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GUIDELINES FOR MANAGING THE CONSTRUCTION STAGE OF A GREEN BUILDING

By

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DECLARATION

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree or diploma at Kwame Nkrumah University of Science and Technology, Kumasi or any other educational institution, except where due acknowledgement has been made in the thesis.

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ABSTRACT

Green building projects are inherently different from their conventional counterparts from a technical perspective. They require the use of special materials and building practices to achieve sustainability hence the demand for green buildings has changed the role of the contractor. This study sought to develop guidelines for managing the construction stage of green buildings by sampling the contractors who have experience in green building construction. The study adopted a qualitative method of enquiry with semi-structured interviews to gather data from construction managers who has experience in the construction of green buildings. Findings from the study revealed that challenges that are faced during the construction of green buildings are Rigid Project Requirements, Inadequate Technical Capacity, Strict Requirements from Certifying Body, Non Availability of Green Materials, High Cost and Lack of Interest from real estate developers. Also some of the skills needed in the construction of green buildings were Knowledge in sustainability and sustainable construction, knowledge in value engineering and training in the systems of green technologies. To ensure that green buildings are constructed in the required and acceptable way, some strategies were suggested and these are; Maximum usage of solar energy even during the construction, Rainwater and Grey water usage, Recycled water for landscaping. Use land which does not contain old-growth forest, providing adequate spaces and ventilation, Design for Disassembly are among many other strategies that were identified as important in the construction of green buildings. It is therefore recommended that skills in Maximum usage of solar energy even during the construction, Rainwater and Grey water usage, Recycled water for landscaping. Use land which does not contain old-growth forest, providing adequate spaces and ventilation, Design for Disassembly are among many others are deemed to be necessary so as to equip the construction managers in the construction of green buildings.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF STUDY

The buildings we live, work and play interacts with our environment, affecting energy and water consumption, transportation patterns, and indoor air quality. Recognition of the role that buildings have on our environment has led to significant efforts to build and maintain more sustainable structures (Dixon, 2010). Green building practices includes environmentally responsible and resource efficient, energy and water resource conservation, preservation of open spaces, minimizing the emission of toxic substances, preserving the ecosystem's capacity at the global level , national level and even the local level (Sharif et al., 2013). All these processes require planning, designing, construction (i.e. executing), monitoring and controlling, that is, throughout a project's life cycle which in other words referred to as project management.

According to Hwan and Ng (2012), the processes for green building projects differ from that of conventional construction, in the sense that project execution under green building implements sustainable practices which are in most cases listed in rating systems like Leadership in Energy and Environmental Design (LEED). A typical example of such practices is the waste management plan developed by the Construction Industry Research and Information Association (CIRIA) 2001, which focuses on reducing waste production at site during construction (Kibert, 2008). The CIRIA (2001) reported that green buildings also employ sustainable practices such as using recycled aggregates for concrete works. Again, the construction manager has to make sure that pollution from the construction is kept at minimum level by controlling airborne dust generation, soil erosion and waterway sedimentation according to United States Green Building

Council (USGBC, 2009). Finally, the natural habitat according to USGBC (2009) must be preserved by ordering the sitting of building to ensure minimal disturbances in its immediate environment. However, the above considerations are often neglected by contractors.

1.2 PROBLEM STATEMENT

According to the U.S Energy Information Administration Statistics (Ramesh, Prakash and Shukla 2010), building related activities consume 50 percent of the material resources taken from nature, more than 50 percent of national waste production comes from the construction sector, 40 percent of the world's energy is consumed by buildings while 50 percent of global greenhouse comes from buildings. Pandey (2014) postulates that, the built environment emanates almost half of the world's green emissions yearly. According to Pandey (2014), green building is constructed and operated so as to reduce its impact on the environment aside enhancing its user's productivity and comfort. Green buildings are unique and different technically as compared to their conventional counterpart. Therefore, green buildings require special skills and building materials in order to achieve sustainability in their construction (Robichand. Et al., 2011). The demand for green buildings has changed the role of the contractor (Nobe and Dunbar, 2004).

As the green building phenomenon continues to increase, the need thus surfaced to better understand the important skills required by construction managers to be able to execute green buildings. In spite the various studies on the competencies of construction managers, very few basically examined the critical skills and knowledge required to successfully execute a sustainable project (Hwang and Jian, 2012). With the fast changing environment with challenges such as, the increasing prioritization of issues such as environmental protection, climate change and sustainability, the role of construction managers needs to be revamped (Hwang and Jian,

2012). However, construction of green buildings keeps facing drawbacks because of the lack of proper construction management guideline for such projects (Hwang and Ng, 2012). Robichaud and Anantatmula (2011), also attest to this by saying that, whereas several case studies exist on the performance and cost of sustainable projects, few of them emphasized on the construction management processes and the integrated team approaches applied on these kinds of projects.

It is thus very necessary to put forward appropriate strategies as well as methods to alleviate the effect of construction activities on the environment, thereby enhancing the sustainability of construction projects.

1.3 RESEARCH AIM

To develop a guideline for managing the construction stage of a Green Building

1.4 RESEARCH QUESTIONS

The study is being guided by the following research questions:

1. What are the main dissimilarities between the management of conventional and green buildings?
2. What challenges are likely to be encountered during the execution of green buildings?
3. What are the essential knowledge and skills required to successfully execute green buildings?
4. What strategies can be adopted for the management of a green building during its construction?

1.5 OBJECTIVES

1. To identify the the main dissimilarities between the management of conventional and green construction projects;
2. To identify the barriers/challenges in the construction of green buildings;
3. To identify the requisite construction management skills needed for the construction of green buildings;
4. To identify contemporary strategies for the delivery of green buildings; and
5. To develop a guideline for managing the construction stage of a green building.

1.6 SIGNIFICANCE OF THE STUDY

Proper organization and planning of projects tames chaos on construction sites. Nevertheless, with regards to green construction the case of impediments still persist as there is no proper project management guideline designed for green projects (Hwan and Ng, 2012).

The study therefore seeks to develop a guideline for managing the construction stage of green buildings. The findings of study will enlighten stakeholders in the construction industry the importance of involving construction managers in the delivery of Green buildings.

Green buildings through effective construction management will ensure protection of the ecosystems and the entire biodiversity; conserving and restoring natural resources; improving air and water quality; reduced operating costs; improved occupant productivity; reducing waste streams; enhancing the value of assets; optimizing life-cycle economic performance; enhance occupant health and comfort; improve indoor air quality through proper ventilation; minimize strain on local utility infrastructure; and overall improvement in the quality of life.

1.7 RESEARCH METHODOLOGY

A comprehensive literature was review on related subject to help achieve the research objectives. In the review, challenges encountered in green construction projects were identified together with the differences between green construction and conventional construction. Purposive sampling technique was employed in this study by sampling construction managers who have worked on green projects in Ghana. Interview guide was used to gather primary data from these experienced construction managers with skills in green construction. NviVo 11 Pro Software was used to analyze the data derived from the interviews.

1.8 RESEARCH STRUCTURE

The study was structured into five main chapters. Chapter one covered the whole of the research introduction which entails the background of the study, problem statement, research questions, aim and objectives, the scope and relevance of the study among others. It also relates to the background of the research and the research question.

The second chapter reviewed the main literature on previous work done around the subject area. It discussed issues related to the research topic by other authors and throws light on various commentaries and the knowledge on the topic served as a foundation to support the study.

Chapter three gave a step by step approach as to how the study was conducted. It also discussed the questionnaire that was developed and data collected.

The chapter four discussed the findings of the study through data presentation and analysis.

The chapter five presented and discussed the implications of the current study and its contribution towards construction management, green building and the construction industry as a whole.

CHAPTER TWO

LITERATURE REVIEW

2.1 THE CONCEPT OF SUSTAINABILITY

Sustainability over the years has become a term which has taken different tolls and turns but the primary concept still remains undoubtedly sound and unchanged as no single definition can cloud the true extent of the concept privily (Walker and Salt, 2006). A critical look at the concept suggests a positioning between merging future and present needs and dealing with the variant issues that stem from long term and short term managing of structures, organizations and resources. The concept of sustainability incessantly runs wide and cold in the heart of scholars, people and the government who are striving to save the planet from the emission of greenhouse gas (GHG) and the adverse energy consumption globally (IPCC, 2007; UNEP-SBCI, 2009). It is as postulated by Eurosat (2011), that energy consumption is increasingly erroneous in the household sector just as seen in the transport or energy sector. Furthermore, information gathered from Energy Information Administration's data in 2012 reveal that GHG emissions from buildings are rising rapidly as compared to other sectors (EIA, 2012; Akashi and Hanoaka, 2012).This is a wakeup call in what we think of as sustainable and it related counterparts of green building. This also shows how so important the concept of sustainable building is when we want to achieve sustainable development (Sev, 2009).

The definition of sustainability in the built environment has been espoused by several scholars over the years (Martens, 2006). The concept can be traced back to the 1970's as the time it was globally discussed by the club of Rome (Meadows et al., 1972). On a global scale, the concept gained recognition in the same year as the previous during the UN Conference on Human Environment which was later called the United Nations Environment Programme (UNEP).

Economically, sustainability is seen on a large scale as foregoing or a better term managing todays essential resources putting in mind tomorrow's dire need of the same resource thus communicating a sense of blending between the present and future (Martens, 2006). Particularly advancing knowledge presented in the past two decades suggests that the rate of population growth extremely outstrips the earths potential to cater for the relative present needs of societies as well be able to harness tomorrow's pertinent demands (Hopwood et al., 2005). A driving concept pulling societies to more of the sustainability concept is the fact that generally populations are rising and limited resources exist to cater for the needs of the growing population (Akashi and Hanoaka 2012). Significantly, if proper care through long term and wise efficient handling of resources such as trees, minerals, water resources are not effectively administered managerially, the earth's inhabitant (entire constituent of living things) are going to suffer the menace of a long-term crisis which could have no irreversible solutions (Hopwood et al., 2005). The extensive implication of this is that as decisions are made for the long-term and short term there should be a balance weighing both timelines upon variable scales and not compromising what each timeline presents (Hopwood et al., 2005).

2.2 SUSTAINABLE DEVELOPMENT

It is hard to put the knot on a particular definition of sustainable development. The concept keeps changing itself over the years and no single concept or definition has been found accurate to keep all the diverse part of this terminology (Hopwood et al., 2005). Robinson (2004) reiterated that the concept is clouded with new meanings continually being added up to the term making a perfect definition becoming difficult, if not impossible to be formulated as critical meanings are on the verge of being left out. Defining sustainable development in their own very good terms,

World Commission on Environment and Development (WCED, 1987 cited by Combemale et al, 2016) stated that sustainable development is development which meets the needs of the present without compromising the ability of future generations to meet their own needs". The evolution of this concept early in the year 1987 only saw the imperative as an observation of a connection between demands of humans and time trends. Progressively the parenthesis surrounding only humans particularly has extended to the premise of environment taking critical and analytical considerations of how sustainable development affects the things around us (Walker 2006). Development is a double plane boundary as it should be able to touch the future and the present at the same time. The further championing of this action was the introduction of the sustainable development goals which categorically and emphatically states required goals set for the future (Cassidy 2003). To sustainably be able to develop as a nation, wise considerations should be applied in the calculation and enactment of privy and important decisions. Sustainable development has been said to be the new phase of qualitative growth and development. It hinges on improved systems, aimed at providing better living conditions for the present and future generations nevertheless, not compromising great deal of stress on people, structures and system (EPA 2008). As no single definition has been compounded to suit the broad entourage the term encompasses, different facets have been spoken. Prime examples categorically imprinted in various literature focus on sustainable development as pertaining to engineering, food and agricultural sciences, social development and architecture and construction (Walker 2006). The growing rate of the term gained notoriety first in the World Conservation Strategy linking issues of prime concern socioeconomic wise to the paramount problems created by human conditions, poverty as a driving factor of the then increased problems of the environment. It gave rise to the notion that ecology, economics, and issues relating to social status of mankind were intrinsically

woven together and they could not be separated once the imperative of a growing and well abled plan of development is conceived (Akashi and Hanoaka 2012). It brings to light the issues that are undoubtedly interim, but past growth models failed to assess the wealth and socioeconomic gap between particularly advanced countries and poor ones. As the concept has become so vastly explained and no boundary has been put on it to determine the extent it can affect society, it has been propounded to a high esteem that the term could soon vanish into vague meaningless identity if no proper lease of defining precept is put on it (Sev, 2009). Variant debates of notability have arisen surrounding the concept. The first is a category of people who define development as the end concept and or not see the need for an empirical improvement of development as a concept. This notion propounds that for one to advocate development to a particular concept then in practicality the thing should have actualized potentially as a sustainable one. The argument is based on the premise that the concept of development was an even bigger loophole as it is too large to define theoretically (Hoopwood et al., 2005). Another standing argument lies between defining what is weak sustainability and strong sustainably (extent of sustainability). The weak concept typifies all resources particularly natural resources as being replaceable that artificially manufactured materials can replace them. The strong advocates that no matter how good materials can be produced, they cannot meet the requirements of already existing natural resources looking strategically at processes like the ozone layer, water cycle and the carbon cycle. It should however be stated that, this argument is only found in issues of environmental concern and not of socioeconomic ones. Even though different views exist on the subject matter, it is agreed that the idea of the concept is one important area that needs to be looked at.

2.3 SUSTAINABLE BUILT ENVIRONMENT AND PRINCIPLES

The principles surrounding sustainable built environment are timely, there have been difficulties when we are trying to quantize what a sustainable building should be. Berardi (2012) and Cole (2012) posit that sustainability assessment systems come with various differences, however, all these systems share one common framework which is sustainable construction.

