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KUMASI, GHANA

**Contractors' Adaptation to Environmentally Sustainable Construction
Processes**

by

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DOCTOR OF PHILOSOPHY

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DECLARATION

I hereby declare that this submission is my own work towards the PhD Construction Management and that, to the best of my knowledge, it contains no material previously published by another person, nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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ABSTRACT

Environmental sustainability is foundational to achieving the global goals of sustainable development. The construction industry has a significant role to play in pursuance of environmental sustainability. However, stakeholders in the industry lack capability and understanding to adapt to environmental sustainability practices in construction. There are lack of guidelines for understanding and promoting sustainable construction, especially in developing countries. Therefore, the aim of this research was to develop a framework that will provide guidelines for contractors to build capacity for Environmentally Sustainable Construction (ESC) processes. Four theories; the Resilience, Ecological Modernization, Institutional and Social Network theories have been adopted to facilitate understanding of the complexities surrounding adaptation to ESC. Through face-to-face semi-structured interviews, qualitative data have been collected from large scale contractors in the country. The data have been analysed using data matrix and template thematic analysis techniques. Adopting an abductive approach, a back and forth iteration between findings and the theories have been applied to facilitate development of the framework. Contractors act within socialecological system of the construction industry. The inability of these system actors to adapt to ESC is attributed to legislative, socio-cultural and other barriers. Improving knowledge of clients and other stakeholders in ESC processes would enable ESC adaptation. Formation of social network of contractors and collaboration with ‘noncontractor’ stakeholders are also primary to creation of drivers and enablers of

ESC. Other frameworks developed for sustainable construction in developing and emerging economies do not provide stakeholder-specific guidelines for developing the needed capability to achieve sustainable construction. The framework developed in this research zeroes in on providing guidelines and strategies for contractors, as construction industry stakeholders, to achieve capability for adapting to ESC processes. The contribution of this research is that studies directed towards achieving sustainability in construction industry have been advanced through application of relevant multidisciplinary theories. The significance of this study is that, in line with the ‘Agenda 21 for Sustainable Construction in Developing Countries’ recommendation, guidelines for contractors to attain capability for sustainable construction have been provided. For successful implementation of the framework, it is recommended that the guidelines provided are to be integrated into a contractor’s organisational policy. ‘Establishing and enforcing’ governmental regulations on ESC is a key driver for bringing contractors’ adaptation to ESC into reality.

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LIST OF ACRONYMS

ACRONYM	MEANING
BE	Built Environment
BERR	Business, Enterprise and Regulatory Reform
BIM	Building Information Modelling
BIS	Business Innovation and Skills
CCA	Climate Change Act (2008)
CESCAF	Contractors' Environmentally Sustainable Construction Adaptation Framework
DEFRA	Department of Environment, Food and Rural Affairs, UK
DECC	Department of Energy and Climate Change, UK
EMT	Ecological Modernization Theory
ENCORD	European Network of Construction Companies for Research and Development
EPA	Environmental Protection Agency
ESC	Environmentally Sustainable Construction
FHI	Family Health International
GHGs	Green House Gases
GHGBC	Ghana Green Building Council
GRI	Global Reporting Initiatives
GNI	Gross National Income
GSA	Ghana Standards Authority
GWP	Global Warming Potential
HM	Her Majesty
IBS	Integrated Building Systems
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IT	Institutional Theory
JHA	Job Hazard Analysis
LEED	Leadership in Environmental and Energy Design

NIST	National Institute of Standards and Technology, USA
N.R.C.D.	National Redemption Council Decree, Ghana
OECD	Organization for Economic Cooperation and Development
RT	Resilience Theory
SC	Sustainable Construction
SD	Sustainable Development
SNT	Social Network Theory
UNEP	United Nations Environmental Programme
UN	United Nations
WCED	World Commission for Environment and Development

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KNUST



CHAPTER ONE

INTRODUCTION TO THE RESEARCH

1.1 Introduction

This chapter elucidates the background to the research and operationalizes the key terminologies of the research. It gives the context of the research and presents the research problem to reveal knowledge gaps in the research area and context. Based on the research problem identified, the relationship between the research questions, aim and objectives are explained. Finally, the research outline, indicating what is covered under each chapter in this thesis, is structured.

1.2 Background

Sustainable Development (SD) is “development that meets the needs of the present without compromising on the ability of future generations to meet their own needs” (World Commission on Environment and Development, WCED, 1987:43). This definition is widely accepted and used in other research works such as (Madu and Kuei, 2012:1; Hult, 2011:4; Spangenberg, 2010; Lozano, 2008). According to Klostermann (2006), there is also a second definition, which is not often used, that depicts SD as a process of change and not a state of utopia. This states that:

“Sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations” (WCED, 1987: 46).

There have been arguments that SD should have a fourth pillar. For instance, United Cities and Local Government, UCLG (2010) points to culture. Ofori (2015) even indicates that technology/ technical is already a fourth pillar. However, the three traditional pillars of SD (Environmental, Economic and Social) have consistently

remained widely acceptable over the years (Borland, 2009; Du Plessis, 2002). In this study, it has been indicated that these three traditional pillars form the principles of Sustainable Construction (SC) which is an offshoot of SD.

The concept of sustainable construction is developed based on the principles of sustainable development. Kibert (1994) was the first to define the concept of sustainable construction as the creation and responsible management of a healthy built environment based on efficient resources and ecological principles. Du Plessis (2002:2) also defines sustainable construction basing it on the principles of sustainable development as:

“...applied to the comprehensive construction cycle from the extraction and beneficiation of raw materials, through the planning, design and construction of buildings and infrastructure, until their final deconstruction and management of the resultant waste. It is a holistic process aiming to restore and maintain harmony between the natural and built environments, while creating settlements that affirm human dignity and encourage economic equity.”

Thus, sustainable construction is based on the principles of sustainable development.

As is popularly known, sustainable development should meet the needs of the present generation without compromising the ability of future generations to also meet their needs. Achieving sustainability in construction is therefore highly necessary for reaching the goals of sustainable development throughout the comprehensive construction cycle from “cradle” to “grave”. Achieving the goals of sustainable development is driven by the three broad traditional pillars of sustainability; economic, environmental and social. However, it is important to note that environmental sustainability clearly stands out as being foundational to a holistic pursuit of sustainable development goals (Du Plessis, 2002).

Developed countries such as Australia, Japan, Germany, UK and USA have taken giant strides in the implementation of sustainable development principles in most of the national development sectors, especially the construction sector (Kibert, 2007). Some of the sustainability assessment standards used in these developed countries include: Leadership in Environment and Design (LEED) of USA; British Research Establishment Environmental Assessment Method (BREEAM); and *Deutsche Gesellschaft für Nachhaltiges Bauen* (DGNB) Certification by the Germany Sustainable Building Council. These certification systems are established to ensure that the construction industry meets sustainability requirements.

The construction industry, having an interdependent relationship with the environment, has a huge task to play in ensuring that the goals of sustainable development are achieved. Hence, the emergence of the concept of SC, which has received a lot of input guidelines from the series of world sustainable summits held, including the 1992 summit where Agenda 21 for sustainable construction in developing countries were outlined. Sustainable built environment establishment in a developing world context, requires solid knowledge foundation that equips the public, professionals, agencies and the government (Du Plessis, 2007). Establishment of sustainable construction in developing countries is needed for achievement of economic, social and primarily, environmental sustainability.

The ultimate focus of this research is to facilitate implementation of environmentally sustainable construction in developing countries by construction contractors. The knowledge, skills and technology required to pursue sustainability in the construction industry have been discovered through a lot of research and development (Du Plessis, 2007; 2005; 2002; Wallbaum *et al.*, 2010). For instance,

some sustainable practices recommended for use in the construction industry include:

- Putting fiscal incentives/penalties and regulations in place (Pitt *et al.*, 2009)
- Use of indigenous construction materials in innovative ways (Li *et al.*, 2012; DuPlessis, 2002)
- Cutting down transportation distance of raw materials (Li *et al.*, 2012)
- Cutting down the use of electricity/energy-demanding processes
- More use of biotechnology for energy generation and sanitation provision (DuPlessis, 2002)

However, sustainable construction has not been established and remains unimplemented, especially in the developing countries (Du Plessis, 2007). Barriers working against the implementation cannot be due to only lack of the required knowledge, skills and technology. This raises question about the inability of stakeholders to adapt effectively to the wave of changing practices in the construction industry, nationally, regionally and globally. Development of the construction industry's capability to adapt to relevant changes in construction practices is therefore imperative.

1.2.1 Research motivation

The stimulus for conducting this present research stems from the urgent need to preserve the ecosystem, which faces threat from non-environmentally-friendly anthropogenic activities. It is undisputable that one of the most pertinent concerns facing the globe is the threat of carbon emissions. Following establishment of the global goals of Sustainable Development, most countries, various sectors of an economy and individual stakeholders are expected to demonstrate responsibility towards managing the environment prudently (UNEP, n.d.). Failure to take appropriate

mitigating and adaptation actions at the international and national levels will lead to worsening of the already irreversible effects of carbon emissions concentration in the atmosphere (IPCC, 2013). In this regard, the role of local construction industries to pursue the SD goals becomes paramount. Specifically, contractors, who are the field developers of the built environment, have significant role to play in taking this global responsibility. Without improving contractor's capability to manage environmental challenges prudently, both the built and natural environments face the threat of collapse and extinction.

While the overarching object of achieving the Sustainable Development Goals (SDGs) by the year 2030 is desirable, the capability of stakeholders, as actors within a socialecological system, cannot be left underdeveloped. The construction industries in developing countries face common challenges such as resource constraints and tough marketing conditions coupled with inadequate financial support (Ofori, 2012). Thus, to facilitate application of Sustainable Construction (SC) processes, it is imperative to improve capability of the relevant construction industry stakeholders.

Researchers such as DuPlessis (2007) and Ofori (2012) have emphasized the need for stakeholders in the construction industry, especially in the developing countries, to prepare to adapt to the adverse effects of climate change. It can therefore not be overemphasized that improving contractors' capability for SC practices is primary to prudent management of the environment. Thus, this research focuses on investigating into improvement of capability of the contractor as a vital stakeholder in the construction industry.

1.3 Key terminologies

This definitions of key terminologies contained in this section and used in this thesis are based on what other researchers have used and are widely accepted as standard terminologies.

1.3.1 Sustainable Development (SD)

As given by (WCED, 1987: 43) the Brundtland report, SD is “development that meets the needs of the present without compromising on the ability of future generations to meet their own need”.

This definition is the most widely accepted and has been used by several researchers in sustainability studies including Madu and Kuei (2012), Hult (2011:4), Spangenberg (2010), and Lozano (2008). However, this definition depicts a state of utopia towards meeting human needs. It may not be aptly adoptable in a situation where more emphasis must be put on the process of change in practices in the construction industry, as the case is in a developing country context. Thus, Klostermann (2006) draws attention to a second definition given in the Brundtland report, which is rarely used. This says that:

“Sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations.” (WCED, 1987: 46).

This definition puts emphasis on the fact that sustainable development is a ‘*process of change*’, an essential element required for sustainable development to take place in developing countries. This definition of SD is adopted in this research.

1.3.2 Sustainable Construction (SC)

Kibert (1994) defines the concept of sustainable construction as the creation and responsible management of a healthy built environment based on efficient resources and

ecological principles. Sustainable construction is also defined based on the principles of sustainable development. SC is a construction process which is:

“...applied to the comprehensive construction cycle from the extraction and beneficiation of raw materials, through the planning, design and construction of buildings and infrastructure, until their final deconstruction and management of the resultant waste. It is a holistic process aiming to restore and maintain harmony between the natural and built environments, while creating settlements that affirm human dignity and encourage economic equity.” – (Du Plessis, 2006:2)

It is worthy to note that the emphasis of this study is on the construction phase as this seems to be a neglected phase of the built environment products cycle with regards to sustainable construction studies (Horvath, 2004). By articulating the above definitions and taking keen note of the research focus on construction phase, Sustainable Construction (SC) is hereby defined in this study as:

‘The application of sustainable development principles to the construction phase of buildings and infrastructure through creation and responsible management of a healthy built environment based on application of ecological management principles aimed at restoring and maintaining harmony between natural and built environment while creating settlements that affirm human dignity and encourage economic equity.’

1.3.3 Environmentally Sustainable Construction (ESC)

From the latest definition of SC given above, it is clear that the concept is based on the pillars of SD. The emphasis of this research is on achieving environmental sustainability, which is foundational to overall achievement of SD goals, especially in the context of developing countries where the concept is at its embryonic stage (DuPlessis, 2002; Ofori 1998).

Moreover, in this study, attention is given to the construction process phase. This phase comprises of manufacturing, design, distribution, on-site operations, refurbishment and demolition, within the overall product life cycle (HM Government, 2011). Most studies have concentrated on the operational phase to the detriment of other phases that equally need to be given research attention (Horvath, 2004). Hence, in this study, ESC is operationalized in this study as:

‘The application of environmentally sustainable development principles to the construction process phase of buildings and infrastructure through creation and responsible management of a healthy built environment based on efficient resources and ecological principles aimed at restoring and maintaining harmony between natural and built environments.’

1.3.4 Construction Organisation

Several definitions for an organisation have been given in literature. In 1956, Parson defined organisation as “a social system oriented to the attainment of a relatively specific type of goal, which contributes to a major function of a more comprehensive system, usually the society” (Downes and Rao, 2008:3). In 1965, Cartwright also defined organisation as an arrangement of interdependent parts of a whole in which behavior is controlled and relatively predictable, and in which individual actions combine to lead to organisational accomplishments (Anderson, 1999; Cartwright, 1965). In 1981, King also defined an organisation as individuals who have specific positions and roles and who use certain resources to accomplish personal and organisational goals (King, 1981 cited in Fawcett and Desanto-Madeya, 2012). Imhoff *et al.* (2001) also defined organisation as a group of people or a legal entity with an explicit purpose and written rules. The 7th edition of the Oxford Advanced Learners

Dictionary (2010) also defines organisation as a group of people who form a business, club etc. together, in order to achieve a particular aim. (Hornby, 2010).

On the basis of the above definitions of organisation, a construction organisation is defined in this research as:

'a legal entity comprising a group of people with an explicit purpose or goal of putting up new building/structure or renovating or rehabilitating an existing building/structure on a contractual and business basis using plant and material resources controlled by a cooperation of human resources over a given period of time.'

1.3.4.1 Large scale contractor in study country

Financial class D1/K1 is the highest contractor designation approved and granted by the Ministry of Water Resources, Works and Housing (MWRWH) of Ghana, the study country. This designation is given to a building and civil engineering contractor that applies for classification and subsequently meets the minimum requirements. The requirements relate to technical and managerial expertise, financial standing, previous performance, and equipment and plant holding (Laryea and Mensah, 2010). Apart from D1/K1 contractors, all other classes of contractors are limited in the value of works they are mandated to execute.

This study engages D1/K1 class of contractors in Ghana, which is the developing country in which this research is undertaken. They are considered as large construction contractors (Amoah *et al.*, 2011). This class of contractors has been particularly selected for carrying out the research in view of the unlimited value of construction works they are legally mandated to undertake. Therefore, selecting a different class of contractors could have limited the applicability of the research

framework. Moreover, sustainable construction is an emerging concept in the study area and BE professionals with relatively wider experience are required to speak on the research subject. Thus, to ensure feasibility of carrying out the research with respondents that are likely to speak to and share varied and wide experiences on the research subject under investigation, selecting the highest class of contractors becomes more appropriate.

1.3.5 Developing Country

According to the World Bank (2013), lower middle income and upper middle income earning countries are classified as developing countries. This is based on the Gross National Income per capita of a country. As of July 2013, the World Bank income classifications by GNI per capita are as follows:

- Low income: \$1,035 or less
- Lower middle income: \$1,036 to \$4,085
- Upper middle income: \$4,086 to \$12,615
- High income: \$12,616 or more

However, this is not intended to imply that all economies in a particular group are experiencing similar development or that other economies in a higher category have reached a preferred or final stage of development.

As per the World Bank national accounts data and EOC national accounts data file, Ghana has an average GNI per capita of \$1,620.00 during the year 2010 – 2014 qualifying her to be a developing country (The World Bank, 2014). Also, according to the April 2016 International Monetary Fund (IMF) World Economic Outlook (WEO) database, Ghana has a GDP per capita income of (US\$ 1,340) (IMF, 2016). This income level categorizes Ghana, the study country, as a developing country.

1.3.5.1 Developing country's construction industry

The construction industry the world over is now faced with the challenge of ensuring that sustainability principles are translated into mundane construction operations. Ogwu and Huapt (2007) acknowledge that this challenge is particularly acute in developing countries. Massive infrastructure development projects are highly needed in developing countries to stimulate economic growth. Therefore rapid urbanization, coupled with its infrastructure development, characterizes most of the developing countries (Du Plessis, 2002).

Ogwu and Huapt (2007) realize that developing countries have different priorities in the areas of poverty alleviation, institutional strengthening, capacity building and utilization, and socio-cultural dimensions that sustain harmony and co-existence. However, the challenges that face the construction industries in most of these developing countries are similar (Ofori, 2012 and 2000; Datta, 2004; DuPlessis, 2002). The significance of this study is to facilitate adequate understanding of the interactions between these challenges and how they can be minimized to develop capability for adapting to ESC. This research specifically recognizes that construction industry in developing countries face common challenges and conditions.

1.3.6 Resilience of a construction industry

“Resilience is the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks” (Folke *et al.*, 2010:3; Walker *et al.*, 2004:2). It is defined by Walker and Salt (2006) as the capacity of a social-ecological system to change in a changing world while maintaining its functionality. Thus, in this research, the researcher refers to the resilience of a construction industry as:

'capacity to absorb instabilities and changes in conventional construction practices and reorganize, while undergoing the essential changes, so as to still retain its essential function, structure, identity and feedbacks, for business continuity.'

1.3.7 Adaptability/ Adaptive Capacity of a contractor

Adaptability is used interchangeably with adaptive capacity. This is defined as “the capacity of actors in a system to influence resilience” (Pisano, 2012:20; Walker *et al.*, 2004:2). Adaptability is also referred to as the capacity of a system to adapt if the environment where the system exists is changing (Gunderson and Holling, 2002). Folke *et al.* (2004) also indicate that adaptive capacity in social-ecological system refers to the ability of humans to deal with change in their environment by observation, learning and altering their interactions. Thus, the adaptive capacity of a contractor, as an actor within a social-ecological system of the construction industry is referred to as:

'the capacity to influence resilience in a manner that will lead to effective adjustment to the demands of ESC as a process of change in the construction industry globally, by observing, learning and altering the interactions.'

1.3.8 ESC Barriers

Environmentally Sustainable Construction (ESC) barriers can prevent ESC from happening. According to DuPlessis (2007), barriers to sustainable construction in developing countries are problems that need to be addressed in a particular way so that SC can happen in a responsible manner. In finding out barriers to lean construction as principles to be adopted to foster sustainable construction, Bashir *et al.* (2010) indicate that barriers are ‘factors that could affect the successful implementation’ of lean construction. In a study that looked at the Indian case of

Agenda 21 for sustainable construction in developing countries, Shah (2003) discussed barriers that stand against the entry of contractors into Indian construction industry. Shah described the barriers as ‘conditions that prevent’ influx of foreign contractors. On the basis of the above definitions for barriers, ESC barriers, in the context of this study, is defined as:

‘the problems/conditions that prevent successful adaptation to ESC in developing countries from happening or being implemented in a responsible manner and need to be addressed’.

1.3.9 ESC Enablers

From the study of DuPlessis (2007), it can be observed that enablers of sustainable construction in developing countries are those factors that empower construction industry stakeholders to embark on a path of sustainable development and construction. In a study into modelling enablers of sustainable logistics collaboration, Grzybowska *et al.* (2014:1311) defined enablers as ‘...the key elements (or drivers) for achieving successful collaboration’. Furthermore, the 7th edition of the Oxford Advanced Learners Dictionary (2010:380) states that enabling involves ‘making it possible for somebody to do something’ or ‘making it possible for something to happen or exist by creating the necessary conditions’. In the context of this study, and based on the above definitions for enabler, ‘ESC enablers’ is operationalized in this study as:

‘the key elements/conditions/situations that need to be created to make it possible for contractors to adapt to ESC successfully’.

1.3.10 ESC Drivers

Drivers of a concept are supposed to give the necessary guidance to ensure that the path towards achieving the goals of that particular concept are embarked upon successfully through the necessary conditions without being hindered by possible barriers. From the study of Shelbourn *et al.* (2006) drivers of sustainable construction could be described as motivating issues/factors that allow clients and/or contractors to steer affairs to lead the construction industry towards achieving sustainability. In another study embarked upon by Qi *et al.* (2012) for the purpose of identifying drivers for contractor's green innovation, drivers are considered as those factors that 'force' contractors to adopt green practices. Specifically, they concluded from their study that drivers include policies and standards that call for 'taking action' towards improvement of environmental conditions.

Other research works on the drivers for sustainable construction/building give an indication that drivers 'influence change' (Tan *et al.*, 2011; Pitt *et al.*, 2009; Manoliadis *et al.*, 2006; Parkin, 2000; Augenbroe, 1998). Thus, in this study, ESC driver is defined as:

'Factors or motivating issues that force/influence the desired change in the actions of contractors and other relevant stakeholders for adaptation to ESC happen in a responsible manner'.

1.3.11 ESC Framework

Armour and MacDonald (2012:54) argue that a framework refers to:

“the identification and categorization of processes or steps that constitute a complex task or mind-set in order to render explicit the tacit/implicit”. This is buttressed by Jones (2012). Armour and MacDonald (2012) also contend that in

research frameworks and paradigms, frameworks should be appropriately referred to as a conceptual structure. A study conducted by Tuuli and Rowlinson (2007) describes the essence of the framework in relation to that study as ‘clarifying’ the integration between empowerment and job performance. The end product is referred to as a *conceptual structure/framework*.

The usefulness of developing a conceptual framework for a study lies in giving a researcher the ability to decide on which paradigm to follow (Ahadzie *et al.*, 2006). It also empowers or guides a researcher to be rational and systematic about the constructs and variables to be included in a research instrument (Miles and Huberman, 1994). Projasek (2007) also described, specifically, a business organisation framework as a means to facilitate self-evaluation and continual improvement and therefore constitutes a body of knowledge that forms the foundation for organisations to practice a concept. They describe business excellence framework as a structure that contains the following specific interconnected elements:

- “a means for mapping an organisation’s core values or guiding principles against a consensus listing of business excellence principles;
- a set of knowledge areas (or criteria) used to guide continual improvement within the organisation; and
- a results-driven methodology used to plan, implement, measure, and continually improve the organisation’s program.” – (p. 84)

In this research, the framework to be developed is for a contractor, as a business organisation, to be enabled and driven to adapt to the concept of ESC. An integration of the various descriptions of framework given elucidates how the ESC framework developed in this study, is operationalized. Hence, the contractors’ ESC adaptation framework developed in this research is referred to as:

‘a conceptual structure of systematic steps that explicitly explains how the elements of ESC and relevant organisational sustainability theories are integrated to provide the

means, body of knowledge and a result-driven methodology for contractors to develop capability for adapting to ESC.'

1.4 Research Context

The construction industry normally has two broad categories of contractors; small scale and large scale contractors. These categories are determined on the basis of the required technical, managerial and project resources (Tengan *et al.*, 2014; Laryea and Mensah, 2010; Sibanda, 1999). The definition of small scale and large scale vary from country to country.

In Ghana, where this study is being carried out, the categories fall into four main classes defined by the MWRWH of Ghana. These are D1/K1, D2/K2, D3/K3 and D4/K4 financial classes for building and civil engineering contractors (MWRWH, 2014). The D3/K3 and D4/K4 classes are considered as the small scale contractors (Tengan *et al.*, 2014).

However, in this study, emphasis is placed on the D1/K1 contractors, who are considered as large building and civil contractors (Amoah *et al.*, 2011). It is obvious that the small scale contractors have low capacity and have limited capital, plant and managerial resources (Sibanda, 1999). These contractors have limited human or professional expertise who can speak on the themes of this research (Tengan *et al.*, 2014). Hence, selecting small scale contractors would not facilitate obtaining information for the pursuance of the objectives of this research. Therefore, D1/K1 contractors, were selected for participation in the study.

Most sustainability studies have targeted the operational phase of the life cycle of projects to the detriment of other phases (Horvath, 2004). The subject of this research, ESC processes, is also relatively new in the selected area of study. ESC

must therefore be tackled piece meal to achieve effective results. Therefore, emphasis is laid on the construction process as defined under section 1.3 in this thesis by HM Government (2011). It is worthy to note that, the manufacturing process is considered as contractor's activities relating to off-site processing of materials and components, for onward distribution to construction site (see Li *et al.*, 2012). This excludes processes undertaken by the manufacturing industry. Having put emphasis on the concepts of sustainable development, sustainable construction and environmentally sustainable construction practices, the research conceptual is given

in framework Fig. 1.1

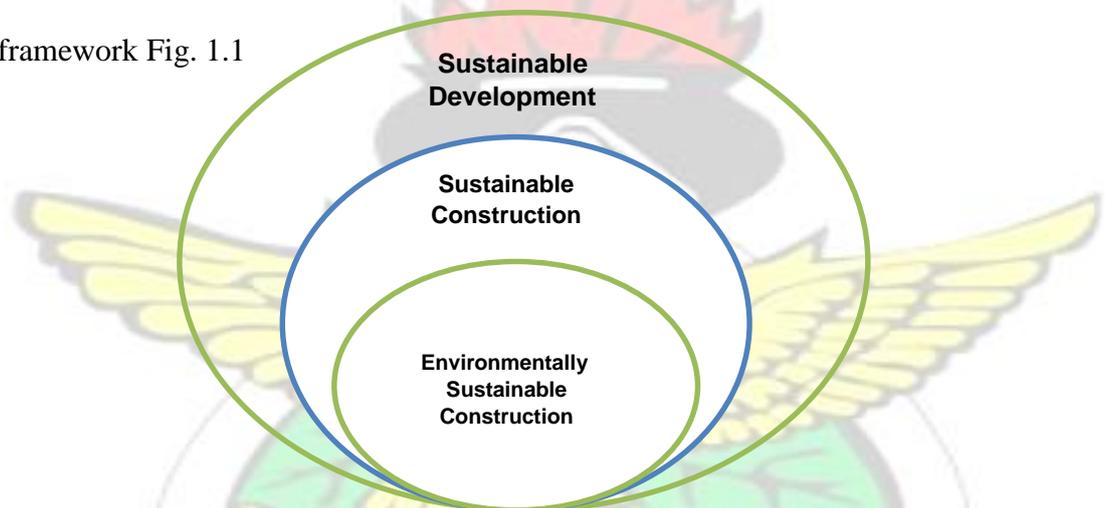


Figure 1.1 Conceptual framework of the study

1.5 Problem Statement and Justification of Research

In view of its importance, environmental sustainability was captured under goal number 7 of the Millennium Development Goals (MDG) for attainment in the year 2015 (United Nations Conference on Sustainable Development, UNCSA, 2012). However, achievement of this target was a mirage, especially in developing countries (DuPlessis, 2014). Therefore, in year 2015, the global goals of SD were established by the UN. This served as a replacement of the MDGs, which were not

evenly achieved across the globe (Sengupta *et al.*, 2015). Subsequently, the need to develop and pursue global goals of SD become indispensable. Seventeen goals of SD, having a target year of 2030, have been established. These are referred to as Sustainable Development Goals (SDGs). To achieve the SDGs by the target year, all developmental sectors need to strengthen research, innovation and industrial efforts. Hence, the construction industry has a significant role to play, especially in ensuring building of resilient infrastructure and smart and sustainable cities. Efficient use of energy and generation and use of renewable energies that promote zero carbon emissions should be encouraged in the construction industry (Intergovernmental Panel on Climate Change, IPCC, 2013). Du Plessis and Brandon (2014) have argued that in order to travel smoothly on the positive curve to sustainability, there needs to be a paradigm shift. The shift towards adaptive capacity of the social ecological system needs to be given global attention (DuPlessis, 2014). Humans need to provide guidelines for interpreting sustainability and the strategies that are relevant to determine the path towards adapting to changes in the planetary system. This requires further investigations to establish effective guidelines to facilitate a paradigm shift that will foster effective adaptation to SC in the construction industry.

1.5.1 Developing countries' contractors' lack of capability for ESC processes

The capability of stakeholders to adapt to ESC processes is primary to the construction industry's overall contribution to the achievement of SDGs. It is worthy to note that contractors remain significant stakeholders in the construction industry (Wong *et al.*, 2013). However, contractors, especially the ones in developing countries, lack capability to pursue practices and systems required to ensure effective achievement of the sustainability agenda (Sarpin and Yang, 2015; Ofori, 2012,

DuPlessis, 2009 and 2007). Furthermore, there are lack of frameworks and little use of theories to guide the interpretation of sustainability issues in the construction industry (Sarkis, 2011). Bon and Hutchinson (2000), Ofori (1998) and Hill and Bowen (1997) have indicated that economic, framework and resource inequalities exist between developed and less developed countries. These inequalities pose challenge to the establishment of sustainable construction concept. More than a decade after these findings by the authors, other recent studies still confirm resource constraints challenges facing construction industry stakeholders and rendering them unable to implement sustainable construction practices in developing countries (Kaygusuz, 2012; Reid, 2011; DuPlessis, 2007). This research focuses on filling the framework gap to enable contractors understand sustainability issues and also develop capability for pursuing the sustainability agenda.

Barriers to implementation of SC in the construction industry exist (Bashir *et al.*, 2010; DuPlessis, 2007; Shah, 2003). However, mere identification of these barriers would not facilitate effective adaptation to SC. Understanding of the nature and context of barriers against ESC adaptation, enablers and drivers of ESC, is primary to development of contractors' capability to adapt to ESC. Thus, knowledge for understanding the complexities surrounding sustainability in the construction industry is crucial. However, construction industry stakeholders in developing countries, most of them in Africa, are not able to effectively apply the knowledge, skills and technology required for establishment of sustainable construction (Du Plessis, 2007 & 2005). The inadequacy of knowledge, skills and technology for implementing SC results in unsustainable development practices (Ospina, 2012; Sexton *et al.*, 2006). Therefore, deeper investigations need to be done to foster increase in stakeholders' understanding of the complexities surrounding adaptation to SC.

Adaptation of the construction industry to SC practices is important. Infrastructural deficit in developing countries, coupled with the quest for accelerated development, is a precipitator of vigorous developmental activities. Such activities have to be well managed on the basis of SD principles in order not to retard global efforts towards achieving sustainability. Hence, the adaptability of social-ecological systems, such as the construction industry, needs improvement in the face of changing industry practices associated with SD. Furthermore, to achieve SD, a new ecological worldview, which advocates for adaptation to the changing patterns of the ecology rather than suppressing the changes, has become paramount and is already being upheld (DuPlessis and Brandon, 2014). A significant contribution to regenerating the world can be achieved globally if capability of the construction industry is enhanced. Therefore, it is critical to direct research efforts towards building contractors' capability to adapt to ESC.

1.6 Research questions

The main research question investigated is:

“How can construction contractors develop capability for adapting to ESC?”

