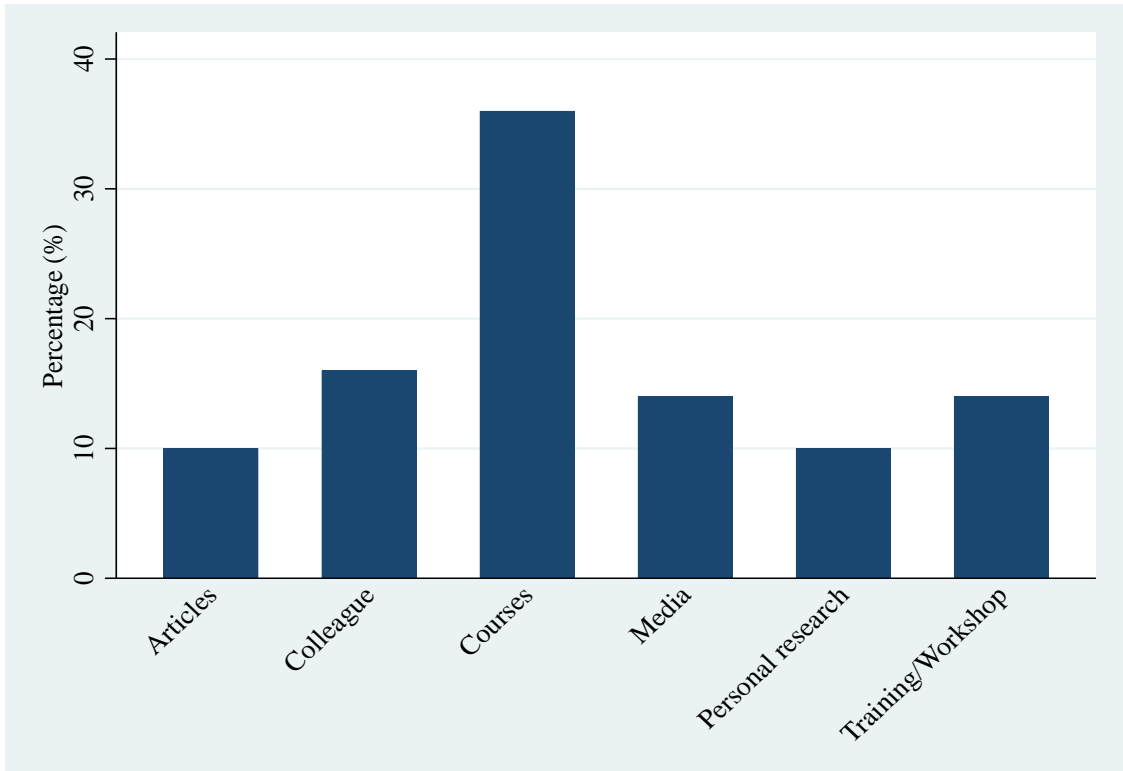


Figure 4.2: Graph representation of Respondents Source of Information on Sustainable Construction

4.2.4 Respondents Level of Awareness of Sustainable Construction Concepts

Generally, respondent's awareness levels of Sustainable construction concept were good as (70%) of the respondents indicated that they had high awareness as against (30%) who indicated low awareness level on sustainable construction.