Over years now, the sustainability assessment systems have led to increase in the awareness of the objectives as well as the principles of sustainability. That is, sustainability has become the backbone of reference in assessing buildings sustainability. Taking inference from the objectives and principles of sustainability, a building is thus sustainable on the bases of it being built not to negatively affect ecology but it reducing environmental impacts. Nevertheless, there has been a lot of limits in these system (Berardi, 2011). Grasping the limits of this when it comes to sustainability, it is thus practical in tracing the definition of sustainability in the construction industry. Hill and Brown (1997) posits that, for a building to be considered sustainable, it must show resource competence and healthy built environment with respect to ecological ethics. A critical look at the above definition exhibit that sustainable buildings must have high efficiencies in materials, energy and water usage, and must minimize also the impact they have on the environment and on health throughout their existence (Cassidy, 2003). Lowe (2007) postulated that the way to sustainability has to do with reduced energy consumptions and GHG emission.

2.3.1 Uncertainties in the Definition of Sustainable Buildings

Several uncertainties exist with respect to defining sustainable buildings and their relations with the domain, time, as well as people-related factors.

a) Time Uncertainty – the relation of time with sustainability limits one to consider the entire life cycle of a structure which is very challenging to predict as most building structures exist normally longer than they are expected (Du Plessis and Cole, 2011). Thus, time cannot be taken out of sustainability. Sustainability depends on it in such a way as the available knowledge at the time of undertaking evaluation. Thus, what may be regarded as sustainable today may be rendered useless and unsustainable tomorrow. Parr and Zaretsky (2010) postulates that flexibility as well as adaptability of buildings have emerged in recent times as the basic aspects for sustainable buildings are required to convene modern requirements. Buildings as we used to know some years past are not the same as today. It has undergone utmost significance changes. Sustainable buildings must stand with the ability of housing diverse changes and changeable patterns. The idea of flexibility in the built environment comes to play here (Cole, 2012). Salt and Walker, (2006) postulate that the resilience of a building is defined by some parameters like the building's ability to resist to change by external or internal impact.

b) Domain Uncertainty - Developed and developing countries are having increasingly diffusion of sustainable building policies, therefore, it is imperative to consider the dimensions of sustainability. The inexorableness of considering the social and economic aspects in the various countries augments what is labelled as sustainability (UNEP-SBCI, 2009). To stress on domain uncertainty, one must identify an economically sustainable building and use it as an example. This fundamental relies on time uncertainty including context of people of economic sustainability. For a fact, change is always possible in considering economic sustainability; buildings always follow economic cycles (Martens, 2006).

2.3.2 Principles for Sustainable Building

The visions of sustainable buildings have recently been reinterpreted by Commercial International Bank after its adoption in the first international conference on Sustainable Construction. Per the new interpretation, ten principles have been outlined for a building to be considered sustainable (CIB, 2010).

- The building should be able to adapt to any change through-out its life span. This implies that the building must be able to adapt by changing performance and functionality requirement in accordance with the current constrains.
- The building should be able to be integrated into relevant infrastructure and local plans, and must be able to connect with existing networks, services, suburban and urban grids as well, in other to enhance stakeholders' satisfaction.
- The building should be user- friendly and cost effective in its operation. Information on operation and maintenance must be available for occupants and operators at any time. The occupants of the building must understand the strategies and philosophy of the building in other to understand how the sustainability aspect works and behave accordingly.
- There building should have minimal impact on the environment through-out it life span. This considers global and regional requirement, efficiency as well as reduction in waste and GHG emissions.
- All interested parties must be allowing to participate I the decision making process and in the construction phases so that occupants need can be met and also be respectful of and

consistent with collective social needs through partnership in design, construction, and maintenance processes.

- Cultural values of the people must be incorporated, thus a sustainable building should be able to provide a since of place to its occupants, it should be seen as a place where work status can be improving and it should be consistent with local culture.
- The building should be design in such a way that it can cover it life span areas to be considered include; designing, planning, operation and maintenance, renovation and end of life and all other aspect during the evaluation of performance stage.
- The principles of sustainability must be applied in other to promote continual improvement, equity, precaution for risk, responsibility, Local action and global thinking as well as transparency.
- The building must be cost effective by delivering economic value through-out it life cycle taking into consideration its future cost, operation, maintenance, renovation and disposal.
- The CIB (2010) report that a sustainable building should be healthy, comfortable, safe and accessible for all. Health criteria include indoor air quality whereas comfort criteria include acoustic, thermal, visual and olfactory comfort. It must allow safe working conditions during its construction and service life, and full accessibility to everyone in the use of building facilities

A critical look at sustainable built environment shows that they seek to solve these various criteria.

2.3.3 Economically

Economically, sustainable built environment meet the solutions of solving the economics of the tenants, the contractor or builder, the client: Government and individuals who are constructing the various structures. A sustainable structure uses various technologies which saves time and cost. There are various programming techniques like the Programmable Logic Controllers (PLC) and other building management systems, which cut the cost of energy into half as compared to the ordinary buildings which are not sustainable enough (Greg et al., 2003).

2.3.3.1 Social

System integration and various connections in the sustainable environment and built structures improves communication even before construction, during and most importantly after construction (Greg et al., 2003). Various smart structures which are sustainable incorporate various technologies which makes communication between the individual and the buildings or structures easier. Numerous cutting edge researches have been ongoing, one standing tall among them is the Massachusetts Institute of Technology 'Oxygen' project which is working towards integrating technologies with the workplace through 'human centered pervasive computing' (Greg et al., 2003).. This would allow a building to interact with its occupants every day in their vast activities as it increase their productivity and output enormously (Greg et al., 2003).

2.3.3.2 Environment

The environment we live in benefit greatly from these sustainable buildings or structures which are being constructed. With the growing government policies about the environment and the various control agencies, we are sure to believe that before long, the amount of GHG released into the atmosphere as well as carbon emissions from homes, factories and cars would be

reduced (Greg et al., 2003). Sustainable built structures produces little to nothing of carbon to be emitted into the atmosphere. This makes the environment clean while improving time, money and health through the implementation of sustainable built environment (Greg et al., 2003).

2.4 GREEN BUILDINGS

Adapting to the new productive environmental demands of society is not a new brand in the construction industry as positive building structures such as green buildings are already engaged in the system. Green building refers to the whole subset composed of building techniques and structures to serve sustainable society, conserve energy, engage non-environmental depletion plans and provide buildings which are cost effective (Kibert, 2013). It has been said that the future of construction technology hinges indirectly on green buildings as many countries are looking towards that direction (Cassidy, 2003). Green buildings are structured to provide comfort and pleasure to individuals whiles meeting societal demands of sustainable development. The component of a green building categorically accomplishes the purpose of saving energy, provides an environmentally viable surroundings for the individual, prevents waste of extensive building materials through the reuse and recycle avenue, saves water resources as water is channeled properly, prevents health and toxic internal environments of buildings and lastly serve to make sustainable use of every product inculcated in the building of the structures (Beradi, 2012). Green buildings and Sustainable buildings are two keywords which walk in close pattern to each other, and they are sometimes used interchangeable in certain settings to give the same idea of presenting buildings which do not further harm environmental processes but rather improve it (Sev, 2009).

Green buildings channel technological advances to an ulterior and more useful impact that protect the environment and provide comfort as well. Developed and developing countries are all shifting focus to the Green Building idea and many international forefront meetings pertaining to the built environment are pushing the agenda of green buildings. The major concern to be considered in dealing with green buildings is the idea of cost. Many have argued that it is costlier to have a building which provides comfort and protects the environment and have it at a very affordable price range. Notwithstanding this argument, governments still propagate that costs be effective and productively less as the focus changing in that direction (Cassidy 2003).

It is thus key that components of green buildings regulate how building construction utilize energy and disposes of the out flux of waste to society. Heightened degrees of global warming and its associated impregnable issues demand that such sustainable buildings do not produce waste to deplete the environment as "conventional buildings have done" (Kibert, 2013).

2.5 THE CONSTITUENTS OF A GREEN BUILDING

A green building has primarily four basic components under which all other subset component falls. They are categorized into materials, energy, health and water.

2.5.1 Materials

The identified materials associated with a green building project is obtained naturally from renewable sources which have been harvested by sustainable means without any damage to the environment. The ability of the material to be recycled or re-used is very key in the selection.

2.5.2 Energy

As the standing argument remains that green buildings save energy, measures should be placed to ensure optimum energy use. The idea of solar panels is key in the system. Solar panels convert light and heat energy into electrical energy for use in buildings. The building should thus be constructed to be drawn to the suns direction geographically and thus it is advised that the building be positioned in the West-East direction. The building should be able to drastically reduce year-round cost of electrical bills. Energy saving bulbs and appliances are potentially the next generation help when it comes to green buildings.

2.5.3 Health

The interior and exterior of a green building should create an ambience which presents a safe environment for the health of people. Use of nontoxic products and materials would completely improve interior air quality and do away with air related diseases. Proper ventilation systems are hatched on and the prospects of planting lots of green shades around the building are points worthy of note in this category.

2.5.4 Water

There should be systems for utilizing water wisely. Underground water can be tapped into as well as systems modulating the use of water and storage should be balanced to a great extent. Rain water storage systems to collect water are internally engineered into the buildings to save water.

All the components of green buildings work by principles that should be strictly adhered to. The first is the prevention principle. The detailed principle here speaks of trying to avoid a lot of waste, material wise, energy wise and water bound wise. The second principle is the reuse of waste. Waste that has been produced should be able to go back into the system and reused.

Recycle waste that can be reused again. The third and final principle is the proper disposal of waste. It should have proper bearing of disposal as this is key to sustainably protecting the environment.

2.6 LIFE CYCLE IMPACT OR ASSESSMENT OF GREEN BUILDINGS

This refers to an internationally accepted module for determining the impact of materials including other building products over the entire building cycle, from extraction to harvesting to processing and more. The assessment is done to allow customers and contractors to make informed decisions during the process of design and building. It does this by compiling an inventory of necessary inputs of energy and their resultant environmental output. It further evaluates the potential environmental impacts associated with identified inputs. The results are then explained afterwards to make meaningful informed decisions.

2.7 DUTIES OF THE CONSTRUCTION MANAGER

According to Garold (2000), the construction manager is part of the three-principal project participants and, most important of them all. The construction manager has the responsibility of performing all work in accordance with the contract documents that have been prepared by the designer. The construction manager plays a pivotal role since construction phase is important because most of the project budget is extended during construction (Garold, 2000)

In Strand (2002), the construction manager has been described as an agent of the owner. However, most literature defines construction manager's functions as involving the effective and efficient use of available funds, proper control of the project scope to avoid scope creep, improving construction designs and quality of construction, avoiding delays as well as ensuring

flexibility contracting procurement. This therefore means communicating project information to the project manager is very important and cannot be overlooked. Conventionally, such information was usually obtain from blueprints, reports, periodic meetings and work schedules. Based on these information construction managers are able to coordinate the construction processes (Yalcinkaya and Arditi, 2013).

In Rasmus (1981), the construction manager's duties were given as follows:

- The construction manager consults and coordinates with other members of the professional team. Preparing and updating details of the construction program,
- Arranging for advance ordering and preparing materials and component flows,
- Taking tenders from suppliers and contractors
- The construction manager evaluates tender presented and make recommendation to client's team, he also coordinate the activities of works contractors to ensure that work is carried out in accordance with the master plan
- Construction managers also make arrangement for what site activities are required and their locations.

Sjostrom and Bakens (1999) posited that the activities of construction managers should be considered especially in green structures for their activities have major impact on the environment.

2.8 GREEN BUILDING CONSTRUCTION MANAGEMENT

To be able to understand the concept of managing green construction, it is better to explore and manage the "Critical Success Factors" (CSF) needed to enhance the environmental performance

of building projects. According to Sjostrom and Bakens, (1999) the ‘iron triangle’ approach is used to measure the success of the project, thus cost, quality and schedule of conventional projects rather than the green building itself. Ofori (1992) on the other hand suggested the relevance of adding environmental dimension in measuring the project success. Hwang and Ng (2012) reveal that not much research has been conducted on green building management. The following are the five core value added processes that contribute to delivering green buildings (Lapinski et al., 2006);

- the decision to adopt and evaluate sustainable objectives very early in the process, even as early as capital budgeting,
- to align the sustainable objectives of the business case of the project
- The identification and pursuit of building features that naturally align with sustainability
- to select an experienced design and construction team early in the project; and
- by investing time to align individual team goals with project goals.

To successfully manage and deliver green building projects, Korkmaz et al. (2010) examined some important factors that were considered independent variables which include; owner commitment, the project delivery system, project team procurement, contract conditions, design integration, project team characteristics and the construction process. On the other hand cost, schedule, sustainability and quality were considered as dependent variables. The timing and involving participants in the project delivery as well as owner type were considered as one of the most relevant factors for project outcome. Moreover, Horman and Enache-Pommer, (2009) posited that, owner commitment, early timing of participant involvement and expertise on sustainable delivery of green buildings are considered as the top three attributes. To achieve a

sustainable, high performing building project, project delivery systems such as design bid-build (DBB), construction manager at risk (CMR), and design and build (D and B) were investigated by Molenaar et al. (2009). Organizational management practice (which include effective feedback, providing adequate communication channels and troubleshooting) must be effective in other for managements to incorporate environmental performance adequately into the buildings performance (Molenaar et al., 2009).

Cam and Ong (2005) argued that one of the ways to ensure sustainable structures is innovative designs. Project managers are at the fore front in ensuring this innovative design. The authors argued that project managers have to set benchmarks for building environmental practices to safeguard the minimum performance standards and evaluate architectural design against these benchmarks, to provide a platform to inspire new designs and finally to raise awareness of institutional setting for the need for the construction sector to deliver an environmentally friendly design.

Project management success factors were identified by Munns and Bjeirmi (1996) as;

- effective and adequately flow of information
- commitment to complete the project within the stipulated schedule,
- careful planning of project activities,
- dynamism to accommodate frequent changes,
- readiness to innovations and compensating employees whenever necessary.