Follow-up research questions include:

- How do contractors apply ESC processes?
- Why do *some* contractors in developing countries have no capability to adapt to ESC processes?
- How can contractors drive and enable organisational adaptation to ESC processes?
- How will a contractor assess organisational capacity to adapt to the ESC processes?
- What strategies can guide a contractor to develop organisational capability to adapt to ESC processes?

1.7 Aim

The aim of this research is to develop a framework that will drive and enable contractors to build ESC processes adaptation capability.

1.8 Objectives

To achieve the above aim, the following objectives were pursued.

1. To find out contractors' application of ESC processes
2. To explain the reasons contractors ascribe to lack of capability to adapt to ESC processes within a given context
3. To describe the enablers and drivers of adaptation to ESC processes from the perspectives of contractors
4. To develop guidelines to assist contractors assess organisational adaptive capacity for ESC processes
5. To develop guidelines for contractors to strategize building up capability for adapting to ESC processes based on the enablers and drivers

1.9 Research methods

The research focused on investigating 'why some construction organisations in developing countries have not adapted to ESC'. Eventually, the aim was to find out 'how contractors would develop capability for adapting to ESC'. The ontological stance of this research is the idealist or realism stance. This stance was taken in order to deal with the exploratory and contextual nature of the research.

Epistemologically, the interpretivism stance was adopted. On the basis of Creswell's (2013) discourse on choice of appropriate research methodology, the interpretivist stance was found to be the appropriate means of seeking knowledge about how contractors can adapt to ESC. The research strategy used was qualitative (Creswell,

2013). Quantitative approach was not useful. Likewise, triangulation of qualitative and quantitative methods was needless. This is due to the textual nature of data that was required to answer the research question.

Non-probability non-quota sampling was found to be appropriate for sampling the units (Kumekpor, 2002). There was the need to obtain data from specific units that could provide relatively relevant and adequate information since the research subject, ESC, seems to be at its embryonic stage in the study area. Specifically, purposive sampling was used to select the contracting organisations. Using the purposive sampling, a selection criteria was developed to select organisations. The selection criteria related to issues such as: data accessibility (willingness of an organisation to be involved in the study); organisation's engagement in current construction projects; the nature and relationship of organisation's activities to the environment; and the availability of construction professionals within the organisation to be adequately engaged in the study.

Face-to-face semi-structured in-depth interviews were conducted. This type of interview approach allowed a closer contact with industry players, the eventual implementers of the framework developed in this study. Such first-hand experience was necessary for achieving reliability. Furthermore, the framework could be considered reliable since the data set upon which it was developed is a representation of cases of typical construction businesses within a developing country context. To be able to find out the understanding of contractors in ESC processes, explain reasons contractors ascribe to inability to adapt to ESC, and describe the drivers and enablers of ESC from the viewpoint of contractors, the use of the semi-structured face-to-face interviews was an appropriate tool. This tool was effective since it

enabled the researcher to probe into the issues raised by contractors to elicit deeper understanding required in qualitative studies (Bell, 2010).

Twenty-four construction organisations participated in the face-to-face semistructured interview. The qualitative data obtained enabled achieving objectives 1 – 3. Data matrices and thematic template analyses techniques were triangulated to carry out qualitative analysis on the data obtained. These methods have been used by King, (2004), Nadin and Cassell (2004) and Miles and Huberman (1994) to perform similar qualitative analysis. The results of the analysis formed foundation for the development of the contractors' ESC adaptation framework.

To ensure reliability of the research findings and framework, a Focus Group Discussion (FGD) approach was adopted to validate the findings and the framework. Participants of the FGD comprised a combination of BE professionals who were interviewed and those who were not interviewed. There was a huge challenge in organizing the participants due to very busy and scattered schedules of the participants. The qualitative data obtained were also analysed using data matrices and template analyses techniques. The findings from the analysis enabled effective fine tuning of the framework.

1.9.1 Relationship between research questions, objectives and methods

Figure 1.2 illustrates the research process and interrelationships between knowledge gaps, questions, objectives and research methods.

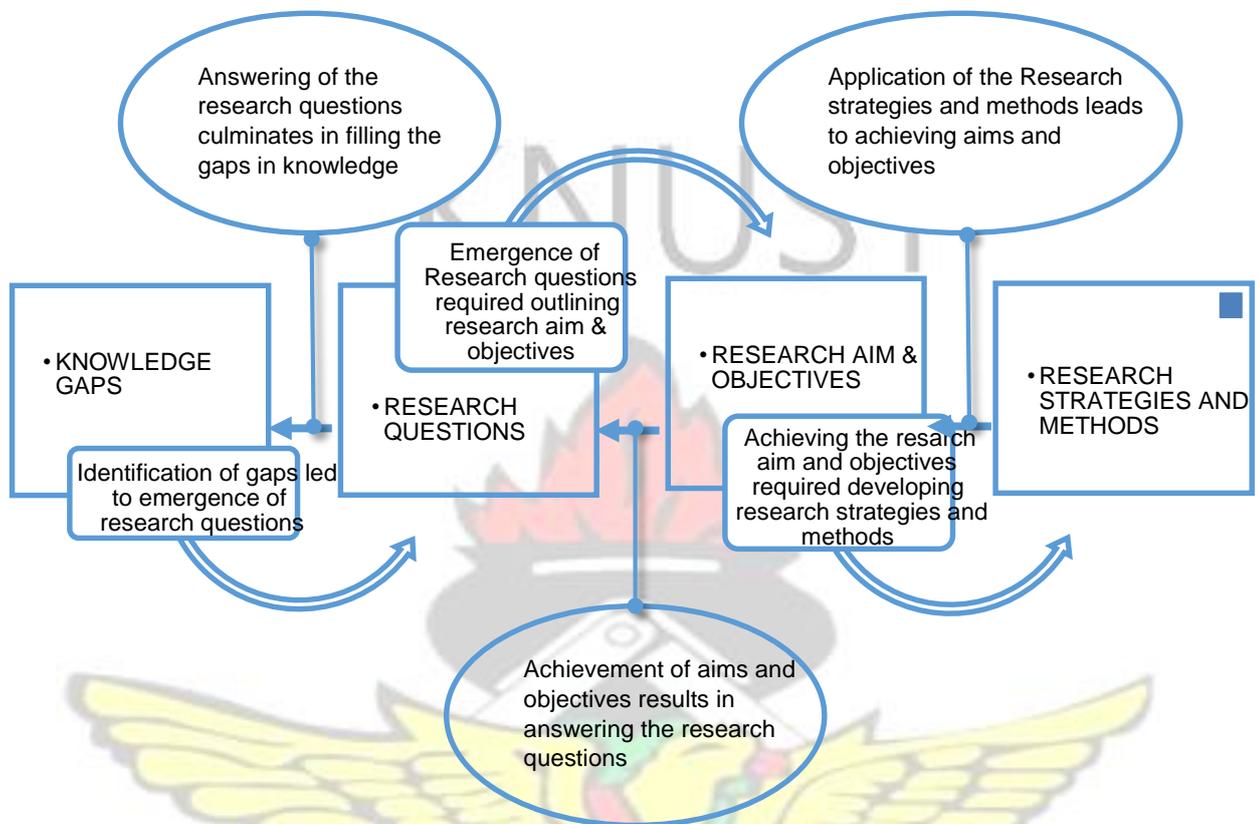


Figure 1.2 Relationship between knowledge gaps, research questions, aim & objectives and strategies

The review of pertinent literature exposed the knowledge gaps regarding the adaptation of ESC by contractors. In order to fill these gaps, research questions were put forward. This was followed by the research aim and an outline of the research objectives. The research objectives were achieved by application of the appropriate research strategies and methods. Achievement of the objectives eventually led to filling the knowledge gaps that were identified at the initial stages of the research.

1.10 Significance of the research

DuPlessis (2002) has argued that environmental sustainability is foundational to the achievement of the other pillars. The scope of this research buttresses this argument since socio-economic development has no place to thrive without sustainable environment. Notwithstanding, achieving sustainable development (SD) is a

multifaceted task that encompasses the three traditional pillars of sustainable development (environmental sustainability, economic sustainability and social sustainability). It should be noted that each of these pillars is broad. Besides, there have been series of advocates for a fourth SD pillar (Dessein *et al.*, 2015; Ofori, 2015; Burford *et al.*, 2013; UCLG, 2010). However, where the concept is at its infantile stage, the fundamentals need to be tackled first to avoid complexities that make understanding by stakeholders difficult. This makes the research focus on Environmentally Sustainable Construction (ESC) a primary one. This approach is an effective way of ensuring that the multiplicity and enormity of the tasks involved in pursuing sustainable development are tackled piecemeal and also contextually to achieve success (Amekudzi *et al.*, 2011).

Also, the construction industry has a major role to play in terms of the sustainable development of human settlements. Therefore, the International Council for Research and Innovation in Building and Construction (CIB) saw the need to push the sustainable construction agenda. This led to the development of Agenda 21 on Sustainable Construction (CIB Report Publication 237) in 1999 after an extensive collaborative research process. That document outlines the giant strides that have been taken by developed countries towards achieving SD goals. There is an indication that the construction industries in those countries are relatively better equipped to pursue sustainable construction than the construction industries in the developing world. In view of this, the Agenda 21 for Sustainable Construction in Developing Countries (A21_SCDC) was developed in 2002. In spite of this, sustainable construction is yet to be established in developing countries (DuPlessis, 2009). Thus, investigations carried in this research has led to conceptualization of a framework that provides guidelines and strategies for contractors in developing countries to build capability for

adapting to ESC. The conditions prevailing in the construction industries in developing countries are similar (Ofori, 2012 and 2000; Datta, 2004; DuPlessis, 2002; CIB, 1999). Therefore, the findings and end product of this research can be deemed to be applicable and useful for improving the sustainability performance of construction industries in most developing countries.

It has become clear that environmental sustainability, as an MDG7, has not been achieved locally and to a large extent, globally by the target year, 2015 (Sengupta *et al.*, 2015; Ghana News Agency, GNA, 2015; Du Plessis, 2014). Despite many successes achieved towards the MDGs, climate change and environmental degradation undermined the progress achieved, (United Nations Department of Economic and Social Affairs, UNDESA, 2015). Global carbon emissions have increased by 50% since 1990 (*ibid.*). Thus, all attention has been drawn to meeting the Sustainable Development Goals (SDGs), which have a target year of 2030. This research contributes to the establishment of the systematic processes that must be adopted, especially by the construction industry, towards achieving the SDGs. Further, the tendency to increase the soundness of governmental policies on SC stands a greater chance of being enhanced in view of the contributions made in this research with regards to formulation of ESC regulations and policies.

Furthermore, the competitiveness of contractors is expected to be improved. Sustainability performance has become an indispensable organisational feature and a driver of competition in the business world. Business organisations are gradually measuring competitiveness based on sustainability performance (Tan *et al.*, 2011). The focus of this work is geared towards making a major contribution to the improvement of the international competitiveness of contractors. Also, the findings of this research

ultimately add to the proper and comprehensive development of organisational policies to enhance regularization of sustainable construction processes, especially in developing countries.

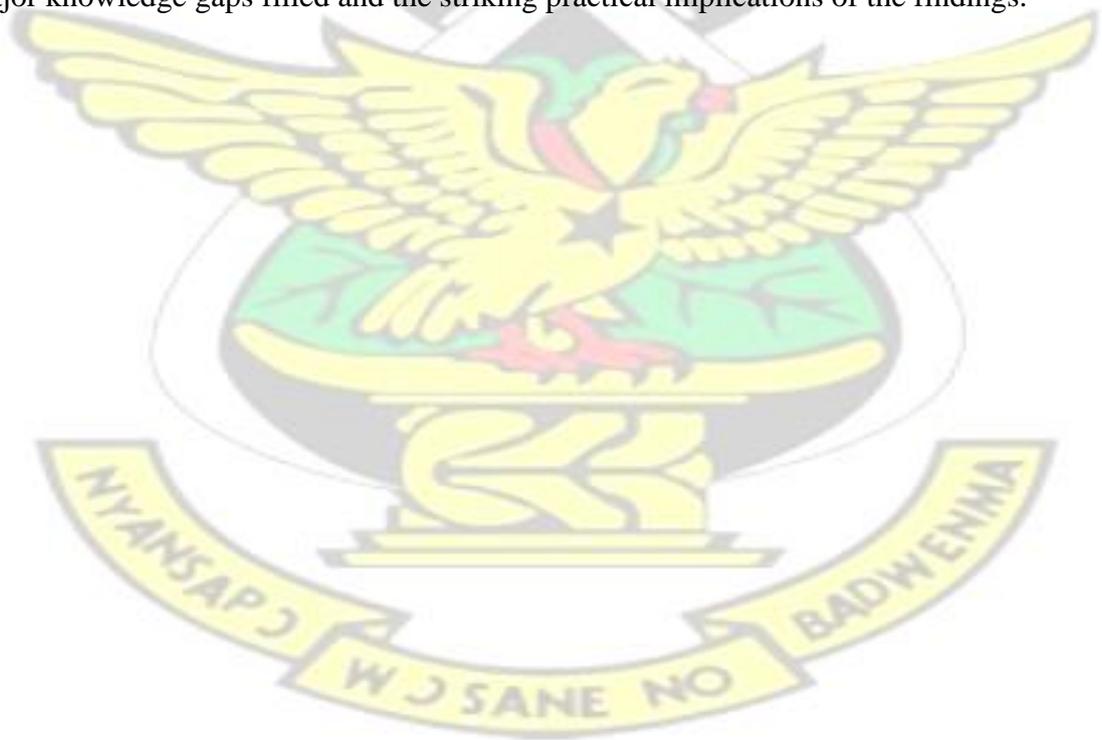
Finally, the need for human resource capacity building and education for both the technical and managerial levels of construction organisations has become evident in this research. This is a major evidence necessitating the introduction of relevant changes into the curricular of germane educational institutions. There is a greater tendency for the awareness creation role of existing regulatory bodies to be stimulated in order to enable ESC in the construction industry.

1.11 Thesis outline

This thesis contains six chapters. Chapter one explains the research background and describes the research problem. It explains the key concepts and terminologies used, in this thesis; states the research questions, aim and objectives; highlights research methods used and the key findings; and illuminates the research contribution.

Chapter 2 reviews the literature on the sustainable construction concept. It discusses SC emergence and importance in achieving global sustainable development and points to lack of frameworks for improving the adaptive capacity of contractors in developing countries. The knowledge gaps, barriers and unrecognized benefits of pursuing sustainability in the construction industry have been exposed. Chapter 2 also comes with a review of ecological and organisational theories relevant to sustainability studies in the construction industry. It discusses how four of such organisational theories can be hybridized to underpin the development of the ESC adaptation framework.

Chapter 3 presents the research methodology. It comprises a discourse of the philosophical underpinnings, where the ontological and epistemological stances taken in this study are argued out. This leads to a clearer explanation and justification of the selected research strategy, approach, method and techniques for collecting and analysing data to achieve the research objectives. In chapter 4, the data analysis process is explained. Further, findings from the analysis are discussed. The discussion comprises the major sections on: the sustainable construction knowledge and understanding of contractors; barriers to adaptation to ESC; and the ESC framework enablers and drivers. Chapter five discusses the process of developing and validating of the framework. Chapter six covers the conclusion and recommendation for further studies. It summarizes the findings and indicate the major knowledge gaps filled and the striking practical implications of the findings.



CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The key concepts dealt with under this chapter include sustainable development, sustainable construction and environmentally sustainable construction. The conceptual framework in Figure 1.1 gives an illustration. A closer look is taken at the origin and nature of sustainability practices that have been adopted for achievement of sustainability development goals, with particular emphasis on how those practices can occur within the construction industry in the context of developing countries. The inefficiencies and challenges against these practices have also been discussed, especially within the context of developing countries. Review of theories useful for understanding the research subject, ESC, and for explaining the research findings to underpin the development of the framework, form a major section in this chapter. Finally, literature on methodologies used to carry out studies in sustainability in the construction sector have also been reviewed creating a link to the next chapter in this thesis (i.e. research methodology chapter).

2.2 The concept of sustainable development

Defining the concept of Sustainable Development (SD) in global development has become a recurrent problem and there have been numerous attempts to find a workable definition. Sustainable Development borders on the simultaneous pursuit of economic prosperity, environmental quality, and social equity (Elkington, 2002). Other researchers such as Madu and Kuei, (2012), Hult (2011), Spangenberg (2010) and Lozano (2008) also agree on the widely accepted definition originally put across by World Commission on Environment and Development, WCED (1987:43). This popular definition of Sustainable Development (SD) is given as:

“Development that meets the needs of the present without compromising on the ability of future generations to meet their own need”.

Madu and Kuei (2012: 23) also describes sustainable development as involving:

“Creating infrastructure of material and energy use in communities that meet human needs while maintaining a wide array of metrics such as environmental quality, human health, social equity and economic vitality”.

This emphasizes the environmental, social and economic pillars of sustainable development highlighted by Borland (2009). Besides, Klostermann (2006) draws attention to a second definition in the Brundtland report which states that:

“Sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations.” - (WCED, 1987: 46).

This definition is rarely used (Klostermann, 2006). It puts emphasis on the fact that sustainable development is a *process of change*, not a state of utopia, towards meeting human needs. The focus of this research, adaptation to ESC processes, relates much to this second definition of SD as it puts emphasis on change of an existing system/practice that is not sustainable. This definition is therefore adopted in this research.

SD is a paramount issue and has become a drive for competitiveness among economies and in the corporate world. SD is a timely research subject and an important area driven by global concerns such as climate change, depletion of fossil energy resources and carbon emissions. For achievement of long term sustainable goals it is essential that agreement is reached by all parties to developmental projects as to what sustainability means for a particular project (Carter and Fortune, 2003). Bouchlaghem (2012) indicates it is widely recognized that the built environment is a major consumer of energy and contributor to the overall CO₂ emissions into the atmosphere. Hence the

role of the built environment industry is highly necessary for achievement of especially, environmental sustainable development goals in any economy. Playing this role requires that the various stakeholders, especially contractors, who are the implementers of construction activities, which have direct relationship with the biodiversity, are knowledgeable in the demands of SD.

2.2.1 Traditional pillars of SD

Sustainable development thrives on three main pillars; economic sustainability, social sustainability and environmental sustainability (Borland, 2009). These pillars are accepted traditionally as pillars of sustainability. However, it is worthy to note that there has been some attempts to include culture as the fourth pillar (United Cities and Local Government, UCLG, 2010; Burford *et al.*, 2013). Cultural sustainability, although not widely entrenched as a pillar of sustainability, focuses on ensuring that development in any community does not trample on the cultural values that border on the progress and integrity of community.

2.2.1.1 Economic Sustainability

The effects of the environmental and social activities come with costs that are internalized in an economy and reflected in the final prices of economic products. According to Schaltegger (2010) there are economic effects of environmental activities and these can lead to either an improvement or deterioration in some economic

‘performance drivers’ that include: Cost and risk; Turnover, price and profit margin; innovation; work satisfaction; and reputation, intangible values and brand value. Oftentimes, those who pursue sustainable development desire having low-carbon economy (Amekudzi *et al.*, 2011). In such an economy, it is expected that various sectors, such as the construction industry and manufacturing industry, should be able

to ensure that activities undertaken do not demand high energy usage, which usually result in high carbon emissions. As these important measures characterize developmental processes and procedures, competitive advantage of an economy could be achieved.

The imposition of penalties such as increase in taxation for contributing to carbon emissions and the giving out of incentives for ensuring energy efficiency are measures proposed globally for the purposes of driving home the goals of sustainable development (European Network of Construction Companies for Research and Development, ENCORD, 2010). The level of establishment, acceptability and enforcement of such relevant policies and laws guiding the implementation of sustainability practices among stakeholders, especially the construction industry in developing countries, depend on several factors. These may include the ability and extent to which sustainability practices may have been adopted and implemented by the relevant stakeholders (Du Plessis, 2007). The ability of construction companies in developing countries to comply with the requirements of some of these measures meant to engender sustainable development is therefore an important subject matter to be investigated in this research.

According to Spangenberg (2005), the definition of economic sustainability borders on continuous and indefinite (or at least long-term) sustained growth. In view of a possible relationship between the economic growth and construction industry growth, it is expected that improvement in sustainability in construction could have a positive impact on the economic growth of a country. For instance in a study conducted by Wang *et al*, (2013) it was found out that the impacts of social and economic sustainability in the housing sector in Beijing pose challenges in housing affordability and subsequently affect sustainability of economic growth. Further, executing a construction project in favourable economic

sustainability conditions on a given construction project is likely to promote the completion of the project within the estimated budget, thus, achieving successful cost performance. Cost performance, according to Peng *et al.* (2012), is a key performance of economic sustainability. In most developing countries, exceeding the budgeted costs has almost become synonymous with construction project execution (Mensah *et al.*, 2011). With the growing desire to achieve global sustainable development, there is the need to emphasize sustainable practices that promote execution of a project within budget in order to realize economic sustainability.

2.2.1.1.1 Economic sustainability and sustainable procurement.

To buttress the importance of improving cost performance for achievement of sustainability, Vadera *et al.* (2008) recognizes that good procurement practice is critical to reducing the overall cost of projects, to improve the economic efficiency of the construction industry. Also, this ensures that projects, when complete, are fit for purpose, securing whole life value. In a report by the UK National Audit Office, NAO (2005), it was identified that there can be significant benefits to the public purse through the adoption of best practice procurement. This brings to bear the issue of sustainable procurement, which is supposed to encompass the procurement life cycle of a project and not only up to the construction phase. Life Cycle Assessment (LCA) of a project is emphasized in economic sustainability and therefore sustainable procurement practices have to be put in place. Sustainable procurement must therefore be desired by built environment professionals in developing countries.

However, awareness of sustainable procurement practices seems to be low in the construction industry in developing countries. In Ghana, Mensah and Ameyaw (2012) found out that most construction professionals are not familiar with the sustainable procurement practices and this serves as a challenge to the achievement of economic sustainability. There is therefore the need to empirically identify the best sustainable

procurement practices, which when implemented, would foster economic sustainability in the construction industry, especially in developing countries. Before implementation of identification of sustainable procurement practices that enhance the implementation of sustainability in the construction industry, contractors, being executors of procurement plans, should first have the capability. Thus, the research focus on development of guidelines and strategies that would enhance contractor's adaptation to sustainability practices.

In a framework proposed by Tan *et al.* (2011) for improvement of contractor's competitiveness through implementation of sustainable construction practices, it is suggested that contractors need to have a clear sustainability strategy based on organisation's sustainability policy that is driven by sustainability principles and legislation. The need for such effective strategies also calls for finding out the necessary enablers and drivers of SC (DuPlessis, 2007). With the presence of such enablers and drivers, contractors would effectively adopt and implement sustainable procurement practices to further nurture economic sustainability. In spite of the need for economic sustainability, achieving environmental sustainability, especially in a developing country where the concept of sustainable construction is at its infantile stage, assumes primacy over economic sustainability. This strengthens the focus of this research on environmentally sustainable construction.

2.2.1.2 Social Sustainability

Social sustainability requires that any developmental project enables fair and just societies that foster positive human development and provide people with opportunities for self-actualization and an acceptable quality of life (Du Plessis, 2002). It also entails ensuring that social equity and cultural or customs of local people are not sacrificed. However, some construction works that are carried out especially in the developing countries fail to uphold the socio-cultural values of people.

Al-Sa'ed and Mubarak (2006) carried out a study into assessment of sustainability of sanitary facilities that employ on-site treatment. They identified that the socio-cultural values of the people were not met. For instance, they identified that: 75% of the sanitary facilities surveyed interfered with the customs of the people in RamallahAlbireh in the Middle East; and, 65% contradicted the cultural tradition. They concluded that onsite wastewater systems in small Palestinian communities were unsustainable as they were mainly constructed based on the low-cost alternative, which was not necessarily the most appropriate solution. Hence, to achieve sustainable development, social factors must be incorporated together with economic and environmental factors into the evaluation and selection of construction options.

Since social equity is important to achieving sustainability of developmental projects, less developed countries are expected to close up the rich-poor gap in society. Most developmental projects in developing countries have oftentimes failed to achieve affordability for the poor and this affects not only economic sustainability but social sustainability (Wang *et al.*, 2013). The rich-poor gap, thus becomes widened through creation of social inequity. Therefore, achieving social sustainability is very essential in the pursuit of sustainable development especially in developing countries where extreme poverty prevails. However, it is maintained that, the foundational nature of environmental sustainability makes it paramount to primarily pursue ESC to form the basis for effective achievement of social sustainability.

2.2.1.3 Environmental Sustainability

None of the three spheres/pillars of SD can be taken in isolation; ignorance of one of them will inevitably damage the others (Zaccai, 2012). However, it is imperative to reiterate that the context of this research, being environmental sustainability, is critical and foundational to achieving sustainable development in developing countries where

the SD concept is at its infantile stage (Du Plessis, 2002). Environmental sustainability seeks to sustain global life-support systems indefinitely. This principally refers to those systems that maintain human life. Therefore, it is paramount that the construction industry, whose activities are symbiotic with the biodiversity, should take action on not only mitigating impacts on the environment, but also regenerating environmental resources.

Raw material inputs such as food, water, air and energy are sourced from the global ecosystem. The processing of these raw materials also yield wastes or outputs that are assimilated by the environment described as sink capacities by Goodland (1995). These sources and sink capacities are finite and that is why sustainability requires that they are maintained rather than run down. Overusing the environment's capacity to assimilate the wastes could impair its life-supporting services such as protecting human life from the damaging effects of Chlorofluorocarbons (CFC's). This is why contractors need to ensure minimized or zero carbon emissions in construction activities. Protection of the environment must be a responsibility of all sectors of an economy. The construction industry is regarded as one of the largest sectors whose construction activities have significant effect on the environment (Tan *et al.*, 2011; Testa *et al.*, 2011; Shen and Zhang, 2002).

Environmental sustainability of construction projects is becoming a critical measure of the success of construction projects all over the world. Ahadzie *et al.* (2008), in finding out critical success criteria for Mass House Building Projects, confirmed that environmental sustainability is a potential critical success factor for the projects studied in the Ghanaian construction industry. The findings from the study of Chileshe and Yirenkyi-Fianko (2012) about risk assessment of construction activities of medium and large construction organisations in Ghana are evidence that construction

projects bear a lot of risks that are related to economic and environmental aspects. These, and several other works point to sustainability as a major theme for the success of construction projects. Therefore, achieving environmental sustainability in construction projects in developing countries is a significant agenda and contractors have significant role to play.

2.2.1.3.1 Drivers and Enablers of Environmental Sustainability

The environmental management capacity of a contractor is highly necessary for its efficient performance and attention needs to be given to their capability to adapt to environmental sustainability processes. To be able to establish an environmental management system within a construction business organisation, there is the need to have enablers that would provide conducive environment for adaptation. Similarly, drivers that would facilitate the implementation and continuous improvement of a construction organisation's environmental management strategy are also vital.

The term green building is sometimes used interchangeably with sustainable building/construction (see Kibert, 2012 and 2007b). In a study on drivers of contractors' green innovation, Qi *et al.* (2010) found out that, for a contractor to be able to adopt green practices in its organisation, factors such as managerial concern, environmental regulations and size of firm, are important drivers. The research findings were obtained in the Chinese context and there is need to also find out in a developing country context in Africa, the factors that would drive contractors' ability to adapt to environmentally sustainable construction. Also, whether some of these drivers identified by Qi *et al.* (2010) are present in a developing country context, such as Ghana, is something that needs to be discovered.

Also adherence to environmental regulations had been considered by Porter and Van der Linde (1995) as a driver of innovation and efficiency in resource use in any

business organisation. However, other findings seem to indicate otherwise. For instance, Testa *et al.* (2011) found out that the building and construction sector is under the threat of losing its competitiveness due to compliance to extensive energy and environmental regulations. Furthermore, Wong *et al.* (2013) found that contractors may not adjust their attitudes in carbon reduction strategy adoption for the sake of avoiding ‘penalty’ given in regulations. Notwithstanding, Wong *et al.* admitted that their finding is thought provoking and further research into the behavioural drift of contractors towards adoption of environment protection strategies is necessary. This makes the pursuance of objective 3 of this research necessary.

Organisation’s competitiveness is also found among the drivers of sustainability in the construction industry. Tan *et al.* (2011) assert that a contractor’s ability to implement sustainable construction practices contributes to the improvement of its competitive performance. They further developed a framework to show that there exists a relationship between the sustainability performance and business competitiveness of a contractor. They further argue that, that relationship is positive. The critical nature of pursuing environmental sustainability in all developmental sectors of developing economies, where less progress has been made towards the achievement of SDGs, cannot be overemphasized (Zaccai, 2012; Du Plessis, 2009).

2.2.2 The need for advancing SD in developing countries

Mostly, developed economies in the world have taken giant strides to become competitive by greening their economies. The UK is said to have taken the leadership in global sustainability (Kurul, *et. al.*, 2012). The British Research Enterprise Energy and Environmental Assessment Method (BREEEAM) is a method that the UK uses to assess the sustainability of projects. Ireland is also developing a sustainable development framework that targets transition to a competitive, low-carbon economy,

in line with the EU climate policy development, which stresses on the need for greenhouse gas emission reductions of at least 80% by 2050 compared to 1990 (Environmental, Community and Local Government of Ireland, 2011).

The green building rating method LEED (Leadership in Energy and Environmental Design) developed by the United States Green Building Council (USGBC), which is used mostly in the USA, has also been used to rate many buildings in the US for about two to three decades now. The US has and continues to explore ways to better integrate the economic, social, and environmental dimensions of sustainable development, building on the successes of the 1992 Earth Summit and the 2002 World Summit on Sustainable Development, and therefore places premium on resource productivity and efficiency as ways to promote sustainable development (Bureau of Oceans and International Environmental and Scientific Affairs New York City, 2011). According to Kibert (2007 (a)) other countries such as Japan and Germany have also increased their latest building stock that have improved energy efficiency in order to minimize environmental impacts of carbon emissions and reduce energy wastage through the use of renewable energy sources.

Just as these leading economies in the developed world are yearning for ways to make development sustainable, less developed countries also desire to achieve sustainability. Wei and Lin (2004) and Yitmen (2007) have argued that the construction industry, mostly in developing countries, is relatively backward and would fail to innovate in order to progress higher in technological advancement. It is worthy to note that, creating a sustainable built environment in the developing world requires a different approach from that taken by the developed world since the level of skills and capacity in local industries, as well as development priorities differ from

each other (Du Plessis, 2002). Du Plessis (2007) argues that in order to establish a sustainable built environment in Africa, there needs to be a solid knowledge foundation that equips the public, professionals, agencies and the government with accurate and relevant knowledge generated within the framework of the continent's social needs, its cultures and its biophysical environment. The need to quicken the attainment of sustainable development goals globally is buttressed by Agenda 21. This document strongly promotes sustainable construction industry activities, especially in developing countries (United Nations Sustainable Development, UNSD 1992:46; Du Plessis, 2002:2).

The problems and challenges existing in the construction industries in developing countries are common. In developed countries, advanced technologies and more industrialized construction processes exist to deal with challenges that contractors face in managing the environment. The authors indicated in Table 2.1 draw attention to the existence of resources and technology inequality between developed and developing countries, which could explain the gap in capacity between the two classes of countries to practice sustainable construction. This inequality has the tendency to affect progress towards achievement of the global goals of sustainable development. Thus, the call for the urgent need to advance SC in developing countries cannot be overemphasized.