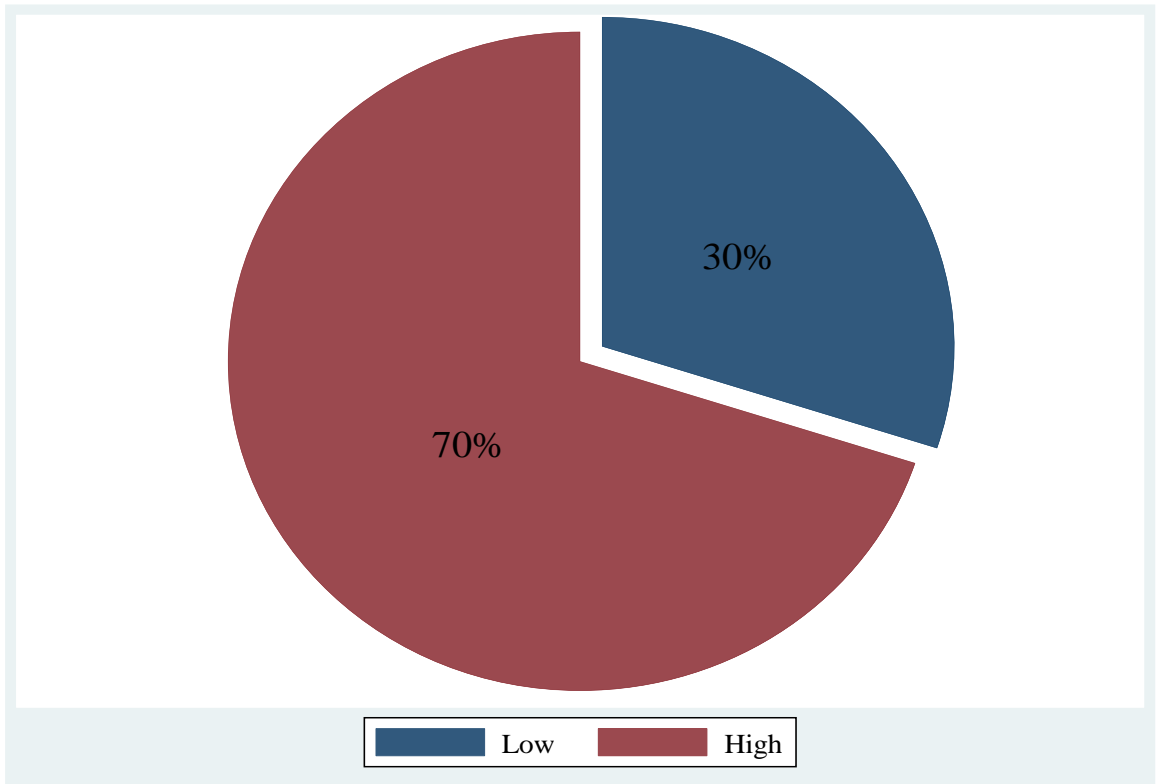


Figure 4.3: Pie chart showing the general Awareness of respondents on Sustainable Construction concept

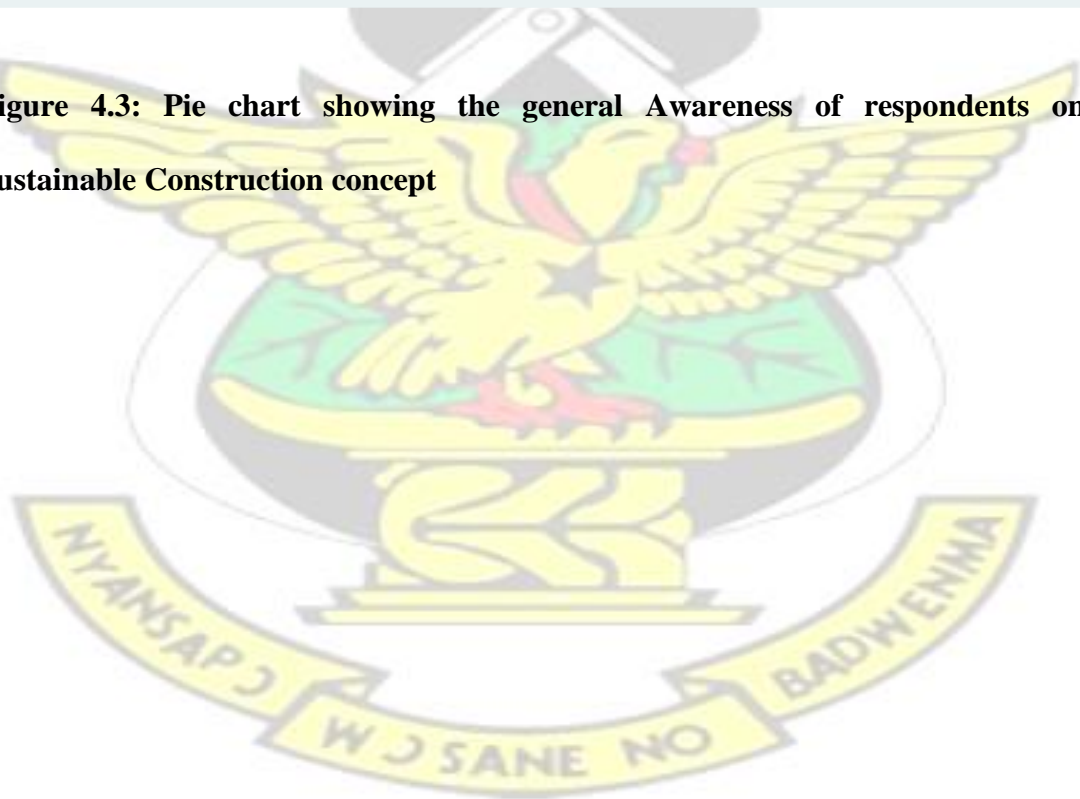


Table 4.2: Mean rating of the extent of Awareness of Respondents on Sustainable Construction Concepts