Chan et al., (2004) investigated D and B projects and these six set of success factors were identify among 31 factors as the most significant factors for the success of the D and B projects;

- contractor’s competencies,
- competencies of client
- commitment of team members
- risk and liability assessment,
- end-users’ needs, and
- constraints imposed by end-users.

Finally, project team commitment, client’s competencies, and contractor’s competencies were found to be most important factors for a successful outcome.

After reviewing several literatures related to Critical Success Factors in seven major management journals, a new conceptual frame work was proposed by Chan et al., (2004). These success factor were categorized under five major headings that is;

- Project procedures
- Project management actions
- Human related factors
- Project related factors and
- External factors

2.9 TECHNIQUES FOR GREEN BUILDING CONSTRUCTION MANAGEMENT

The emergence of the concepts of sustainable design and high-performance buildings in the 1990s have been furthered to the point of developing assessment tools to evaluate the performance of structures. These tools have contributed to the emergence of this field and provide a way of communicating with building owners and managers, architects, builders,

interior designers, landscape architects and others interested in the built environment. Several tools and techniques have been developed to assess the design and constructed structures. Todd et al. (2001) posited some of such tools to include Building Research Establishment Environmental Assessment method (BREEAM UK), Leadership in Energy and Environment Design (LEED) rating system for commercial buildings, EcoProfile, ESCALE and EcoEffect. Todd et al. (2001) further indicated that the techniques used for the assessment of green buildings are based on the breadth, inclusiveness levels and increasing order of inclusiveness. .

Cooper (1999) pointed the necessity to include sustainability issues into the methods for assessing green buildings. The author argued most of the valuation methods have prioritizes the increased level of environmental enhancements intended to yield green structures. Such sustainability concerns include economic and social concerns in addition to the ecological features of sustainability (Cole, 2000).

According to Ali and Al Nsairat (2009), the need for green assessment in the planning/construction process can yield substantial welfares. The authors indicated that valuation dimensions on the bases of building lifespan can yield substantial lasting welfares for building proprietors and inhabitants. Some of the benefits include reducing environmental effects, generating improved and extra industrious places, solving existing construction problems and reducing building operations cost. In addition to this, life cycle cost includes all cost of obtaining, possessing and selling a building.

The building sector uses dual kind of valuation methods. The first is based on purely criteria system and the second uses life cycle assessment (LCA) methodology (Ali and Al Nsairat, 2009). The system-based criteria method describes the process of allocating point values to a

designated number of constraints on a scale sandwiched between small and large environmental effect. These methods are deemed as environmental valuation methods. Examples of the criteria-based methods are BREEAM (Great Britain), GBTool (Canada), LEED (US), EcoProfile (Norway and Environmental Standing (Sweden)

Improvements in environmental assessment from the 1990s have seen a growth in the building division. This assessment is founded on LCS and it is objective is to help in the selecting of designs for buildings, construction materials and indigenous usefulness selections throughout the planning phase. One improvement of this method over the environmental assessment tools is that within lifespan valuation, dissimilar weighting procedures founded on dissimilar grounds for assessment are employed. Bees (USA), Beat (Denmark), EcoQuantum (Netherlands) and KCL Eco (Finland) are examples of tools that contain LCA components.

Other framework for classifying green building valuation methods was setup based on the possible roles of the methods. This categorization groups building valuations using binary kinds of tools. The first is the D-tools. They are tools inside the investor and building process category that are planned mainly to enhance, hand-picked, crisscross, envisage and assess decisions and also include matters, gives an account of the methods of green building procedures which results in certain performance goals. The second is P-Tool; a tool inside the performance class that are planned for performance assessment and ranking (Ali and Al Nsairat, 2009).

2.10 GHANA GREEN BUILDING COUNCIL

The Ghana Green Building Council is a non- profit association and private public firm that is aimed at supporting the creation of sustainable buildings in Ghana through practices that conserve energy, reduce water consumption, proper resource administration and cost-effective

techniques. The Ghana Green Building Council (GGBC) provides Ghanaians with management openings, access to funds and tutoring to all investors in the construction business to aid in the process of change in the direction of sustainability. Its undertaking is to transform the construction environment in the country towards sustainability.

2.11 MERITS OF A GREEN BUILDING

Green building enhances the human wellbeing, communal, ecological health and the cost of living (Adler, 2006). Smith et al. (2006) indicated that a major factor in the idea of sustainable building is green building. The author suggested green building should not be taken to be a mere assemble of new supplies, know-hows, and extra parts of environmental welcoming inventions but rather an all-inclusive approach toward achieving the idea of justifiable growth in the project lifetime together with project scheduling, proposal, building and functioning. Green building has the possibility of improving the welfare and budget of consumers and enterprises because of enhanced construction performance, and also helps create extended tenure aids on the economic scale due to the decreased discharges and consumption of resources that exist naturally.

2.11.1 Energy Savings

It was evident in a U.S Green Building Council (USGBC) report in 2006, that the usage of natural resources, the production of waste and pollution and the efficiency and wellbeing of people all had substantial effects on developed environments (UNEP). In 2002, the United State of America had residential buildings in excess of 76 million and more than 5 million commercial buildings (Department of Energy, United States Green Building Council, 2003). The statistics shows that the developed environment in the United States of America is responsible for 30% of greenhouse gas discharges, 12% of clean water usage, 70% of electrical energy usage, and 39%

of the entire energy consumption (United States Green Building Council). Additionally, buildings use 30 to 40% of the entire main energy worldwide (UNEP, 2007).

Green design includes energy proficiency and related procedures, this aids in the reduction of energy which is a significant and widely known cost of building operations as indicated by (state the tittle of the book). According to a study conducted regarding buildings in Massachusetts buildings, the cost of energy generally for a year is about $2.00/ft2. Typically, the amount of energy used by green buildings is 30 % lesser than that of conventional buildings. Base on this, a decrease for a 100,000 ft2 office of the state, valued approximately at seven hundred and fifty thousand (750,000) dollars. This savings is categorized by reduced electricity consumption and the capacity to produce renewable energy.

2.12 CHALLENGES IN THE CONSTRUCTION OF GREEN BUILDINGS

Challenges act as obstacles in the construction of green buildings. These challenges need to be identified and tackled so as to improve upon the current green building construction.

2.12.1 Higher Costs for Green construction practices and materials

The cost of constructing green buildings is higher than conventional buildings with a difference between 2% and 25% (Tagaza and Wilson, 2004). Zhang, Shen and Wu, (2011) posit that green buildings are expensive as a result of the complexities in the building design and the modeling of green practice incorporated into the project. Hwang and Tan, (2010) attribute the higher cost of green buildings to the technology used as well as the cost of green materials. Zhang, Shen and Wu (2011) continue that the cost of building materials for green buildings are 4% higher than conventional buildings, more so the cost of green boards alone is 10times higher than the ordinary boards used in conventional buildings. This higher cost of green construction affects the overall budget of the project.

2.12.2 Technical Difficulty during the construction process

Green construction requires complex techniques and building designs (Civil Exchange, n.d)). During green construction, mangers performance can be adversely affected if he fails to address these complexities. Tagaza and Wison (2004) revealed complexities and technical difficulties as the main constraints of green projects. The presence of complex materials and systems makes the design and construction of green projects more complicated and complex (Hwang and Tan, 2012).

2.12.3 Risk due to different contract forms of project delivery

The success of the development and implementation of green design heavily depends on the type of contract selected for the project deliverables (Tagaza and Wilson, 2004). The type of contract selected must fully incorporate green designs. Huge problem may arise in the implementation of the project if there is a design locked prior to the actual design of the green project. The higher cost of green buildings can be attributed to the many changes which are required at different stage of the project (Hwang and Tan, 2012).

2.12.4 Lengthy approval process for new green technologies

According to Tagaza and Wilson (2004) the planning process of green buildings are usually prolong due to the steps to follow before approving green projects taking into consideration new technology and materials. As result approval of green designs needs additional time as compared to conventional designs. Hence there is always the challenge of delayed time and additional time which managements have to deal with and this intern affect payment time of suppliers and dealers (Ling, 2003). Tagaza and Wilson (2004) recycling materials can be lengthy due to protracted planning process. Likewise, research reveals that additional time is required before green designs can be approved (Zhang, Shen and Wu, 2011; Eisenberg, Done and Ishida, 2002).

2.12.5 Unfamiliarity with green technologies

Ishida and Eisenberg (2011) revealed unfamiliarity with green design and inadequate knowledge with green systems and designs as the two main hindrances for the approval of green projects. As compared to the technology used in conventional projects green projects uses more sophisticated technology and materials (Tagaza and Wilson, 2004). Another research conducted by Zhang, Shen and Wu (2011) revealed the same findings. Moreover, Hwang and Tan opine that unfamiliarity with green design and inadequate knowledge with green systems and designs may affect the outcomes of green projects.

2.12.6 Capacity Barrier

CIB reported in 1999 that lack of capacity of contractors to implement sustainable practice possess one of the most critical barriers to green construction. Hakkinen and Belloni (2011) also added that lack of understanding of sustainability and its relevance can be an obstacle to green projects. Designers boost with confidence in their ability to use knowledge in general but this falls short when matters of sustainable issues are being addressed (Rydin et al., 2006). This therefore means that professionals of the built environment must acquaint themselves with the principles of sustainable construction practice and how it is implemented. Djokoto et al. (2013) suggest that not only must professionals be knowledgeable, but also they need to foam an integrated team from conception to inception with the following team members on board; owner, contractor, project manager, architect, civil engineer, structural engineer, service engineer, building surveyor, environmental engineer, cost planner and landscape consultant.

2.12.7 More time required to implement green construction practices on site

Tagaza and Wilson (2004) opine that, it is required for construction managers to do random checks and visits site to ensure that implementation of projects is following sustainable practices as expected. This is very important as worker can forgo sustainable practices because of its time-consuming nature when there is time pressure to complete the project.

2.13 STRATEGIES FOR THE DELIVERY OF GREEN BUILDINGS

2.13.1 Materials

BRE (2000) define construction to entails the extraction of metal ores, aggregate and minerals from the ground, and the consumption of such substances could also mean that they will be unavailable for future generation. Timber for instance is being extinct due to deforestation. Moreover, manufacturing process may pollute the environment and consume substantial amount of energy. It is therefore important to use green product which uses less energy and poses less risk to the environment (BuildGreen, 2008). The first most important thing to consider in green project is specifying the selection of less hazardous materials for manufacturing through to the projects recycling

2.13.2 Transport

WBDG (2006) opine that specifying local materials can aid in minimizing transportation impact which include air pollution, consumption of fossil fuel and labor. It is noted that this principle is generally true for countries with vast land where construction materials are spread across in the country but these attributes are not true about developing countries.

2.13.3 Embodied Energy

Embodied Energy of a building material is said to be the total primary energy consumed from manufacturing through to disposal that is from 'cradle to grave' (GreenSpec, 2008). According to Canadian Architect (2008) 'Recurring embodied energy' is the energy consumed in refurbishing, maintaining, restoring, repairing or replacing materials during the life of the building. It is not practical to actually specify the numerical value of embodied energy in construction; however, the principle should be reflected in the selection of building materials. .

2.13.4 Use of recycled materials

It could be more relevant to design buildings which could be easy recycled than to use materials which required less energy for production (Thormark, 2000). Building Green, (2008) suggest that in some instances recycling product such as rubber flooring which has the potential of emitting harmful chemicals should be specified and indicated where it should be used to minimize its impact. In countries like Hong Kong, the government through the publication of standard specification specifies the use of recycled aggregates for concrete and paving blocks.

2.13.5 Manufacturer's Information and certification

Contractors are required to submit manufactures information and certificates for thorough checking in conventional prescriptive specifications. This is very critical especially when using recycled products and moreover statutory bodies will want to ensure that the product use have minimal impact in the environment. Also, consumers would want to ensure that by using recycled product the quality of their building is not compromised. Van Eijk and Brouwers (2002) indicate that all these can be achieved by adopting clear and unambiguous certification system.

2.13.6 Applicable published standards for materials

Construction standards are written documents intended to govern on a mutual terms of the processes for which they were drawn. Piper, (2003) suggest the following components to be included in the document: preferred processes to be used for execution, allowable materials properties, requirements for prescribe testing etc. ASCE (2000) opine that standards is a good specifying approach since once they are widely used, it will be familiar to those involve. Lam et al (2009) indicate that the specifier should be conversant with the standards that are being referred to in order to avoid incompatibility or options being missed.

2.13.7 Additional tests for greenness/suitability on materials

When there is no manufacturer's certificate available for some natural materials, tests should be specified to enable verification of compliance with relevant standards, or even in their absence, with the desirable properties required by the designer. Green buildings are increasingly gaining acclaimed status through environmental assessment schemes (such as Green Star in Australia, BREEAM in the UK or LEED in the US and Canada), which may impose some criteria (such as percentage of recycled content or toxicity level) for verification. In the case of Hong Kong, the HK-BEAM assessment scheme requires demonstration of no fire hazard for bamboo flooring and partitions (HK-BEAM Society, 2004), the acceptable test for which is not specified and presumably the specifier needs to include a test acceptable to the local fire authority for the contractor to comply.

2.13.8 Waste Management plan for surplus/residue

Waste includes any scrap material, effluent or unwanted surplus substance or article that requires to be disposed of because it is broken, worn out or contaminated (Micklethwaite, 2004). Waste

Management should be part of a contractor's environmental management plan. Most countries have limited landfill capacity. Hence, the proper disposal or treatment of construction and demolition waste has to be effected partly by regulations and always beneficial through contract specifications. In some countries like Hong Kong, designated deductions are effected from payments should specified action not be taken.