The Agenda 21 document reveals the challenge of lack of stakeholders' capacity to ensure sustainability in the construction industry. There is therefore the need to find out how the capabilities of stakeholders can be enhanced to facilitate establishment of SC. This highlights the importance of the goal of this research, which is to provide information for stakeholders to ensure that sustainable construction practices become well diffused in the construction industry in developing countries in order to attain

minimization or eradication of the negative impacts on the environment due to construction activities. This will drive the achievement of sustainable development goals in developing countries, thus achieving not only the ‘green’ agenda but also the ‘brown’ agenda (economic progression through national infrastructure development) as described by Du Plessis (2005).

Table 2.1 Common problems and challenges of construction industries in developing countries noted by some authors

Problems and challenges	Source
<ul style="list-style-type: none"> ▪ Resource and expertise constraints ▪ Administrative weaknesses 	Ofori (2000)
<ul style="list-style-type: none"> ▪ Engineering integrity and design flaws in response to constrained availability of materials. ▪ Flexible industry in response to funding constraints. ▪ Labour force is willing and adaptable to difficult working conditions** 	Datta (2004)
<ul style="list-style-type: none"> ▪ Source of finance being agricultural products and raw materials ▪ Increasing difficulty to access financing necessary to move towards industrialisation and a knowledge economy ▪ High levels of inequity ▪ Lack of infrastructure and basic services ▪ Rapid growth of most cities in the developing world, coupled with a lack of funds for urban investment ▪ Having a colonial past that imposed certain norms, standards and bureaucratic procedures on the development of settlements and, by implication, on the construction industry ▪ Consumption of far fewer resources, and releases far less greenhouse gases than the developed world, yet environmental degradation experienced has a more direct and visible impact and present a more immediate threat to the survival of the poor ▪ Strong grassroots ability for innovation in the use of building materials, settlement development, and institutional structuring 	Du Plessis (2002)
<ul style="list-style-type: none"> ▪ Need for effective reporting and management information systems ▪ Serious management gap owing to the drift of young engineers to other organisations ▪ Focus of donors on specific projects rather than the broad road programme ▪ Long gestation period of donor loans ▪ Perennial problem of arrears in payments to road contractors ▪ Need to Improve local consultancy and contracting capacities ▪ Inability to secure adequate working capital ▪ Inadequate management ▪ Insufficient engineering capacity ▪ Poor workmanship. ▪ inadequate operating cash flow ▪ inadequate flow of jobs ▪ low level of fees, hinders the development of their technical support system ▪ low productivity ▪ poor quality of work ▪ lack of means and opportunities for providing training 	Ofori (2012)

** Important characteristic for improving the construction industry

2.2.2.1 Influence of socio-cultural values on promoting SD in developing countries in Africa

Salm and Falola (2002) note that in most parts of Africa, informal education pervades. This form of education allows societal elders to give moral lessons to young ones. It encourages young ones to give respect and heed instructions from elders without, most of the times, interrogating the basis of such elderly instructions. The informal education utilizes the apprenticeship training, which dominates artisanship in the construction industry in most of the developing countries that were colonized. The dominance of the apprenticeship system as means of training artisans for the construction industry in the sub-Saharan African region has been noted by Kheni *et al.* (2006) and Yeboah (1998). This system normally establishes the master-apprentice relationship, which is a superior-subordinate relationship. In view of the argument of Salm and Falola (2002) about the presence of socio-cultural values of young ones taking moral lessons from elders unreservedly, most of the times, artisans are used to taking instructions from superiors without questioning to understand the rationale behind the instructions.

Furthermore, in spite of the cultural variations existing among people across the developing world as indicated by DuPlessis (2002), there is a link between language and culture/customs of a people. For instance, Salm and Falola (2002) notes that the local languages spoken in Ghana have roots in countries such as Mali, Niger, Congo, Cote d'Ivoire, Sierra-Leone, Guinea and Togo. On this basis, it would not be surprising to find similarities in the socio-cultural behaviours of people in these developing countries, which were also colonized. These socio-cultural values are essential to establishment of SC in developing countries and are therefore worthy of investigation in this research.

2.2.3 The role of the construction industry in achieving sustainable development goals

It has been argued that the capability and viability of the construction industry is necessary for enabling sustainable construction in view of the construction industry's backwardness, lack of innovation and its fast changing environment (Hwang and Ng, 2013; Yitmen, 2007; Wei and Lin, 2004). Therefore, contractors need to also build capability in order to respond to the demands that sustainable development places on construction activities. There are shortfalls with the capability of indigenous contractors in some developing countries. For instance, in Ghana, large construction works are undertaken by foreign firms rather than the indigenous ones, in view of capacity challenges that face the indigenous construction firms (Laryea and Mensah, 2010). To ensure that sustainable construction targets are set and achieved in the developing countries, indigenous firms need to build up skills, knowledge and innovation that will enable the application of sustainability practices in construction activities.

Sustainable construction is a major medium for achieving environmentally friendly construction, low carbon economy and the goals of sustainable development at large. Therefore, the construction industry would need to play a pivotal role in ensuring that construction activities are executed without compromising on sustainability principles. This pivotal role creates the opportunity, and almost an obligation, for the construction industry to take up a leadership position in promoting sustainable development. This requires going beyond only the execution of construction contracts to act as advocates in preparing the government, broader public sector, and business and public opinion leaders for the huge task of realizing sustainable development.

The need for the construction industry to take up the leadership in ensuring that the environmentally sustainable construction practices are adopted in order to reduce the negative environmental effects, such as the global warming, is becoming increasingly important. Governmental initiatives are not adequate to solve the environmental problems we face. This important role of construction business organisations is buttressed by the statement given in the GHG protocol reporting standard of the WRI/WBCSD World Resources Institute and World Business Council for Sustainable Development (2013:3) that:

“Emissions of the anthropogenic greenhouse gases (GHG) that drive climate change and its impacts around the world are growing. According to climate scientists, global carbon dioxide emissions must be cut by as much as 85 percent below 2000 levels by 2050 to limit global mean temperature increase to 2 degrees Celsius above pre-industrial levels. Temperature rise above this level will produce increasingly unpredictable and dangerous impacts for people and ecosystems. As a result, the need to accelerate efforts to reduce anthropogenic GHG emissions is increasingly urgent. Existing government policies will not sufficiently solve the problem. Leadership and innovation from business is vital to making progress.”

2.3 Sustainable construction

Sustainable construction, which is sometimes referred to as green construction, is the construction process that ensures energy efficiency, environmental sustainability, low carbon, and resource efficiency (Kibert, 2012 and 2007b). It is defined by Kibert (1994) as:

“The creation and responsible management of a healthy built environment based on efficient resources and ecological principles’ (cited in DuPlessis, 2007:69).

Hill and Bowen (1997) have since then divided Kibert’s principles into four ‘pillars’: social, economic, biophysical and technical. They successfully explained the four themes of sustainable construction. Hill and Bowen advocate that, it is always necessary to pursue sustainable construction in these themes. Du Plessis (2002:6) also defines sustainable construction by linking it to sustainable development principles:

“Sustainable construction means that the principles of sustainable development are applied to the comprehensive construction cycle from the extraction and beneficiation of raw materials, through the planning, design and construction of buildings and infrastructure, until their final deconstruction and management of the resultant waste. It is a holistic process aiming to restore and maintain harmony between the natural and build environments, while creating settlements that affirm human dignity and encourage economic equity.”

The definitions given above demonstrate application of the principles of sustainable development throughout the entire life span of a building. In this research, a more focused direction on the construction process of the building life cycle is taken. This direction becomes more affirmed in light of the assertion of Horvath (2004) that, literature on environmental impacts of infrastructure is still limited and that most attention has been devoted to the use-phase energy consumption of residential, commercial, and industrial buildings, especially in heating, ventilation, air conditioning, and lighting. He added that although future research should continue with the study of the use phase and energy issues, it should also focus more on the other lifecycle stages of the infrastructure that have received limited attention but are just as important.

This research therefore focuses on finding out practices that must be adopted by contractors during the construction process as defined by HM Government (2011). This focus would contribute to improving resource usage efficiency and regeneration, while lowering negative impacts such as carbon emissions on the environment. Application of environmentally sustainable construction practices is also expected to

drive the shift towards constructing buildings and other infrastructure that would operate based on renewable energy sources and energy efficiency principles.

2.3.1 The interplay between SD and SC

There is pressure on industry practitioners to incorporate environmental and social considerations in addition to the traditional cost, time and quality as infrastructure project success factors (Renard *et al.*, 2013). It should be noted that the economic considerations would also come to play. The emergence of the sustainable development concept has placed infrastructure projects in a pivotal role with regards to giving information on progress in sustainability practices.

The highly influential Brundtland report released in 1987 was the first document to define the three pillars of modern sustainable development as environmental, social, and economic (Chong *et al.*, 2009). Although this report touched deeply on environmental aspects even more than social sustainability, sustainable construction was very faintly discussed. The Rio Summit in 1992, the Kyoto Protocol in 1997, and the Johannesburg Meeting in 2002 also followed up with primary focus on the needs of society and the environment. Economic issues were secondary at these meetings too. However, the concept of sustainable construction started gaining grounds with specific efforts dedicated to establishment of sustainable construction worldwide through the development of Agenda 21 for Sustainable Construction in Developing Countries in (1992). These developments have propelled awareness among researchers in the built environment. However, awareness of environmental sustainability is still low among some practitioners in the construction industry in developing countries (Sengupta *et al.*, 2015; Mensah and Ameyaw, 2012). The activities of the construction industry pose threat to environmental sustainability. The Agenda 21 report (1992) outlines some issues to promote sustainable construction in every country.

Specifically, the document states that is the need to:

“Encourage the organisation of indigenous community based organisations, private voluntary organisations, and other forms of nongovernmental entities which can contribute efforts to reduce poverty and improve the quality of life for low-income families.” – UNEP (n.d.: 3)

Sexton *et al.* (2006) argues that there needs to be an appreciation and active management of the different motivations and capabilities of small and large construction companies. To grow the capabilities of contractors, technology transfer initiatives into the construction industry in developing countries needs to be promoted for establishing sustainable construction. Establishment of sustainable construction practices requires application of sustainable construction technologies. It is therefore relevant to also investigate into the issues affecting contractors’ inability to adopt relevant technologies for implementing ESC processes.

2.3.2 Challenges faced in changing unsustainable construction practices

In most developed countries, sustainable construction practices have advanced (Kibert, 2012; HM Government, 2011). Developing countries must follow suit (Ofori, 2012). This will facilitate realization of sustainable development globally. Nonetheless, there are challenges encountered in implementing sustainability practices in various organisations in the construction industry. And stakeholders in the construction industry need to take note of these challenges.

Opoku and Fortune (2011) have confirmed that having a committed leadership in the promotion of sustainable practices in construction organisations is highly imperative. Lack of the needed leadership could therefore be a challenge to the practice of sustainable construction in other parts of the globe where SC is at its embryonic stage. The need to replace traditional practices in construction with modified practices

through innovation is also highly necessary for achieving sustainability in construction. According to Kurul *et al.* (2012), delivering sustainability in the built environment sector will require step changes in practice. Practitioners will need to discard long-held beliefs and practices, and thus transform the built environment sectors across the globe from their current fragmented and adversarial states to a state where collaboration across organisational and professional boundaries becomes the norm.

This draws attention to the fact that professionals' resistance to change or failure to embrace new technologies and innovation in the construction industry could pose barriers to adoption of sustainable development principles and technologies. For instance, in major European Union Countries, buildings in use produce between 25 and 30% of CO₂ emissions. Also, according to the World Green Building Council (2009), in the UK, 45% of the total CO₂ emission comes from buildings (23% from residential buildings and 18% from non-domestic buildings). In view of these disturbing trends, immense pressure is put on the construction and manufacturing sectors to improve their practices, (traditional unsustainable practices) in order to deal with a changing climate by substantially reducing energy use in buildings (World Business Council for Sustainable Development, 2009). It is not clear whether these challenges identified could even exist as barriers to adaptation to SC in another setting. Therefore investigations are required to establish and contextualize barriers to SC in order to facilitate successful adaptation to ESC.

2.3.2.1 Strategies and actions for promoting SC in the construction industry To

promote sustainability in the construction industry, contractors need to have strategies that facilitate adopting environmentally sustainable construction practices in place. The United Nations Environment Programme, UNEP (2009) put forward some carbon

reduction strategies. Prominent among them are: educating the supply chain; dedicating research and development to zero net buildings; working with governments to develop policies that would change behavioural attitudes towards emission reduction; and moving to a holistic and systematic solutions to sustainable buildings. Furthermore, Häkkinen and Belloni (2011) also outline important actions to promote sustainable building. These include: the development of the awareness of clients about the benefits of sustainable building; the development and adoption of methods for sustainable building requirement management; the mobilization of sustainable building tools, the development of designers' competence and team working; and the development of new concepts and services. In spite of the presence of these strategies and actions, sustainable construction in the developing world remains a mirage to a large extent. Thus, the capability of construction organisations to adapt to the sustainable construction principle by the application of some of these strategies require further investigation as being embarked upon in this research.

It is worthy to note that the works of Ofori (2012), DuPlessis (2007), Price and Ochieng (2007) and Agenda 21 for Sustainable Construction in Developing countries (DuPlessis, 2002) come with frameworks for achieving or managing sustainable construction in developing countries and emerging economies. In spite of the existence of these frameworks, construction industry stakeholders, especially in developing countries, still lack capability for addressing environmental challenges. This necessitates the development of contractors' capability-improving guidelines in this research.

2.3.3 Common sustainable construction practices

Du Plessis (2002) and Li *et al.* (2012) draw attention to some of the sustainability practices, which, when employed in the construction industry, would forge ahead the efforts being made to establish SC globally. Some of the SC practices include:

- Using indigenous building materials that have the tendency to reduce transportation hazards associated with delivery of construction materials to site of long or “cross-country” distance (Li *et al.*, 2012)
- Through research and development, developing materials to suit the local environment (appropriate technology)
- Improving the use of affordable renewable materials such as bamboo, sugar cane straw panels,
- Use of recyclable materials such as plastic
- Marrying modern production methods with traditional building practices
- Reducing transportation distance of manufactured materials to construction sites by considering proximity of material production centres to building sites
- Cutting down transportation distance of raw materials from point of extraction to processing centre (Eg.: siting timber processing centers near production sites in forests (Li *et al.*, 2012)).
- Using building materials with longer life span
- Efficient use of non-renewable natural resources such as chippings and steel
- Minimizing extreme mechanization of the construction process (i.e. using manual methods where possible and more efficient)
- Cutting down the use of electricity (energy)-demanding processes such as metal structures construction that require a lot of welding in the assembly process.
- Establishing and building institutional capacities to promote sustainable development

- Increasing public awareness of sustainability and building sustainable development concept into construction education curricular
- Development and enforcement of regulations and legislation that promote incentives for sustainable practices and penalties for anti-sustainable practices
- Promotion of knowledge sharing among construction professionals in academia and industry
- Frequent usage of natural processes for cooling and heating shelters
- More use of biotechnology for energy generation and sanitation provision
- Integration of construction planning, designing and implementation phases of construction by overcoming the challenge of fragmentation within the construction industry
- Rethinking the traditional construction process by upgrading/innovating in order to produce traditional buildings that provide improved standard of living while maintaining cultural heritage and values.

Other SC practices directly related to contractor's organisation are described in Table 2.2. Implementation of these SC practice would inure to the benefit of both contractor and project owner. Some of the benefits include increase in competitiveness due to high green rating (Sinha, 2010). However, there could be some commitment challenges associated with SC practices.

When a company carries out these green practices, the project cost increases by 2% as against the 7% reported by the US green Building Council (USGBC) (Valente *et al.*, 2013). This confirms the finding from the study conducted by Opoku and Fortune (2011) in which they identified that there is a perceived additional cost associated with sustainability, making it difficult for construction companies and construction clients

to adapt to the concept easily. However, the finding of Casado *et al.* (2009) is an evidence that further studies at different regions could demystify this perception.

Table 2.2 Description of contractor's SC practices

SC Practice	Description
Green Commitment	This is where a programme is embarked upon to reverse degradation that is caused by construction activities. In this practice, a construction company is required to plant a tree in place of every m ² of land cleared for construction. Since plants are known to absorb CO ₂ for the process of photosynthesis, carbon emissions due to construction are then going to be minimized.
Use of recycled and regional materials	Using recycled and regional/local materials would contribute to reducing the volume of waste that would have been otherwise disposed either through landfilling or incineration causing CO ₂ emissions. Encouraging the use of regional or local materials for construction would also avoid the situation where raw and processed materials would have to be transported over long distances increasing the rise in CO ₂ emissions.
Selective waste collection	This practice involves making a conscious effort to retain or divert a considerable amount of waste during the construction process for recycling or reuse. This avoids a situation where 100% of waste arising from construction are sent to landfill or incinerated to cause rise in the CO ₂ emissions.
Erosion and sedimentation control at site	This practice is more focused on protection of slopes with grass planting and minimization of dust pollution caused by transportation of sediments to and from the construction site.
Use of more sustainable accessories and equipment	This practice is more focused on promoting significant savings during the operation and maintenance phase of a project and it involves the use of equipment that promotes energy efficiency in heating and lighting as well as increase efficiency in use of natural resources such as rainwater. This practice can also be adopted during the construction phase when there is the need to use energy as well as natural resources for production purposes. As energy efficiency increases CO ₂ emissions are also minimized.
Use of Wood Certified by Forestry Authorities:	The use of unauthorized trees for construction activities could cause extinction of some tree species in the ecosystem and that is why there is the need for government forestry authorities to control the use of these natural resources used for construction. It is important that construction practitioners ensure compliance with such regulations in order to promote the restoration and renewal of flora towards sustainable development.
Community Connectivity and promotion of public transportation:	The aim of this practice is to minimize the total transportation distance within a given community by providing facilities within walking distances and also ensuring easy access to public transport terminals. It calls for holistic planning of cities. By adopting this in construction in the form of proper site planning and organisation, the frequency of transportation of materials, plant and human resources can be controlled to reduce emissions. To adopt sustainable construction practices it is necessary that contractors, on whom the responsibility of site planning lies, are knowledgeable and

	experienced in applying this SD principle of connectivity and proximity of transportation during construction activities.
Energy Efficiency Monitoring and Auditing	In this green practice, the use of an Energy commissioning agent in monitoring and auditing projects to ensure that the systems therein have been well designed to reduce energy consumption is encouraged. In order to ensure maximum effectiveness of this exercise it is important that this practice is not restricted to only the design and operational phases of a project but also to the construction phase.

Source: (Valente *et al.*, 2013; Li *et al.*, 2012)

2.3.4 Sustainable Usage of Resources in Construction

Resource usage in the construction industry that is not based on sustainable construction principles, assumes a linear pattern. To achieve sustainability in construction, resource usage/processing must be cyclic and not linear (Miyatake, 1996). This could be accomplished by changing the form of thinking, behavior and resource production and consumption associated with the traditional unsustainable construction practices. Figures 2.1 and 2.2 indicate the resource usage/processing cycle in unsustainable construction and sustainable construction modes respectively.

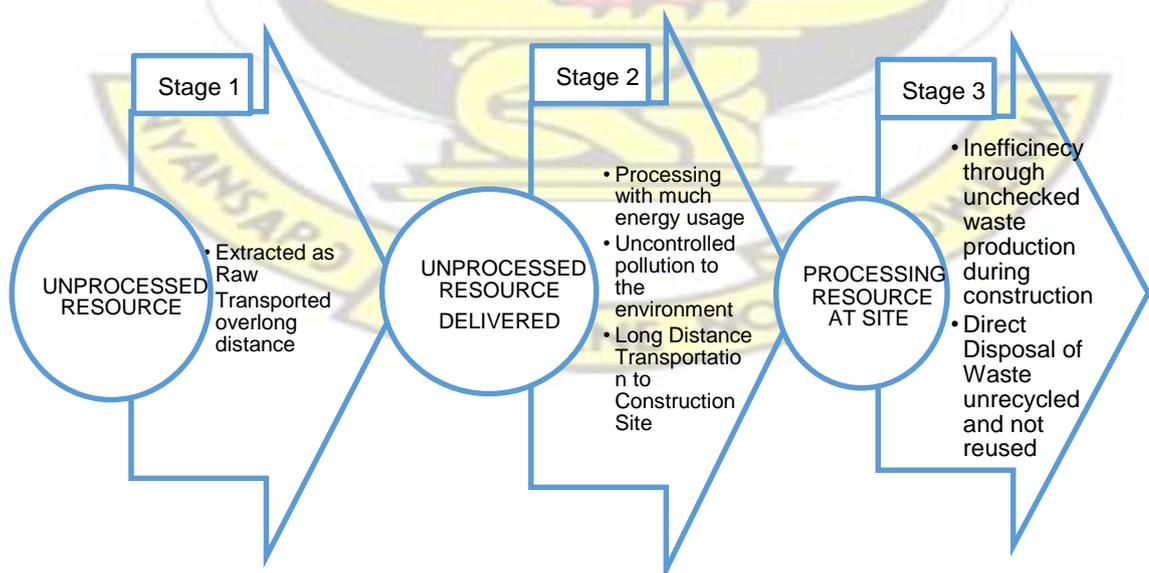
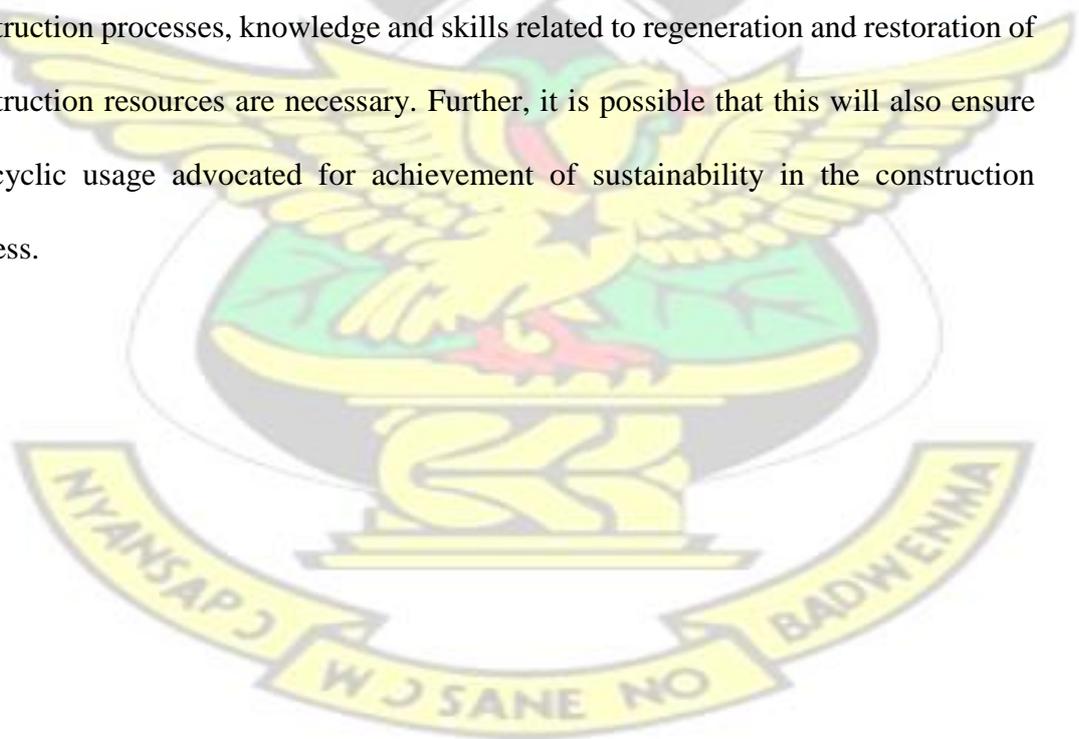


Figure 2.1 Linear usage of resources in an unsustainable construction process

(Source: Author's construction)

To achieve a complete cycle of resource usage that promotes sustainability in construction, regeneration of resources for reincorporation into the construction process becomes imperative. In examining the future of sustainable construction, Kibert (2007) found out that a shift towards regeneration is highly likely to empower sustainability in the construction process. For transformation of the construction industry into an era of sustainability, it has been advocated that regeneration and restoration of resources are necessary. Consequently, frequent usage of renewable resources more than non-renewable resources, would be prompted. For designers and constructors to develop the ability to ensure sustainability in the design and construction processes, knowledge and skills related to regeneration and restoration of construction resources are necessary. Further, it is possible that this will also ensure the cyclic usage advocated for achievement of sustainability in the construction process.



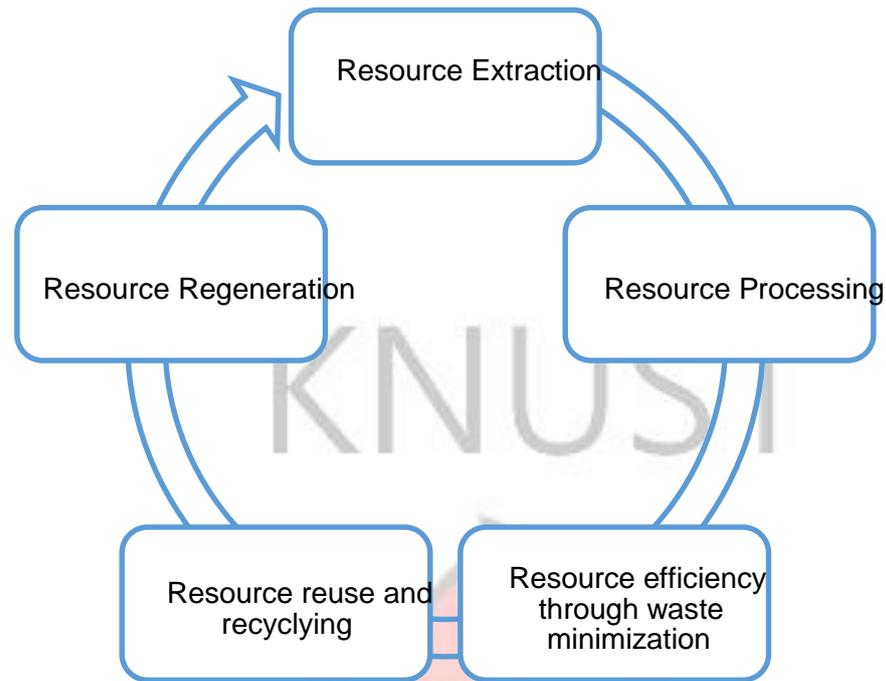


Figure 2.2 *Cyclic usage of resources in a sustainable construction process*
 (Source: Author's Construction)

2.3.5 Benefits of SC practices

To promote sustainability in the construction industry, it is important for stakeholders to be acquainted with the general benefits thereof. Musango and Brent (2011) claim that sustainable technology development has the potential to advance economic growth and societal benefits and also, enhance stakeholders' ability to minimise negative effects on the natural environment. Likewise, Weaver and Weaver (2000) had also made mention of the fact that sustainable technology development can lead to efficient use of resources putting less stress on the environment. Sagar and Holdren (2002) have also argued that since technological development is a key driver for the energy sector, efficiency is introduced in the use of energy with the adoption of sustainable practices. John *et al.*, (2013) have also indicated that sustainability practices in the ship building industry lead to reduced carbon emissions and damage to the environment.

There are benefits directly associated with implementation of SC practices. For instance, Kibert (2007b) has highlighted that the revolution of building materials and technologies will accelerate sustainable construction development. This acceleration is important for the construction industry to contribute to achievement of the goals of sustainable development without further delays, which can aggravate the negative impacts on the environment. Ping *et al.*, (2009) also argue that practicing sustainability in construction projects lead to increased capacity of contractors to achieve better project performance. This reveals that enhanced resource capacity could be a product of practicing sustainability within a construction organisation. However, little has been done in investigating contractors' awareness of these benefits associated with SC processes.

Green rating systems have been established in some developed countries due to the need to attain the goals of Sustainable Development. The Ghana Green Building Council GHGBC (2011) also outlines some benefits that could accrue from choosing to have a green rating system applied to one's project. These include: lower operating costs, higher return on investment, greater tenant attraction, enhanced marketability, productivity benefits, reduced liability and risk, a healthier place to live and work, demonstration of corporate social responsibility, future proofed assets, and competitive advantage. The benefit of having increased competitive performance by contractors has also been relayed by Tan *et al.* (2011) and Testa *et al.* (2011).

Realization of the benefits would be difficult, if not impossible, without construction organisations in developing countries gaining the needed awareness, education and capability to practice sustainable construction. However, little has been done in

investigating into the barriers, enablers and drivers of adaptation to ESC by these construction organisations.

2.3.6 Potential barriers to the practicing of SC

In spite of the existence of some benefits associated with green buildings, lack of awareness can be a barrier towards achieving overall sustainable construction goals. Research and development needs to be carried out to investigate into the ability of the stakeholders in the construction industry, especially the contractors, who are the executors of construction plans and designs, to overcome some of the barriers associated with adapting to SC.

Stakeholders seem to have the view that high cost is associated with ensuring sustainable development (Opoku and Fortune, 2011; Shi *et al.*, 2013). There are also lack of steering mechanisms and client understanding (Hakkinen and Belloni, 2011) for SD. These could be barriers against SC being practiced in a reasonable manner. Furthermore, there is lack of the needed human resources required to ensure sustainability in various sectors of an economy (Adegbite *et al.*, 2012; Arthur and Mensah, 2006). Also, among the few professionals in the construction industry, there seems to be low level of awareness of the benefits associated with ensuring sustainability in construction (Mensah and Ameyaw, 2012). This is also a barrier. However, there seems to be lack of guidelines that can facilitate minimizing these barriers. Also, factors that have led to the low level of awareness of sustainability practices and its benefits in amongst construction professionals remain faintly discovered and need to be investigated in order to identify ways of enabling adaptation to SC.

2.3.6.1 Other potential SC barriers specific to developing countries

According to Du Plessis (2007), there are systemic challenges and framework formulation challenges that face the establishment of sustainable construction in developing countries. The systemic challenges include uncontrolled rapid rate of urbanization, deep poverty, social inequity, low skills levels, institutional incapacity weak governance and uncertain economic environment and environmental degradation. These challenges could have a strong link with the construction industry and possibly affect its capacity, especially that of contractors, to implement SC.

In Nigeria, it has been identified that some of the barriers facing the implementation of sustainable development practices in business firms include: "... insufficient employee awareness; inadequate knowledge base on sustainable businesses; lack of experts in the field of sustainable development in firms; corporate and individual indifference to environmental issues; and uncoordinated government policies" (Adegbite *et al.*, 2012:86). These findings were made amongst firms in the oil and gas, telecommunications and banking industries and the barriers facing contractors in the construction industry remains unclear.

On a national scale, the development agenda of developing countries are focused on fulfilling survival needs more than meeting the requirements of sustainable development. To drive sustainable construction, policy and decision makers' involvement is crucial. This will foster finding effective ways of developing actionoriented approach towards sustainable construction practice in the construction industry. Hence, strategies are required to guide how stakeholders in the construction industry can collaborate to create enablers of sustainable construction. This could empower contractors to overcome existing barriers against adaptation to SC.