Parameters	Mean	Std. Err.	Rank
Consider occupant health and safety	4.44	0.15691	1 st
Minimize pollution	4.4	0.17143	2 nd
Use durable materials	4.34	0.15282	3 rd
Provide clean and healthy environment	4.24	0.16303	4 th
Consider quality of life of the occupants	4.2	0.17379	5 th
Implementing cost effective measures	4.14	0.17145	6 th
Use products and materials that can be recycled or biodegradable	4.02	0.15777	7 th
Use energy source with low environmental effects	3.96	0.17133	8 th
Respect people and local environment	3.94	0.16515	9 th
Develop on environmentally appropriate area	3.8	0.19378	10 th
Use locally manufactured materials	3.8	0.21571	11 th
Using materials from recycled sources	3.72	0.19175	12 th
Analyze building density in the area	3.6	0.20203	13 th
Design for less materials usage	3.52	0.17436	14 th
Maintain biodiversity and ecology of the site	3.5	0.20454	15 th
Designing to attract investors	3.4	0.20404	16 th
Conserve building water and cooling power consumption	3.28	0.22864	17 th

Table (2) above indicate the mean ratings of respondents on the extent and level of awareness of the sustainable construction concepts and its practices. Among the various questions asked, respondents exhibited that they had fair knowledge of the environmental, economic and social aspects of sustainable construction. Results

showed that all the measures assessed had a mean value of above average of 3.0, which means respondents rated themselves as having a high awareness level. Among the practices assessed as having high meaning ratings included, Consider occupants health and safety (mean =4.44), minimizing pollution (mean=4.40), using durable materials (mean=4.34), the 4th and 5th rated measures were providing clean and healthy environment (mean=4.24) and considering quality of life of the occupants (mean=4.20) respectively.

4.2.5 Respondents Knowledge of Sustainable Construction Practices

The general knowledge of respondents on sustainable construction concept were considered good with majority (64%) of the respondents indicating that they had high knowledge on sustainable construction as against (36%) who indicated low knowledge levels.

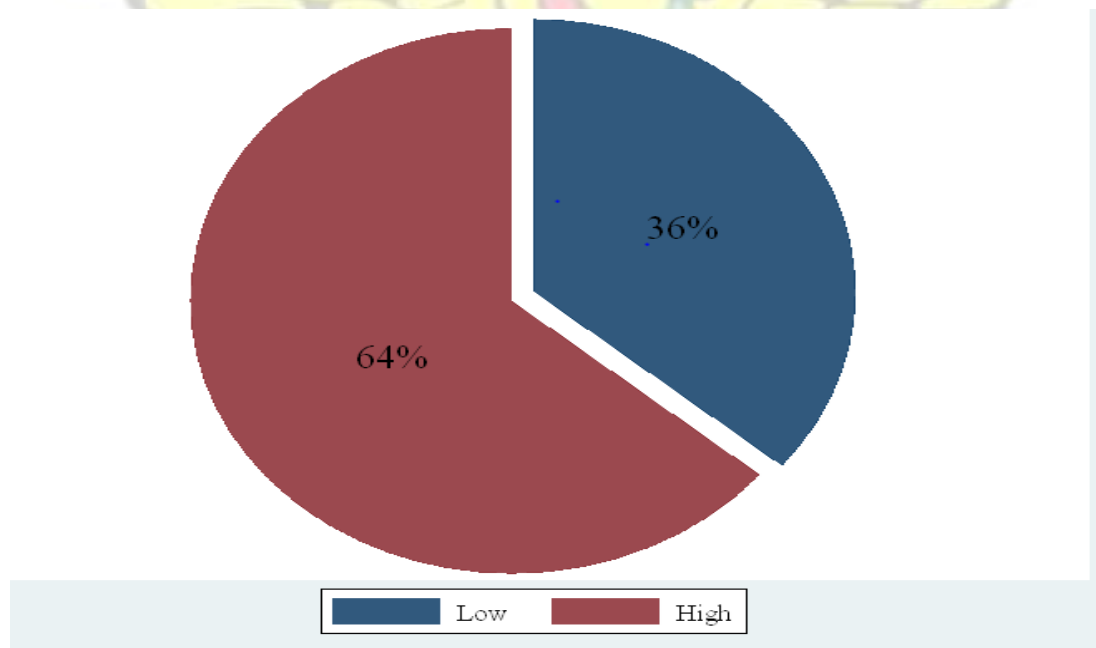


Figure 4.4: Pie chart showing the general knowledge of respondents on Sustainable Construction practices