2.13.9 Procedures of application to minimize pollution during construction.

There are a number of impacts on the environment during construction Cole (2000). Some of these impacts include: discharge of waste water, excessive noise, fumes and dust from asphalt heating and the like. HK-BEAM therefore suggests "specification of measures to reduce water pollution during construction". LEED and BREEAM also suggested similar incentive to mitigate the hazardous materials being released into the environment. During the design of these projects procedures to prevent pollution should also be specified.

2.13.10 Protection measures to vulnerable parties/structure

It is very important to take remedy actions on site suspected or known to be polluted. However, Tilford et al., argue that this may take huge time and cost. According to Cole (2000), specifications can be employ by construction stakeholders to as a preventive strategy to minimize health hazards on its occupants and surrounding environment. Example of such specifications include: providing enough ventilation and specifying respirators for paints.

2.13.11 Recycling practice/instructions

Generally, when the method to be used for recycling of the product is not suggested by the contractor, the designer have specified what to be achieve and how to achieve it. Research reveal that limited space in Hong Kong is a hindrance in recycling construction waste (Tam and Tam, 2005). Mobile crushing plant or temporary off-site storage facility maybe needed for effective sorting of waste. This instruction should be specified where ever possible and it should be flexible enough to allow innovations.

2.13.12 Indoor and outdoor air quality

Usually the materials section specifies that material containing VOC minimized all totally replaced. Outdoor air quality maybe affected during construction by dust and fumes whiles indoor air quality (IAQ) maybe polluted due to emission from VOC materials such as paints, adhesives and sealant. Where the use of these materials cannot be avoided no matter what, indoor and outdoor air quality should be constantly monitored so that necessary action can be taking to avoid hazardous impact to workers and adjoining occupants. One of the precautions to take in the event of compact fluorescent lamps (CFL) breakage is shutting down air-conditioning and provision of enough ventilation (U.S EPA, 2010).

2.13.13 Additional Acceptance tests on completion of works for verifying green effects

Davidson (1996) explain that once all the necessary pre-commission checks are carried on the building to check if the building meets all the specifications and drawings, commission tests are then carried out to ascertain whether the building will be accepted or rejected. Some government for instance has implemented a voluntary certification scheme for promoting good 1AQ in public

spaces and offices. With this arrangement the certificate have initial validity of 12 months with 5 years' renewable interval thereafter. More focus is put on post-certification management of 1AQ by building managers or owners. Roof test is conducted by measuring the temperature above and below the roof desk to ascertain whether they fall within the required range. Moreover, green materials can be pre-tested before installation

2.13.14 Instructions for maintenance and operation

Green materials like any other construction materials need maintenance during it life span. However green materials unlike the conventional building materials needs less maintenance in its service life. Example of such maintenance activities include; preventive maintenance and cleaning of lighting and air condition systems to maintain their energy efficiency. It is noted that green product needs careful maintenance to enable the product to be used in its intended period. Another example worth of mention is regular cleaning of waterless urinals, which require special skills to change the cartridges. Non-toxic detergents are required in cleaning some of the green products. For green carpets for instance to last longer, walk-off mats should be specify at the entryways to save the carpet from soil. Specifications are also needed for green roof and vertical green walls for regular irrigation of vegetation underneath.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter has been dedicated to discussing methodological issues. Further, research approach, research strategy, research design, research methods, source of empirical data and design of interview guide as well as study's population sample have all been captured and expounded so as to achieve the set objectives for this study. Finally, how empirical data gathered from respondents were analyzed has also been addressed.

3.2 PHILOSOPHICAL CONSIDERATIONS

Research philosophy can be defined as the method of developing the research knowledge and the research background based on which research is conducted (Saunders and Thornhill, 2007). Research paradigms aid is explaining research philosophy. Research paradigm is explained as a broad framework which house beliefs, perceptions and understanding of research theories.

3.2.1 Epistemological Considerations

Epistemology indicates the validity, limits of inquiry and nature (Campana, 2010) buttressed by Hughes et al., (1997) in the statement "How probable it is without difficulty to have access to the knowledge of this world?", Sarantakos (2005) describes epistemology as a philosophical branch of research which controls the processes of knowledge acquisition combined with its validation. Epistemology also spells out the mechanism acquiring knowledge and its validation (Gall et al., 2003) which Babbie (1995) simply puts it as the science of knowing. Epistemology is a

philosophical branch which concerns itself with what is right for an individual; positivism and interpretivism (Snape and Spencer, 2003).

3.2.2 Ontological Consideration

An ontological position enables the researcher to choose whether the realities are external and objective to the researcher or it is socially constructed (Collis & Hussey, 2003; Thurairajah, *et al.,* 2006).Ontology can also be described as "the product of one's mind". The view of reality which is based on a researcher's assumption plays a critical role in all other assumptions and also serves as a basis for various assumptions, what is assumed aids in the prediction of the researcher's other assumption (Creswell, 2009).

3.2.3 Axiology

Axiological positioning is associated with values. Creswell (2009), established two core values associated with the axiological consideration namely "value—freedom" and "value-laden". Saunders et al. (2009) defines axiology as the value of knowledge and perspective of the researcher on the role of value in the research. Axiological positioning is concerned with values. Axiology considers the philosophy surrounding the reality, as to whether research philosophy is 'value free' or value driven. If the choice for what or how to study is examined by an objective criteria, it can be described as value free research. On the other hand, value laden is driven by subjective criteria. (Pathirage, Amaratunga and Haigh, 2005). In value-laden research, the researcher is inspired by their own skill, beliefs, interests and values that result in the innate biases of what and how to study. The value-free research is where what to study is not then determined by human beliefs and interests.

3.3 RESEARCH APPROACH

Saunders et al. (2009) defined research approach selection is tied to the research paradigm. Bryman and Bell (2015) also asserted that, the research strategies used including the method engaged to undertake these strategies gives description to the complete way to view research approach. According to Saunders et al. (2012) and Bryman and Bell (2015), research approach can be categorized into three separate approaches namely; deductive, abductive and inductive.

3.3.1 Deductive Research Approach

This approach according to Saunders et al. (2012) involves a theory development that has been subjected to a thorough test. Deductive research approach is more centered on hypothesis development that is grounded on other theories, then after tested using a designed research strategy (Wilson, 2010). Thus, this research approach is the most popular in the natural sciences according to Collis and Hussey (2003). Saunders et al. (2009) postulated that deductive research approach owes more to the positivism approach especially when it is attached to different research philosophies. Though such classification is misrepresented theoretically and poses no real practical value. According to Baxter and Jack (2008), the deductive approach, is also referred to as quantitative method. A key characteristic of deductive approach is that concepts need to be operationalized in a way that enables facts to be measured quantitatively. Additional, with deductive approach, the principle of reductionism is followed (Saunders et al. 2012). The deductive approach is more generic and requires a considerable data (sufficient numerical size). Oppenheim (2003) stressed that, survey instrument such as a questionnaire and or a statistical test is considered appropriate using deductive approach and the key instrument used involving sampling for its collection of data to take a broad view of drawing inferences.

3.3.2 Inductive Approach to Research

Inductive research approach involves the case where the researcher gathers information for the purpose of developing a theory (Saunders et al., 2012). With this result, this approach involves theory development by empirically observing reality as well as inferring broad interpretations from precise occurrences (Neuman, 2002). Inductive research approach is targeted to engender meanings with respect to data set gathered to identify relationships and patterns to build a theory. Again, this approach is primarily tied to the context in which the study's background is placed (Saunders, 2011). Consequently, a small sample of subject becomes more apt as compared to a large sample size. According to Easterby-Smith, Lyles and Tsang (2008), researchers are more likely to use qualitative data with inductive approach and employ various methods in gathering data so as to ascertain different opinions of phenomena.

3.3.3 Abductive Research Approach

The abductive research approach is basically used to address the weaknesses accompanying deductive and inductive research approaches. Clearly, with respect to deductive research approach, it is criticized for the lack of precision as to how to select theory for testing in the formulation of hypothesis. Conversely, the inductive research approach is criticized of the view that, no empirical data could essentially facilitate theory building (Saunders et al. 2012). Dudovskiy (2016) asserted that, abductive research approach is not different from the other approaches as it is applied to construct theories and to make logical inferences. Researchers in most cases stick to the application of deductive and inductive approaches as the application of abductive approach in practice is very challenging.

3.3.4 Research Approach Used

This thesis made use of the inductive research approach as the study intends to make use of considerable data which will support the study's adoption of qualitative method of analysis. The study employed also inductive reasoning which builds theories based on identified relationship and patterns (Saunders, 2011).

3.4 RESEARCH DESIGN

The guidelines for guiding a research to the extent that the research variables can be controlled to make available answers to the research questions is termed research design (Kallet, 2004). Malhotra and Burks (2007) stressed that, research design makes provision for procedural information needed to attain information required to solve the research problem. This research adopted descriptive research design so as to give a clear picture of the situation as it naturally happens. That is, situations are in most cases described using this type of research design. For descriptive research design, the basic element of measurement includes persons' profile, situations or events. Descriptive research design is used in the justification of contemporary practices, make judgment as well as develop theories. An interview guide was used in this case to address the set objectives.

3.5 RESEARCH STRATEGY

Saunders et al. (2009) draws no clear distinction with regards to research design and research strategy. Nevertheless, their study made a precise emphasis indicating how the choice of research strategy is guided by the research questions including the set objectives for the study. That is, research strategy constitutes the plan which provides mounting answers to the listed set of

research questions. Likewise, Remenyi et al. (2000) emphasized that, research strategy provides a direction along which research is conducted. Yin (2003) and Saunders et al. (2009) made it clear there exist big overlaps considering that there are various types of strategies for research. However, the contemplation would be to choose the appropriate strategy. Saunders et al. (2012) asserted that, research strategy can be grouped into seven (7) different strategies. They include; grounded theory, experiment, action research, survey, ethnography, case study, and archival research. As already indicated, the choice of these strategies has more to do with the research objectives as with the research questions. This study adopted the survey strategy as a result of its strong relation with the inductive logic.

3.6 RESEARCH METHODS

A coherent research method stands key for conducting a research. Fellows and Liu (2015) define research methodology as the ethics and measures of logical thought applied to a scientific investigation. The three-advance methods of research are: qualitative, quantitative and triangulation/mixed methods. There have always been contradictions on the most reliable and appropriate method in undertaking any research activity. Within the mid of 19th century and 20th century, qualitative research methods have proliferated providing sound and statistical evidence to the field (Chan et al. 2003). Some researchers however have also focused on both the quantitative and qualitative methods to collate relating information with practice by looking for critical success factors, including formulating conceptual and practical models of construction partnering (Cheng, 2004). Consequently, there is the need to identify the definitions of these very important terms (qualitative, quantitative and triangulation/mixed) as was adopted for this study.

3.6.1 Quantitative Method of Research

Creswell (2009) defined quantitative research method as the means of testing objectives theories by examining the relationships among variables. Li (2012) also asserted that, quantitative research method makes use of experimental methods and thus aims to test hypothetical generalizations for a large sample size. Quantitative research method is considered a systematic research with a structured approach. Again, quantitative research method is employed to measure and as well explain the phenomenon with the use of statistical analysis of the data collected. According to Yin (2015), researchers often employ this method when their objective is to get answers to the questions like how often, how many, how much etc. This method gathers information which can be numerically examined, and the findings of which are generally presented using descriptive statistics, graphs and tables. Saunders et al. (2012) stated that, quantitative research makes use of questionnaires, surveys and experiments to gather information that is revised and tabulated in numbers. In most cases, quantitative research methods are deductive, which involves the development of a theory that is subjected to a thorough test.

3.6.2 Qualitative Research Methods

According to Creswell (2009) qualitative research method is a means for investigating as well as understanding the meaning of groups or individuals assign to a social or human problem. Denzin and Lincoln (2000) stated that, qualitative research includes an interpretative, naturalistic style to its subject matter, subjects' actions and their verbal statements are what is being analyzed for meaningful interpretation. Thus, this method is grounded in practical investigation and evidence. Qualitative research method represents the views and perspectives of the people by establishing the contextual conditions (Li, 2012). Further, it gives insight into present or developing concepts by striving to combine diverse sources of evidence than relying on a single source. They were

also framed as a case study and a summary rather than to show a group of numeric data. Qualitative research methods are also inductive in nature. This method answers questions like how, why and what (Yin, 2015). The researcher obtains resulting information directly from observing the behaviour of human, written opinions, public documents and interviews.

3.6.3 Triangulation/Mixed Method

An approach or inquiry combining or associating both qualitative and quantitative forms (Creswell, 2009). This approach does not put any limitation on the use of methods across the quantitative and qualitative school and provide complementary advantages (Ng and Han, 2012). Through the use of this method researchers can achieve purposes of triangulation (for convergence and corroboration), complementarities (employ additional methods for elaboration and clarification), development (employ the result of one method to inform the other), initiation (identification of inconsistencies for reframing), as well as expansion (by employing different methods for different aspects).

3.6.4 Research Method Adopted for the Study

This research adopted qualitative method to identify the challenges as well as the strategies to aid the development of guidelines. The interview guide was developed to capture a specific set of challenges encountered in the green construction industry in Ghana. Again, to identify the requisite skills or knowledge a construction manager must poses in order to successfully execute a green building. Also, the interview guide contained questions to identify the main dissimilarities between managing the construction stage of a green building and that of a conventional building.

3.7 DESIGN OF RESEARCH INSTRUMENT

Xiao (2002) indicated that, response to research on construction management in the construction industry is relatively low. An interview guide was designed to suit the aim and objectives of this study. The interview guide consisted of two sections, that is, Part 'A' and 'B'. The first section (i.e. Part 'A') captured the profile of respondents as it looked at the respondents' contextual background information. The second section being Part 'B' was designed to capture questions regarding the drivers of green construction, materials used in the construction of green buildings, the challenges encountered during green construction and the skills and knowledge needed for the green construction.