2.4 Environmental policies and regulations in the construction industry

The construction industry stands as one of the major sectors whose activities result in depletion of natural resources. The industry has negative effect on the environment, especially with respect to carbon emissions. Due to this, governments in some countries have instituted regulations to ensure that activities are environmentally friendly (Lam et al., 2010). Construction contractors are known to be at the forefront of construction activities and therefore hold much responsibility in taking steps towards complying with such environmental policies that are meant to regulate the activities of the construction industry. Some have argued that environmental regulation is one of the important drivers of contractors' environmental and competitive performance (Tan *et al.*, 2011; Testa *et al.*, 2011). Other operational features of environmental regulations such as: 'penalty (cost/charges) for carbon emissions' (Sathre and Gustavson, 2007; UNEP, 2009); 'tax rebate and loan schemes for carbon reduction efforts' (UNEP, 2009; HM Government, 2011; Acquaye and Duffy, 2010; Scleich et al., 2009); 'more severe ratings/standards' (UNEP, 2009; HM Government, 2011; Acquaye and Duffy, 2010; Sathre and Gustavson, 2007); and 'receiving education and training from governments and professional associations' (UNEP, 2009; HM Government, 2011) have enhanced efforts to promote environmental sustainability.

In spite of the existence of these policies, which could be regarded as sustainability drivers, further research needs to be carried out among contractors in a developing country setting such as, Ghana, the study country. This will enable finding out other barriers and driver of Environmentally Sustainable Construction (ESC) that may be precursors of adaptation to ESC. This is especially necessary since other research works such as that of (Wong *et al.*, 2013) in Australia, have indicated the

powerlessness of penalties as drivers for contractor's carbon reduction strategy. They showed that contractors would not change their attitude to minimize the effect of construction activities on the environment due to penalties inherent in environmental regulations and policies. In most developing countries, where sustainable construction practices are not fully established, there is the need to find out what would drive contractors active participation in ensuring that the requirements of environmental sustainability are met in the execution of construction works.

2.4.1 Operation of contractor's organisational policy on ESC

Having contractor's ESC policies in place apart from governmental environmental regulations may be an enabler of sustainable construction practice. However, Du Plessis's (2007) revelation about sustainable construction not yet established in developing countries seems to suggest that contractors may not have their own organisational policies on how to ensure environmental sustainability. This raises the need to find out other internal barriers that may be influencing ability of contractors to institute organisational sustainability policies. For instance, as advocated by Global Reporting Initiatives, GRI (2011), construction organisations should be able to report on their sustainability performances in order to enhance their chances of complying with relevant environmental regulations. The question that remains is: 'do contractors in majority of developing countries have the ability to assess their sustainability performance let alone reporting on such performances?'

Zhou *et al.* (2013) emphasizes the growing trend towards the need for sustainability in construction to be adequately measured. Sustainability experts should be present within organisations to carry out such duties. However, such personnel are lacking in many business organisations in some developing countries (Adegbite *et al.*, 2012).

There are also some barriers that could hinder organisations' from reporting on sustainability performance even if the GRI standard should be used. Some of these barriers have been highlighted by Fonseca (2010) as: lack of capacity-building at sites; lack of interest from local stakeholders; unclear cost-benefits; increased information management and excessive corporate exposure.

Apart from the need to overcome some of the barriers outlined above in order to report effectively on sustainability matters, contractors should have the ability to pursue specific organisational efforts directed towards achieving environmental sustainability. For instance, on the basis of inventory proposal by European Network of Construction Companies for Research and Development, ENCORD (2010), a specific goal for reducing carbon emissions from construction activities, would require planning well on how to reduce fuel usage and electricity consumption. This plan need to feature on a given project as well as in general daily business operations. In Africa, where most of the developing countries exist, such organisational inventory evaluation strategies are yet to be established.

2.4.2 Contractors' networking and collaborative efforts towards ESC regulations

There seem to be no existence of such government-private business collaborative efforts in the developing countries. This kind of collaborative effort is recommended by Adegbite *et al.* (2012). These authors found that although businesses in Nigeria have started pursuing sustainable development programmes to improve their corporate social responsibility, there have not been efforts by the government to develop sustainable development policies with the private organisations. Adegbite *et al.* studied activities of organisations in the oil and gas, telecommunication and banking industries. However, there the ability of contractors within the construction industry to embark upon self-initiated sustainable development programmes needs to be investigated. Also, ability of

contractors to take the initiative to stimulate governmental efforts towards the development of ESC policies, is important. There are however lack of strategies and guidelines on how this collaborative capacity of contractors can be developed.

2.4.3 Green rating in environmental policies

Policy making bodies such as government and other established relevant institutions play significant role in the formulation and enforcement of environmental regulations. Green rating tools like the LEED by the US Green Building Council (see Kibert, 2012) and the BREEAM by the British Research Establishment have been established and have been in operation for the past two decades. However, Ghana, a developing country, just established the Ghana Green Building Council (GHGBC) in the year 2009 (GHGBC, 2011). The Council is at its infantile stage making efforts to develop a rating system for use in the country.

According to GHGBC (2011), the purpose of the rating system is: to establish a common language; set a standard of measurement for green buildings; promote integrated, whole-building design; recognise environmental leadership; identify building life-cycle impacts; and raise awareness of green building benefits. This effort, although comparatively recent, requires stakeholders in the Ghana construction industry, especially contractors who are the implementers of professional plans and design, to reposition themselves to be able to adapt to green building practices, which are in line with sustainable development principles.

2.4.4 Contractors' capability to adopt the ISO 14000

The major objective of the ISO 14000 series of standards is to promote more effective and efficient environmental management in organisations (ISO, 2015). The ISO 14000 family includes most notably the ISO 14001 standard, which represents the core set of

standards used by organisations for designing and implementing an effective Environmental Management System (EMS). Other standards included in this series are ISO 14004, which gives additional guidelines for a good EMS, and more specialized standards dealing with specific aspects of environmental management. The ISO 14000 Environmental Management System Standard has become a wide-spread administrative tool in the field of corporate responses to sustainability.

Briggs and Nestel (1996) indicate that ISO 14000 is a pro-active scheme. However, there are arguments about its ability to address environmental challenges effectively. For instance, MacDonald (2005) argues that, as a framework for the administration of sustainable development in firms, ISO 14000 in itself does not speak of strategic planning for sustainability, nor of upstream solutions of problems at their source.

Furthermore, the author contends that confusion exists with respect to where ISO 14000 fits in relation to a complex array of tools for sustainable development. Additionally, Ball (2002) also argues that although ISO 14000 is an important step towards environmental management, yet by definition, they become reactive to the situation of global environmental destabilisation without restoration. Therefore, it is important for restorative culture that brings in environmental awareness to be established.

This research focuses on environmental management in the developing country context, where awareness of sustainability is low. In such situations, a culture that improves awareness and capability to manage environmental challenges becomes primary as the case is in this research. For all the positive steps that ISO 14000 might be making, there are issues that still remain un-addressed. According to Ball (2005), the most important of these issues are cultural sustainability, rationality and materiality, environmental restoration and, as far as construction is concerned, the

consideration of buildings, not just in the environment, but as a part of ecological systems. The social-ecological considerations, which take significant position in this research, are essential in building the capability of contractors to manage the environmental challenges. This would subsequently facilitate contractors' effective adoption of ISO 14000, especially the 14001 standard.

2.5 Carbon emissions: nature and control in the construction industry

Carbon emissions is a central theme in the discourse on sustainable construction. There is now a growing industry trend that calls for use of renewable construction materials, which when applied efficiently and effectively, can deliver buildings with enhanced environmental properties towards minimizing carbon emissions. Governments in the developed countries are investing in promoting such sustainable practices. Similar efforts towards minimization of carbon emissions have not been forthcoming in most developing countries. For instance, the UK government, through the Department for Environment, Food and Rural Affairs (DEFRA) has invested well in minimization of carbon emissions using the Renewables and Low Carbon programme in collaboration with the department of Business, Enterprise and Regulatory Reform (BERR), now replaced with the Department of Business Innovation and Skills (BIS). (Vadera *et al.*, 2008). It is worthy to note that, research work in construction has taken a trend towards having Integrated Building Systems (IBS), which focus on solutions for the construction of new low-carbon buildings. Achieving low carbon buildings and grounds comes with a focus on the development of models for infrastructure and zonal design. Some of these models developed by some researchers include: digital information modelling (Tizani and Mawdesley, 2011); distributed utility services (Nguyen *et al.*, 2011; energy efficient housing typologies (Wehage *et al.*, 2013; Moon, 2011) etc. In line with such current trends of research there is the need to build frameworks that would enable construction industry stakeholders deliver new and regionally-based

environmentally sustainable, healthy, and socially inclusive infrastructure to communities in especially, the developing countries. It is expected that such frameworks would allow efficient knowledge management and technology application for delivery of sustainable infrastructure. It is therefore important to find how contractors in developing country construction organisation could be equipped with some of the modern knowledge and technology that are being suggested for use in environmentally-friendly infrastructure development.

2.5.1 Embodied and Operational Carbon

In the construction sector, embodied carbon is known as the carbon emitted due to the energy sequestered for the production and fixing of construction materials. It is carbon emitted due to embodied energy – that is

“The energy consumed in the extraction or manufacture of the materials and products required for construction work, or in the process of transporting and assembling them” (HM Government, 2011:25)

The embodied carbon in construction materials comes from two sources:

“Fossil fuel inputs (directly related to the embodied energy); and that which is released during production process of materials and components” (Hammond and Jones, 2008:89).

An example of the latter source of embodied carbon is the process of converting limestone to cement” This category of emission occurs during the construction stage of the building as contrasted to operational carbon, which is emitted during the usephase. This is carbon emitted due to energy consumed by people in buildings (HM Government, 2011). The construction industry faces the challenge of developing a built environment that supports and encourages a life lived at radically lower energy level consumption. However, this research focusses on emissions occurring during the construction process, which is part of the whole life cycle of a building. This is more related to embodied energy (energy consumed in creating the asset). There are

emissions resulting from the use of the building but this does not form part of the core activities of contractors, who are target units of this research. The major phases of building life cycle upon which carbon emissions are based are illustrated in Figure 2.3.

KNUST



KNUST

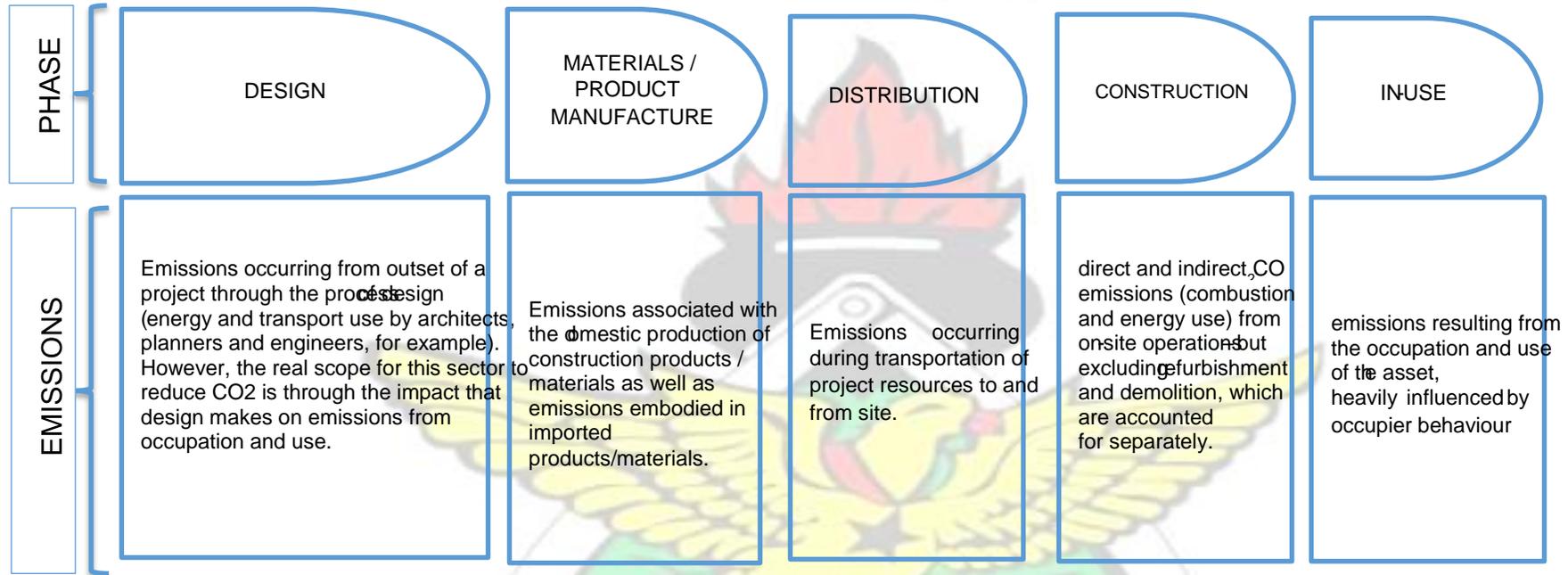


Figure 2.3 Carbon Emissions at Broad phases of a building's life cycle

Source: (Author's construction based on UK Green Building Council³)



KNUST



Based on the United States National Institute of Standards and Technology, NIST (2007), the major stages of a building where carbon emissions are normally regarded include the materials extraction, materials transportation and usage (cited in HM Government, 2011). To demonstrate the trend of carbon emissions in various national sectors in relation to the built environment sector, Table 2.3 gives an example from UK regarding sectorial carbon emissions.

Table 2.3 Proportion of total UK CO₂ emissions that construction can influence

BUILT ENVIRONMENT SECTOR		*SECTORIAL CO₂ EMISSIONS	
Non-Residential Buildings		18%	
Residential buildings		27%	
Other		44%	
Construction Process	<i>Manufacturing</i>	8%	10%
	<i>Design Distribution On-site operations Refurbishment and demolition</i>	2%	

**totals add up to 99% due to rounding up figures*

(Source: DECC, National Communication, Carbon Trust Report, BIS estimates (HM Government, 2011))

As demonstrated in Table 2.3, construction processes stage does not contribute the largest CO₂ emissions. However, choices made during the construction process could have a significant influence on the performance of buildings throughout its life cycle, especially with regards to performance in energy consumption and associated emissions. Also, Horvath (2004) advocates that it would be detrimental to the goals of sustainable development to ignore research into sustainability issues of the ‘construction process’ merely due to comparatively low level of emissions that occur during that stage. The focus of this research is on construction contractor’s capability

for adapting to ESC. Contractor's role usually occur at the construction process phase of the project life cycle. Where design-build form of contracts are used, contractors also play significant role at the design stage. Since the research interest is on construction contractors' capability for adaptation to ESC, the focus is on sustainability practices during the construction process phase.

2.5.2 Carbon footprint in the construction industry

According to the HM Government (2011), CO₂ makes up roughly 83.33% of Greenhouse Gases (GHGs), which were targeted for reduction by the Kyoto Protocol and the Climate Change Act 2008 (CCA). It is not clear whether there is capability of stakeholders in the construction industry, especially in developing countries, to ensure mitigation and adaptation strategies aimed at achieving the Kyoto protocol CCA objectives. The other non-CO₂ GHGs are methane, nitrous oxide, Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur Hexafluoride. Each of these have Global Warming Potential (GWP), which are measured in CO₂ equivalency (CO₂e) (Kneifel, 2013). For instance according to a report by Wilkinson and Kirkup (2009) each unit of methane is 21 times the GWP of CO₂ or 25 times according to Kniefel (2013). Carbon footprint of a given construction material is known as the sum total of the CO₂e figure for each stage that the material is processed or used for construction works. There are various approaches for measuring carbon footprint and this will depend on the scope or boundaries defined for measuring the footprint. However, the focus of this research is not on measuring carbon footprint.

Wilkinson and Kirkup (2009) mention two approaches for measuring carbon footprint: organisational footprint and product footprint. The organisational footprint, which is based on the standard set by the WBCSD, World Business Council for Sustainable

Development (2009) and World Resources Institute (WRI), considers that all the 6 major GHGs should be measured. With the product footprint a Life Cycle Assessment (LCA) methodology, which estimates the CO_{2e} of any good or service for each stage of a product's life cycle, is normally adopted. The organisational carbon footprint measurement approach has become increasingly common among both public and private organisations in developed countries.

Li *et al.* (2012) in developing a computational model for measuring carbon emissions at construction stage of a building, using Building Information Modeling (BIM), adopted the organisational foot printing approach. In this approach, there are three recommended categories, Scopes 1, 2 and 3 as per the WBCSD and WRI standard, for measuring CO_{2e} as are defined in Table 2.4.

Table 2.4 Categories of organisational carbon footprint measurement approach

Scope	Emission type	Description
Scope 1	Direct Emissions	These are emissions from activities that cause consumption of fuel in the process of carrying them out. In the construction industry, this results mostly from the use of mechanical equipment for a given planned period of work.
Scope 2	Emissions from the use of electricity	These emissions are due to carrying out activities that go with consumption of electricity. In the construction industry this emissions is normally due to the use of equipment that consume electricity in the construction process. Li <i>et al.</i> (2012) however refer to Scope 2 emissions as <i>indirect emissions</i> .
Scope 3	Indirect emissions	Li <i>et al.</i> (2012) refers to emissions under this scope as " <i>other emissions</i> ". Li <i>et al.</i> refer to these emissions as CO ₂ emitted from disposal of waste of materials during the construction process. Meanwhile, Wilkinson and Kirkup (2009) report defines scope 3 emissions as those that are generated as consequence of an organisation's activities but which are not directly under its control.

Source: WBCSD/WRI (2009)

Carbon emissions control form significant part of implementation of sustainable construction. Hence, it is important that contractors, in improving upon their ability to implement sustainable construction, put in place carbon reduction strategies (Zuo *et al.*, 2012). Such carbon reduction strategies would include effective measurement of emissions. For contractors to be able to report on their sustainability performance, according to reporting standards such as the GRI, it is expected that they should be able to also measure emissions from their activities in order to improve their sustainability performance (Tan *et al.*, 2011). Although the focus of this research is not on measurement of carbon emissions itself, it is intended to investigate how contractors would be able to establish strategies and improve their ability to measure and control carbon emissions from construction.

2.6 Construction industry's adaptation to climate change

According to John *et al.* (2013:574),

“Climate change refers to any significant change in the measures of climate lasting for an extended period of time.” He adds that, “...climate change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer.”

According to the report of the working group 1 of Intergovernmental Panel on Climate Change, IPCC (2013:25), changes in climate have become more visible and these include:

“...more frequent heat waves, increased frequency and intensity of rainfall and flooding events, increased average temperatures, increases in intense tropical cyclone activity, rising sea levels and changes in the salinity and acidity of the ocean; and loss of both glacier and polar sea ice.”

A most worrying revelation in the report indicates that even if emissions of CO₂ due to anthropogenic activities are stopped, most aspects of climate change will continue for many centuries. This is due to the fact that most of the emissions are already saturated in the atmosphere. An affirmative action from the construction industry to curtail

unsustainable practices to meet the global sustainable development agenda can therefore not be postponed. The time to improve the ability of contractors to pursue sustainable practices is now.

The significance of this research becomes more vivid in light of these revelations regarding developments in the ecosystem. The WRI/WBCSD (2013) had indicated that much more increased efforts are needed by all stakeholders involved in anthropogenic activities that result in emissions to ensure that the rise in the world mean temperature brought about by the phenomenon of climate change with its associated consequences of global warming should not go beyond 2°. Otherwise, the whole ecosystem faces serious and unpredictable impacts. In the effort to overcome such a huge challenge that the ecosystem faces, Du Plessis (2014) and Reed (2007) advocate that going green alone is not enough. Rather, embarking on sustainable and restorative designs and regenerative approach and efforts to revive the ecosystem should be the new direction. To be able to pursue these restorative and adaptive efforts, contractors need to develop capability. Moreover, at areas where sustainability is at its embryonic stage, there is largely lack of understanding of the issues surrounding adaptation, regenerative sustainability and restorative designs advocated by researchers in sustainable construction. To develop understanding of these issues, and to subsequently foster successful adaptation to ESC, there is the need to use relevant theories to advance knowledge and improve understanding in the research subject. In line with this need, the next section of this chapter discusses postulations of four relevant theories. The discussions foster understanding of the complexities surrounding adaptation to sustainable construction and also underpin development of the framework in this research.

2.7 Theoretical review towards framework development

Sarkis *et al.* (2011), reviewed literature on Green Supply Chain Management, an aspect of sustainability practices. In the review, the authors employed organisational theories. It was remarked that the use of theories to advance studies in sustainability has only seen some initial investigations. This supports Cabezas's (2002) assertion about the need to utilize more theories to underpin sustainable systems studies. To further develop knowledge in sustainability studies, the potential of some of these theories have to be well explored to advance research, especially in the field of sustainable construction.

In this research, four theories have been used to facilitate the development of a framework aimed at enhancing the capability of contractors to adapt to Environmentally Sustainable Construction (ESC). The four main theories include: Resilience theory, Ecological Modernization theory, Institutional theory and Social Network Theory. The latter three are regarded as organisational theories, which Sarkis *et al.* (2011) have noted as being suitable for use in the field of sustainability/green studies. Resilience theory, though a multidisciplinary theory, as noted by Vanbreda (2001), has originally been applied in the ecology discipline. These theories have been particularly selected due to their relevance to the development of organisational framework aimed at enabling and driving contractors' effective adaptation to ESC (Folke *et al.*, 2010; Walker *et al.*, 2004; Holling, 1973). Moreover, the theories have the required organisational and social-ecological orientation that will facilitate investigations into the research question. Thus, their choice for advancement of knowledge in this research.

2.7.1 Resilience Theory (RT)

Since the introduction of the resilience concept by the ecologist, Hollings (1973), the concept of resilience has grown to be multidisciplinary. It is applied in ecological, sociological and even political studies. By the year 2002, awareness about the resilience theory in sustainable development studies had grown for about two decades (Folke et al., 2002). Thus, for over three decades now, a lot more discourse on the importance of resilience theory for the achievement of sustainable development goals, have developed and continue to develop (Pisano, 2012; Folke *et al.*, 2010; Folke *et al.*, 2004; Walker *et al.*, 2004).

Due to the interdisciplinary nature of the resilience theory, the role that anthropogenic activities play, which disturbs the resilience of the ecology, cannot be overlooked.

Construction activities that lead to deforestation and emission of Green House Gases (GHG) have high tendencies to push resilience of the ecosystem as well as social systems within it beyond bearable limits if not checked. According to VanBreda (2001), resilience theory addresses the individual (child, adult), family, communities, work places and policies.

To garner some lessons from the various definitions given to resilience and its application in a social system, a look is taken at for instance, “individual resilience”. Individual resilience has been defined by several researchers, few of which are outlined below:

“...the capacity to maintain competent functioning in the face of major life stressors (Kaplan, *et al.*, 1996:158)

“...the skills, abilities, knowledge and insights that accumulate over time as people struggle to surmount adversity and meet challenges. It is an ongoing and developing fund of energy and skill that can be used in current struggles” (Gamenzy, 1994, cited in VanBreda, 2001:5)

“... the capacity for successful adaptation, positive functioning or competence, despite high risks, chronic stress, or following severe trauma” (Egeland et al., 1993 cited in VanBreda, 2001:5).

Carpenter *et al.* (2001) defined resilience as the ability of a system to build and increase the capacity for learning and adaptation.

Based on the above definitions, resilience theory, within the context of social system, would demand that an organisation, possesses the skills, abilities, knowledge and insights that will enhance its capacity to adapt to ESC. This should happen while the system still maintains its functionality, competence and energy.

The construction industry is regarded as social-ecological system. Folke *et al.* (2010:3) defines social-ecological system as:

“An integrated system of ecosystems and human society with reciprocal feedback and interdependence.”

The definition emphasizes human-in-nature perspective. The construction industry is described as a social-ecological system in view of its interdependent relationship with the environment (Tan *et al.*, 2011); natural resources feed into construction activities while wastes and various emissions generated out of the activities of construction organisations are given back to the environment. According to Pisano (2012) humanity depends on services of ecosystems for its wealth and security. Thus, humanity and ecosystems are deeply linked. It is therefore highly imperative for human organisations to strive for resilient social-ecological systems in order to meet the goals of sustainable development.

Contractors are regarded as actors within the social-ecological system of the construction industry. The focus of this research is on the use of the principles of sustainable development by these actors to ensure efficient environmental management for pursuance of resilient social-ecological system. Therefore, RT is

found to be very relevant in explaining the dynamics involved in achieving the ultimate goal of having contractors organisations adapted to ESC.

“Resilience is the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks” (Folke *et al.*, 2010:3; Walker *et al.*, 2004:2). Resilience is also known to be the capacity of a social-ecological system to change in a changing world while maintaining its functionality (Walker and Salt, 2006). The concept also refers to the ability of a system to resist and recover from disturbances to the ecosystem (Chapin *et al.*, 1996). Resilience is described by four main aspects.

Box 2.1 The four aspects of resilience

These are as given in Box 2.1

Source: Walker *et al.* (2004)

1. **Latitude:** the maximum amount a system can be changed before losing its ability to recover (before crossing a threshold which, if breached, makes recovery difficult or impossible).
2. **Resistance:** the ease or difficulty of changing the system; how “resistant” it is to being changed.
3. **Precariousness:** how close the current state of the system is to a limit or “threshold.
4. **Panarchy:** the degree to which a certain hierarchical level of an ecosystem is influenced by other levels. For example, organisms living in communities that are in isolation from one another may be organized differently from the same type of organism living in a large continuous population, thus the community-level structure is influenced by population-level interactions.

The resilience of a system, whether ecological or social, can be well described by the above four main aspects. In the light of the four aspects of resilience, there is the need for a contractor, as social-ecological system actor, to know its limits in terms of technology and financial capacity, beyond which successful environmental management cannot be possible. In spite of external and internal pressures battling against improved sustainability performance, the construction industry, as a socialecological system, should be able to develop resilience in order to adapt its practices to the changing practices associated with introduction of modern ESC technologies. This should be done without losing the basic functions of the

construction industry, which border on contributing to infrastructure and economic development through routine construction business activities while generating and maximizing profit for the benefit of humans within. This will ensure that the practice of ESC does not lead to collapse of construction business operations and subsequently economic downturns.

Therefore, adaptive capacity, an important element of resilience theory, becomes a vital feature required for realizing resilience for an effective and improved sustainability performance of contractors.

2.7.1.1 Social-ecological system's adaptability/ adaptive Capacity

An important element of resilience theory is the 'adaptability of a system', which is also referred to as adaptive capacity. Adaptive capacity is a key theme in resilience thinking (Pisano, 2012). A system should be able to have an adaptive capacity in order to act resiliently. Adaptability / Adaptive Capacity is defined as: "the capacity of actors in a system to influence resilience" (Pisano, 2012:20; Walker *et al.*, 2004:2). Thus, contractors, as actors within a social-ecological system, should be able to develop the capacity to influence resilience in a manner that will lead to effective adjustment to the demands of ESC.

Adaptability is also referred to as the capacity of a system to adapt if the environment where the system exists is changing (Gunderson and Holling, 2002). Folke *et al.* (2004) also indicate that adaptive capacity in social-ecological systems refers to the ability of humans to deal with change in their environment by observation, learning and altering their interactions. Thus, contractors should be able to observe and learn about changes within the construction industry, both local and international. This will

yield the needed capability to alter practices that do not meet changing demands, especially the ones emanating from the concept of sustainable development.

In social systems, adaptive capacity is demonstrated by the stability of social relations, the maintenance of social capital and economic prosperity. Gonsalves and Mohan (2012: 343) state that:

“Adaptive capacity confers resilience to perturbation, giving ecological and social systems the ability to reconfigure themselves with minimum loss of function”

Thus, contractors’ organisations, as actors within social-ecological system, should be able to maintain and improve on the routine functions of producing and competing to make business profit. These business functions are expected to be carried out effectively while demonstrating resilience to demands emerging out of modern sustainable construction practices.

For instance, one of the challenges that would have to be overcome with acquisition of adaptive capacity, is the challenge of initial high costs associated with ESC practices. This challenge seems to deter most developers and construction contractors from embracing sustainable construction (Shi *et al.*, 2013). For this challenge not to weaken the efforts of social-ecological system actors to adapt to ESC practices, there is the need for contractors to possess the adaptive capacity needed to influence resilience. This would enable actors to function effectively and efficiently as business entities while adjusting to changes occurring in the daily business practices.

In an ecological system, adaptive capacity is determined by: genetic diversity of species; biodiversity of particular ecosystems; and heterogeneous ecosystem mosaics as applied to specific landscapes or biome regions (Gunderson and Holling, 2002). On the other hand, adaptive capacity of a social system is determined by: the ability of

institutions and networks to learn, and store knowledge and experience; creative flexibility in decision making and problem solving; and the existence of power structures that are responsive and consider the needs of all stakeholders (ibid.) For contractors to gain the adaptability to demonstrate resilience, they should be able to network with other similar construction organisations that have been successful in the practicing of sustainable construction. This needs to be done in such a manner that will ensure effective learning and storing of knowledge and experience for implementation of ESC processes.

In order to achieve sustainable use of environmental resources, contractors require understanding of the resilience of the ecosystem and its limits too. These are part of the knowledge required to be accumulated to facilitate alteration of unsustainable construction practices. It is not clearly known whether contractors operating in a developing country context are able to network with other organisations locally or internationally in order to acquire the relevant knowledge and experience for establishing ESC practices for meeting the global demands of sustainable development. It has been found that, the ESC knowledge of BE professionals working in some large construction contractors organisations in Ghana, a developing country, is low (Mensah *et al.*, 2015). Therefore, such networking could be an important facilitator of ESC knowledge and skills acquisition in a contractor's organisation.

2.7.1.2 Adaptive Cycle

To facilitate deeper understanding of the concept of adaptive capacity, and subsequently, resilience thinking for development of the framework in this research, discussion on adaptive cycle is key. The Resilience Alliance, as illustrated by the work of Holling and Gunderson (2002) and also expanded on by Walker *et al.* (2004),

Walker and Salt (2006), Folke *et al.* (2010) and Pisano (2012), gives a clear understanding of the adaptive cycle illustrated in Figure 2.4. There are the four main phases of the adaptive cycle: growth and exploitation (r phase); conservation (K phase); release or creative destruction (Omega, Ω , phase); and reorganization or renewal (alpha (α) phase). These are indicated in figure. 2.4.