Table 4.3: Knowledge level of Respondents on Sustainable Construction Practices

Knowledge	Mean	Std. Err.	Rank
Appropriate disposal of waste water on site	4.04	0.1828571	1
Using alternate energy supplies like solar panels	3.9	0.1767045	2
Specify and use local materials sourced	3.78	0.1964792	3
Use bio-based products or materials	3.68	0.17009	4
Indoor air quality control	3.58	0.2022123	5
Install water efficient fixtures	3.52	0.232537	6
Use products or materials with recycled content	3.5	0.1720228	7
Minimize use of PVC based products or materials	3.4	0.185164	8
Install whole house ventilation systems	3.36	0.1846342	9
Conduct frequent material audits	3.3	0.2005096	10
Restore ecosystem native plants	3.16	0.1574283	11
Use of low or no VOC emitting paints and adhesives	3.1	0.2104417	12

Data is presented as mean score ratings and ranking of respondents

Table (3) above shows the extent of knowledge of respondents on the selected measures of sustainable construction practices. Question on the practices of

sustainable construction were asked and the mean ratings were ranked accordingly. Generally, respondents had high knowledge on the questions asked. Among the first five (5) practices the respondent rated high as having more knowledge include, appropriate disposal of waste water on site (mean=4.04) received the highest ratings, followed by using alternate energy supplies like solar panels (mean=3.90), specifying and use of locally sourced materials (mean=3.78). also, the least rated practice indicated by the respondents was the use of low or no VOC emitting paints and adhesives(mean=3.1). Again, restoring ecosystem native plants(mean=3.16) and conducting frequent materials audits (mean=3.3) received low ratings.

4.2.6 Respondents Consideration of Effective Methods of Achieving Sustainable Construction Practices

Table (4) below shows respondents consideration of on effective methods of achieving sustainable construction in construction. Various sustainable construction practices were identified and respondents asked in a five-point Likert scale to indicated their level of consideration whether low or high. The general consideration of respondents was good with an average mean of 3.0, Among the selected practices for, using alternative energy supplies such as solar) and Installing water efficient fixtures both had a mean score of (3.64) which represented the most effective measures considered as means of achieving sustainable construction. Restoring ecosystem native plants (mean=3.64) and ensuring appropriate disposal of waste water on site(mean=3.46) were respectively as high by respondents. The use of low or no VOC emitting plants and adhesives(mean=3.04) and installing whole house ventilation systems were however considered as the least effective methods of achieving sustainable construction.

Table 4: Effective methods of achieving Sustainable Construction Practices

Parameter	Mean	Std. Err.	Rank
Using alternative energy supplies such as solar	3.64	0.1890038	1
Installing water efficient fixtures	3.64	0.1974532	2
Restore ecosystem native plants	3.56	0.1982783	3
Ensuring appropriate disposal of waste water on site	3.46	0.1789083	4
Using products or materials with recycled content	3.44	0.2102671	5
Use bio-based products or materials	3.36	0.2015451	6
Minimize use of PVC based products or materials	3.34	0.1971429	7
Specify and use local materials sourced	3.32	0.2127373	8
Ensuring indoor air quality control	3.32	0.1988539	9
Conducting frequent material audits	3.18	0.2244085	10
Installing whole house ventilation systems	3.14	0.2138281	11
Use of low or no VOC emitting plants and adhesives	3.04	0.2079246	12

Data is presented as mean score ratings and ranking of respondents

4.3 DISCUSSION OF RESULTS

4.3.1 Introduction

This section discusses the results of this study in harmony with the stipulated objectives and research questions. The results are discussed with support of the literature review in the chapter two of the thesis.