3.7.1 Interviews

Construction Managers with relevance experience with green building construction were contacted to partake in this survey. The interviews were scheduled per the time and date given by the construction managers. These interviews were conducted fact-to-face within approximately 30 to 45 minutes. The interview followed the semi-structured interview guide in which the interviewer asked the questions and the interviewees responded. The interview session was recorded with an audio recorder and hand written notes were also taken and transcribed using MS Word 2016 which was later analyzed with NViVo software.

3.8 STUDY POPULATION

The study population for this study was construction managers with experience in both green building construction and conventional projects as well.

3.9 SAMPLING TECHNIQUES AND DATA COLLECTION

Sampling provides the means by which data is collected from a sub-group rather than the entire population (Saunders et al., 2009). The purpose of sampling is to obtain a manageable size of the population for the study (Kothari, 2004). Sampling techniques are divided into probability sampling and non-probability sampling. Probability sampling is considered as the best because it mitigates the possibility of unrepresentative sample. Non-probability sampling techniques have the likelihood of each case being selected as unknown (Saunders et al., 2009). Probability sampling are simple random, stratified random sampling, systematic sampling and cluster sample (Fellows and Lui, 2008; Saunders et al., 2009). Non-Probability sampling techniques are quota, snowball, purposive, and convenience sampling. Hence, the sampling for this research was purposive sampling specifically. The number of respondents for this interview were 6 construction managers. These construction managers were identified by contacting the managers of the green buildings in Ghana and also the certifying body in Ghana that is EDGE SGS who then gave out the names and contact information of the construction managers that worked or are still working on green buildings. The logical reasoning for selecting purposive sampling is to obtain in-depth and adequate information by purposively selecting the most viable sample. The selection criteria used in sampling the construction managers are;

1. The respondents must be Construction managers
2. Relevant experience in the green construction

3.10 ETHICAL CONSIDERATIONS

Confidentiality with regards to respondents was followed stringently. Respondents were also assured that the information they were offering towards this research will not be used against them. The study had no interference of the private affairs of the respondents with regards to the information offered. The principle of not revealing the identity of respondents was sustained throughout interactions with the respondents.

3.11 DATA ANALYSIS

According to Merriam (2009), verbatim transcribing of interviews provides a complete database for analysis. The transcribed data obtained from the interview were uploaded into the Nvivo 11 Pro Software. Deductive coding was then used by identifying portions of the transcripts that arises with challenges in green construction, skills needed in constructing green buildings and the strategies needed in constructing green buildings. These deductive coding was as a result of review of literature that enabled the researcher to identify portions of the transcripts that arose with literature. Also these codes emanated from the Nvivo software. Content analysis was used as a technique in analysis the responses from the interviewee. A picture of the word frequency which was run using the NViVo software is seen at the Appendix section of this report, where the biggest word means it was frequently used by the interviewees during the interviews.

Table 3.1 Criteria for Coding Frame Responses

Constructs	**Frame-related keywords**
Challenges	Higher Costs, Technical Difficulty, Inadequate, Risk, Unfamiliarity, Capacity, rigid, Lack, Strict, non-availability, low
Skills	
Strategies	Cost analysis, adequate spaces, adequate hoarding, airborne dust, green appliances,

	Recycled water, run-off water,
Green Practices	Waste management, recycle, rain harvesting, energy efficient lighting, greening
Strategies (Cost)	Cost analysis, dust prevention, recycled water landscaping,
Strategies (Health)	Hazardous, materials, ventilation, greening, chemicals
Strategies (Environmentally Friendly)	Soil erosion, waterway sedimentation, hoarding, grassing to prevent run off water

CHAPTER FOUR

RESULTS PRESENTATION AND DISCUSSIONS

4.1 INTRODUCTION

The chapter four presents the results, analysis, discussions and findings of the data collected. Analyses of responses derived during the interviews were analysed using Nvivo 11 Pro software. The discussions of the result were done according to the objectives.

4.2 DEMOGRAPHIC DATA OF RESPONDENTS

This section shares out profile of interviewees including the influence such attributes have on the study. The subsequent section also highlight further the analysis questions tied to specific objectives of the study in relation to the management of green buildings at the construction stage.

Table 4.1 Demographic Data on Respondents

Interviewees	Profession	Years Of Working Experience	Mode Of Interview
Interviewee 1	Assistant Project Manager / Commercial manager	15	Face-to-Face
Interviewee 2	Assistant Project Manager	10	Face-to-Face
Interviewee 3	Project Manager / Structural Engineer	12	Face-to-Face
Interviewee 4	Director / Project manager	15	Face-to-Face
Interviewee 5	Construction Manager	8	Face-to-Face
Interviewee 6	Assistant Project Manager (Ridge Hospital)	10	Face-to-Face
Interviewee 7	Country Manager, SGS/EDGE	13	Face-to-Face

4.3. DISCUSSION OF RESULTS

4.3.1 DIFFERENCES BETWEEN GREEN CONSTRUCTION AND CONVENTIONAL

Interviewees were asked to identify the differences between green construction and conventional construction. This is because as construction managers who have worked on green projects and conventional projects before, they would definitely know the differences between these two. Some of the responses are as follows.

Not much difference especially with the management. It's just more stressful than the conventional method. This requires a lot of meetings with stakeholders **(Respondent 1)**

The construction manager must adopt sustainable construction practices such as waste management, pollution, energy usage etc. which is most often not considered in the traditional construction **(Respondent 2)**

Like earlier said, this requires the use of new technologies which differs from the conventional methods. A construction manager must obtain constant training of these technologies as when they are available **(Respondent 3)**

Not much difference, one only needs to follow the manual from the certifying building which is not available from the conventional method **(Respondent 4)**

Not much difference, one only needs to follow the manual from the certifying body an example is when you want EDGE certification, you would definitely need a manual from Edge to guide you in the design and construction (**Respondent 5, Respondent 6, Respondent 7)**

4.3.2 Factors Pushing Professionals for Green Building Construction

4.3.2.1 Delays in Conventional Construction

Some of the interviewees mentioned delays in conventional buildings as one of the reasons in deciding to build green. Below are some of the responses.

In a typical conventional construction, the architects design the building and later gives it to the structural engineers for their designs as well, sometimes discrepancies in drawings causes the drawings to move frequently in between the designers until it reaches the contractor. This cause delays as compared to when in green construction, all the professionals involved are brought together at the beginning of the project in order to save time and avoid any delays at the pre-construction stage **(Interviewee 1, Interviewee 5)**

4.3.2.2 Client Requirement

Mostly clients request for green buildings because the donors that are funding such projects add them as a requirement. Below are some of the responses that emanated from the interviews.

Sometimes clients do request that we design their buildings to have some green building features especially energy efficient **(Interviewee 1, Interviewee 4)**

Some of the clients do not necessarily request for green building designs and construction unless the financier of such projects use them as a leverage before releasing funds for such projects. **(Interviewee 5).**

4.3.2.3 Company policy (Green building Company)

According to Chan et al (2016) good company image/reputation or marketing strategy' can also make GBTs attractive to market stakeholders. Stakeholders can gain good image and reputation by adopting green technologies. For instance, the application of technologies that have less impact on public health can help companies increase their public reputation and gain a green image. This can help them differentiate their products and hence enjoy certain market advantages, such as high sale prices (Chan et al., 2016).

There are some companies who have committed themselves in joining the movement of green building construction by dedicating their resources in training their workers so as to win contracts in green building. You know that there are few contractors in Ghana that can actually design and construct green buildings so the few companies that are able to launch themselves and prove to be efficient in green construction of buildings land themselves big gigs in the industry. **(Interviewee 4, Interviewee 5)**

4.3.2.4 Green building certifying body

Certifying bodies produce green building certification systems that are supposed to followed during their design and construction. The benefits that are derived from having your building certified also push people go in for green certification systems that would be used to design and construct buildings.

Certifying body exist because of their passion to make the world a healthier place to live. Also there are people who might want to be associated with either living in a certified green building and may want to have a proof of that. That is when the green building certifying body comes in **(Interviewee 1, Interviewee 6, Interviewee 7).**

4.3.3 Sustainable Construction Practices Mostly Incorporated In Projects

To identify the sustainable construction practices professionals normally incorporate at the construction stage, it was necessary to find out which practices interviewees deem environmentally sustainable. Thus, questions were asked to elicit for relevant and detailed data on the sustainable construction practices adopted during the construction phase. Though, interviewees indicated that there are no regulations or laid down practices however depending on what the key stakeholders require, some green building elements are incorporated in design. The subsequent list emerged from the interviews carried out with construction professionals:

i. *Waste management* **(Interviewee 1, Interviewee 2, Interviewee 3)**

ii. *Not using chemicals that may harm the living organisms* **(Interviewee 1)**

iii. *Planting as much as possible* **(Interviewee 1)**

iv. *Using recycled materials* **(Interviewee 4, Interviewee 3)**

v. *Using materials from renewable sources* **(Interviewee 4, Interviewee 5)**

vi. *Ensuring that pollution from the construction is kept to the minimum* **(Interviewee 4)**

vii. *Energy efficient lighting, refrigeration, AC* **(Interviewee 7)**

viii. *Using materials from renewable sources* **(Interviewee 6)**

ix. *Rain water harvesting* **(Interviewee 7)**

x. *Black and gray water recycling* **(Interviewee 7)**

xi. *Alternative building materials (environmentally friendly materials)* **(Interviewee 7)**

xii. *Water efficient fixtures* **(Interviewee 5, Interviewee 6)**

4.3.4 Challenges in the Construction of Green Buildings

4.3.4.1 Rigid project Requirements

In identifying some of the challenges encountered in green buildings, some of the respondents mentioned the rigidity of green project requirements.

The requirement required in green designs and construction are just too much which sometimes delays the construction. This is because until the designs are approved by the certifying body the next phase of the project cannot be proceeded **(Respondent 4, Respondent 5, Respondent 6, Respondent 7)**

No flexibility in construction as to delays (cannot break and resume later) **(Respondent 1)**

4.3.4.2 Inadequate Technical Capacity

According to Shi (2008) there are many architects and engineers who are experienced in project design and construction, few of them have education or training background of sustainable construction, let alone the green building assessment practice. Tagaza and Wilson (2004) asserts that compared with conventional technologies, green technologies are more complex and professionals do not have sufficient knowledge and are unfamiliar with the design, material and systems.

Most workers are not well trained in the methods of green buildings. This becomes a problem when you employ such people because instead of constructing according to schedule, more time would be spent in training them **(Respondent 1, Respondent 2)**

Managing your workers is a huge challenge as most of the workers do not understand some of these new methods of doing things **(Respondent 5, Respondent 6, Respondent 7)**

Not enough educated staff in green technologies and methods **(Respondent 4)**

4.3.4.3 Strict Requirements from Certifying Body

According to the Tagaza and Wilson (2004) The planning of green projects can be prolonged due to the approval of process of new green technologies and materials. A survey by Zhang, Shen and Wu (2011) showed that green design projects have strict guidelines that require additional time for approval than conventional designs. This is confirmed by the responses from the interviews conducted as indicated below.

Very strict supervision from the green certifying body to make sure that all the requirements are followed **(Respondent 1)**

Requirements from the green certifying body can be frustrating **(Respondent 3, Respondent 4)**

Green building requirements (construction manager has less control over say sitting of building **(Respondent 2)**

4.3.4.4 Non Availability of Green Materials

The challenge in scouting for green building materials deters individuals from investing in green buildings. The non-availability of green materials at the country of location for green buildings would mean they have to be imported from other countries which makes it a challenge for contractors to even bid for green building projects.

Non-availability of sustainable materials readily on the market is challenge to the green building industry. Because the green construction is still in the early stages in Ghana, there is a challenge in getting the specified green materials and technologies to be used in construction ***(Respondent 3)***

4.3.4.5 High Cost

Green projects are subject to higher costs than conventional building projects. Tagaza and Wilson (2004) stated that the cost of green building projects is 2% to 5% higher that of conventional projects.

The cost of green projects is expensive as compared to conventional buildings, especially if the materials and technologies needed in green buildings are not available in the country of construction. Also the overall cost of constructing green buildings is higher due to the types of materials needed. **(Respondent 1)**

4.3.3.6 Lack of Interest from real estate developers

Though green building has been regarded as a good thing, the real estate developers, designers, and contractors are only interested in if they can get more profit. Developing a project with high-level green building performance may not directly lead to an immediate payback (Shi, 2008). Except for some of the performance such as energy saving and indoor environment quality which are concerned by the consumers, the developers seldom really devote themselves to promote the life-cycle environmental loading performance of a building, notwithstanding they always boast they have developed a green building project in the advertisement (Shi, 2008).

There are many real estate agencies springing up and building more houses but none of these houses are green **(Interviewee 4,8)**

4.3.4 Strategies Adopted To Ensure The Delivery Of Green Buildings

Interviewees were asked to identify some of the strategies that they have adopted in the construction of green buildings that they have been involved. With the diverse responses that emanated from the interviews and how they categorized them, it was necessary to tabularize their

responses according to the categories which are cost, health, materials and environmentally friendly strategies. Table 4.2 is a list of strategies that emanated from the interviews.