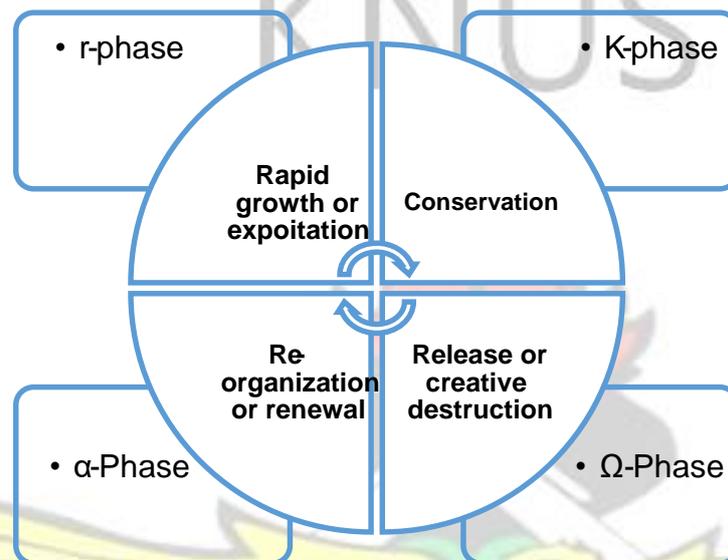


Figure 2.4 Phases of the Adaptive Cycle

Source: Pisano (2012) and Walker and Salt (2006)

The r-phase of a social-ecological system is explained as a period where there is rapid growth of people or a new business venture (Pisano, 2012). This occurs at the earliest stage of the cycle. It is the phase where there are innovators and entrepreneurs who seize an opportunity identified to fill a market niche (Walker and Salt, 2006). From this description of r-phase, a construction industry within a certain economy could find itself in this phase of adaptive cycle when new construction opportunities loom. In such state, the search for job opportunities in the market would be pursued with all efforts by construction organisations than in the succeeding phase. Here, internal structures and the internal state of affairs of a construction industry, as a socialecological system, would be weakly regulated.

The r-phase occurs in a comparatively shorter period. Thus, the success achieved by the social-ecological system actors become short term success. A contractor's organisation could find itself in this situation in a period when there is rapid environmental and technological changes. Some of these changes may come as a result of demands placed on the construction industry by sustainable development.

At the K-phase, Pisano (2012) explains that association between actors increase for establishment of mutually reinforcing relationships. Specialist, rather than exploiters, emerge. Efficiency in the use of resources improve, lasting over a longer time period. These indicate that actors in a construction industry, at the conservation phase, would be able to accumulate capital at an increasing rate. There would be rise in competition among construction organisations.

Holling and Gunderson (2002) show how positive feedback of the r phase, replaced by the K negative feedback strategy, is an important part of adaptive capacity. Therefore, for the construction industry to sustain success realized in the r-phase, there is the need for movement into the conservation, K, phase. This movement characterizes the K negative feedback strategy, which fosters high adaptive capacity of a system. According to Walker and Salt (2006), movement to the conservation phase, is associated with situations of high complexity, high resilience and capability of a social-ecological system. At this stage of the cycle, contractors could have growing businesses gearing towards more specialization and greater efficiencies of large economies of scale (Walker and Salt, 2006). Adopting the K negative feedback strategy could therefore be very important for contractor's improvement in adaptive capacity for implementing ESC processes.

However, with time, as growth rate stabilizes and disturbance to the system continues to increase, rigidity sets in and resilience begins to decline. The system becomes increasingly vulnerable leading to the release or creative destruction phase (Ω -phase), which happens swiftly with a little shock (Pisano, 2012). This is where resources that were tightly bound for efficient production are now released. Interconnectedness between actors in the system breaks down weakening regulatory controls. Thus, capital leaks out of the system resulting in a chaotic situation. However, Pisano (2012) indicates that the released capital and resources become source for reorganisations and renewal. This is where the system is ushered into the next phase, α -phase, reorganisation or renewal phase.

It seems that some situations could lead to the movement of the construction industry, as a social-ecological system, from the conservation phase to the release phase and subsequently, to the reorganization phase. Some of these situations are likely to be: diversification of capital of construction organisations into other business ventures; and loss of built environment professionals and other human resources within a construction organisation for the purpose of establishing other construction companies. The existence or otherwise of such conditions in the CI requires investigation. There is the need to identify circumstances that could lead to situations of low resilience that negatively affects the adaptive capacity of contractors to practice ESC. This would provide basis for developing strategies to counteract situations that lead to destruction of contractor's conserved resources.

2.7.2 Ecological Modernization Theory (EMT)

York *et al.* (2010) note that EMT emerged around 1980 and was introduced by James Martin Jainicke and Joseph Huber. EMT has since then received a lot of attention from

researchers across various disciplines over the years. A lot of academic research works on the application of EMT, especially with regards to sustainability of the ecosystem, have been carried out (see Lockie *et al.*, 2013; Spaargaren *et al.*, 2009; Young, 2001; Mol and Sonnenfeld, 2000). EMT theorizes that:

“continued industrial development, rather than inevitably continuing to degrade the environment, offers the best option for escaping from the global ecological challenge” (York and Rosa, 2003:273).

Also, one of the key arguments of the EMT is that ‘ecological rationality’ should percolate all aspects of society to ensure efficiency in resource usage (York *et al.*, 2010; Mol, 2001).

The term modernization deals with the cessation of traditional methods in order to pursue more contemporary effective methods within an organisation (Hemant, 2011). This calls for the use of innovations and modern technology to operate. Due to the rise in population and increased rate of rural-urban migration, urbanization has become an unavoidable feature of society. However, urbanization puts pressure on the limited ecological resources and this can lead to localized depletion of natural resources. Having efficient methods to deal with the negative consequences of ecological trends must therefore be part of organisational practices within any industry such as the construction industry where contractors are significant stakeholders.

2.7.2.1 Aspects of EMT

According to York *et al.* (2010), EMT approach emphasizes three aspects. The first and most important is that modern societies tend to use *processes* to achieve environmental sustainability. This is where “reflexivity” of modern society comes to play to ensure that society will, by itself, use modern efficient processes for production to ensure ecological rationality. The second aspect borders on focusing much more on the environmental approaches at the micro level to solve environmental problems

rather than emphasizing on macro theories that proffer economy-wide process solutions. Therefore, it would be effective for contractors to pay attention to specific examples where environmental policies and practices of certain firms, industries and governments have been used to pursue environmental sustainability.

The third aspect is about the argument that most modern societies that are affluent, especially heavily industrialized societies, can achieve sustainability as there is evidence of such trend across the world (Mol, 2001; Mol and Spaargaren, 2000). With regards to this third aspect, it seems there will be a difficulty for societies in the developing world, to achieve sustainability. Taking a closer look at the adaptive capacity concept discussed under the resilience theory in this research, the need for contractors to build and improve upon organisational adaptive capacity for establishment of ESC becomes crucial in the light of the third aspect of EMT.

2.7.2.2 Basis for application of EMT

According to Dobbin (1994), there is a modern view that promotes the idea of having an evolutionary progression towards more efficient forms. Thus, governments, modern firms and organisations should have the goal of maximizing efficiency. These laws should be able to govern contemporary construction organisations and lead them in the direction that will make them maximize profits efficiently. With the understanding and application of these concepts, contractors should be able to generate maximum profit, through the use of sustainable construction technological/innovations. Through the application of SC technologies, which encourage resource efficiency, contractors would be able to ensure ecological rationality. Consequently, organisation's business performance gains could be maximized. Zhu *et al.* (2011) indicate that an emergent ecological modernization tool among Chinese manufacturers has been Green Supply

Chain Management (GSCM). They claim that this tool has been used to balance environmental performance with productivity and business performance gains.

Contractors in the developing world, like any other business organisation, are focused on maximizing profit. However, these organisations sometimes suffer losses due to inability to compete. Low capacity in terms of modern methods used by advanced contractors from advanced countries, characterize most of the contractors in developing countries (Laryea and Mensah, 2010). This situation seems to be a reflection of the argument of EMT, that, ability to manage ecological challenges becomes more prevalent with industrialization. This challenge facing contractors in developing countries require further investigation in order to find out strategies that will enable increase in capacity to pursue sustainability in the construction industry.

2.7.2.3 Challenges facing EMT

York and Rosa (2003) raised some challenges that face EMT and these are worth looking at in the context of the CI in a developing country. Significant among the challenges raised is whether every organisation necessarily modifies to deal with environmental problems. They found out that the challenge has not been well addressed. Another key challenge revealed by York and Rosa (2003) is that EMT should go beyond the mere introduction of efficient forms. They argue that rate of efficiency introduced within organisations should exceed the overall level of production to ensure sustainability. The challenges identified in their study emerged out of macro level observation of institutions. However, it will be effective to observe the existence of these challenges within micro level of contractor's organisation as encouraged by York *et al.*, (2010).

2.7.3 Institutional Theory (IT)

Institutional theory (IT) relates to recent theory and research on organisations and institutions (Scott, 2008). IT examines how a company is influenced by external pressures (Hirsch, 1975 cited in Sarkis *et al.*, 2010). Institutional Theory is a widely accepted theoretical posture that emphasizes rational myth, isomorphism and legitimacy (Scott, 2008). In the light of Jennings and Zandbergen's (1995) study, it is relevant to use the claims of IT to form basis for the development of guidelines for contractors to achieve environmental sustainability.

Institutional Theory has been used to study the ecological sustainability of organisations. Also, the theory can be extended to help organisations build consensus around the meaning of sustainability and how the concepts and practices associated with sustainability can be used. IT advocates for the use of *isomorphism* (similar organisation forms) for creating a robust structure to deal with changes in its environment (Scott, 2008). Linking this argument of IT with the social-ecological system adaptability requirement of resilience theory, inter-organisational learning becomes very relevant to acquiring knowledge in sustainable construction technologies and methods. Contractors should be able to learn from other contracting organisations that are advanced in the application of SC technologies to help deal with environmental challenges in construction business operations.

2.7.3.1 The isomorphic drivers of IT

According to DiMaggio and Powell (1983), IT comes with three isomorphic drivers; normative, mimetic and coercive drivers. To drive ESC practices among construction organisations these drivers could play significant role. In the context of this research, the normative drivers deal with customers market situations that would drive a

construction organisation to implement ESC practices. The survival of construction organisations would then depend on the conformance to the rules and belief systems prevailing in the economic environment (Scott, 1995). Here, the awareness of construction projects' clients or end users about advantages of sustainable buildings could be a normative driver for incorporation of sustainable technologies into the construction process. It is not clear whether contractors face such market and client situations as a source of motivation for intensive adoption of ESC practices and this requires empirical confirmation.

The mimetic isomorphic drivers would occur in situations where construction enterprises would imitate other enterprises that have been successful in sustainable construction practices. The rationale here is for construction organisations to merely follow the actions that have been taken by competitors in order to imitate successful sustainable processes and practices. However, for organisations to establish guidelines that will guide the adaptation to ESC over time, resilient social structures have to be put in place (Scott, 2004). For instance, Aerts *et al.* (2006) indicate that imitation plays a significant role in the development of enterprises in developed countries such as Germany, USA and Canada. Zhu and Liu (2010) also indicate that in developing countries, where there are many small scale enterprises, the use of joint ventures would be useful for implementation of Green Supply Chain Management (GSCM) practices. The effectiveness of the mimetic isomorphic drivers in motivating contractors to improve upon capability to adapt to ESC is an area that require further inquiries.

Coercive isomorphic drivers are the governmental rules and regulations that could pressurize an organisations adapt to a change voluntarily. This is buttressed by Kraft and Furlong (2007), stating that, IT is a policy-making theory that emphasizes the

formal and legal aspects of government structures. However, it is not clear whether contractors could be reacting differently to similar pressures in developed and developing countries due to differences in social, economic, and political factors that constitute the institutional structure of a particular government. Therefore, empirical evidence was required to clarify this challenge associated with the coercive driver of IT.

2.7.3.2 IT in different economic conditions

The conditions that provide firms with advantages for engaging in specific types of activities could differ from economy to economy. From the review of Sarkis *et al.* (2010), businesses tend to perform more efficiently if they receive sufficient institutional support. For instance, according to Porter (1990) buttressed by Martinsons (1993), a multinational cooperation operating in different countries with varying institutional environments face diverse pressures. Some of those pressures in host and home institutional environments are testified to exert fundamental influences on competitive strategy. Hasmath and Hsu (2014) indicate that even Non-governmental organisations and social organisations can also be susceptible to isomorphic pressures. The contribution of relevant institutional and regulatory supports to the improvement of contractor's capability to adapt to ESC is important for inquiry.

Martinsons (2008) extended the theory of institutional deficiencies (TIDE) he developed in 1998 to show how the development of relationship-based e-commerce in China has emerged due to that country's lack of trustworthy and enforceable set of rules for doing business. The theory suggests that factors such as international and national organisational networks and Social Networks could foster the sharing of both informal and formal information for the establishment and improvement of

contractors' ESC practices. The use of such social networks could strengthen contractors' ability to circumvent unclear business-government relations, which sometimes encourage corruption.

The mention of the importance of Social Networks in fostering ESC practices among construction organisations makes it worthy to explore the potential of Social Network Theory (SNT) in facilitating development of the guidelines that will enable construction contractors to establish ESC practices. The SNT is therefore discussed in the following section to be able to explain how the use of contractors' social networks is important to adaption to ESC.

2.7.4 Social Network Theory (SNT)

Connelly *et al.* (2010) has suggested that a suitable theory to facilitate understanding of sustainability developments as a new or emerging concept in a social system is the Social Network Theory (SNT). It is an organisational theory. SNT cogitates organisational outputs to be dependent on both inter-organisational and intraorganisational relationships (Jones *et al.*, 1997). Lee and Kim (2011) argue that employees' effective commitment is influenced by their social networks in an organisation. Thus, commitment of individuals within a construction organisation towards ESC practices could depend on the presence of effective social networks.

Sustainable construction is an emerging concept in most developing countries (Ofori, 2012 and 2000; Mensah and Ameyaw, 2012). Thus, to achieve effective and quick understanding of sustainability issues, there would be the need for construction organisations to share relevant information, feedback and techniques as advocated by SNT. Environmental information sharing for promotion of ESC practices in construction organisations is a potential dimension worthy of investigation (Zhu and

Liu, 2010).

2.7.4.1 Main elements of SNT

According to Rowley (1997) SNT has two main elements that characterize the structure of a social network: density and centrality. The density of a network denotes the relative number of ties in that network. Centrality connotes the position of an individual or organisation in a social network and the ability to control dissemination of information. Consideration needs to be given to these elements to facilitate management of external pressures that may arise from the social ties.

As density increases, capacity to control information needs to improve. This would imply that increase in centrality is important as density increases (Sarkis *et al.*, 2010). From the study of Maignan and Mcalister (2003) into socially responsible organisations, it is observed that increased density, as conceptualized in SNT, could put contractors under greater pressure to adopt sustainability practices. This is so in view of the likely greater number of ties with clients (both public and private) and suppliers. The presence of higher density among stakeholders in a CI would promote greater awareness about ESC. This would put enormous pressures on contractors to meet sustainability demands that would be coming from enlightened customers. Amidst high network density, caution should be applied to improve centrality. The centrality element of SNT suggests that, to be able to adapt to ESC practices much more effectively, contractors should be in a position to have effective control over information sourcing and sharing. This could facilitate acquisition of the right ESC knowledge needed to engender successful implementation of ESC processes. Being in social network without ensuring network centrality could be detrimental to the contractor's organisation's business performance. However, guidelines on how contractors can ensure centrality and density in order to promote ESC are lacking in

literature.

2.7.4.2 Advocacy for application of SNT in promoting sustainability

Sarkis *et al.* (2010) indicates that few studies investigating sustainability issues on the basis of SNT exist. They therefore advocate for paying greater attention to the above two main elements of SNT, density and centrality, in order to advance research investigations into sustainable development issues. Thus, in this research, SNT is triangulated with other theories discussed earlier to facilitate development of guidelines and strategies to enhance contractor's capability to adapt to ESC.

2.7.5 Summary of theoretical basis for framework development

In the effort to develop a framework for the adoption and application of ESC practices by contractors, four theories have been reviewed. The theories have been employed to strengthen conceptualization and understanding of the issues that could lead to the development of a framework for adapting to ESC. The relationship between these theories lies in their strength to offer the relevant rules for improving sustainability performance of organisations as well as expounding on the challenges social ecological systems face in managing the ecology. These strong characteristics of the theories made their selection in this research appropriate. The theories address the main themes of the research and subsequently laid basis for developing the issues to be interrogated in the field during data collection. From the Resilience Theory (RT) it has been understood that, for ESC to be effective, a contractor's organisation need to possess the ability to conform to changing environment without losing its basic function. This would ensure that ESC practices, when adopted and applied, do not lead to collapse of construction business operations and subsequently economic downturns. Adaptive capacity, a significant element of RT, has been found to be important in

influencing resilience for an effective and improved sustainability performance of a contractor's organisation.

According to York *et al.* (2010) Ecological Modernization Theory (EMT) argues that modern societies possess the reflexivity that enables them to adopt more efficient methods and technologies in the wake of urbanization and industrialization. EMT further argues that the more affluent a society is, the easier it will be to achieve sustainability since there are evidences available all over the world. The challenges highlighted by York and Rosa (2003) about the deficiencies of EMT at the macro institutional level have also been critically examined. For effective development of the framework in this research, it is crucial to understand the aspects of EMT at the micro level of a contractor's organisation, and within the context of a developing country, which is invariably not an industrialized society.

It has been found that Institutional Theory (IT) is a policy-making theory that emphasizes the formal and legal aspects of government structures (Kraft and Furlong, 2007). IT argues for the existence of normative, mimetic and coercive drivers. Looking at these aspects of IT, it is observed that a voluntary application of ESC processes by a contractor can be achieved with presence of the relevant organisational and governmental policies. There is therefore the need to understand that governmental rules and regulations have important role to play in pressurizing contractors into an eventual regularized implementation of ESC processes.

Social Network Theory (SNT) puts emphasis on organisational outputs being dependent on both inter-organisational and intra-organisational relationships (Jones *et al.*, 1997). Thus, effective social networks stemming from commitment of individuals

within a contractor's organisation and a controlled inter-organisational relationship are important setups for adapting to ESC. The two most important elements of SNT: "density" and "centrality" also have roles to play in making effective relationships needed for successful adaptation to ESC. The postulations of SNT reveal that effective and quick understanding of ESC could be achieved via effective information control, feedback and techniques at both the intra and inter-organisational levels.

2.8 Review of typical research methodologies used in sustainable construction studies

Studies into sustainable construction have been carried out by either qualitative or quantitative method. Triangulation of the two methods is an emerging trend in construction research. Creswell (2003) identifies that there are three main strategies that are adopted in construction research: quantitative, qualitative and a combination of the two. The latter is more recent. However, the research question being investigated, has a major role to play in determining the appropriate methodology to be applied (Walker, 1997).

Under this section of chapter two, a review of some methods adopted by other researchers in sustainable construction practices in various construction industries has been carried out. Close examination of how other authors selected appropriate research methodologies vis-à-vis the research questions and research objectives, has been taken. The methods reviewed have been categorized into quantitative, qualitative and a triangulation of quantitative and qualitative approaches. Subsequently, justifications for adopting a qualitative approach for this research have been provided in chapter three.

2.8.1 Quantitative Studies in Sustainable Construction Research

In reflecting upon whether the UK construction sector is sustainable, Pearce (2006) employed the asset-based approach, where the man-made wealth and the natural capital/wealth of a nation are valued economically, to answer the research question.

He made reference to growing literature that measures the asset base of a nation and set out to find whether this approach could be applied in the construction industry. The author focused on determining whether the building and construction sector is sustainable or not. In the study, a preliminary quantitative analysis that attempted to estimate the wealth account of the UK building and construction sector was pursued. It was indicated that, with little more effort, it can be said with more authority whether the sector is sustainable or not. This was a preliminary study. Hence, it served as foundation for a further quantitative study.

Lam *et al.* (2011) looked at how environmental management system complements green specifications in the construction industry. The authors first conducted a pilot survey to identify any ambiguity in questions and also test the effectiveness of the instructions given in a draft questionnaire. They proceeded to randomly select respondents in organisations to seek their general opinions on green specifications under eight general statements through ranking of agreement levels. Respondents were also made to rank the acceptability of percentage change of some five factors. In analyzing the data, the reliability of the scale of ranking was assessed using Cronbach's coefficient alpha; an ANOVA (analysis of variance) and an independent *t*-test was applied to determine the differences between responses from organisations having an EMS, Environmental Management System, and those from organisations not having EMS. They observed and checked for the significance of correlation between "availability of guide for green specifications" and "adequate information on green

specification available in the offices” using cross-tabulation and Pearson Chi-Square techniques respectively. Quantitative approach was used for the study in view of the purpose of surveying people’s opinion on how green specifications can be used to drive green performance in construction through contract management.

Shi *et al.* (2013) conducted a survey questionnaire to solicit for information from major stakeholders in the construction industry to enable identification of critical factors associated with the adoption of green construction. Similar to the work of Hwang and Ng (2013) a 5-point Likert scale was adopted in the questionnaire to allow for respondents assessment of barriers associated with green construction. They combined both closed-ended and open-ended questions that allowed them to obtain additional information as opinions of respondents. As an additional effort in their study, Cronbach’s coefficient, as employed by Lam *et al.* (2011), was used to test the reliability of the five-point Likert scale. Quantitative analysis methods such as Kendall’s concordance analysis, nonparametric Mann Whitney *U* test and two-sample Kolmogorov-Smirnov test were used. The purpose of these methods was to facilitate assessment of the extent of agreement of within group ratings as well as statistical difference in the rankings among the groups. Thus, potential barriers to green construction adoption as found among the various groups of stakeholders (clients, contractors, and supervisors) could be assessed. The use of the survey and these quantitative analytical techniques resulted in identification of some of the critical barriers including: additional cost, incremental time and limited availability of green suppliers and information.

Wong *et al.* (2013) investigated into the carbon policies in contractors’ organisations for the purpose of understanding their response to the introduction of such policies. The subject matter of their study is similar to that of the Adegbite *et al.* (2013). These

two studies were all dealing with sustainability-related policy operation in organisations. However, the approach used differed. Wong *et al.* (2013) first of all used qualitative information gleaned from literature to develop a conceptual model describing the relationship between carbon reduction drivers and strategies and organisational culture. The next step was to conduct a pilot study. This was followed by a main survey involving experienced project managers, to test the model. The main survey targeted 300 contractors, which were selected randomly. Unlike the studies done by Adegbite *et al.* (2013) and Hwang and Ng (2013), Wong *et al.* (2013) did not employ interview as part of the data collection tools. The analysis of data obtained from the survey was carried out using two main quantitative techniques: Pearson correlation analysis and multiple moderated regression (MMR) analysis. The former was used to test their first hypothesis, which was to determine whether the adoption of the carbon strategies by the contractors was contingent on the drivers, whilst the latter was used to test a second hypothesis, which was to find out whether the interactions between the carbon reduction drivers and organisational culture have a moderating effect on the contractors' adoption of carbon reduction strategies.

Testa *et al.* (2011) carried out a study to find out whether environmental regulations have effect on the competitive performance of some firms in the building and construction sector in some EU regions. After literature review, research hypotheses were formulated and a survey conducted to test them. The research hypotheses bordered on: 1) finding out whether environmental policy stringency affects the competitive performance of firms in the B and C sector; and 2) how a specific form of environmental regulation affects that competitive performance. In testing these research hypotheses, they combined both questionnaire and interviews to collect data in a survey in which the respondents were sampled randomly from established codes

of stakeholders associations that determined active construction organisations. Before the questionnaire were distributed for the survey, they took steps to ensure that any bias, usually associated with such surveys were minimized or eliminated. Thus, a pretest analysis that involved use of several procedural remedies in the questionnaire design and application of Harman's single-factor test was employed to evaluate the presence of biasedness. A five-point Likert scale was also adopted in the questionnaire to allow respondents rank the level of effect of some of the identified variables on the competitive performance of the organisations. The analysis was carried out mainly through the use of regression model to test the two hypotheses. Similar to the studies of Adegbite *et al.* (2013) and Hwang and Ng (2013) questionnaire (including Likert scale ranking) and interview have been combined to collect data in the study by Testa *et al.* (2011).

In another study in which an investigation was carried out to find out the drivers for contractor's green innovation from an industry perspective, having a similar theme as that of Shi *et al.* (2013), Qi *et al.* (2010) used data gathered from a survey to identify those factors influencing contractors to adopt green construction practices. Structured questionnaire was used to collect data from contractors in the Chinese construction industry. Specifically, the personnel within managerial positions were selected as respondents. In order to increase the response rate, two means were used to send the questionnaire to all the companies selected via the website of the Ministry of Housing and Urban-Rural Development of China by means of postal mail and electronic mail. Prior to distribution, the validity of the questionnaire was tested by communicating with two companies. From literature review 13 factors affecting contractors' green practice were identified and these were used as variables in the regression analysis. Like Testa *et al.* (2011), they also adopted a five-point Likert scale to allow

respondents indicate the relative importance of each of the factors. The ranking was meant to enable the researchers identify significant factors driving green construction practices. Factor analysis was employed to analyse the structure of the interrelationship among the factors. Regression analysis was also performed to find out the relationship between the drivers and the green construction practices. Specifically, the Poisson Regression Model (PRM) and the Zero-Inflated Poisson Regression Model (ZIP) were applied. Further the Vuong statistics was used to test the validity of the ZIP vs. PRM model. Here, it is observed that, the principle of robustness was very much applied in the analysis. Testa *et al.* (2011) recognized that the research was conducted within the Chinese context but also recommend that the findings provide valuable reference for conducting sustainable-construction-related research in other construction industries.

Since the issue of carbon emissions control is paramount in sustainable construction research, the research methodology used in the study conducted by Li *et al.* (2012) has also been looked at. It was observed that in exploring a computational model to be able to measure carbon emissions from buildings using Building Information Modelling (BIM), the authors adopted the case study approach. The purpose for adopting that approach was to allow for a demonstration of the potential application of the model on a building. Thus, an international expo-centre was selected for the case study and used to validate the proposed model.

It has been revealed that the need to explore deeply into a new or an emerging concept serve as basis for employing the case study approach. This has been demonstrated by Shen *et al.* (2010), Zhou *et al.* (2013), Valente *et al.* (2013) and Lehmann *et al.* (2013). Li *et al.* (2012) have also demonstrated the usefulness of case study approach in validating a model or framework.

Teriö and Kähkönen (2011) carried out an investigation into the development and implementation of environmental management systems (EMS) for small and medium-sized construction enterprises and adopted the action research approach. An experiment was fashioned to test an EMS solution for 15 selected contractors. In this action research approach, the researcher acted simultaneously as a developer and an inside observer. Along with the action research, workshops with employees were held to allow for EMS structuring and testing. One of the aims of action research is to change a social system by using data generated from the system itself (Elden and Chislom, 1993). Thus, this approach was adopted and the results of the study presented for management's action.

2.8.2 Qualitative Studies in Sustainable Construction Research

Zuo *et al.* (2012) used a qualitative approach to investigate the sustainability policy practices in the construction industry in Australia. In this qualitative approach the authors examined the statement of principles, the sustainability reporting incorporated into financial reports and the stand-alone sustainability reports of 50 Environmental News Record (ENR) top-ranked international construction contractors. Content analysis technique was subsequently used to analyse the sustainability practices adopted by the contractors.

Lind (2012), also conducted a study to find out what users think about sustainable buildings in practice. The study was done by only a review of major books written by experienced researchers on the subject of sustainable buildings. Abidin (2010) did a similar study in which both qualitative and quantitative methods were combined.

However, Lind's study was purely a qualitative review of information from secondary source and differs from that of Abidin (2010) who used analysed data from primary sources to find out the understanding of developers of sustainability concept.

Kashyap *et al.* (2003) did an exploratory study of various approaches that foster a practical approach to the practice of sustainability in construction. They examined the nature of traditional approaches and integrated approaches and found out that the concurrent engineering approach, which is integrated, could improve construction project performance as well as facilitate incorporation of sustainability principles into construction. By the qualitative review of various approaches, as an examination of information from secondary sources, the authors were able to develop a sustainability approach framework that worked on the basis of process protocol phases. This is a framework that specified the goals, activities and sustainability considerations of the various project cycle phases from need identification to operation and maintenance.

Tan *et al.* (2011) carried out a preliminary study to find out the linkage between sustainable construction practice and contractors' competitiveness. Since this was a preliminary study, the approach used was majorly a qualitative review of literature bordering on the variables of the study. These variables included: sustainability in the construction industry and competitiveness of construction organisations. Through qualitative review, they were able to introduce a framework for implementing sustainable construction practice to improve contractors' competitiveness in order to meet the demands of the changing environment.

In another study undertaken by Du Plessis (2007), qualitative review was used to develop a framework for implementation of sustainable construction in developing countries. This was based on the Agenda 21 strategy by International Council for Research and Innovation in Building and Construction (CIB). . In this research work, she described the strategies suggested by the Agenda 21 based on a matrix of immediate, medium and long-term enablers. This matrix served as a basis for her to reveal that the challenge that needs to be overcome was to find means to implement

the CIB suggestions at regional and national levels. It can be realized that in developing a framework, which is preliminary in nature, the qualitative review approach was adopted in these two studies; that of Tan *et al.* (2011) and DuPlessis (2007).

Kibert (2007) also adopted the qualitative review approach in preparing an editorial description of research works done on sustainable construction to reveal the current trend and implication for future research work in the area of sustainable construction. This approach enabled him to identify some common emerging sustainable construction themes such as: the theory of resilience; adaptation to climate change; a shift from sustainability to regeneration; users' perception of green buildings; the pressing need to carry out green rating of buildings; and the emergence of the sustainable construction concept in developing countries.

The case study approach has been adopted by some researchers in a qualitative study. Valente *et al.* (2013) conducted a case study of an internationally recognized company to find out the complementarity of lean and green principles in improving the strategic, tactical and operational perspectives of a company. They first reviewed literature in both concepts; lean and green. This was meant to establish how the concepts interact in the Architecture-Engineering-Construction industry. This was complemented by an interview of top managers and project managers of the company selected for the case study in order to understand the strategic, tactical and operational viewpoints of the company. Subsequently they were able to identify the interaction between the two concepts. The authors found that the company already had a consistent lean management philosophy whilst sustainable construction was considered as a way of adding value to customers.

Lehmann (2013) set out to investigate how GHG emissions could be reduced using solid wood panels. The author specifically looked at cross-laminated timber (CLT) in urban housing project. A case study approach was employed in view of the novelty of the CLT technology. Knowledge in this research area was found to be narrow and hence extensive literature on the engineering basics and also the relatively higher GHG-reduction ability of the timber technology was carried out in the study. Findings on the building used for the case study were described to complement the literature review done. These formed the basis for him to present the methodology to be used for the next step in the research on the new technology. Zhou *et al.* (2013) also investigated sustainability best practice in a Private Finance Initiative (PFI) project in the UK using the case study approach. The purpose was to demonstrate how best practice in sustainable development can be achieved through the PFI project in the UK. One of the largest PFI Hospital projects in UK was used for the study. In this case study approach, interviews results and other secondary data on the projects were used as an evidence to show how the sustainability issues have been addressed within the procurement process.

The above studies in which the case studies approach was used by the researchers indicate that research into a new concept can be undertaken suitably using case study. The concept in this current research, sustainability, is yet to be adopted by construction industry practitioners in most developing countries including Ghana (Kheni and Akoogo, 2015; Mensah and Ameyaw, 2012; DuPlessi, 2007). However, adopting the case study approach in this study will not be appropriate in view of the need to capture experiences and accounts of built environment professionals from more than a case of a construction project. Detailed justifications for not adopting this approach are given in the research methodology chapter of this thesis.