4.3.2 *The level of awareness on sustainable construction practices among stakeholders*

The awareness of sustainable construction appears is popular among developed countries compared to developing countries (Bond & Perrett, 2012; Upstill-Goddard et al., 2016). In this study, respondent's awareness levels of Sustainable construction concept were very good as 70% indicated that they had high awareness. Among these were 92% of the respondents who were acquainted with the issues on sustainable construction in the construction industry with their major sources of information being from courses at school and information from colleagues, training/workshops and the media. This is in concordance with a study by Ametepey and Aigbavboa (2014) in Ghana among practitioners with relatively high level of formal education that showed awareness level of sustainable construction to be 83%. In this same study, majority 71% of these participants got to know the concept through academic work (Ametepey & Aigbavboa, 2014). A similar study further iterates higher awareness of construction sustainability issues among polytechnic students, 91 out of 100 people in Nigeria (Zaki et al., 2016). However, a study conducted among respondents in Kuwait showed a moderate level of awareness of sustainable construction.

Respondents exhibited that they had fair knowledge of the environmental, economic and social aspects of sustainable construction. Among the practices assessed as having high ratings included, consideration of workers health and safety, minimizing pollution, using durable materials, providing clean and healthy environment and considering quality of life of the occupants. This high awareness level among the respondents could be attributed to the campaigns against global warming, depletion of non-renewable natural resources and the infusion of such topics into the curriculums.

4.3.3 Level of knowledge on sustainable construction concept and practices.

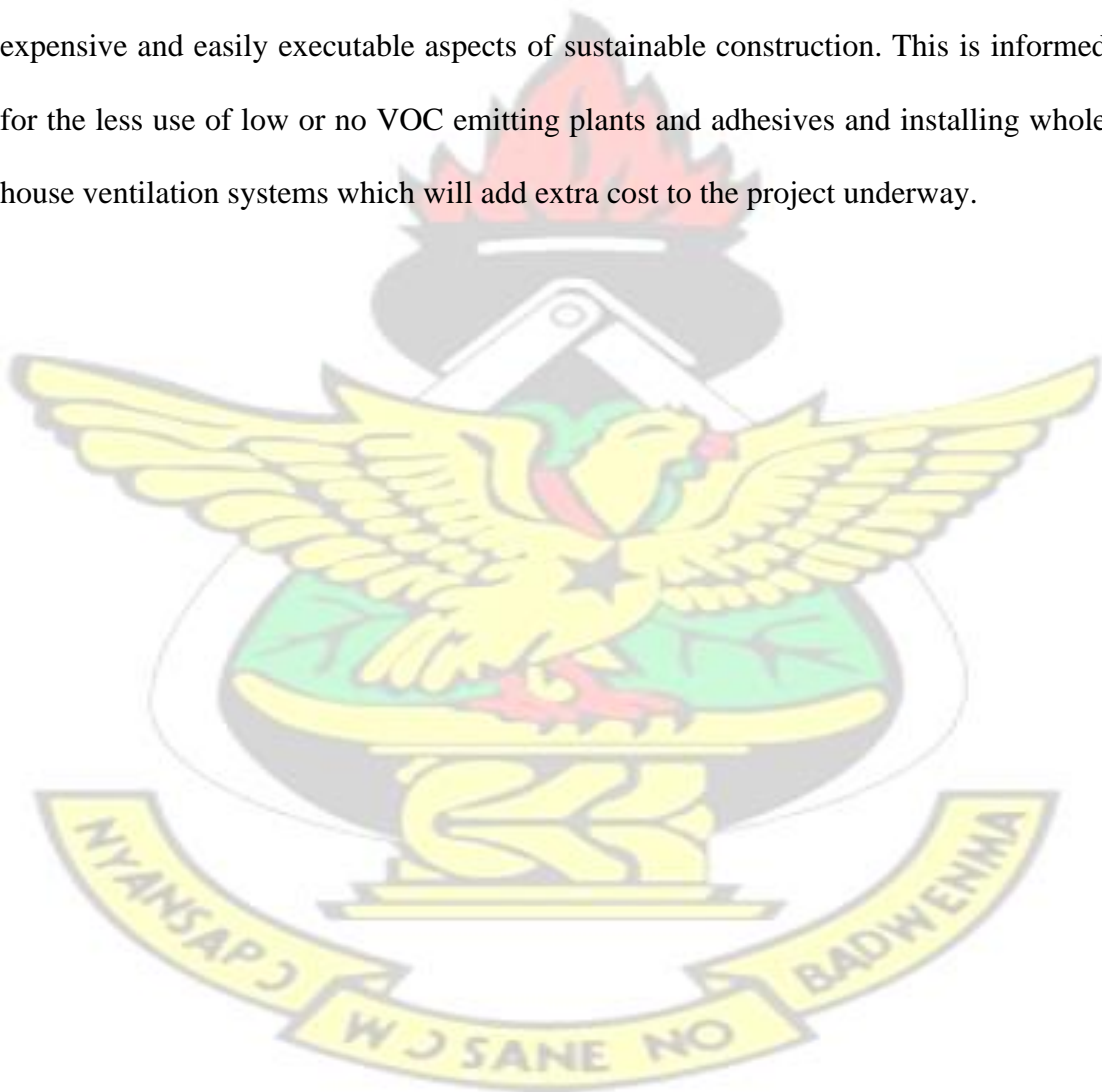
The general knowledge of respondents on sustainable construction concept were considered good where majority (64%) of the respondents indicated that they had high knowledge on sustainable construction. This is expected due to the high awareness level among the respondents as a result of the campaigns against global warming, depletion of non-renewable natural resources, the infusion of such topics into the curriculums and many more.