Table 4.2 Strategies Adopted to Ensure the Delivery of Green Buildings

Cost Strategies	**Health Related Strategies**	**Environmentally Friendly Strategies**	**Materials and Technologies**
Cost analysis from several suppliers' tender **(Respondent 1, Respondent 3, Respondent 4)**	*Doing away with hazardous materials* (**Respondent** 1)	*Controlling soil erosion* (**Respondent** 1, **Respondent** 2)	*Stucco bond fibre was put into mortar to reinforce it* (**Respondent** 1)
Adequate supervision **(Respondent 1, Respondent 2, Respondent 3, Respondent 7)**	*Providing adequate spaces and ventilation* (**Respondent** 2)	*Waterway sedimentation* (**Respondent** 1, **Respondent** 2)	*Concrete walling system for walls and roof* (**Respondent** 1, **Respondent** 2, **Respondent** 3)
Budgeting for every specific task and not buying too many materials that will be left unused **(Respondent 1, Respondent 2)**	*Providing greens around and the building which would allow for fresh air* (**Respondent** 2)	*Reduction in airborne dust generation by using nets around the construction* (**Respondent** 1)	*New technologically accessed materials* (**Respondent** 3)
Not delaying in the delivery of the work **(Respondent 1, Respondent 3)**	*Mostly depends on the design, the construction manager has not enough control over the design. But the construction manager must ensure that, chemicals that may harm human life are not incorporated in the building* (**Respondent** 3, **Respondent** 4, **Respondent** 5, **Respondent** 7).	*Providing adequate hoarding* (**Respondent** 2, **Respondent** 3, **Respondent** 4)	*Certified green appliances* (**Respondent** 4, **Respondent** 7)
Analyzing the tenders of material suppliers **(Respondent 2)**		*Providing nets around the construction area to prevent dust from over spreading* (**Respondent** 3, **Respondent** 4, **Respondent** 7)	*Recycled water for landscaping* (**Respondent** 4, **Respondent** 6, **Respondent** 7)

Cost Strategies	**Health Related Strategies**	**Environmentally Friendly Strategies**	**Materials and Technologies**
Avoiding working overtime **(Respondent 2, Respondent 3)**		*Using carbon dioxide to controlling equipment and filters to reduce the emissions* (**Respondent** 5, **Respondent** 6)	*Heat reflective materials incorporated in the building to ensure that the inside of the building is cool* (**Respondent** 6)
Taking right measurements and buying adequate quantities (avoiding over quantities) **(Respondent 3)**		*Not using dilapidated equipment that will produce large amounts of fumes* (**Respondent** 5, **Respondent** 6)	*Reduced water for landscaping toilets* etc (**Respondent** 5)
Sticking to the works of programme **(Respondent 5, Respondent 7)**		*Avoiding the use of hazardous chemicals like anti-termites' chemicals* (**Respondent** 1, **Respondent** 2, **Respondent** 3, **Respondent** 4, **Respondent** 5, **Respondent** 7)	*Maximum usage of solar energy even during the construction* (**Respondent** 5)
		Adopting foundations types that reduces the extent of excavations (**Respondent** 1)	
		Reducing waste on site by using the right quantities of materials for activities (**Respondent** 3, **Respondent** 6)	
		Grassing to prevent run-off water (**Respondent** 3)	

4.3.5 Requisite Construction Management Skills for Green Construction

Adapting to the new productive environmental demands of society is not a new brand in the construction industry as positive building structures such as green buildings are already engaged in the system. Like earlier discussed in the preceding section, though managing green construction projects does not differ that much from managing the conventional, however, a project manager is expected to meet certain requirements in a manual provided by a certified body of green during and after construction. Meeting the requirements of green construction and that of conventional construction seems not to be the same and thus practitioners who wish to practice green may require additional management skills which this study sought to identify. Interviewees in this context where asked to highlight some of the requisite construction management skills a construction manager may need for successful delivery of green projects. The subsequent list emerged from the interviewees based on their professional expertise:

- *Knowledge in sustainability and sustainable construction*
- *Knowledge in lean construction*
- *Knowledge in value engineering*
- *Training in the systems of green technologies*
- *Ability to follow guidelines provided by certifying body*
- *Knowledge in green building materials*
- *Access to suppliers in green building materials* **(Interviewees' Responses)**

Table 4.3 Skills for Green Construction

Energy	Water	Indoor Air Environment	Materials	Land Use and Ecology	Pollution	Design
Maximum usage of solar energy even during the construction	Water Saving	Low-emitting Materials e.g. Paints and Coatings	Use of recycled materials as structural frame materials	Use land which does not contain old-growth forest	Reduction in airborne dust generation by using nets around the construction	Design for Disassembly
	Rainwater and Greywater usage	Low emitting materials like composite wood and agrifiber products	Use of recycled materials as non-structural materials	Reclaim Contaminated Land	Using carbon dioxide to controlling equipment and filters to reduce the emissions	
	Grassing to prevent run off water	Providing adequate spaces and ventilation	PVC Minimization	Recycled water for landscaping		
			Reducing the usage of non-renewable resources			
			Avoid the use of materials with Pollutant Content			
			Reducing waste on site by using the right quantities of materials for activities			

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter draws curtains on the entire study. It starts with a discussion on how each of the objectives were achieved and presented in the report. This is followed by a discussion on the contributions of the study. Recommendations, limitations and future work are also discussed.

5.2 SUMMARY OF FINDINGS

5.2.1 Objective One: To identify the the main dissimilarities between the management of conventional and green construction projects

This objective sought to identify the differences between green construction and conventional construction. This is because as construction managers who have worked on green projects and conventional projects before, they would definitely know the differences between. Some of the differences emanated from the interview were new technologies in regards to the green buildings, the use of specifications from a green certification system in regards to the green building, the use of integrated teams, precision needed when constructing a green building in accordance with the requirements of green buildings.

5.2.2 Objective Two: To identify the barriers/challenges in the construction of green buildings

From the interviews conducted it was realized that challenges that are faced during the construction of green buildings are Rigid Project Requirements, Inadequate Technical Capacity, Strict Requirements from Certifying Body, Non Availability of Green Materials, High Cost and Lack of Interest from real estate developers.

5.2.3 Objective Three: To identify the requisite construction management skills needed for the construction of green buildings

Some of the skills that this research could come out with were Knowledge in sustainability and sustainable construction, knowledge in value engineering, training in the systems of green technologies, ability to understand the guidelines provided by the certifying body, knowledge on green building, materials and access to suppliers on green building materials.

5.2.4 Objective Four: To identify strategies for the delivery of green buildings

Maximum usage of solar energy during the construction, rainwater and Grey water usage and recycled water for landscaping. Use land which does not contain old-growth forest, providing adequate spaces and ventilation, Design for Disassembly are among many other strategies that were identified as important in the construction of green buildings.

5.2.5 Objective five: to develop a guideline for managing the construction stage of a green building

Table 5.1: Guideline for managing the construction stage of a green building

Cost Strategies	Health Related Strategies	Environmentally Friendly Strategies	Materials and Technologies
-Cost analysis from several suppliers' tender -Adequate supervision -apply value engineering technique where necessary	-Ensure that chemicals that may harm human life are not incorporated in the building and also not used during the construction	-Controlling soil erosion -Waterway sedimentation -Providing adequate hoarding -Grassing to prevent run-off water	-Stucco bond fibre into mortar as a form of reinforcement -Using Certified green appliances -Use of recycled materials -purchase materials from renewable sources
-Avoiding working overtime -Sticking to the works programme	-Providing adequate spaces and ventilation	-Reduction in airborne dust generation by using nets around the construction	-Concrete walling system for walls and roof, MFE walling system, etc.
-Budgeting for every specific task and not buying too many materials that will be left unused (avoiding over quantities)	-Providing greens around the building which would allow for fresh air	-Providing nets around the construction area to prevent dust from over spreading -Reducing waste on site by using the right quantities of materials for activities	-New technologically accessed materials -Correct materials estimation
-Not delaying in the delivery of the work		-Using carbon dioxide controlling equipment and filters to reduce the emissions	-Recycled water for construction, toilets and for landscaping
		-Not using dilapidated equipment that will produce large amounts of fumes -Avoiding the use of hazardous chemicals like anti-termites'	-Heat reflective materials or Low heat emitting materials like composite wood and agrifiber products incorporated in the building to ensure that the inside of the buildings are cool to reduce the use of Air conditioners

5.3 CONCLUSION

In conclusion, there is the need for construction managers to have the necessary skills and knowledge in green buildings. Also strategies like the use of grey water, brown sites, adequate spaces, design to assembly and using low heat emitting materials. These strategies are useful in the construction of green buildings. Though there are similarities between green and conventional construction projects, however, green construction includes sustainable construction practices like waste management, minimum energy usage, pollution prevention etc. which lacking in conventional construction.

5.4 LIMITATIONS OF THE RESEARCH

- The study took into consideration green construction practices from the contractors' side without consideration of project clients and thus constitutes just a section of the whole project stakeholders.

5.5 RECOMMENDATION

The following recommendations are made with the findings of the study being in mind:

- Construction professionals must be trained in the required knowledge and skills areas needed in the construction of green buildings.
- For the enforcement of the stringent rules of green construction to be possible, materials should be made available to building professionals. Additionally, the support from government would popularize the concept of green construction.
- The authorities and bodies set up in Ghana to oversee the integration of the concept of green construction into our construction industry should be up and doing in the training of personnel and making available materials to be used in green construction.

REFERENCES

ABRI, 2003. Evaluation manual for green building in Taiwan, Ministry of Interior, 3rd Edition. Architecture and Building Research Institute, Taiwan.

Adler, N.J., (2006). The arts & leadership: Now that we can do anything, what will we do?. *Academy of Management Learning & Education*, *5*(4), pp.486-499.

Agyekum, K., (2012). Minimizing Materials Wastage at the Construction Stage of a Project through the Implementation of Lean Construction (Doctoral Dissertation, Department of Building Technology, Kwame Nkrumah University of Science and Technology).

Akashi, O., and Hanaoka, T. (2012). Technological feasibility and costs of achieving a 50% reduction of global GHG emissions by 2050: Mid- and long-term perspectives. Sustainability Science, 7(2), 139–156.

Ali, H.H. and Al Nsairat S.F., (2009). Developing a green building assessment tool for developing countries- Case of Jordan. Building and Environment, 44(5), pp. 1053-1064.

Allen, E. and Iano, J., (2011). Fundamentals of Building Construction: Materials and Methods. John Wiley & Sons.

Anantatmula, V.S. and Robichaud, L.B., 2011. Greening Project Management Practices for Sustainable Construction. *Journal of Management in Engineering Vol*, *27*.

ASCE (2000), Preparing Specifications for Design-bid-build Projects, Committee on Specifications, Construction Division, American Society of Civil Engineers, Reston, VA

Avots, I., (1969). Why does Project Management Fail? California Management Review, 12(1), p.77.

Babbie, E., (1995). The Practice of Social Research, 7th ed. Wadsworths Publishing Co., New York.

Baxter, P. and Jack, S., (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The qualitative report*, *13*(4), pp.544-559.

Berardi, U. (2011). Beyond sustainability assessment systems: Upgrading topics by upscaling the assessment. International Journal of Sustainable Building Technology and Urban Development, 2(4), 276–282.

Berardi, U. (2012). Sustainability assessment in the construction sector: Rating systems and rated buildings. Sustainable Development, 20(6), 411–424.

Bon-Gang Hwang and Jac S. T. (2012). 'Sustainable project management for green construction: challenges, impact and solutions' world Construction Conference 2012 – Global Challenges in Construction Industry 28 – 30 June 2012, Colombo, Sri Lanka

Bon-Gang Hwang and Wei Jian Ng (2012) 'Project management knowledge and skills for green construction: Overcoming challenges' International Journal of Project Management 31 (2013) 272–284

BRE (2010), "Mineral resource extraction", available at: www.bre.co.uk/greenguide (accessed 2 February 2010).

Bruce, M., Cooper, R. and Vazquez, D., (1999). Effective design management for small businesses. *Design studies*, *20*(3), pp.297-315

Bryman, A. and Bell, E., 2015. *Business research methods*. Oxford University Press, USA.

Building rating systems: A comparison of the LEED and Green Globes Building Research and Information, 27(4/5), 321–31.

Building Green (2008), Green Building Products: The GreenSpec Guide to Residential Building Materials, New Society Publishers, Gabriola Island

California Integrated Waste Management Board (CIWMB). (2008). Green Building.

Cam, C.N. and Ong, B.L., (2005), September. Building environmental assessment tools and the multidimensional pathways towards sustainable architecture. In *Proceedings of the 2005 world sustainable building conference (SB05Tokyo)* pp. 27-29.

Cassidy, R. (2003). White paper on sustainability. Building design and construction (p. 11). Reed Business Information. Available at: http://www.usgbc.org/Docs/Resources/BDCWhitePaperR2.pdf.

Chan, Edwin H. W., Queena K. Qian and Patrick T. I. Lam. 2001. "The market for green building in developed Asian cities—the perspectives of building designers." Energy Policy 37 (8): 3061 -3070. doi: 10.1016/j.enpol.2009. 03.057.

Chaudhuri, A., Sopher, B. and Strand, P., 2002. Cooperation in social dilemmas, trust and reciprocity. *Journal of Economic Psychology*, *23*(2), pp.231-249.

Cheng, C.L., 2004. Water environment issues and sustainable strategy in Taiwan. Proceedings of the International Workshop, Tokyo, September

Chick, A. and Micklethwaite, P. (2004). Specifying recycled: understanding UK architects' and designers' practices and experience. *Design studies*, *25*(3), pp.251-273.

CIB, Conseil International du Bâtiment. (2010). Towards sustainable and smart-eco buildings. Summary report on the EU-funded project smart-ECO buildings in the EU. Rotterdam: CIB

CIRIA. (2001). Sustainable construction procurement: A guide to delivering environmentally responsible projects. London: CIRIA.

Civil Exchange (CE). Submission on a proposal on the mandatory implementation of the building energy codes. [Online]. Available: http://www.civicexchange.org/eng/publication.aspx

Cole, S., 2012. A political ecology of water equity and tourism: A case study from Bali. *Annals of tourism Research*, *39*(2), pp.1221-1241.