2.8.3 Triangulation of quantitative and qualitative methods in SC research

Abidin (2010) employed surveys and interviews to find out the awareness level, knowledge and implementation of sustainable practices among Malaysian developers. The research was qualitative in nature since he was finding out a situation which would increase understanding, expand knowledge and explore phenomenon that had little research done on it as advocated by Creswell (2003). Although Abidin claimed the research was qualitative in nature, some of the questions, which were closed-ended, were analysed quantitatively using averaging statistical analysis. The other data were analysed qualitatively by describing the responses from the interview and other openended questions. Here combination of qualitative and quantitative methods has been applied. Through this triangulation, Abidin found out that many developers have limited understanding of sustainability concept in construction especially the cost aspect and are therefore reluctant to pursue sustainable practices in their business activities. He therefore recommended that stakeholders should direct efforts towards improving the knowledge of developers in sustainability practices.

Häkkinen and Belloni (2011) carried out a study to find out the actual barriers and drivers for sustainable building in Finland using literature review, interviews and case study to address the research question. They also employed expert panels and workshops, which facilitated describing the characteristics, tasks and roles in sustainable building processes. In finding out the most significant barriers the authors employed a web-based enquiry system, which studied the viewpoints of 158 out of 350 Finnish building professionals. This approach adopted in that whole study demonstrates a triangulation of both quantitative and qualitative methods.

Shen *et al.* (2010) carried out a study with the aim of introducing a new approach for conducting project feasibility studies by embracing the principles of sustainable development. A case study approach was used in selecting 87 construction projects. The projects were classified into residential, public sector, industrial and commercial projects. The feasibility reports of the projects were examined to find out whether the principles of sustainable development have been embraced. Attributes from the project feasibility reports were categorized into economic, environmental and social and were used to measure the extent to which sustainability issues are given concern in the feasibility reports. The examined results of the feasibility reports were complemented by primary data from interviews of various construction personnel on the projects. This facilitated understanding the kind of attributes adopted to ensure successful project performance in the current practice in China. The data obtained from the projects selected in the case study were analysed quantitatively using descriptive statistics. Observing the study of Shen *et al.* (2010) it can be realized that in view of the aim of finding out whether sustainability principles are applied in project feasibility reports or not, interviews and survey were combined in the case study approach. This underlies the importance of achieving richness of data through combination of two or more data collection methods. Also the attributes that were categorized were extracted qualitatively through examination of the project feasibility reports and the interview results. However the analysis of the rate at which these attributes occurred in all the projects surveyed was carried out quantitatively. This is also a strategy of triangulation.

It buttresses Creswell's (2003) assertion that triangulation of qualitative and quantitative methods is becoming popular in construction research.

In implementing green construction practices the knowledge and skills of project managers are critical. Hence, Hwang and Ng (2013) investigated into the kind of knowledge and skills that project managers need to overcome the challenges associated with implementation of green construction practices. In carrying out this study, a pre-survey was conducted to rank the importance of project manager's knowledge and skills. The mean value ranking was used to obtain the top 20 knowledge and skills out of 52 identified from literature. They added results from an interview of experts about other knowledge and skills a project manager needs to manage green construction projects to the ranked knowledge and skills found in literature. The interview also enabled the researchers to obtain information on the challenges that project managers face in implementing green construction practices. The combined results from the pre-survey and the interview were used to carry out the main survey in which the respondents were made to rate the extent to which each of the listed challenges affect them using a 5-point Likert scale. In the main survey, the respondents were also asked to rank the importance of the listed attributes of the project manager in responding to the challenges. Mean scores were used for the analysis of the challenges.

A rank correlation analysis was also performed to find out the difference between traditional and green practices in terms of the knowledge and skills required by the project manager. This enabled determination of whether the knowledge and skills required by the project manager for managing green construction projects differed significantly from the knowledge and skills that are being used in executing traditional construction projects. In their work it can be observed that methods used are majorly quantitative (survey, rank correlation and mean score analytical methods). However, some qualitative data was obtained from the complimentary interview. Thus, there is

some level of triangulation of qualitative and quantitative methods although not as high as in the studies of Häkkinen and Belloni (2011) and Shen *et al.* (2010).

In an investigation into the adoption of green policies by some companies in Nigeria, Adegbite *et al.* (2012) used structured survey questionnaire and guided interview to gather data on the policy and corporate social responsibility of firms randomly selected. The firms were however selected from specific targeted industries: oil and gas, telecommunication and banking. Descriptive statistical method such as percentages and frequencies were used for the analysis of data obtained through the interview and the survey. This example of combining interview and survey questionnaire as data collection tools in one study is similar to the study conducted by Hwang and Ng (2013) where surveys and interviews were combined to gather data on the kind of knowledge and skills a project manager requires to overcome challenges associated with execution of green construction.

2.8.4 Review of the sustainable construction research methodologies: Way forward

The quantitative methods reviewed in this chapter have been found to be useful for situations where a researcher would be looking out for relationships and causal relationships between variables of interest. It has also been found that the strategy of triangulating both quantitative and qualitative methods in one study is premised on the need for researchers to answer questions that require description or narration of situations as well as questions requiring determination of relationships between variables. The wholly qualitative research strategy becomes necessary when the research issues to be investigated require deeper understanding and description of emerging issues. This research seeks for explanations and descriptions of the why and how of adapting to an emerging concept within the context of a developing country.

At this stage, it is clear that adopting qualitative approach or strategy stands a better chance of answering the research questions more than the quantitative strategy or a triangulation of the two methods. Detailed justifications for adopting the qualitative strategy to conduct this research are given in the next chapter; research methodology chapter.

2.9 Acmes of literature review

Environmental sustainability has been given global attention for more than two decades (Zaccai, 2012; DuPlessis, 2009; Shah, 2003; WCED, 1987). There have been specific efforts made to promote establishment of sustainable construction practices, especially in developing countries (Ofori, 2012; Price and Ochieng, 2007; DuPlessis, 2007 and 2002; CIB Report 237, 1999). However, sustainable construction continues to remain a complex concept to understand and practice in the construction industry, and less use of relevant theories has been made to advance ESC studies (Sarkis, 2011; Bashir *et al.*, 2010; Shah, 2003; Cabesaz, 2002). Furthermore, lack of CI stakeholders' (especially contractors') capability for sustainable construction practices continue to exist (Ofori, 2012; Kaygusuz *et al.*, 2011). Therefore, this research is focused on making use of empirical data and application of relevant theories to develop guidelines for contractors to improve upon capability to understand and apply ESC processes.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter explains the philosophical underpinnings of the research. Very important also, the three approaches to research – deduction, induction and abduction – have also been briefly discussed indicating their relationship to research philosophical stances. In addition, basis has been laid to underpin the adoption of a particular approach. The research strategy adopted and the research design have been elucidated. Arguments for the choices of methods of sampling, collecting and analysing data have been provided. Measures taken to ensure data reliability and validity have also been specified. Finally, the chapter gives attention to the ethical and integrity considerations of the research.

It is important to emphasize the distinction between research methodology and methods. The broad research approach adopted in solving a problem is termed as a ‘research methodology’ (Anvuur, 2008; Smyth and Morris, 2007). This is the philosophical basis upon which the research is conducted. Research methodology is considered as the overall approach to the design process of conducting research in all phases from the theoretical underpinning to the collection and analysis of data (Creswell, 2009). It is distinguished from ‘research methods’, which are the tools and techniques by which data is gathered, analysed and presented.

In the choice of appropriate strategies and methods for answering the research questions, there are often dilemmas that arise in the research process. While some methodological difficulties can be easily resolved, others are more difficult. McGrath (1982) describes the process of making methodological choices as ‘dilemmatics’, in that there are no ideal solutions, only a series of compromises. However, the research

questions, as given in chapter one of this thesis, play pivotal role in the determination of the research paradigm, approaches, methods and strategies (Creswell, 2013; Yin, 2002; Walker, 1997). Hence in this chapter, a justification of the selected research methodology and methods has been provided. This is done juxtaposing other available methods not found to be suitable for the study.

3.2 Philosophy of research

Carrying out a research requires having the philosophical underpinnings. These indicate the researcher's knowledge claims and mode of acquiring the knowledge. The research philosophical foundations are embodied in its ontological and epistemological considerations. Creswell (2013) indicates that the ontology of a research is the claim of the researcher about what knowledge is, whilst the research epistemology indicates how that knowledge is to be acquired.

The realist view of knowledge argues that knowledge is a single reality while the relativist who takes the idealist view sees knowledge as that which can be constructed (Kalin, 2004). Looking at the research subject being a new phenomenon in the developing world context, the social constructivist approach of seeking knowledge becomes consequential.

The main research question borders on finding out how construction organisations will be enabled to adapt to Environmentally Sustainable Construction (ESC). This necessitates an empirical investigation into why sustainable construction has not yet been established in the developing world context such as Ghana. Searching for this knowledge as a single truth that works everywhere in the world cannot be appropriate. Therefore, relativism would be an appropriate stance to take in answering a research question of this nature.

3.2.1 Ontological stance

Ontology is a claim about what knowledge is (Creswell, 2013). It is the nature of reality. Scholz *et al.* (2006) consider ontology as a way of conceptualizing the phenomenon/problem/case a research is dealing with. Thus, the ontological position taken in this research is a reflection of the nature or type of research phenomenon being investigated.

Ontological realism is associated with the school of thought that: there are individual objects, which exist in a suitably mind-independent manner (and which are open to scientific investigation) (Devitt, 2006:6). The struggle between constructivist relativism and scientific realism is appropriately about the level of observables. Employing scientific methods, mostly experiments, is aimed at investigating into these observables or 'real objects'. Through manipulation, the researcher is able to verify theories made about the observables irrespective of location and human constructs about the truth. Therefore ontological realism does not consider the contextual nature of truth or reality.

On the other hand, Nola (2012:6) indicates that "...a kind of ontological relativism arises when the perceptual experiences are the objects, which, as Socrates puts it, are 'at any moment my reality'". Ontological relativism goes hand in hand with an explicitly constructivist account of objects or kind of objects that are alleged to exist (albeit relativity). Although the realists view theories as our own constructions, they believe that what the theories are about are not our own making.

Environmentally Sustainable Construction is the phenomenon being explored in the context of developing countries. The contextual nature of the phenomenon brings to bear

its relativism nature contrary to the realists' position. Taking a logical perspective of the nature of the phenomenon of this research, the ontological position that the research should appropriately take becomes evident. Whilst the realism school of thought does not consider the contextual or constructivist evolution of knowledge (reality) in the world in which we live, the relativist school of thought does (Nola, 2012). Thus, based on the nature of research questions, the ontological stance of this research has been indicated by the arrow in Figure 3.1 as ontological relativism.

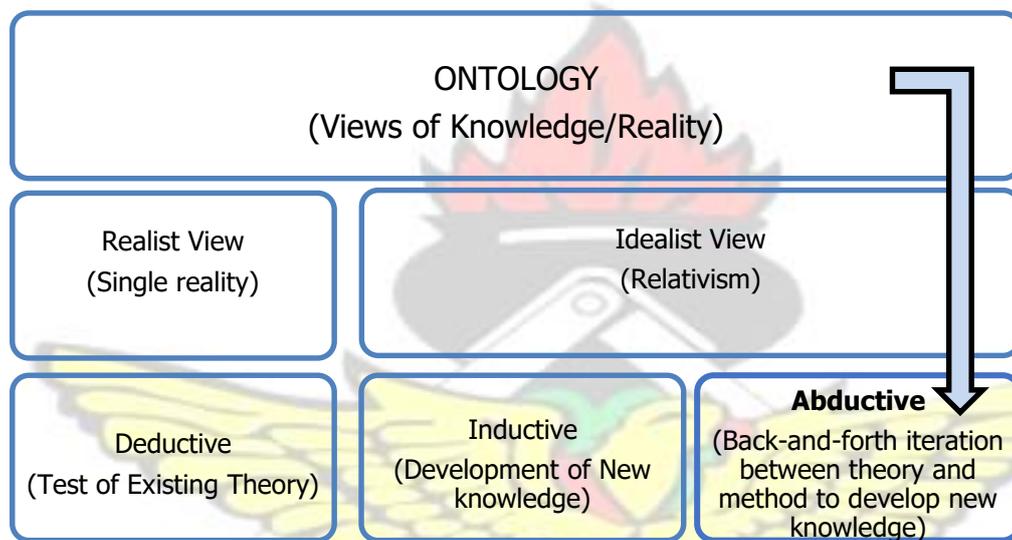


Figure 3.1 Ontological stance of research
(Source: Nola, 2012; Danermark, 2009)

3.2.2 Epistemological stance

Establishing the epistemological stance of a research is very important since it clarifies how best the research can be conducted in order to achieve valid and reliable findings.

The long standing debate on the epistemology of a research diverges into two main schools of thought: Positivism or Logical Positivism and the Interpretivist/Phenomenological/interpretive science positions (Creswell, 2013; Amaratunga *et al.*, 2002).

Logical positivism calls for the use of quantitative and experimental methods to test hypothetical-deductive generalisations, where the independence of the researcher is a

crucial requirement. Remenyi *et al.* (1998) and Easterby-Smith (1991) supports the assertion that searching for causal explanations and fundamental laws is typical of positivism. They argue also, that, positivism generally reduces the whole to simplest possible elements in order to facilitate analysis.

The interpretivist epistemological school of thought has a different tactic and is found to be appropriate for addressing the issues being interrogated in this research. This school of thought argues for having the researcher's thoughts, intervention and experience as bases for interpreting the results of the study, which obviously eliminates the objectivity aspect of the researcher as characterized in the positivist approach (Creswell, 2013). This is also referred to as social constructivism (often combined with interpretivism) (Crotty, 1998). This viewpoint make claims about knowledge being acquired through an alternative process and set of assumptions. Other recent researchers who have argued for this position include: Creswell (2013); Lincoln and Guba (2000); and Neuman (2000).

In social constructivism, it is assumed that individuals seek understanding of the world in which they live and work, developing subjective meanings of their experiences. The meanings are normally directed towards certain objects or things. What makes constructivism complex is the convolution of views that arise out of varied and multiple meanings given by participants. The researcher would not be able to obtain wider meaning of the research subject under investigation if a rather narrowing meaning into a few categories or ideas are being looked for. Hence, in line with the arguments of Creswell (2013), the intent of this research is to rely, as much as feasible and acceptable, on the participants' views of the situation or research subject being studied. The objective is to develop a contextualized agenda workable within the system in which the unit of analysis operates.

Interviews, case studies and focus group discussions are typical methods that are used by the social constructivist (Kumepkor, 2002). These methods have been discussed in detail in the research methods section. For instance, using interviews as data collection instrument, the type of questioning that is normally effective is the more open-ended ones (Kumepkor, 2002). The open-ended questioning facilitates the researcher's better understanding of the research subject by allowing him/her to listen carefully to what people say or do in their life setting. Creswell (2013) confirms that often, these bring out subjective meanings and are negotiated socially and historically. Thus "... they are not simply imprinted on individuals but are formed through interaction with others (hence social constructivism)" (ibid. pp. 8).

Creswell (2013) continues to argue that constructivist researchers often address the "processes" of interaction among individuals. In this case there is a focus on the specific contexts in which people live and work in order to understand the historical and cultural settings of the participants. Finding out how contractors can develop capability to adapt to the concept of sustainable construction in the developing world setting requires understanding and interpreting the experiences of the study participants as alluded in their responses to the research questions. Also, in interpreting qualitative data, researchers acknowledge that their own background has influence. They position themselves in the research to recognize how their interpretation flows from their own personal, cultural, and historical experiences. The constructivists researchers' intent, then, is to make sense of (or interpret) the meanings others have about the world, under the influence of their own experiences and cultural setting. It can be observed that, the independence of the researcher is missing.

For example, in discussing constructivism, Crotty (1998) identified several assumptions:

1. Meanings are constructed by human beings as they engage with the world they are interpreting. Qualitative researchers tend to use open-ended questions so that participants can express their views.

2. Humans engage with their world and make sense of it based on their historical and social perspectives. We are all born into a world of meaning bestowed upon us by our culture. Thus, qualitative researchers seek to understand the context or setting of the participants through visiting this context and gathering information personally. They also make an interpretation of what they find, an interpretation shaped by the researchers' own experiences and backgrounds.

3. The basic generation of meaning is always social, arising in and out of interaction with a human community. The process of qualitative research is largely inductive, with the inquirer generating meaning from the data collected in the field. Thus the epistemological stance of this research is relativism as indicated by the arrow in Figure

3.2.

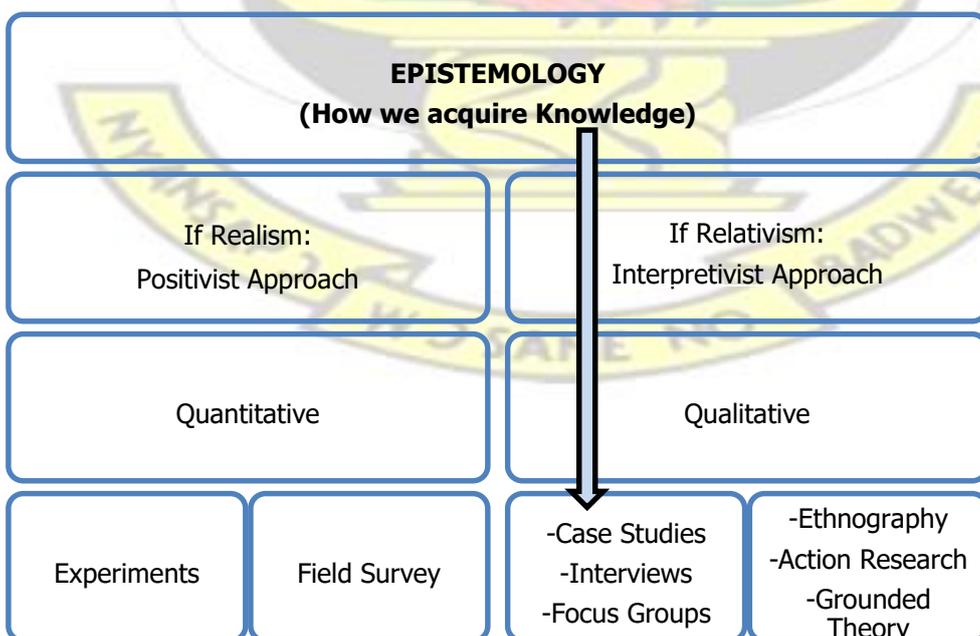


Figure 3.2 Epistemological stance of research

Source: (Creswell, 2013)

3.3 Research approach

The philosophical stance of this research has been discussed in the above section. This section deals with the arguments for the appropriate research approach. A research approach is required to provide specific direction for procedures in the research design and methods (Franz and Robey, 1987). The interplay between theory, case method and empirical phenomena are often contemplated by researchers during the design of research approach. Deciding on how theories are to be developed (whether by testing or by building new) and the kind of empirical phenomenon being captured, forms basis for further development of a study.

With regards to connecting theory, method and empirical phenomenon, three main schools of thought exist in the social science discipline. According to Dubois and Gibbert (2010) the first takes a deductive approach, where hypothesis are deduced from existing theory(ies) to be empirically validated. The second relies on an inductive approach where empirical data is either presented before or after theoretical considerations or sandwiched between them. The third assumes an abductive approach, where empirical observations evolve simultaneously and interactively with theoretical frameworks.

The three approaches are related to research paradigms. Järvensivu and Törnroos (2010) argue that positivist researchers tend to adopt the deductive research approach, where the research is begun with theoretical argumentations. Subsequently, these argumentations are validated with empirical observations. In contrast, realists usually start the research with subjective account of lived experiences and thereafter inductively build theories. On the other side, the constructivists are inclined towards

adopting the approach based on abduction. The following sub-sections develop further discussions on the three main approaches indicated above. The processes involved in deductive and inductive approaches have been distinguished in figure 3.3.

3.3.1 Deductive research approach

With the deductive research approach, theory is tested. This begins with establishing a theory or generalisation and seeking specific instances to which the theory applies (Hyde, 2000). The theory testing is carried out through empirical research (Saunders *et al.*, 2007). Deductive research approach is usually adopted by positivist researchers as argued by Järvensivu and Törnroos, (2010). This positions the deductive approach within the perspective of objective ontological reality. Bryman and Bell (2003) had indicated that deductive approach involves the testing of a priori hypotheses or theories using quantitative data that incorporates standardised measures and statistical techniques. With this ontological position, the deductive methodology establishes a relationship with the natural sciences, which gives roots to quantitative data. The techniques normally associated with the natural sciences include quantifying and measuring the information that is observed and collected by the researcher (Myers and Avison, 2002). This requires setting aside pre-conceptions and prejudices in order to identify objective facts based on empirical observations.

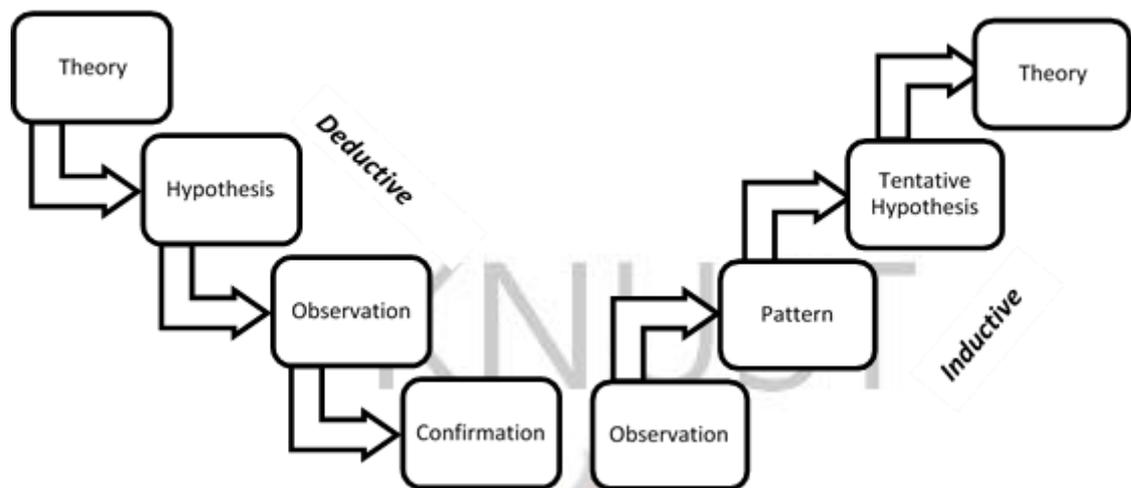


Figure 3.3 Theory confirmation and generation processes
(Source: Leiringer, 2015)

Ackroyd (2004) states that the goal of deductive research is to identify generalizable laws that are based on the identification of statistical relationships. Normally, such statistical generalisations are made from a sample of a wider population. The weakness of the deductive approach is revealed in its inability to reflect the contextual social characteristics of the phenomenon under investigation. The approach is normally biased, focussing on very restricted relationship and sequence between theory and empirical data (Bryman and Bell, 2003). It normally commences with developing a *priori* theory with literature and is characterized by stepping into the field to verify, falsify, or modify a unified, firmed-up theory of social research. In that path, deductive research only manages to scratch the surface of the details in the research context in order to produce generalizable, reproducible results that, in the end, only adds to the 'objectivity' and 'testability' of social research (Kauber, 1986). The approach hardly reproduces the social reality and context of the phenomenon under inquiry.

3.3.2 Inductive research approach

From Fig. 3.3, where the logical ordering of the theory generation process is depicted, induction is the inverse of deduction (Leiringer, 2015; Anvuur, 2008). This is particularly so because induction moves from specific empirical facts or a collection of observations, to developing but not testing theory (Spens and Kovacs, 2006). In this approach the empirical world is observed, and that leads to creation of concepts to explain the observations made. In giving a typical description of an inductive research, Spens and Kovacs (2006) indicate that, inductive research moves from a particular case or empirical observations to creating general facts and finally developing theories based on the findings from that context.

The contrast between the inductive research approach and the deductive becomes more evident with regards to the placement of theory (Naoum, 2012). While the inductive approach starts from taking subjective accounts of lived experiences and opinions to build basis for theory development, the deductive places theory at the beginning of the research process and collect facts to test in order to falsify or confirm the theory (Järvensivu and Törnroos, 2010). Inductive research places greater emphasis on the way in which the world is socially constructed and understood (Blaikie, 1993).

3.3.3 Abductive research approach

The abductive approach differs from deduction and induction in its research process. It aims at developing an understanding of a new phenomenon and suggesting a new theory with the application of the new theory in an empirical setting (Alvesson and Skoldberg, 2009; Andreewsky and Bourcier, 2000). Sackey (2014) clearly explains the processes involved in the abductive research and clearly distinguishes it from the deductive and inductive approaches using the “case/result/rule” argument put forward by Danermark (2002) and Kirkeby (1994).

For instance, in describing the process involved in deductive approach, Kovacs and Spens (2005) indicate that this commences with deriving theories from literature review, presenting the theory in the form of hypotheses and/or propositions, testing these hypothesis and propositions in an empirical setting and then presenting generalized conclusion(s) based on confirmation or falsification of the hypothesis and propositions with respect to specific instances. Danermark (2002) describes this logical sequence of deductive approach as from 'rule-to-case-to-result' sequence. Conversely, induction starts from empirical observations about the world, moves to the development of emerging propositions and their generalisation in a theoretical frame. This sequence is described by Danermark (2002) as 'case-to-result-to-rule'. In contrast with deduction and induction, the logical sequence characterizing the abductive approach is described as 'rule-to-result-to-case' sequence (Danermark, 2002; Kirkeby, 1994).

There is an assumed independence between method and theory development or testing in scientific research process and the abductive research process defies this traditional view. Dubois and Araujo (2004) and Van Maanen *et al.* (2007) argue that, with the abductive approach, knowledge is developed through an iterative dialogue between empirical data and a combination of existing theories or propositions. In this instance, the initial proposition or theoretical framework of the research phenomenon evolves simultaneously with empirical observation towards new knowledge development. In line with this instance, Taylor *et al.* (2002) had also described the abductive process as that in which data is collected simultaneously to theory building implying a learning loop.

The 'rule-to-result-case' logical sequence of the abductive reasoning has been detailed by Dubois and Gadde (2002) as first, the search for suitable theories (rules) to an empirical observation (result), which is called "theory matching", or "systematic combining", or a "back and forth" direction between theory and empirical study (Spens and Kovacs 2006; Dubois and Gadde, 2002). Further, the process involves a corroboration in a theory-testing phase (case) (Spens and Kovacs, 2006). However, due to the iterative nature of the process, which aims at suggesting new knowledge, the generalisation of the new theory only occurs after applying it in further empirical studies, i.e., after the theory-testing phase (ibid). This research investigates into the adoption of ESC processes within a specific context of a developing country's CI. Moreover, the complexities surrounding sustainability requires explaining the empirical findings in the light of relevant theories reviewed. Thus, a back-and-forth iteration between theory and empirical findings would be needed to foster understanding. Furthermore, the aim of this research is to develop a framework that will guide contractors to build capability for ESC. This requires development of new set of guidelines for application in a given context (case) on the basis of theories (rules) and empirical findings (result). Therefore, adopting abductive research approach for this study is found to be appropriate to facilitate the achievement of the research aim.

Some of the methods that have been considered as suitable in abductive processes are mostly qualitative such as: action research and case studies (Dubois and Gadde, 2002). These methods provide an enabling context for abductive research due to the possibility of allowing for simultaneous data collection and theory-building processes (McEvoy and Richards, 2006). Thus, qualitative studies allows empirical observations to be made in a real social setting and dissolves the assumed independence between

method and theory testing/development. Abductive researchers should be able to revisit a phenomenon under study on the basis of illuminations from theories.

Qualitative methods provide the platform for researchers to embark upon this iterative process, which is characteristic of abductive reasoning. This process allows the researcher to re-evaluate and rethink commonplace experience to break the familiarisation of perceptions (Kilpinen, 2009). Perceptions of BE professionals of sustainability needs to be heightened through qualitative data such as interview transcriptions, detailed field notes from observations, and/or documentary analysis. Through this repetitive abductive methodological processes, data on the ESC, which may have been less glowing, would begin to gain significance. Timmermans and Tavory (2012) highlight the weakness of abductive reasoning in the sense that it is vulnerable towards achieving unexpected empirical evidence and unorthodox theoretical insights. This does not contribute to minimizing biasedness in the research findings. In view of this the authors suggested that abductive researchers must provide explicit description of the research process as well as thoroughness and consistency concerning research ethics in order to increase the reliability and validity of the research in question, gain rigor, and render it possible for other researchers to replicate the research and its findings (*see also*: Spens and Kovacs, 2006). Detailed explanation on how ethics was ensured has been given at the end of this chapter. Further steps taken to overcome the weakness of the abductive approach include: triangulation of manual data analysis with computer analysis; and use of both ‘strangers’ and ‘acquaintances’ types of discussants in the FGD (Morgan *et al.*, 2013).

3.4 Research type

The two distinct types of research that exist are Quantitative and Qualitative (Family

Health International, FHI, 2014; Creswell, 2013; Bell, 2010; Amaratunga, 2002; Kumeprkor, 2002). Quantitative research deals more with the use of numbers to represent opinions or concepts while qualitative dwells more on the use of words and observations to express reality describing the experiences of people in the research subject under investigation. The epistemological stance taken by a researcher normally creates the direction for choosing the appropriate research methods or strategy for answering the research questions (Creswell, 2013; Yin, 2002). Also, quantitative and qualitative research types differ in their analytical objectives, the types of questions they pose, the types of data collection instrument they use, the forms of data produced and the degree of flexibility built into the study (FHI, 2014).

3.4.1 Quantitative research

Quantitative research comes with a research design that is concerned with defining epistemological methodology for determining the truth-value of propositions.

Quantitative research is objective in nature. Quantitative research is defined as “an enquiry into a social or human problem, based on testing a hypothesis or theory composed of variables, measured with numbers, and analysed with statistical procedures in order to determine whether the hypothesis or the theory hold true objective” (Naoum, 2012:37). According to Amaratunga (2002) and Easterby-smith (1991), quantitative research in built environment studies becomes more expedient to use when:

- Placing emphasis on formulation of hypothesis for subsequent verification;
- Searching for causal explanations and fundamental laws in order to reduce the whole to the simplest possible elements to facilitate analysis;
- Making comparisons and replications;
- Independence of the observer from the subject being observed is necessary;

- There is the need to measure the subject under analysis through objective methods rather than inferring subjectively through sensation, reflection or intuition;
 - There is the need to determine reliability and validity more objectively;
 - It is necessary to measure descriptive aspects of the built environment;
- Quantitative research type is associated with the traditional scientific methods of carrying out research. This is where a researcher seeks to confirm hypotheses about a phenomenon, use more rigid instruments of eliciting and categorizing data and adopting highly structured methods such as questionnaires, surveys and structured observation. According to Nau, (1995) quantitative investigations tend to look for “distinguishing characteristics” elemental properties and empirical boundaries and therefore normally looks for “how much” or “how often”. In this research, the aim is to look for ‘why a phenomenon is not practiced’ and ‘how to build capability to adapt to a concept’. The focus is not on ‘how much’ or ‘how often’ it is done. This does not make quantitative type of research the most suitable.