Among the first five (5) practices the respondent rated high as having more knowledge included; appropriate disposal of waste water on site, followed by, using alternate energy supplies like solar panels, then, specifying and use of locally sourced materials.

4.3.4 Sustainable construction practices that are implemented by stakeholders.

Among the commonest sustainable construction practices according to the respondents were, using alternative energy supplies (such as solar) and Installing water efficient fixtures. These were the most effective measures considered as means of achieving sustainable construction. Restoring ecosystem native plants and ensuring

appropriate disposal of waste water on site were also considerably recognized among the respondents. However, the use of low or no VOC emitting plants and adhesives and installing whole house ventilation systems were the least considered effective methods of achieving sustainable construction. It is argued by (Asokan and Osmani (2009); Tam and Tam (2006) that sustainable construction is to result in cost reduction of construction projects, hence it is believed that, based on the availability of materials as well as expertise, stakeholders settle for or pick and choose less expensive and easily executable aspects of sustainable construction. This is informed for the less use of low or no VOC emitting plants and adhesives and installing whole house ventilation systems which will add extra cost to the project underway.



CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter forms the last of the study and it comprises a review of the objectives of the study as well as findings, followed by conclusion and recommendations of the study.

5.2 Review of Study Objectives and Findings

This segment categorically sections the findings based on the objectives. This can be found as follows:

Objective One: Ascertain the level of knowledge on sustainable construction concept and practices among stakeholders in universities in Ghana.

The general knowledge of respondents on sustainable construction concept were considered good where majority (64%) of the respondents indicated that they had high knowledge on sustainable construction and sustainability as a whole. Among the first five (5) practices the respondent rated high as having more knowledge included; appropriate disposal of waste water on site, followed by, using alternate energy supplies like solar panels, then, specifying and use of locally sourced materials.

Objective Two: Ascertain the level of awareness on sustainable construction practices among stakeholders in universities in Ghana.

The awareness levels of Sustainable construction concept were very good as 70% indicated that they had high awareness. Among these were 92% of the respondents who were acquainted with the issues on sustainable construction in the construction industry with their major sources of information being from courses at school and information from colleagues, training/workshops and the media.

Objective Three: To suggest effective methods of achieving sustainable construction among construction professionals' universities in Ghana.

Among the commonest sustainable construction practices considered as the effective ways of achieving sustainable construction, according to the respondents were, using alternative energy supplies (such as solar) and Installing water efficient fixtures. However, the use of low or no VOC emitting plants and adhesives and installing whole house ventilation systems were the least considered as the effective ways of achieving sustainable construction.

5.3 Conclusion

This study has brought to light that 70% of construction stakeholders in public universities indicated that they had high awareness, with majority (64%) of the respondents indicated that they had high knowledge on sustainable construction.

The commonest sustainable construction practices according to the respondents were, using alternative energy supplies (such as solar) and installing water efficient fixtures.

5.4 Recommendations

Based on the above conclusion, the following recommendations were made:

1. There is the need for more education on sustainable construction.
2. There is the need for a regulatory body that will enforce sustainable construction.
3. There is also the need for more experts in the area of sustainable construction.
4. All the cadres in the construction industry need a workshop or short training on sustainable construction so its implementation become easier.
5. All public and private universities need to set good examples by enforcing the use of sustainable construction in the execution of any university project.