Cole, R.J. (2000), "Building environmental assessment methods: assessing construction practices", Construction Management and Economics, Vol. 18 No. 8, pp. 949-57

Cole, R.J., (1998). Emerging trends in building environmental assessment methods. Building Research and Information, 26 (1), 3–16.

Cole, R.J., 1994. Assessing the environmental performance of office buildings. Proceedings of CIB Congress, Watford, UK

Collis, J. and Hussey, R., (2013). *Business research: A practical guide for undergraduate and postgraduate students*. Macmillan International Higher Education.

Combemale B., Betty H.C., Moreira A., Bruel J.M and Gray J. (2016), Modeling for Sustainability, IEEE/ACM 8th International Workshop on, pp. 62-66, 2016

Crawley, D. and Aho, I., (1999). Building environmental assessment methods: application and development trends. Building Research and Information, 27 (4/5), 300–308.

Creswell, J.W., (2009). Mapping the field of mixed methods research. cycles: shifting from green to sustainable, Proceedings,

Davies, H., (2001). Environmental benchmarking of Hong Kong buildings. Structural Survey, 19 (1), 38–45

Davison, I. (1996), Managing Projects, Ian Davison Pty, Sydney Design and construction intelligence, New York

Denzin, N.K. and Lincoln, Y.S., (2005). *The Sage handbook of qualitative research*. Sage Publications Ltd.

Du Plessis, C., and Cole, R. J. (2011). Motivating change: Shifting the paradigm. Building Research and Information, 39(5), 436–449.

Djokoto, J.G., (2013). Openness and Agricultural Performance in Ghana. *Journal of Science and Technology (Ghana), 33*(2), pp.24-36.

Ding, G.K., (2008). Sustainable construction—The role of environmental assessment tools. Journal of environmental management, 86(3), pp.451-464.

Dixon, W. (2010), The impacts of construction and the Built Environment. Retrieved from http://www.nap.edu

Easterby-Smith, M., Lyles, M.A. and Tsang, E.W., (2008). Inter-organizational knowledge transfer: Current themes and future prospects. *Journal of management studies, 45*(4), pp.677-690

EIA, (US), 2012. *Annual energy review 2011*. Energy Information Administration.

Eisenberg, D., Done, R., and Ishida, L. (2002). *Breaking down the barriers: Challenges and solutions to code approval of green building*. Retrieved from http://www.mrsc.org/artdocmisc/breaking_down_barriers.pdf.

Enache-Pommer, E. and Horman, M., 2009. Key processes in the building delivery of green hospitals. In *Construction Research Congress 2009: Building a Sustainable Future*, pp. 636-645.

EPA, Environmental Protection Agency. (2008). Green Building Strategy – Defines green building and explains EPA's strategic role in facilitating the mainstream adoption of effective green building practices. Available at: www.epa.gov/greenbuilding/pubs/greenbuilding

Fellows, R., & Liu, A. (2008). Research Methods for Construction (3rd ed.). United Kingdom: Blackwell Publishing Ltd.

Fellows, R.F. and Liu, A.M., (2015). *Research methods for construction*. John Wiley & Sons

Gall, M. D., Gall, J. P., & Borg, W. R. (2003). *Educational research: An introduction* (7th ed.). Boston, MA: A & B Publications. Kvale, S. (2007). *Doing interviews.* Thousand Oaks, CA: Sage

Garold, D.O., 2000. Project management for engineering and construction.

Gransberg, D.D. and Shane, J.S., (2010). Construction manager-at-risk project delivery for highway programs (Vol. 402). Transportation Research Board.

Häkkinen, T., and Belloni, K. (2011). Barriers and drivers for sustainable building. *Building Research & Information, 39*(3), 239-255. http://dx.doi.org/10.1080/09613218.2011.561948

Hill, R., and Bown, P. (1997). Sustainable construction: Principles and a framework. Construction Management and Economics, 15(3), 223–239.

HK-BEAM Society (2004), "Hong Kong Building Environmental Assessment Method for new buildings", Version 4/04, pp. 3-13.

Hopwood, B., Mellor, M., and O'Brien, G. (2005). Sustainable development: Mapping different approaches. Sustainable Development, 13(1), 38–52.

Hughes, B., 2004. Disability and the body. *Disabling barriers–Enabling environments*, pp.63-68

Hwang and Jian, 2012, Green building project management: obstacles and solutions for sustainable development, Available Online at, https://doi.org/10.1002/sd.492

Hwang Bong-Gang and Ng W.J., 2013. 'Project Management Knowledge and Skills for Green Construction: Overcoming Challenges', International Journal of Project Management, Vol. 31, Issue 2, pp. 272-284

Hwang, B.G., and Tan, J.S. (2010). Green building project management: obstacles and solutions for sustainable development. *Sustainable Development.* doi: 10.1002/sd.492.

Intergovernmental Panel on Climate Change, (2015). Climate Change 2014: Mitigation of Climate Change (Vol. 3). Cambridge University Press.

IPCC, Intergovernmental Panel on Climate Change. (2007). Summary for policymakers, climate change, IPCC WG1 fourth assessment report. New York: Cambridge University Press.

J. U. Ling, (2003) "The project manager's personal characteristic, skills and roles in local construction industry," Faculty of Civil Engineering, University Technology Malaysia

Kallet, R.H., (2004). How to write the methods section of a research paper. *Respiratory care*, *49*(10), pp.1229-1232.

Kendall J. (2016). 4 keys to Effective Construction Project Management.

Kibert ,C.J. (2013), Sustainable Construction Green Building Design and Delivery, (3rd Ed.), John Wiley and Sons Inc., New Jersey

Kothari, C.R., (2004). *Research methodology: Methods and techniques*. New Age International

Koster, R.D., Dirmeyer, P.A., Guo, Z., Bonan, G., Chan, E., Cox, P., Gordon, C.T., Kanae, S., Kowalczyk, E., Lawrence, D. and Liu, P., 2004. Regions of strong coupling between soil moisture and precipitation. *Science*, *305*(5687), pp.1138-1140.

Lam, P.T.I., Chan, E.H.W., Chau, C.K., Poon, C.S. and Chun, K.P. (2009a), "An overview of the development of green specifications in the construction industry worldwide", International Sustainable and Urban Regeneration: Case Studies and Lessons Learned, ICONUS, Earthscan, London, pp. 86-93

Lapinski, A.R., Horman, M.J. and Riley, D.R., 2006. Lean processes for sustainable project delivery. *Journal of construction engineering and management*, *132*(10), pp.1083-1091

Larsson, N.K., (1999). Development of a building performance rating and labelling system in Canada. Building Research and Information, 27 (4/5), 332–341.

Lee, W.L., Chau, C.K., Yik, F.W.H., Burnett, J. and Tse, M.S., (2002). On the study of the credit-weighting scale in a building environmental assessment scheme. Building and Environment, 37, 1385–1396

Li, Y.Y, 2012. Exploration of critical resources and capabilities of design firms for delivering green building projects: Empirical studies in Singapore. Habitat International, 41, pp.229-235.

Liu, Y., Prasad, D., Li, J., Fu, Y. and Liu, J., (2005). A holistic approach to developing regionally specific framework for green building assessment tools in China. Proceedings of The 2005 World Sustainable Building Conference, Tokyo, 27-29 September 2005, 1634-1641.

Lowe, R. (2007). Addressing the challenges of climate change for the built environment. Building Research and Information, 35(4), 343–350.

Macaluso, J., and Walker, H. A. (2006). Green building: Project planning.

Martens, P. (2006). Sustainability: Science or fiction? Sustainability: Science, Practice, and Policy, 2(1), 36–41.

McGraw-Hill Construction. (2006). Green building smart market report:

Meadows, D. J., Randers, J., and Meadows, D. L. (1972). Limits to growth. New York: Universe Books.

MinterEllison (2007), "Green buildings: do not leave it to goodwill and collaboration alone", 18 April, available at: www.minterellison.com

Molenaar, P.C. and Campbell, C.G., 2009. The new person-specific paradigm in psychology. *Current directions in psychological science*, *18*(2), pp.112-117

Mollaoglu-Korkmaz, S., Swarup, L. and Riley, D., (2011). Delivering sustainable, high-performance buildings: Influence of project delivery methods on integration and project outcomes. *Journal of Management in Engineering*, *29*(1), pp.71-78.

Munns, A.K. and Bjeirmi, B.F., 1996. The role of project management in achieving project success. *International journal of project management*, *14*(2), pp.81-87.

Naoum, S. G., (2012). Dissertation Research and Writing for Construction Students. Routledge.

Neuman, W.L., (2013). *Social research methods: Qualitative and quantitative approaches*. Pearson education

Nobe, M. C., and Dunbar, B. (2004). "Sustainable Development Trends in Construction."Proc., ASC Proceeding of 40th Annual Conference, Fort Collins, CO.

Norris, M. and Oppenheim, C., 2003. Citation counts and the Research Assessment Exercise V: Archaeology and the 2001 RAE. *Journal of Documentation*, *59*(6), pp.709-730.

Ofori, G., 1998. Sustainable construction: principles and a framework for attainment-comment. *Construction Management & Economics*, *16*(2), pp.141-145.

Pandey, S., (2014). Impact of Green Building Rating Systems on the Sustainability and Efficacy of Green Buildings Case Analysis of Green Building Index, Malaysia.

Parr, A., and Zaretsky, M. (2010). New directions in sustainable design. London: Taylor and Francis.

Pathirage, C.P., Amaratunga, D. and Haigh, R., 2005. Knowledge management research within the built environment: Research methodological perspectives.

Piper, D.T. (2003), "The risks of not knowing standards", The Construction Specifier, Construction Specifications Institute, Alexandria, April 28-29

Polit, D. F., Beck, C. T. and Hungler, B. P., (2001). Essentials of Nursing Research Methods.

Pushkar, S., Becker, R. and Katz, A., (2005). A Methodology for Design of Environmentally Optimal Buildings by Variable Grouping. Building and Environment, 40(8), pp.1126-1139.

Ramesh, T., Prakash, R. and Shukla, K.K., (2010). Life Cycle Energy Analysis of Buildings: An overview. Energy and buildings, 42(10), pp.1592-1600.

Remenyi D, Williams B, Money A, Swartz E (2000). "Doing Research in Business and Management" (An Introduction to Process & Methods); (London): Sage Publication.

Richards, G. and Hall, D. eds., (2003). *Tourism and sustainable community development* (Vol. 7). Psychology Press

RICS, (2001). Comprehensive project appraisal: towards sustainability. RICS Policy Unit, Royal Institution of Chartered Surveyors, London.

Robichaud L. B. and Vittal S. A. (2011) 'Greening Project Management Practices for Sustainable Construction' Journal of management in engineering , Vol. 2 No. 14, pp. 4366-4368 (http://www.ascelibrary.org)

Rosenau, M. D. and Githens, G. D., (2011). Successful Project Management: A Step-by Step Approach with Practical Examples. John Wiley & Sons.

Rydin, Y., Amjad, U., Moore, S., Nye, M., & Withaker, M. (2006). Sustainable Construction and Planning. The Academic Report. Centre for Environmental Policy and Governance, The LSE SusCon Project, CEPG, London School of Economics, London

Sarantakos, S., (2005). Social Research. 3rd. *Hampshire: Palgrave Macmillan*

Saunders, M., Lewis, P. and Thornhill, A., 2007. Formulating the research design. *Research methods for business students*, *2007*, pp.130-161.

Seo, S., Tucker, S., Ambrose, M., Mitchell, P. and Wang, C.H., (2006). Technical evaluation of environmental assessment rating tools, Research and Development Corporation, Project No. PN05.1019.

Sev, A. (2009). How can the construction industry contribute to sustainable development? A conceptual framework. Sustainable Development, 173(3), 161–173.

Sharif, S., Kamaruzzaman, S. N. and Pitt, M., (2013). Implementation Framework of Green Building Design for Malaysian Government Building. In 2nd International Conference on Chemical, Ecology, and Environmental Sciences (ICEES'2013) (pp. 230-235).

Sjostrom, C., and Bakens, W. (1999). "CIB Agenda 21 for sustainable construction: why, how and what. *Building Research & Information*, *27*(6), pp.347-353.

Smith, T. M., Fischlein, M., Suh, S., and Huelman, P. (2006). "Green Sustainable Buildings 2000, 22–5 October, Maastricht, systems in the U.S." http://www.usgbc.org/docs/LEEDdocs/LEED_

Snape, D. and Spencer, L., (2003). The foundations of qualitative research'in Ritchie, J. and Lewis, J (eds) Qualitative Research Practice

Stopwaiste.org (2009), "A Guide to green maintenance operation", available at: www.stopwaste. Org

Tagaza, E., and Wilson, J. L. (2004). *Green buildings: drivers and barriers e lessons learned from five Melbourne developments*. Melbourne, Australia: University of Melbourne and Business Outlook and Evaluation.

Tam, V.W.Y. and Tam, C.M. (2005), "Evaluations of existing waste recycling methods: a Hong Kong study", Building and Environment, Vol. 41 No. 12, pp. 1649-60.

Thormark, C. (2000), "Including recycling potential in energy use into the life-cycle of buildings", Building Research & Information, Vol. 28 No. 3, pp. 176-83

Thurairajah, N., Haigh, R. and Amaratunga, D., (2006). Leadership in construction partnering projects: Research methodological perspective

Tilford, K.R., Jaselskis, E.J. and Smith, G.R. (2000), "Impact of environmental contamination on construction projects", Journal of Construction Engineering and Management, January/February, pp. 45-51.

Todd, J.A., Crawley, D., Geissler, S. and Lindsey, G., (2001). Comparative assessment of environmental performance tools and the role of the Green Building Challenge. Building Research and Information, 29 (5), 324–335

Todd, J.A., Crawley, D., Geissler, S. and Lindsey, G., (2001). Comparative assessment of environmental performance tools and the role and the role of the Green Building Challenge. Building Research and Information, 29(5), pp. 324-335.