3.4.1.1 The placement of theory in quantitative research

The placement of theory in quantitative research is such that theoretical framework forms the basis for the study (Naoum, 2012). Since the objective in quantitative research is to test rather than develop a theory, the theory is placed at the beginning of the study. Data is collected to test and confirm a theory. Thus the theory becomes the framework for the entire study as well as a model for organizing the research questions and hypotheses for the data collection procedure (Creswell, 1994).

The aim of this research is not to test theories. The framework development in this research requires dissolution of the independence between theories and empirical

results in order to develop new guidelines for adaptation to a new practice. Thus, the postulations of relevant theories are adopted to explain the processes needed to ensure adaptation to the phenomenon under investigation. This approach is not favored by the placement of theory in quantitative research.

3.4.1.2 Questions typology for quantitative research

FHI (2014) indicates that quantitative research adopts close-ended type of questions to solicit numerical data for quantifying variations, predicting causal relationships and describing characteristics of a population. The purpose of this research is not to determine relationships between variables but to find out barriers and drivers of a phenomenon in order to facilitate development of a framework that would guide adaption to such phenomenon. Further the novelty of sustainable construction concept in most developing countries requires the use of open-ended question types, typical of qualitative studies, to unearth the status of ESC practices among construction organisations in a given context.

It is worthy to note that the questions being investigated in this research relate to looking for ‘Why practices are not carried out’, ‘Why something is done the way it is done’, and ‘How organisations can adapt to new ways of doing things’. This would require ascertaining deeper underlying meanings and explanations on the issue of ESC practices in the construction industry in a developing country context. Quantitative research is stronger in measuring variables but weaker in ascertaining deeper meanings of factors such as: physiological factors, motivating factors, employees’ capability, etc. (Amaratunga, 2002). Similarly, the ramifications of the practicing or nonpracticing of ESC by construction organisations would not be effectively investigated using quantitative methods. This is particularly necessary in the situation where there is limited knowledge about sustainability concept in construction

industries of developing countries (Kaygusuz, 2012; Mensah and Ameyaw, 2012; Reid, 2011).

3.4.2 Qualitative research

Qualitative research is defined as “...any type of research that produces findings not arrived at by statistical procedures or other means of quantification” (Strauss and Cobbin, 1998:10). Qualitative research refers to a non-mathematical process of interpretation carried out for the purpose of determining concepts and interpretations in a raw data and then organizing these into a theoretical explanatory scheme. (Cobbin and Straus, 2014) An epistemological stance that considers social constructivism as a means of revealing knowledge normally employs qualitative research methods. The epistemological considerations of this research renders the use of qualitative research methods more suitable. This is in view of the strength of qualitative methods to gather the kind of data that facilitate descriptive and explanatory discourse. Qualitative research has the ability to facilitate the conduct of research through an intense and/or prolonged contact with a "field" or life situation (Amaratunga *et al.*, 2002). Miles and Huberman (1994) described these situations as typically banal, reflective of the everyday life of individuals, groups, societies, and organisations.

Methodologist routinely urge researchers to assess the fit between purpose and method (Walker, 1997). The choice of qualitative type of research by a researcher is determined by the research question and purpose, rather than by prior preference of the researcher (Maxwell, 2013; Richards and Morse, 2012). If the objective is to obtain a detailed understanding of a process or an experience, qualitative approach is more suitable (Bazeley and Jackson, 2013). Such an investigation requires gathering information that is non-numeric from a purposively derived sample (*ibid.*)

Development of framework to facilitate adaptation to ESC in a developing country's CI requires contextual constructivism approach. This requires exploring and describing the normative construction practices of construction organisations in order to develop a foundational understanding. Qualitative research enables building of constructs of reality from the perspective of social beings (built environment professionals in construction organisations in this case). Qualitative type of research is adopted when developing new theory or concept or in an effort to get deeper understanding of a phenomenon (Creswell, 2013). Related to understanding the ramifications of construction organisations adaptation to ESC is the need to discover the contextual ESC barriers, drivers and enablers. Consequentially, a basis is built for developing a new framework to enhance organisational capacity to adapt to ESC.

3.3.2.1 Qualitative approaches

Qualitative research also gathers information in two main approaches; exploratory and attitudinal (Naoum, 2012). The exploratory becomes necessary where there is limited amount of knowledge about a topic while the attitudinal research becomes appropriate to use when a person's view, opinion or perspective towards a subject is to be subjectively evaluated. In exploratory research, interview is used for gathering data while the attitudinal research normally relies on questionnaire for gathering subjective answers that can be measured (ibid.). Although subjective answers may emerge from participants (BE professionals) in the search for data, the objective is not to measure the subjective answers. Thus, the exploratory approach is adopted to facilitate interrogation of construction organisations' inability to practice ESC. This paves way towards gaining understanding of how the adaption to the new concept will be effective in a given socio-economic context.

3.4.2.2 Questions typology for qualitative research

Qualitative research frequently uses open-ended questions and probing. This gives participants the opportunity to respond in their own words in order to bring out their actual understanding of the subject under study. Participants are not forced, as in the case of closed-ended questions, to choose from fixed responses. Data obtained from the use of open-ended questions therefore possess the qualities of being rich and explanatory in nature and brings out the points that are meaningful and socially salient to a participant.

3.4.2.3 Placement of theory in qualitative research

According to Naoum (2012), the placement of theory in qualitative research is such that there are no clear rules and standards about the use of theories in qualitative research. While the use of theory in quantitative study appears at the planning stage at the beginning, it is normally placed towards the end of qualitative studies. Thus, new concepts and hypotheses are yielded at the end of qualitative studies to prompt quantitative studies for rigorous testing of same. In designing qualitative research, principles that should guide the use of theory in qualitative studies have been identified by Creswell (1994). Generally, he says that theory should be:

- Employed in a manner consistent with the type of qualitative design;
- Used inductively so that it is developed and shaped throughout the research process instead of becoming something to test;
- Made to emerge through the use of a visual model; and
- Compared and contrasted with other theories if used at the end of the study.

The need to understand the values, belief systems, knowledge path, motivations and also challenges of construction organisations as novel findings regarding environmental sustainability of construction activities in the context of a developing

country makes the choice of qualitative approach more suitable for this study. This would allow a tail-end comparison of new findings with theories applied in sustainable construction research.

3.4.2.4 Qualitative methods

Qualitative methods mostly include interviews and observations and these normally allow the researcher to develop an overall picture of an investigation (Amaratunga, 2002). The goal of these methods is to examine the informant's point of view or the participant's understanding of the issue under investigation. In order to have a deeper knowledge about the views of built environment professionals in construction organisations in a developing country context, it is appropriate to adopt qualitative methods such as interviews and observations.

The qualitative type of study allowed in depth face-to-face interviews to be conducted with BE professionals within the construction organisations in order to understand the issues of the research from industry perspective, a significant aspect required for understanding the practical nature of ESC in a developing country context. The use of the qualitative approach in sustainable construction research is clearly supported in literature (Abidin, 2010; Ding, 2008; Revell and Blackburn, 2007; Williams and Dair, 2007)

It was highly essential to use the qualitative methods to answer the research questions since this is a process that facilitates gaining a better understanding of the complexities involved in application of the ESC concept and the human experiences behind it (Witter *et al.*, 2011; Marshall and Rossman, 2010; Sidat *et al.*, 2007). The understanding obtained consequently becomes necessary for forming the bases for taking action towards a standardized and regularized application of ESC.

3.5 Research strategy

Amaratunga *et al.* (2002) indicate that research strategy, in the built environment research, has been argued to be a fundamental and necessary requirement to achieve sound empirical results. Yin (1994) indicates that research strategy is dependent on the research situation. He argues that a research strategy comes with its own specific approach to collect and analyse empirical data. This implies that there can be no predetermined strategy for certain types of research. Hence, each strategy comes with its own merits and demerits.

Notwithstanding the fact that research strategies have unique characteristics for a given research, there are overlapping areas that introduce some complexity into the process of strategy selection. Various writers also use terms that may be incomprehensible to readers in such a manner that they bring confusion. In order to avoid gross eccentricities between the desired outcome and the chosen strategy, Yin (1994) outlines the conditions that should provide the grounds for the choice of a research strategy. These include: type of question posed; the control over actual behavioural elements; and the degree of focus on historical or contemporary events. Creswell (2012:37) defines research strategy as “the way in which the research objectives can be questioned”. He outlines the purpose of a study, and the type and amount of required information available as the deciding factors for choosing a research strategy.

It is worthy to note again that the research questions in this study relate to looking for why ESC practices are not established by construction organisations in a developing country context and also how construction organisations thereof can adapt to ESC practices.

There are various types of research strategies by various researchers:

- Turkson (2011) outlines ‘Survey’, ‘Case study’ and ‘Action research’ as three research strategies available.
- Naoum (2012) points to two main ones: ‘Qualitative research strategy’ and ‘Quantitative research strategy’
- Creswell (2013) also lists four strategies of enquiry used for designing a research: “Experimental”, “Ethnographic”, “Narrative” and “Mixed methods”

In all these various forms of categories of research strategy, the factor that distinguishes one strategy from the other is the type of research question being investigated. Thus the choice of research strategy adopted in this study is highly dependent on the research questions and objectives being investigated. In times past researchers have believed that the only phenomenon that counts are those that can be measured. The use of ‘variables’ thus dominated in most research works (Tesch, 2013). For instance: How many construction organisations have more than one Health and Safety officers?; How many construction organisations post annual sustainability reports on their websites?; How long does it take an organisation to win an international contract? Such observable statistics merely scratch the surface.

Conducting such scientific investigations appears to be a matter of following recipes. Philosophers however argue that conducting research is not a matter of following mere methods but should focus on understanding and interpreting the research findings for the empowerment of the participants from which the data were obtained (Tesch, 2013).

In cases where the issues of interest do not come in natural quantities, there may be the need for the researcher to create concepts or ‘constructs’. Thus, further examination can be carried out in order to understand and explain reasons for the presence of certain behaviors or how a system can incorporate a concept. The research questions here require gathering data that narrates happenings and practices as well as those that express practitioners’ opinions for development of a practical framework for enabling

adaptation to a concept. Thus, the focus is on developing a new way of doing things but not theory testing effort.

3.5.1 Survey research strategy

Survey research strategy is said to answer *what, who, how, and where* questions (Turkson, 2011). Naoum (2012) also indicates that surveys are used in fieldwork research and answers questions such as: *how many, who, what is happening, where and when*. Thus where there is the need to gather information from relatively large number of respondents within a limited time frame, survey approach becomes the appropriate strategy to adopt. In the situation where the focus of a research is on understanding how things are or can be done and why things are happening or are not happening, survey cannot be an appropriate method to use. It would not enable deeper enquiries to be carried out from a participant to a participant in order to foster deeper understanding of the research issues at hand.

3.5.2 Case study research strategy

According to Amaratunga and Baldry (2002), case study research strategy focuses on the dynamics present with a single setting. Case study research puts emphasis on one aspect of a problem and conclusions drawn cannot normally be generalized but related to only one event. It provides the opportunity for the researcher to support his/her argument by in-depth analysis of the unit of analysis. The unit of analysis could be a person, group of persons, a particular project or an organisation (Naoum, 2012). Yin (1994), cited in Amaratunga (2002:7), defines case study as an empirical investigation into contemporary phenomenon operating in a real life context.

Case study also tends to answer *who, what, how and where* questions. Case study research strategy is said to be more associated with the formulation of theoretical

propositions/hypothesis at the beginning of the study. Such a strategy tends to be prominent in quantitative research where the placement of theory is at the research planning stage (Naoum, 2012).

3.5.3 Tracer study

According to Cohen (2004) tracer study is basically a follow-up study. In a context of a study aimed at tracking the employment and training of health sector graduates in Uganda after graduation, Mubuuke *et al.* (2014:52) defined Tracer studies as “alumni surveys that attempt to track activities of graduates of an educational institution, which enable the contextualization of these professionals through a dynamic and reliable system to determine their career progression”. The authors of the study above emphasized that tracer studies are useful for gathering information that positively impacts on training and policy. Hence, tracer study is seen as an experimental approach for tracking and observing changes occurring to a given unit of analysis over a given period. The results are therefore beneficial for decision making or policy formulation.

Tracer study has been applied in sustainability studies such as de Andrade *et al.* (2015), Field *et al.* (2013) and Currell *et al.* (2012). However, in all these, the approach was quantitative survey follow-up or experimental in nature. The nature of the research problem under investigation does not require survey or experimental processes. This study does not demand follow-up surveys. The use of tracer study is therefore rendered unfit.

3.5.4 Field research process

The field research type of study deals with the interpretation of how and why a change occurs (the process and the contexts), while there may be approximate equivalence of standards on what (content) change occurred (Pettigrew, 1990). Similar to tracer

studies, field research studies concentrate on exploring the content, context and process of change (Pettigrew, 1990).

Little of the research works in sustainability studies have applied the field research process. In other subject areas such as business, marketing and management where the method has been applied in organisational studies, the aim relates to tracking the process of change for an effective decision making. (See for example: Halinen and Mainela, 2013; Edmondson and McManus, 2007; Ahrens and Chapman, 2006; Van de Ven and Huber, 1990). The focus of this research is not on studying the process of change in sustainability practices in the construction industry. Rather, the investigation is to understand and explain the ‘why’ and ‘how’ of adaptation to ESC. Thus field research process cannot suitably deal with the research focus.

3.6 Research design

Then (1996) argues that an effective research having sound methods that can be used to seek answers to the research questions under investigation, take into consideration the resources available. The research questions outlined at the earlier sections of chapter one require the use of methods that facilitate in-depth study. To be able to answer the “why” and “how” questions, Yin (2002) argues that a case study is appropriate. However, the interest is not to observe sustainable construction practices occurring in a single setting of an organisation or a project. Meanings are to be made out of the experiences and expert opinions of participants in a social constructivism stance. Hence in-depth interviews becomes a suitable tool for investigating into a new social-ecological concept such as sustainable construction in a given context (Bos. Brouwers, 2010; Young *et al.*, 2010; Revell and Blackburn, 2007; Williams and Dair, 2007). Thus, ‘in-depth semi-structured face-to-face interviews’ was the dominant method adopted by the researcher to investigate contractors’ adaptation to ESC in a

developing country context. Figure 3.4 illustrates the relationship between the research questions and the research methods employed for data collection and analysis.

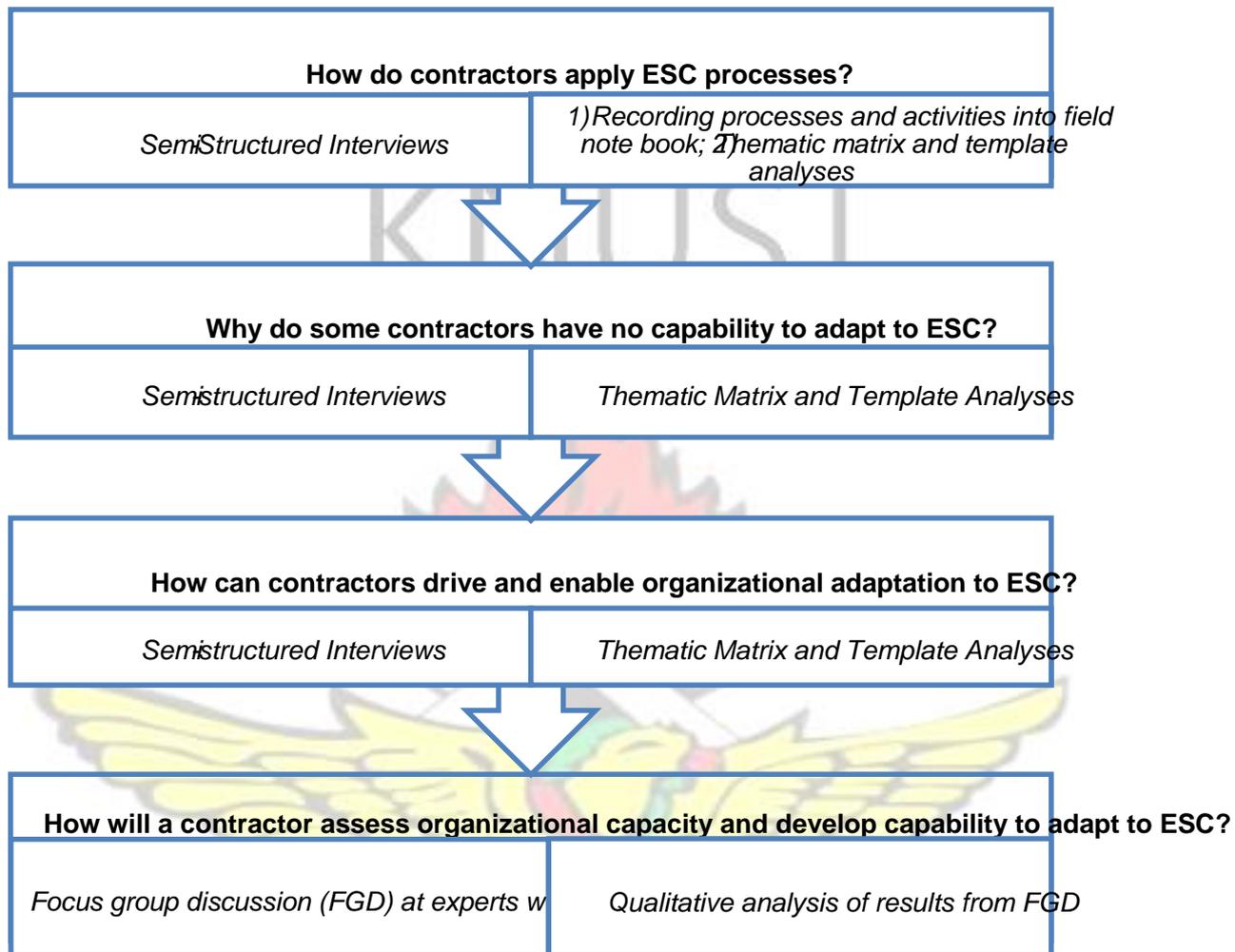


Figure 3.4 Research Design: relationship between research questions and methods
(Author's own construction)

Observation, is one of the methods used for conducting qualitative studies (FHI, 2014; Kumekpor, 2002). Thus, with regards to understanding the sustainable construction practices of construction organisations, field observation was employed as a complementing tool to the interviews. The befitting choice of these instruments contributed significantly to the designing of this research.

3.7 Research methods

Research methods refer to the techniques researchers use in performing research operations (Kothari, 2011). The object of research methods therefore is to apply

procedures to arrive at a sound solution (*Then, 1996*). Choosing the appropriate methods in order to arrive at the appropriate solution is therefore highly critical in any research work (*Walker, 1997*). Research methods are concerned with the, sampling, collection of data, statistical techniques that will be used for establishing relationships between the data and the unknowns or finding out patterns or emerging trends or themes (*Anvuur, 2008*). Subsequently the accuracy of results obtained will be verified. Hence, generally, research methods can be considered as the analytical tools of research.

3.7.1 Sampling

It is well rehearsed in literature that surveys and field experiments are not useful sampling techniques for qualitative research. These techniques facilitate the gathering of numeric data more than non-numeric (*FHI, 2014; Bazeley and Jackson, 2013; Kumepkor, 2002*). Surveys deal with large number of sample while experiments also deal with measurement of variables under controlled conditions (*Kumepkor, 2002*).

Three main sampling types used in qualitative research as given by the Family Health International, *FHI (2014)* are: purposive sampling, quota sampling and snowball sampling. While snowball sampling stands distinct, purposive and quota sampling methods bear the similarity of selecting a sample based on predetermined criteria/characteristics that are necessary for achieving the objectives of a given research (*Turkson, 2011; FHI 2014*). The only difference is that quota sampling has a rigid number to be used for a described group different from other groups in the study with different characteristics.

The purposive sampling has target number but this is not normally predetermined. The number of sample units that may be covered when using purposive sampling would

depend on the theoretical saturation of data, and other research challenges such as available resources and time (Kumekpor, 2002). Purposive sampling is also appropriate in situations where not all the sample units in a given population bear characteristics of the phenomenon being studied. Consequently, a sample unit would be selected based on meeting set of criteria developed based on the characteristics of the research phenomenon.

Purposive sampling is considered as non-probability sampling (Kumekpor, 2002). Non-probability sampling techniques involve the drawing of samples from a larger population without the requirement of random selection (Tansey, 2007). Unlike probability sampling, purposive sampling does not require drawing a relationship between the sample unit and the populations from which it is being drawn (Tansey, 2007). The aim of non-probability sampling is to arrive at findings that are indicative of the population but not generalizable results. The objective therefore is to describe processes and behaviour of sample units of a population (Henry, 1990). The goal of this research is to develop an adaptation framework based on the accounts and experiences of participants/stakeholders who are professionals and can speak to the subject matter of the research. This makes the application of a non-probability type of sampling appropriate.

3.7.1.1 Application of purposive and snowball sampling methods

The purposive sampling method was adopted for selecting construction contractors in this research. In applying this method, a selection criteria was developed for choosing the appropriate BE professionals, as respondents, from the appropriate construction organisations. The purposive sampling method also facilitated obtaining data from interested participants who were qualified and were willing to offer the needed information. However, at a certain stage of the data collection, amidst limited time and

other resources, obtaining immediate access to the respondents became difficult. This difficulty necessitated application of the snowball sampling method also. Augmenting the purposive sampling with the snowball sampling facilitated overcoming the challenge posed by some of the respondents who were reluctant to give information for fear of insecurity since audio recordings of the interviews were to be taken. The snowball sampling took the form of personal recommendations and introduction of the researcher by one company to the other. With such recommendations, the fear of giving information to a complete stranger was eliminated and other participants could readily provide the needed information upon first or second appearance at the place of interview. According to Noy (2008), snowball sampling is a widely employed sampling method in qualitative research and enhances easy access to data.

Walker (1985) and Burrell and Morgan (1979) have argued for the use of different kinds of techniques for data acquisition in the same empirical study in order to ensure minimization of prejudices and also overcome weakness(es) inherent in one method or the other. Application of these sampling methods also facilitated overcoming the weakness of the quota sampling which restricts the researcher to a certain number of sampling units. Moreover, having different groups with different characteristics within the set of study participants (construction organisations) was not necessary.

Applying the two sampling methods ensured availability of the built environment professionals targeted for the interview, eased accessibility to data, and also facilitated identification of participating organisations that met 100% of the selection criteria set.

3.7.2 Characteristics of Sample

With the adoption of purposive sampling, certain characteristics of the target participants, Built Environment (BE) professionals working for construction organisations, were predetermined. These characteristics were used to develop a selection criteria that enabled effective sampling of participating organisations. This

step facilitated achievement of the research objectives. Table 3.1 presents the criteria developed for the selection of the interviewees. *Table 3.1 Selection criteria for interviewees*

S/N	CRITERION	INDICATOR
1	Large construction organisation operating in a developing country (Ghana as the study country)	Ministry of Water Resources, Works and Housing financial class 'D1/K1' Contractors
2	Having defined organisational structure; considered as a characteristic necessary for investigating organisational capacity to adapt	Presence of the key requisite human resources in designated office positions
3	Presence of designated Built Environment (BE) professionals who are willing and interested to share knowledge and experience on the research subject via face-to-face interview	Responsive BE professionals with a minimum of tertiary qualification and 5 or more years of working experience; these professionals must be willing to avail themselves for validation of framework also.
4	Larger volumes of work demonstrating the tendency to put higher demand on environmental resources	BE professional should have experience in construction projects with financial size of more than USD 200,000, the upper limit for D2/K2 contractors in Ghana.
5	Use of heavy construction plant items	Having at least earthmoving or transporting equipment or electric power generation plant in place for construction activities. This serves as a source of contractor's experience in use of energy in construction activities; a theme central to sustainability
6	Currency of information from construction projects	Organisation should have at least a construction project in progress where a site visit can be undertaken during interview

The reasons for selecting the financial class D1/K1¹ contractors, as categorized by the government of Ghana Ministry of Water Resources, Works and Housing (MWRWH), was based on their large-scale size in the Ghanaian construction industry. This largescale size quality positions the 'D1/K1' contractor as an appropriate organisation that would facilitate achievement of the study objectives. Due to the need to: preserve research ethics; compromise not on organisational policies; and uphold the exploratory nature of the study, random sampling could not be appropriate (Gill and Johnson,

¹ The highest financial classification given to a building and civil engineering contractor by the Ministry of Water Resources Works and Housing of the Republic of Ghana.

2002). Furthermore, the willingness of the construction companies to allow their place and workers' time for carrying out the studies was crucial. The nature of the required data relate to practices, which could even reveal firm's competitive strategies, and there was therefore the need to obtain an organisational consent and will to offer the needed platform for pursuit of the research objectives.

3.7.3 Data collection

In qualitative research, Family Health International, FHI (2014) outlines three main methods for collecting data: in-depth interviews, focus group discussions and participant observation. This is partly supported by Kumekpor (2002) who rather indicates field observation instead of participant observation, in addition to the former two methods. The in-depth interview allows face to face interaction with participants to be able to obtain their ideas and responses to the research issue under investigation. On the other hand, the field observation allows a direct contact with activities or personal behavior in its natural setting. In this research these methods are triangulated (see for example Creswell, 2013). This allowed corroboration of interviewees' responses and description of organisations' routine construction practices that facilitated understanding some ad hoc adopted sustainable construction practices. This triangulation ensured achievement of reliability of the data (Bell, 2010).

The in-depth interview was carried out specifically by adopting a semi structured interview that allowed iterative questioning and introduction of other questions that were not predetermined in the interview guide. The questions introduced during the interview were necessary for probing further, statements made by the interviewees and also crosschecking earlier answers given to ensure that the understanding obtained conforms to actual intentions of interviewees. In this study, audio recordings of the semi-structured face-to-face interviews were taken. The purpose of the semi-structured

interview was to enhance understanding of the extent to which construction organisations understand and/or practice ESC. This data collection instrument enabled textual descriptions of the construction activities undertaken by the selected organisations that were deemed by themselves as environmentally sustainable. These activity textual descriptions were meant to form the basis for a later stage field observation.

3.7.4 Data analysis

There are a multiplicity of viewpoints to analysis of qualitative data. Tesch (1991) managed to reduce these to three basic approaches. First, she identifies ‘language-oriented’ approaches. This is related to the use of language and the meaning of words—in how people communicate and make sense of their interactions. Second, she identifies ‘descriptive/interpretive’ approaches. These are oriented to provide thorough descriptions and interpretations of social phenomena, including its meaning to those who experience it. Lastly, there are ‘theory-building’ approaches, which are orientated to identifying connections between social phenomena—for example, how events are structured or influenced by how actors define situations. Tesch herself acknowledges that these distinctions are arguable, and the classifications given can be challenged. However, a strong family resemblance between these different research orientations is suggested by the author. An emphasis is put on the meaningful character of social phenomena, and the need to take this into account in describing, interpreting or explaining communication, cultures or social action. These suggestions and arguments give a clue about the direction of discussing findings from qualitative analysis in this study.

Several techniques exist for analyzing qualitative data. These include grounded theory, Inter Phenomenological Analysis (IPA), content analysis, thematic analysis using templates and data matrix analysis (Lansisalmi *et al.*, 2004; King, 2004; Nadin and Cassell, 2004). In all these coding and categorization of the qualitative data along emerging themes or themes set *a priori* are common features.

3.7.4.1 Grounded theory

Qualitative researchers use grounded theory to advance social enquiries. Grounded theory adopts a process that begins with inductive logic. It also uses emergent strategies and rely on comparative inquiry (Charmaz, 2011). These methods are clearly analytic in nature. Also, Bloor (1978) as cited in Anvuur (2008:124), outlines four hierarchical stages of grounded theory development process, which together, give an analytic induction process. These are:

- gaining access to phenomenon to be studied;
- defining the phenomenon, identifying and categorising variations in terms of shared characteristics and differences;
- creating a provisional list of case features to each identified category and reviewing for any deviant cases of the established categories of the phenomenon; and based on the above; and
- presenting theoretical explanations of the variance in the phenomenon already tested through observation.

Therefore, the goal is to present theoretical explanations of deviant cases observed in an identified phenomenon. This orientation of grounded theory would not be useful in situations where contextual descriptions of practices within a particular economic developmental setting or a certain culture is the focus as it is in this study. With this focus, variance in a phenomenon are not to be tested as indicated in the steps above.

The emphasis is on looking for optimum ways of establishing a concept (i.e. ESC) within a given economic developmental setting.

Further, grounded theory targets discovering the kinds of concepts and hypotheses that are relevant to the area one wishes to understand (Lansisalmi *et al.*, 2004). With the use of grounded theory, the researcher's aim is to inductively build a theory that accounts for much of an observed behavior from a qualitative data (Strauss and Corbin, 1990). The aim of grounded theory is not to produce a perfect description of the subject matter under research as the case is in this research. Grounded theory rather starts from uncovering the conceptual scheme without predetermined theoretical or conceptual framework. This study seeks to understand and describe barriers, enablers and drivers of ESC. With this research focus, other qualitative techniques could offer better solutions. There is the need to predetermine theoretical underpinnings to enhance development of the organisational adaptation framework, which is the ultimate goal of this research.

3.7.4.2 Interpretative Phenomenological Analysis (IPA)

IPA, similar to template analysis, comes with development of conceptual themes and classifying them into broader groupings and identifying 'master themes' and associated 'subsidiary themes' (King, 2004). IPA is relatively more time consuming since it tends to carry out individual cases analysis in greater depth before trying integration of full set of all cases. In this study there is a greater focus on integration of a full set of cases of data from all the construction organisations involved in order to develop a new framework. IPA has lower level of ability to handle larger data sets comfortably. According to King (2004) while IPA studies are capable of handling samples of 10 or fewer, template analysis studies are commonly capable of handling participants of 20 – 30.

3.7.4.3 Content Analysis

Content analysis seeks to “analyse data within a specific context in view of the meaning someone – or a group or a culture – attributes to them” (Krippendorff, 2012:403). It is a research method that focuses on “the subjective interpretation of the content of textual data through the systematic classification process of coding and identifying themes or patterns” (Hsieh and Shannon, 2005:1278). As a research tool, content analysis is used to “determine the presence of certain words or concepts within texts or sets of texts” (Busch *et al.*, 2012:2).

Taking on a more quantitative appearance, content analysis involves “systematic assignment of communication contents to categories according to rules, and the analysis of relationships involving those categories using statistical methods” (Riff *et al.*, 2014:3). Thus, content analysis can be used to quantitatively and/or qualitatively analyse any occurrence of communicative language. It is also observed to exhibit most of the elements of analysis that all the other qualitative methods of analysis portray.

Researchers have argued that the ability of content analysis to quantify and analyse the presence, meanings and relationships of some words and concepts is a systematic and objective procedure as well as the only logic way for describing and assessing communication content. (Riff *et al.*, 2014; Busch *et al.*, 2012; Rourke and Anderson, 2004). Hsieh and Shannon (2005) have also contended that emerging trends show more of qualitative content analysis, which eliminates the quantitative aspect of the process of analysis. However, the specific type of content analysis approach chosen by a researcher varies with the theoretical and substantive interests of the researcher and the problem being studied (Weber, 1990).