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APENDIX A: QUESTIONNAIRES

RESEARCH QUESTIONNAIRE: Level of Knowledge and Awareness of Sustainable Construction on Selected University Campuses

INVITATION TO PARTAKE IN A RESEARCH SURVEY

Dear Sir/Madam,

I am an MSc. Construction Management student undertaking a research study on the topic "Level of knowledge and Awareness of Sustainable Construction on Selected University Campuses in Ghana. The main objectives of the studies are;

1. To ascertain the level of awareness on sustainable construction concept among stakeholders in universities in Ghana.
2. To assess the level of knowledge on sustainable construction practices among stakeholders in universities in Ghana.
3. To suggest effective methods for achieving sustainable construction among stakeholders in universities in Ghana.

I would be grateful if you could help answer this questionnaire to aid in my study. All information collected will be treated as confidential and would be used only for academic purposes. Thank you for your contribution in advance.

Yours faithfully,

Restlaw Owusu-Mensah

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Hon. Joe Kingsley Hackman

Project Supervisor

Department of Construction Technology and Management, KNUST.

Email: jhackman.Cap@knust.edu.gh



SECTION A

Please kindly answer questions in this section by ticking the appropriate response for each item

DEMOGRAPHIC CHARACTERISTICS

1. Age

20-40 years

41-60 years

2. Highest academic qualification

Certificate

HND

Bachelor's Degree

Master's Degree

PhD

3. Area of specialty

Project Manager

Quantity Surveyor

Architects

Engineer

Other:

4. Name of Institution.

University of Health and Allied Sciences (UHAS)

Kwame Nkrumah University of Science and Technology (KNUST)

University of Energy and Natural Resources (UENR)

5. Years of experience

1-5

6-10

11-15

16-20

Over 20

6. Please are you aware of sustainable construction?

Yes

No

7. What is your major source of information on sustainability in construction?

Personal research

Colleague

Media

Articles

Courses

Training/Workshop

KNUST

SECTION B

Kindly answer the questions in this section my using a liker scale of 1 to 5 according to your level of agreement.

AWARENESS OF SUSTAINABLE CONSTRUCTION CONCEPTS

To what extent are you aware of the following suitable construction concepts? Kindly indicate your level of awareness using a scale of 1 to 5.

8. Develop on environmentally appropriate area.
9. Maintain biodiversity and ecology of the site
10. Conserve building water and cooling power consumption
11. Use energy source with low environmental effects.
12. Provide clean and healthy environment
13. Use products and material that can be recycled or are biodegradable

14. Use materials from recycled sources

15. Use locally manufactured materials

16. Use durable materials

17. Implement cost effective measures

18. Design to attract investors

19. Design for less materials usage

20. Respect people and local environment

21. Consider occupant health and safety

22. Consider quality of life of the
occupant

23. Analyze building density in the area

24. Minimize pollution



SECTION C

LEVEL OF KNOWLEDGE OF SUSTAINABLE CONSTRUCTION PRACTICES

To what extent do you consider or have knowledge about the following sustainable construction practices? Please indicate your level of knowledge on a scale of 1 to 5.

- 25 Specify and use local materials sourced
- 26 Using alternative energy supplies like solar panels
27. Install whole house ventilation systems
28. Appropriately disposal of waste water on site
29. Conduct frequent materials audits
30. Indoor air quality control
- 31 Install water efficient fixtures
- 32 Use products or materials with recycled content
- 33 Restore ecosystem native plants
34. Use bio-based products or materials
35. Minimize use of PVC based products
36. Use of low or no VOC emitting paints and adhesives

SECTION D

EFFECTIVE METHODS OF ACHIEVING SUSTAINABLE CONSTRUCTION

To what extent are the following effective methods of achieving sustainable construction in your institution? Please indicate using a scale of 1 to 5

- 37 Specify and use local materials sourced.
- 38 Using alternative energy supplies such as solar
- 39 Install whole house ventilation systems
40. Appropriate disposal of waste water on site
41. Conduct frequent materials audits
42. Indoor air quality control
43. Install water efficient fixtures
- 44 Use products or materials with recycled
- 45 Restore ecosystems native plants
46. Use bio-based products or materials
47. Minimize use of PVC based products or materials
48. Use of low or no VOC emitting plants and adhesives