Turner III, D.W., (2010). Qualitative interview design: A practical guide for novice investigators. *The qualitative report, 15*(3), pp.754-760.

U.S. Environmental Protection Agency. (October 28, 2009). Green Building Home. Retrieved May 10, 2017, from http://www.epa.gov/greenbuilding /pubs/ components.htm.

US Green Building Council (USGBC) (2014), "LEED 2009 for Existing Buildings, Operations and Maintenance", Available Online at https://www.usgbc.org/resources/leed-2009-existing-buildings-current-version

UNEP-SBCI, United Nations Environment Programme - Sustainable Buildings and Climate Initiative. (2009). Buildings and climate change: A summary for decision makers. Paris: UNEP DTIE Sustainable Consumption and Production Branch.

US EPA, (2010). Renewable fuel standard program (RFS2) regulatory impact analysis. US Environmental Protection Agency. Available Online at http://www.epa.gov/otaq/renewablefuels/420r10006.pdf

Van Eijk, R.J. and Brouwers, H.J.H. (2002), “Stimulating the use of secondary materials in the construction industry: the role of certification”, International Journal of Construction Marketing, Vol. 3 No. 2, pp. 1-6

Vasileva, K., 2011. Population and social conditions. 6.5% of the EU population are foreigners and 9.4% are born abroad. Statistics in Focus. Eurosat, editor Luxembourg: European Commission.

Walker, B. H., and Salt, D. (2006). Resilience thinking. Sustaining ecosystems and people in a changing world. Washington: Island Press.

WCED, World Commission on Environment and Development. (1987). Our common future. New York: Oxford University Press. Why, how and what.” Build. Res. Inf., 27(6), 347–354.

Whole Building Design Guide (WBDG), Sustainable Committee. March 2006. *Sustainable*. Available Online at, http://www.wbdg.org/design/sustainable.php

Woolley, N., Footitt, A. and Hickman, M., (1999). Comprehensive project evaluation. Proceedings of ROOTS’ 99, RICS Research Foundation, Royal Institution of Chartered Surveyors, London

Yalcinkaya, M. and Arditi, D., 2013, July. Building Information Modeling (BIM) and the construction management body of knowledge. In *IFIP International Conference on Product Lifecycle Management* ,pp. 619-629. Springer, Berlin, Heidelberg.

Yau, R., Cheng, V. and Yin, R., (2006). Building performance assessment in China. Proceedings of The 2nd International Conference on Intelligent Green and Energy Efficient Building and Technologies and Products expo, Beijing, 28-30 March 2006.

Zhang, X. L. L. Y. Shen, and Y. Z. Wu, (2011) "Green strategy for gaining competitive advantage in housing development: A China study," Journal of Cleaner Production, vol. 19, no. 1, pp. 157–167

APPENDICES

Appendix I – Semi-Structured interview guide

INTERVIEW GUIDE FOR RESEARCH (MASTER OF PHILOSOPHY)

Topic: ***A Framework for Managing the Construction of a Green Building***

I am Nusetor, Jacob Jimmy, an MPhil student of Kwame Nkrumah University of Science and Technology, Department of Building Technology.

I write to kindly seek for an appointment with you for an interview on the topic above. Sustainability is gradually becoming a must in the construction industry in order to ensure that, construction activities do not affect the environment we live in.

This research therefore seeks to elicit the views of construction managers on the subject based on their experience and the high profile jobs undertaken in their capacity in ensuring sustainability of the buildings.

I also want to appreciate that this interview is going to take some of your valuable time, I however want to urge to partake in the research as the findings will help promote sustainability in the building sector and also for the achievement of the research aim.

Confidentiality of your views is assured.

Thank you in advance for your cooperation.

Sincerely Yours,

Nusetor, Jacob Jimmy (MPhil Student)
Mob: 0242313218
E-mail: jnjimmy@live.com

Dr. Barbara Simons (Project Supervisor)
Lecturer, Department of Building Technology
KNUST – Kumasi

DURATION OF INTERVIEW: 45 MINUTES

This semi-structured interview guide consists of detailed questions that will be discussed during the interviews with respondents (Construction Managers) of certified Green Buildings. The interview is aimed at developing a framework for managing the construction of a Green Building.

PART A: Background of Interviewee

Name: …….

Position in Organization: ……

Date of Interview: ……..

E-mail / Contact No.: …….

PART B: Construction of a Green Building

Theme 1: General knowledge

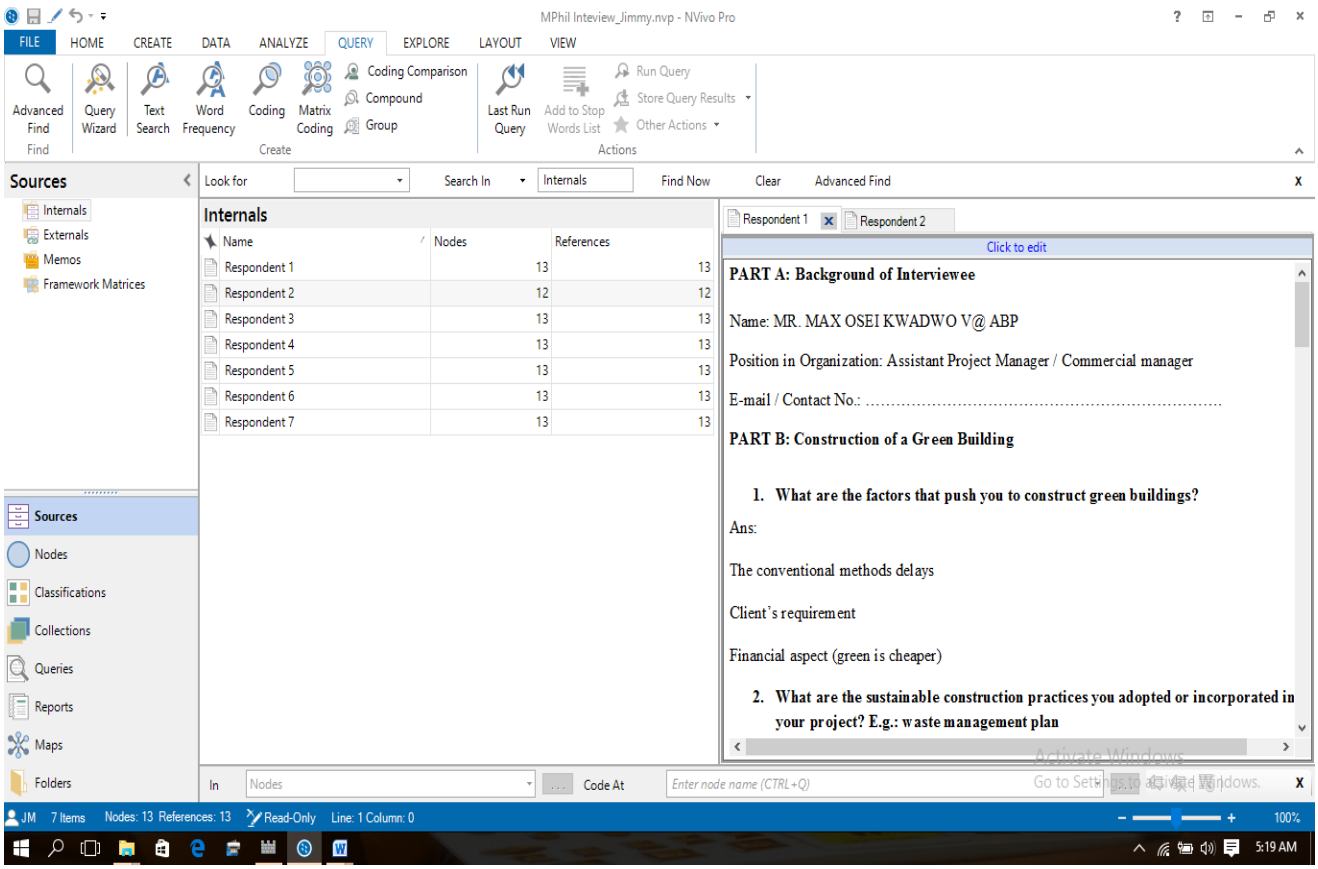
1. What is sustainable development?
2. What is your understanding of Green Buildings?
3. What is the difference between a conventional building and a green building?
4. Have you undergone any training in green/sustainable construction?
5. Which of the green building rating systems have you worked with?

Theme 2: Construction

6. What are the factors that push you to construct green buildings?
7. What are the sustainable construction practices you adopted or incorporated in your project? E.g.: waste management plan
8. What did you put in place to ensure that the natural habitat was not disturbed during construction?
9. What did you put in place to ensure that pollution from the construction did not affect the environment?
10. What did you do to ensure that the cost of construction was minimized?

11. What special materials did you use in your construction to ensure that sustainability was achieved?
12. What special skills or knowledge will a construction manager need in order to successfully execute a green building?
13. What strategies did you employ to ensure that the sustainability of your project is achieved?
14. What are the challenges that you faced as a construction manager executing a green building?
15. What are the differences between managing the construction of a green building and that of a conventional building?
16. What did you put in place to ensure that even the construction process and methods were sustainable?
17. What do you do to ensure that materials incorporated in your buildings are sustainable?
18. What did you incorporate in the building so that occupants will live healthy?
19. What risks are associated with sustainable principles in your construction? E.g. using recycled materials
20. What are the factors that affect the implementation of green buildings in Ghana?

THANK YOU FOR YOUR PARTICIPATION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PART A: Background of Interviewee
Name: MR. MAX OSEI KWADWO V@ ABP
Position in Organization: Assistant Project Manager / Commercial manager
E-mail / Contact No.: .....
PART B: Construction of a Green Building
1. What are the factors that push you to construct green buildings?
Ans:
The conventional methods delays
Client's requirement
Financial aspect (green is cheaper)
2. What are the sustainable construction practices you adopted or incorporated in your project? E.g.: waste management plan
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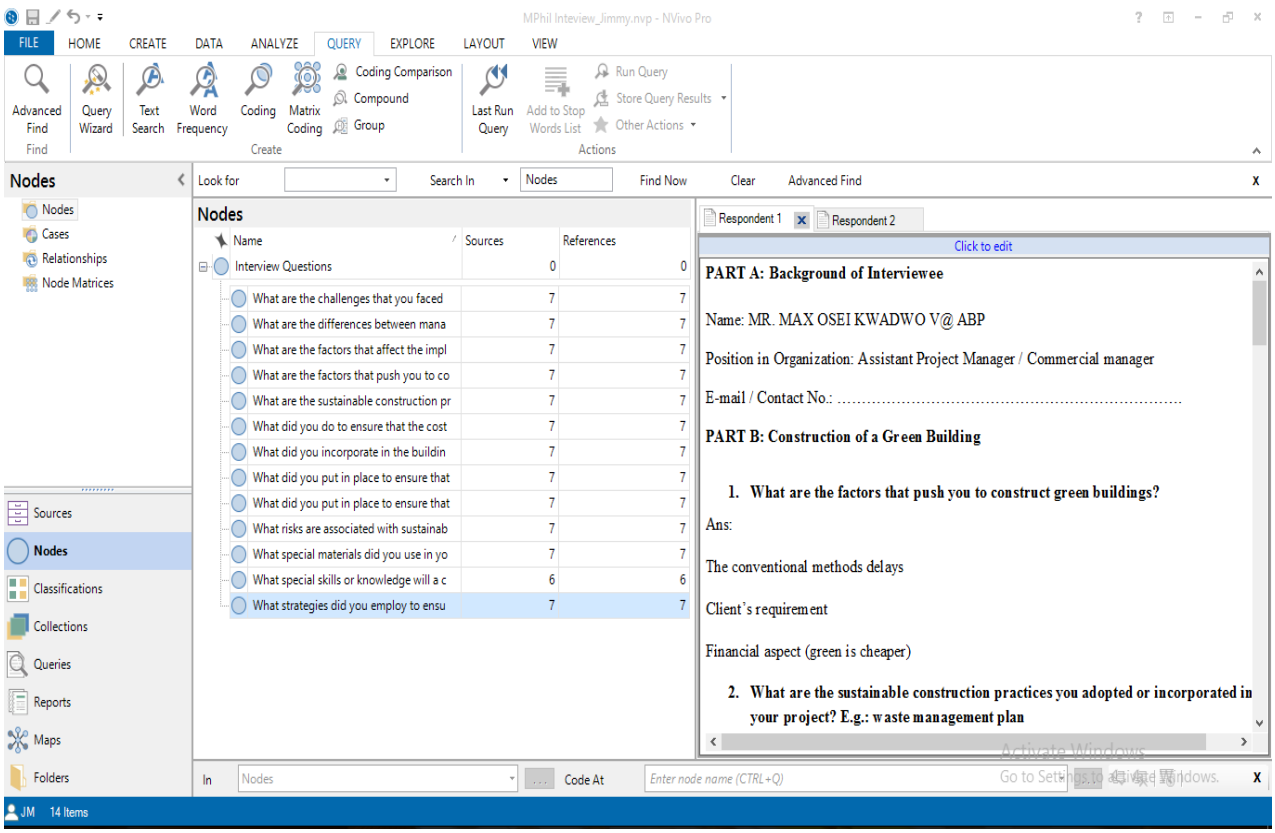
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Interview Questions
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What strategies did you employ to ensu
Respondent 1
Respondent 2
Click to edit
PART A: Background of Interviewee
Name: MR. MAX OSEI KWADWO V@ ABP
Position in Organization: Assistant Project Manager / Commercial manager
E-mail / Contact No.: .....
PART B: Construction of a Green Building
1. What are the factors that push you to construct green buildings?
Ans:
The conventional methods delays
Client's requirement
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2. What are the sustainable construction practices you adopted or incorporated in your project? E.g.: waste management plan
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