The problem under investigation in this research requires in-depth discussion of the difficulties surrounding adaptation to ESC practices as well as describing into detail the systematic process that will facilitate effective adaptation to ESC within a given context. This does not require a quantitative analysis of data since such approach does not engender in-depth discussion of primary data (Bazeley and Jackson, 2013).

3.7.4.4 Thematic analysis using templates – ‘template analysis’

Analyzing textual data normally requires development of codes. A code is “...a label attached to a section of text to index it as relating to a theme or issue in the data which the researcher has identified as important to his or her interpretation” (King 2004:257). Considering coding as an activity Naoum (2004:102) indicates that it is “the process of identifying and classifying each answer with a numerical score or other character symbol”. Thus, the codes become the numerical score or character symbols that facilitates identification of the various categories or themes inherent in the data. This is where organizing and analyzing the textual data thematically, referred to as template analysis, become evident. The list of codes referred to as ‘template’ (King, 2004), represent the themes identified in the textual data or fixed *a priori*, a typical feature of template analysis (Brooks and King, 2012; Waring and Wainwright, 2008).

In a highly structured questionnaire, all categories are pre-coded. This form seems to be normal characteristic in quantitative analysis of qualitative data (Naoum, 2004). However, in this research, semi-structured interview has been adopted in view of the need to probe answers during interviews in order to get an in-depth discussion with participants (Opoku and Fortune, 2011). Although the approach adopted is not a theory-testing one, the development of the framework, which is the ultimate research goal, requires preparation of interview guide in light of relevant organisational theories used in sustainability studies. This would imply that some of the codes would be

defined *a priori* while the rest are allowed to emerge out of the analysis (King, 2012). The codes are also typically organized following a hierarchical order (ibid.). This order characterizes the organisation of both the theory-driven and data-driven codes in the analysis of the qualitative data obtained from the interview. Hence, template analysis, which has gained credibility in the analysis of large rich qualitative data since the 1990's, according to Waring and Wainwright (2008), is appropriately adopted for the qualitative analysis in this research.

This analytical technique covered two stages; initial template development and final template development. The development of the initial template was based on outlining of the themes of the research. These themes guided the development of theory-driven codes. The theory-driven codes were *set a priori* adopting the hierarchical form of coding, which is typical of template thematic analysis technique. This yielded higherorder and lower-order codes (Brooks and King, 2012; Waring and Wainwright, 2008).

During the development of the final template, the revision of the initial codes took four forms: deletion; modification; splitting; and fusing of two or more (King, 2004). The revision of the codes formed the basis for development of the final template shown in Appendix IV. In all these processes, there was an iterative dialogue between the empirical data and theories used in this research due to the abductive approach of this research (Van Maanen *et al.*, 2007; Dubois and Araujo, 2004).

3.7.4.4 Thematic analysis by data matrix

The inability to easily interpret analysed data renders the analytical technique adopted ineffective or unsuitably applied. Using Data matrices in thematic analysis of textual data allows effective data display in a format that makes them even readily accessible for interpretation (Nadin and Cassell, 2004). The format normally comes in square or

triangular matrix that represent the relationship between the expressions of a participant and themes set *a priori* (Volfovsky and Hoff, 2014; Nadin and Cassell, 2004). In qualitative analysis of data in matrices, cells, which are nodes, are created and used to explore and further code on the data (Bergin, 2011).

The feature of data matrix analysis, which facilitates effective organisation of large qualitative data into predetermined themes and sub-themes has been capitalized on to enhance successful qualitative data analysis in this research. Manual coding of data was first carried out using the template thematic analysis (King, 2004).

3.6.4.5 Exploratory data analysis

Exploratory data analysis is similar to thematic analysis in templates. The only difference is that the exploratory analysis allows the use of numerical score in addition to other symbols for coding (Naoum, 2004), while the thematic template analysis employs codes (templates) that are mostly textual. Thus, in exploratory data analysis some of the data may be quantified afterwards.

Naoum (2004) argues that quantifying some of the data still makes the analysis qualitative. However, the purpose of developing the ESC adaptation framework is not to quantify data but to understand the essential features that would facilitate effective organisational adaptation to an emerging concept within a given context. Therefore, the quantifying aspect of exploratory data would not be useful. However, the use of pre-coding and post coding as well as revision of codes in the process of the analysis is allowable in both the quantitative and the qualitative analytical approaches.

3.7.4.6 Aiding Analysis with NVivo

Bazeley and Jackson (2013) indicate that using NVivo for analysing quantitative data allows the researcher to manage data, manage ideas, query data, and visualize data and

report from the data. NVivo excels by creating categories, coding text, and building nested tree structures in the middle of text processing (Rath, 2011). It simplifies the manual process of coding based on an individual reading of text, line by line. For smaller amount of data at a time, whether during the exploratory phase or after the coding system has been developed, NVivo is an effective manager of text and analysis (Rath, 2011).

However, analyses of large quantities of data, requiring several reading, searching and sorting, to derive contextual meanings from phrases and sentences, not just words, is not conceivable by NVivo. Moreover, the ultimate aim of the qualitative analysis of this research is to extract meaning from the respondents' submissions and not the recurrence of certain words (Bell, 2010).

It was therefore appropriate to employ the manual coding as the main means of analysis, where repetitive hearing and reading by the researcher is necessary to understand the intentions and perspectives of respondents. It is argued here that the manual means is considered to be more advantageous in categorizing meanings of words since two people may use *different words* to express the *same meaning*. Effectiveness in the analysis becomes more achievable with the manual approach more than the NVivo analysis. Notwithstanding, to minimize biasedness and achieve rigour in the analysis, the NVivo tool was used to aid coding during the analysis.

3.7.5 Data analysis strategy

Burrell and Morgan (1979) and Walker (1985) have argued for triangulation of techniques in data collection in order to ensure minimization of prejudices. On this basis, and to achieve rigor in the analysis, the strategy adopted was to triangulate the relevant qualitative data analysis techniques. Data matrices and template analysis have been triangulated to carry out the analysis. This makes use of some similar

characteristics of exploratory data analysis in view of the similarity it bears with template analysis. The matrix developed for organizing the data in this research is shown in Table 3.2.

Table 3.2 Data in matrix

		Themes									
		Theme 1		Theme 2		Theme 3		Theme 4		Theme 5	
		Organisational ESC Adaptability		ESC knowledge and practices		ESC barriers		ESC drivers		ESC Framework enablers	
Respondents/ Interviewees/ Organisations	Org. 1										
	Org. 2										
	Org. 3										
										
	Org. 24										

Also, the NVivo 8 qualitative analytical tool was employed in coding the data after manual coding and categorization had been done. The use of the NVivo in addition to the manual coding facilitated identification of the trend at which the issues were emerging out of the data. Furthermore, the triangulation of the manual coding with the NVivo coding minimized biasedness towards some issues during discussions of the findings. First, triangulation of all these techniques facilitated effective data presentation and quick overview of the large qualitative data obtained over months of interviews. Thus, data reduction, a prominent goal of qualitative analysis, was facilitated (FHI, 2014; Rugunna, 2013). Second the contextual constructivist stance taken in this research makes the use of template analysis more advantageous as it aids in-depth discussion of qualitative data in a given setting. Third more flexibility is introduced into the analysis permitting the tailoring of the research to match the

contextual requirements of the social constructivism stance. In this instance, the rigidity associated with quantitative techniques is highly suppressed to permit in-depth discussions, descriptions and explanations as expected of qualitative analytical process. Fourth, comprehensive development of the framework is enhanced since the triangulation allows use of both theory-driven codes and data-driven codes. In view of the semi-structured interview, obtaining codes set *a priori* and those emerging from data becomes consequential. Finally, fifth and very important, the strategy of triangulating the techniques enabled enriching and completing knowledge towards transgressing the epistemological potentials of using an individual method. (University of West of England (UWE) Flick, 2009). The triangulation allowed a hierarchical arrangement of codes in the template (hierarchical order of coding) which formed a good foundation for the development of the ESC adaptation framework.

3.7.6 Designing the data analysis

In view of the data analysis strategy appropriately adopted, the actual analysis was carefully designed as indicated in Figure 3.5. The entire process for the data analysis went through five main stages. Throughout the five stages, the aim of the analysis was to ensure data analytical rigor and effective methodological triangulation. The triangulation was essential in view of the multiple theoretical perspectives on the issues comprised in the research phenomenon. Moreover, making use of the triangulation, through the data analysis design, further grounding of the knowledge obtained through the qualitative methods was ensured. This design is tantamount to validating the process, which certainly has increased scope, depth, and consistency in the methodological proceedings. (University of West of England, UWE Flick, 2009; Denzin, and Lincoln, 2005).

Based on the design, the analysis was carried out by performing manual coding of the data before the NVivo coding, described in the above section. During the manual coding, there was identification of recurring items, formation of textual coding frame using the recurring items, and grouping of codes under various categories. These categories were formed *a priori* based on the research themes emerging from the discourse on theoretical postulations. Combination of the manual and NVivo coding yielded list of theory-driven and data-driven codes catalogued in the final template (see appendix IV).



KNUST

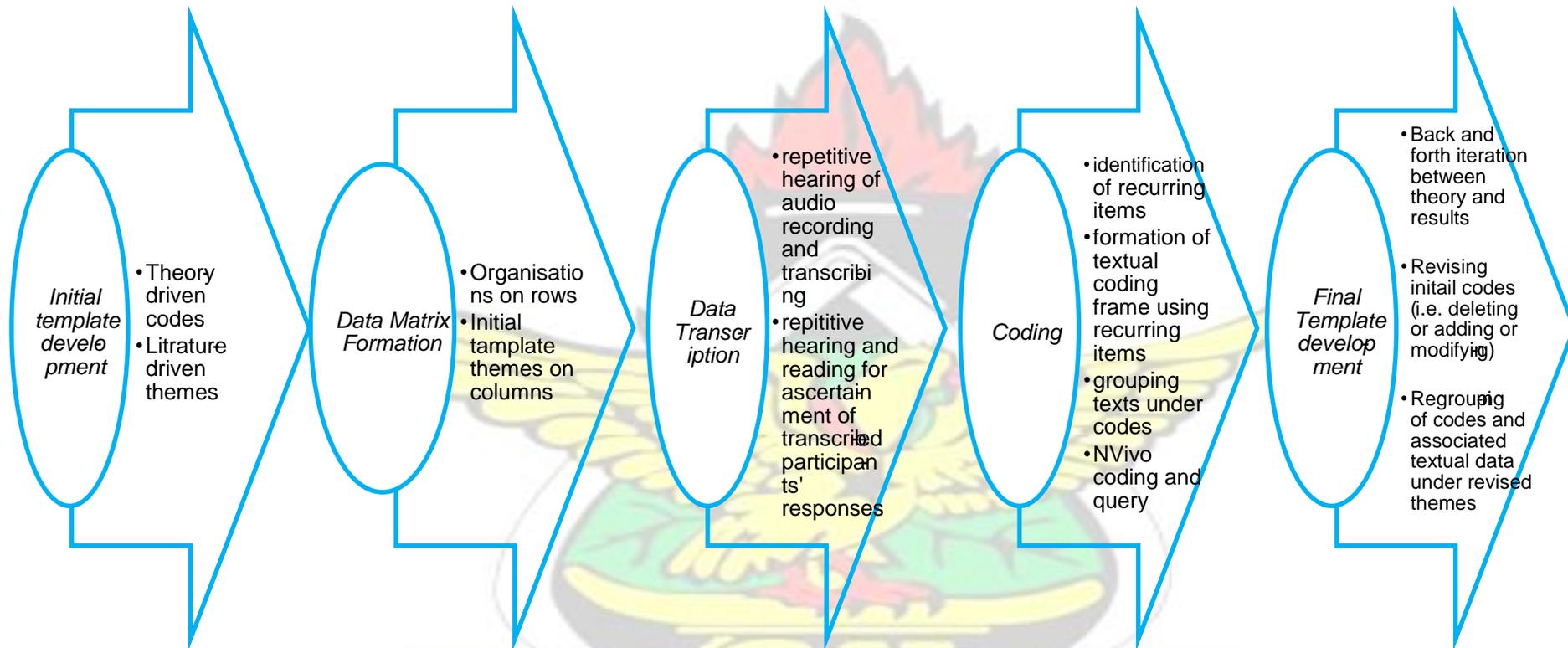


Figure 3.5 Data analysis design of triangulated template and matrix techniques

(Author's construction based on Ruggunan (2013/4); Bell (2010); King (2012 and 2004); Nadin and Cassell (2004))

KNUST



Mostly the objective of qualitatively analyzing qualitative data includes describing and explaining relationships between factors or explaining the nature of norms of a group (FHI, 2014). The objectives of analysis of the qualitative data obtained from the interview were to first describe the norms, in terms of ESC practices, of the construction organisations to foster understanding of adopted sustainable construction practices. Second, there was the need to explain and describe the barriers to adaptation to ESC and also find out the ESC enablers and drivers within and without the construction organisations. In order to have an effective adaptation framework, there was also the need to describe the relationship between the identified ESC barriers, enablers and drivers to define the path towards construction organisations' adaptation to ESC. These formed the skeletal frame for discussing findings from the qualitative analysis.

3.8 Data reliability and validity

A great deal of attention is applied to reliability and validity in all research methods in order to ensure rigor. "Without rigor, research is worthless, becomes fiction, and loses its utility" (Morse *et al.*, 2008:14). Achieving rigor in qualitative inquiry is as important as it is in quantitative inquiry. Some qualitative researchers have argued that reliability and validity were terms pertaining to the quantitative paradigm and were not pertinent to qualitative inquiry (Altheide and Johnson, 1998; Leininger, 1994). However, Morse *et al.* (2008), argues that it is highly necessary to achieve rigor in qualitative data, a quality without which qualitative research would face acceptability challenges in both academia and the industry.

The nature of knowledge within the rationalistic (or quantitative) paradigm is different from the knowledge in naturalistic (qualitative) paradigm. However, all research must have 'truth value', 'applicability', 'consistency', and "neutrality" in order to be

considered worthwhile (Guba and Lincoln, 1981). Hence, each paradigm requires paradigm-specific criteria for ensuring the achievement of "rigor" (the term most often used in the rationalistic paradigm) or "trustworthiness", their parallel term for qualitative "rigor" (Morse *et al.*, 2008). Guba and Lincoln (1981) noted that, within the rationalistic paradigm, the criteria to reach the goal of rigor are internal validity, external validity, reliability, and objectivity. Within the qualitative paradigm, the authors proposed credibility, fittingness, auditability, and confirmability as the criteria to ensure "trustworthiness". After these suggestions, Lincoln and Guba (1985) refined the criteria into credibility, transferability, dependability, and confirmability. In this research, specific strategies that were used to attain trustworthiness include: prolonged engagement and persistent observation (where in-depth face-to-face interviews method was combined with field observation of construction activities on site). Additionally, peer debriefing, audit trails and member checks were also applied. This is where findings from interviews were discussed with BE professionals for their confirmation through focus group discussion (FGD). Besides, findings from FGD were also presented to discussants for further confirmation. During the data collection, rigour was ensured through the interviewer/moderator's demonstration of responsiveness, sensitivity and ability for clarification and summarization.

3.8.1 Ensuring data reliability

For a given research method to yield the same data when applied on different occasions under the same conditions, certain steps need to be undertaken by the researcher. Similarly, to achieve reliability of research findings it is necessary for an analysis of a given set of data under constant conditions on different occasions, to yield the same results or findings. Bell (2010:119) defines reliability as "the extent to which a test or procedure produces similar results under constant conditions on all occasions".

Rust and Cooil (1994) discuss the theory and implications of reliability measures for qualitative data. They argue that measuring reliability is important for ensuring stability and quality of the data. Hence, with a theoretical approach, the authors employed Proportion Reliability Loss (PRL) measure that is known to generalize many existing quantitative and qualitative measures. With this approach they were focused on determining:

- 1) how reliable a qualitative data was (using the Cronbach's alpha in quantitative measurement);
- 2) how many judges are necessary; and
- 3) given a fixed number of judges, the level of agreement required to ensure adequate reliability.

This approach works much more appropriately with a judgment-based qualitative data where it is possible to analyse by computing level of agreement between respondents. The nature of analysis of the qualitative data in this research is not about judgmentbased. Thus, determining the level of agreement or otherwise between construction organisations' BE professionals as a means of ensuring reliability is not apt. The issues that formed basis for the framework development were expected to emerge out of coding and categorization of the qualitative data under themes (some determined *a priori*). Hence this approach (PRL) would not be applicable.

However the principle of reliability, as given in the above definition, was ensured during the data collection by first developing a criteria that put all the respondents on a level platform. Second the means by which qualified construction organisations were identified and approached were common to all. All the interviews were carried out under the similar conditions, on a site where construction works were in progress paving way for field observation of construction processes. Third, site observations were carried out to verify accounts given by interviewees concerning construction

processes and workers relationships at site. This was to corroborate the interview proceedings in order to ensure that the data given were reliable. Fourth, during the data analysis, manual and computerized methods (use of NVivo) were triangulated to minimize prejudices or biases in the discussion of results. It has been argued that a combination of both manual and computer assisted methods is likely to achieve the best results (Welsh, 2002). These steps were taken to ensure data analysis reliability.

3.8.2 Ensuring data validity

Morse *et al.* (2008) looked at verification strategies for establishing reliability and validity in qualitative research and concluded that such strategies help a researcher identify when to continue, stop or modify the research process in order to achieve reliability and validity to ensure rigor. They argued that the mechanism of verification, which include checking, confirming, making sure, and being certain are used to contribute the ensuring reliability and validity of a study. Creswell (1997) also argue that these mechanisms are woven into every step of qualitative enquiry in order to ensure constructing a solid product. Thus, if the principles of qualitative inquiry are followed, the process of collecting data, analysing and interpreting would be selfcorrecting.

In this qualitative research, the process was iterative rather than linear. Thus the movements were back and forth between data collection, tool designing and implementation. This was done to ensure correspondence between question formulation, literature, recruitment, data collection strategies, and analysis. For instance, to ensure that the findings measured what is expected to be measured, NVivo was triangulated with the manual approach of repetitive hearing of audio recording and reading of scripts. This aided sifting out superfluous responses, as given by respondents, which did not relate to the research objectives. Moreover, arrangement

of data using data matrices enabled effective determination and categorization of responses under the appropriate predefined themes.

Rigor is a desired goal that is met through specific verification strategies, whether conducting quantitative or qualitative studies. Therefore, during the data analysis and interpretation, the unprocessed data were systematically and constantly checked and monitored to maintain focus and ensure fit of data. These are the strategies of verification, as a means of ensuring validity, which facilitated obtaining rigour in this research. The strategies took into account the philosophical perspective inherent in this qualitative enquiry. Focussing the research process on these verification strategies enhanced responsiveness to data and constantly gave a reminder to the researcher to be proactive and take on the responsibility for ensuring rigor. The iterative process adopted during the analysis also ensured effective minimization of incomplete and thin data sets.

Most of the standard or criteria used to evaluate the goal of rigor, have always come at the end of the research; they are applied after the research is completed, and therefore are used to evaluate quality and worth of findings. In this research the iterative nature of the qualitative inquiry processes applied guaranteed validity at all essential stages of the research process and not at the end only. Therefore, effective validity was achieved since standards and criteria applied only at the end of the study cannot direct the research as it is conducted, and thus cannot be used pro-actively to manage threats to reliability and validity from the beginning (Morse *et al.*, 2008).

3.9 Framework development process

The process of developing the framework involved three steps. First, review of relevant theories to determine the framework parameters was conducted. Secondly, the discussion of the empirical findings from analysis of the interview data, in light of

the theories, facilitated determination of detailed components of the framework under the various parameters/themes. The third and final stage of development of the framework involved validating the detailed components of the framework, which had been determined on the basis of a back-and-forth iteration between the theories and empirical findings, through a focus group discussion. The purpose of the focus group discussion was to ensure trustworthiness, reliability, validity, rigour and ease of implementation of framework. Comments from the FGD were applied to fine-tune the framework. The detailed application of these processes towards actual development of the framework are expounded in chapter 5 of this thesis.

3.9.1 Framework validation

The research is aimed at developing an ‘ESC’ adaptation framework to guide contractors in developing capability to adapt to ESC. Using qualitative data as basis for development of framework requires validation, which will ensure workability of the framework for the target group. A framework that does not possess the qualities of credibility, transferability, dependability, and conformability cannot be reliable and valid (Lincoln and Guba, 1985). To achieve this reliability and validity, the framework developed out of the data analysis and discussions was validated.

The validation process required collection of qualitative data from construction organisations. At this data collection stage, the main method that was used was Focus Group Discussion (FGD) (Kumekpor, 2002). This method was particularly utilized in view of its ability to:

- Allow for expression of views, opinions and counter opinions on sustainability within the construction industry practices;
- Provide pointers on the direction of the framework as a policy guideline for the use of construction organisations;

- Be useful for explaining/understanding behavioural issues, opinions and attitudes and for identifying the trends towards favouring or opposing the proposed framework. This also gives a clue as to the extent to which the final research product (framework/guidelines) would be patronized; and
- Providing bases for assessing the contents and acceptability of the framework in curriculum development and industry market research.

Furthermore, the FGD is widely known as an effective means of soliciting information for purposes of validating qualitative research findings or product (Morgan, 2013; Carleson and Glenton, 2011; Kumekpor, 2002). It was necessary to use the FGD approach in view of its ability to allow discussions and interactions among practitioners who are the target stakeholders as far as implementation of ESC processes is concerned. The discussants for the FGD were BE professionals from the industry and BE researchers from the academia. A selection criteria was developed to select the BE professionals. These criteria are outlined in Box 3.1.

Box 3.1 Selection criteria for FGD participants

- Has relatively deeper understanding of research subject;
- Organisation in which BE professional works operates internally established scheme for improving environmental, health and safety practices
- BE professional's organisation has experience in construction works in which strict conformance to environmental requirements was contractually demanded

In all, there were 10 discussants of the FGD. Eight of them are practicing BE professionals from the construction industry and the remaining two, BE researchers from the academia. The participants comprised of 'acquaintances' who participated in the interviews, and 'strangers' who are not part of the interviewees. The total number of 10 participants satisfies the FGD group size requirement of 4 – 12 participants (Carleson and Glenton, 2011; Krueger and Casey, 2009; Stewart *et al.*, 2007; Kitzinger J, 1995; Bender and Ewbank, 1994). In view of the need to achieve the purpose of the

validation, before participants gathered for the discussion, information on summary of the research findings and guidelines and strategies provided for development of the framework was sent to them. This information was sent through the electronic mail. The object of this prior information was to provide participants with basic knowledge of contents of discussion in order to facilitate their preparation ahead of time.

The focus of the FGD was on the interactions and discussions between participants but not the interaction between the moderator and the participants (Morgan, 2013; Kumepkor, 2002). Thus, ample time was given to participants to review and comment on the framework proposed based on the findings.

3.9.1.1 FGD data processing

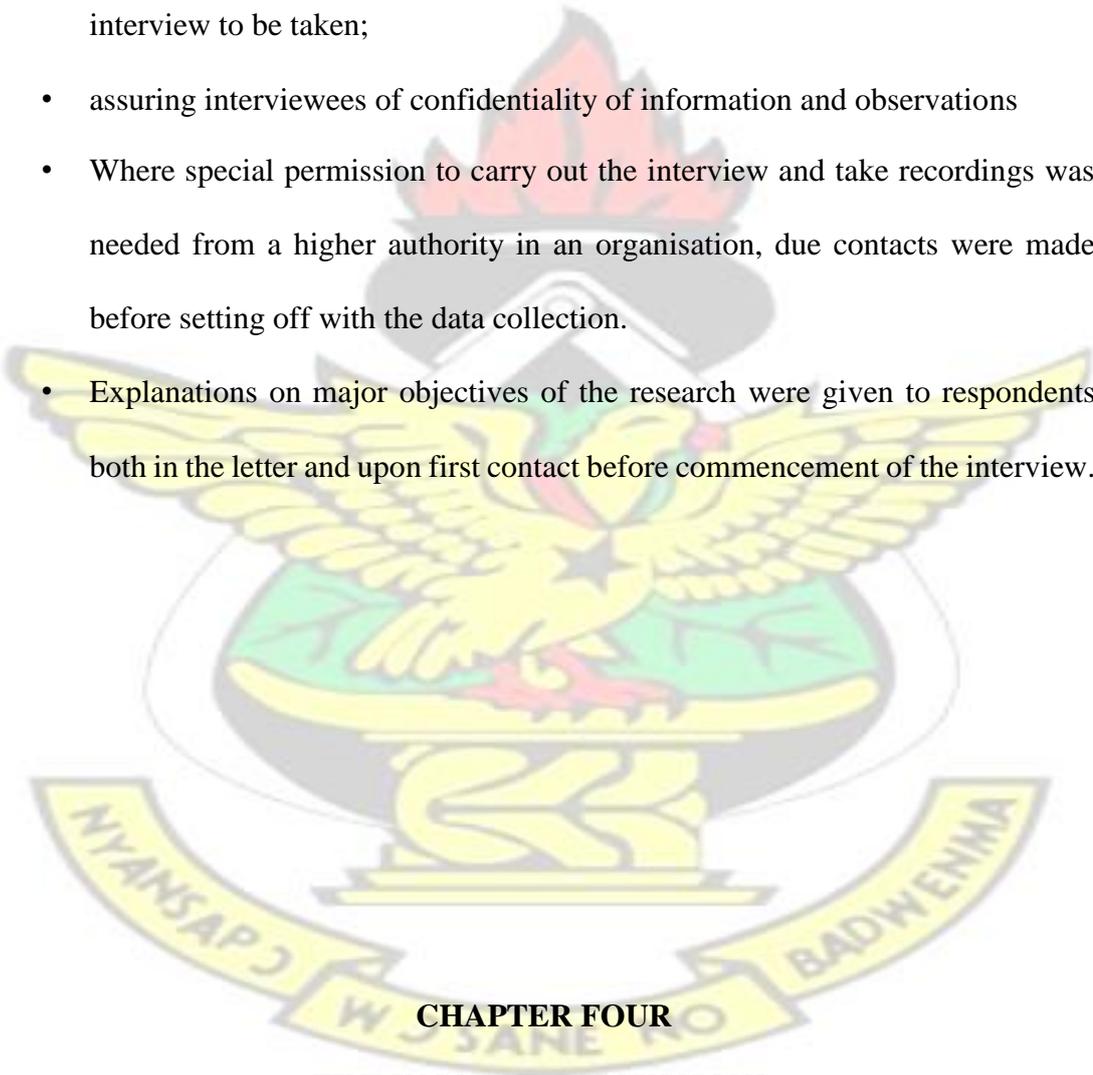
The data recorded during the FGD was systematized, processed and organized by relating the emerging salient points to the main themes of the discussion. This was done bearing in mind the research objectives. An audio recording of discussions were taken in addition to manual recording of the opinions of discussants. The audios were transcribed and read over several times to facilitate coding and categorizing under the main themes of the research framework.

3.10 Ethical and integrity considerations

According to Blaxter *et al.* (2006), research ethics is about being clear about the nature of the agreement the researcher enters into with the research contacts or participants. It is always necessary to get the consent of prospective participants to allow for interviews and observations especially when qualitative enquiry methods are being used as the case is in this study. Bell (2010) adds to these thoughts that it is highly necessary to reach an agreement about the use of the data to be collected and how the analysis will be reported and disseminated. The researcher is expected to comply with any agreements reached.

In this study, steps taken to avoid compromising ethical issues include:

- obtaining introductory letter from the Head of Department of Building Technology, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana (see appendix I);
- with the introductory letter, securing the consent of identified BE professionals working with organisations meeting 100% of the selection with regards to time and place for the interview, and also allowing for an audio recording of the interview to be taken;
- assuring interviewees of confidentiality of information and observations
- Where special permission to carry out the interview and take recordings was needed from a higher authority in an organisation, due contacts were made before setting off with the data collection.
- Explanations on major objectives of the research were given to respondents both in the letter and upon first contact before commencement of the interview.



CHAPTER FOUR

FINDINGS AND DISCUSSIONS

4.1 Introduction

This chapter presents discussion of the findings emanating from the data analysis. In view of the abductive approach of this research, the analysis is guided by postulations of the theories as well as detection of new trends emerging from the data. The findings

are discussed indicating emerging issues concerning the main subject matter being investigated. Discussions centre on the adaptability level of organisations and the observation of application or otherwise of sustainable construction processes by the contractors involved in the studies. Barriers that prevent contractors from adapting to ESC have been discussed. Also, the enablers and drivers of contractors' adaptation to ESC have been explained and described based on the findings from the analysis. In all, the discussions have been carried out in the light of the four theories adopted in this research. The four theories include Resilience Theory (RT); Ecological Modernization Theory (EMT); Institutional Theory (IT); and Social Network Theory (SNT). The approach adopted for the discussions is a back and forth iteration between empirical findings and theories. This is premised on the abductive approach used in this research. This form of discussions lays basis for development and validation of the framework, which is subsequently discussed in chapter 5.

4.2 Triangulation of matrix and thematic template analytical techniques

The procedure for analysing the data comprised: development of initial template; designing of the data matrix; and transcribing of data into matrix. This was followed by manual coding and categorization of the data based on the initial template developed (see analysis tables in Appendix VI). Further coding was carried out with the aid of NVivo (see analysis chart in Appendix IV). This provided basis for development of the final (revised) template (see Appendix IV).

4.2.1 Coding and categorization of data

On the basis of theories reviewed and the research themes, an initial hierarchical form of coding, which is typical of template thematic analysis technique, was developed. This initial template is shown in the analysis table in Appendix IV. The development

of the initial template aided formation of the data matrix, which facilitated systematic organisation of the large qualitative data obtained over an eight-month period.

4.2.2 Data organization

The large volume of qualitative data obtained was effectively organized and presented using the data matrices analytical technique as illustrated in Table 3.2 in Chapter three of this thesis. (King, 2004; Nadin and Cassell, 2004). The audio recordings were transcribed into the data matrix. Transcribed data were double-checked by revisiting the audio recordings and subsequently, effecting necessary corrections in transcribed data. This was achieved through the repetitive reading of the transcribed data and auto coding of data with the aid of NVivo, version 8 qualitative analytical software (see Appendix IV). These steps led to revision of the codes set *a priori* and subsequently development of the final template shown as part of the analysis tables in Appendix IV.

4.3 Respondents' characteristics

Twenty-four large construction organisations participated in the interviews. Within each organisation, a built environment professional was interviewed. The built environmental (BE) professionals were project officers with designated organisational positions. Such professionals had academic and/or professional qualification as a BE professional. These qualities facilitated obtaining personnel who could speak to the issues (or subject matter) of the research, which focused on adaptation to a new form of construction practices/processes. This was also in fulfilment of the requirements of purposive sampling, where the selection of a respondent should be based on his/her ability to speak to the research issues under investigation (Kumekpor, 2002).

Construction organisations classified as D1/K1 contractors by the Ministry of Water Resources, Works and housing (MWRWH) of the Republic of Ghana were involved in the study. These are regarded as large construction organisations (Amoah *et al.*,

2011). The organisations interviewed were all actively engaged in construction projects at the time of the interview. This facilitated obtaining current data on sustainability issues/practices within the organisations. This approach also facilitated undertaking field observations of construction practices to corroborate interview responses.

4.3.1 Work experience of Respondents

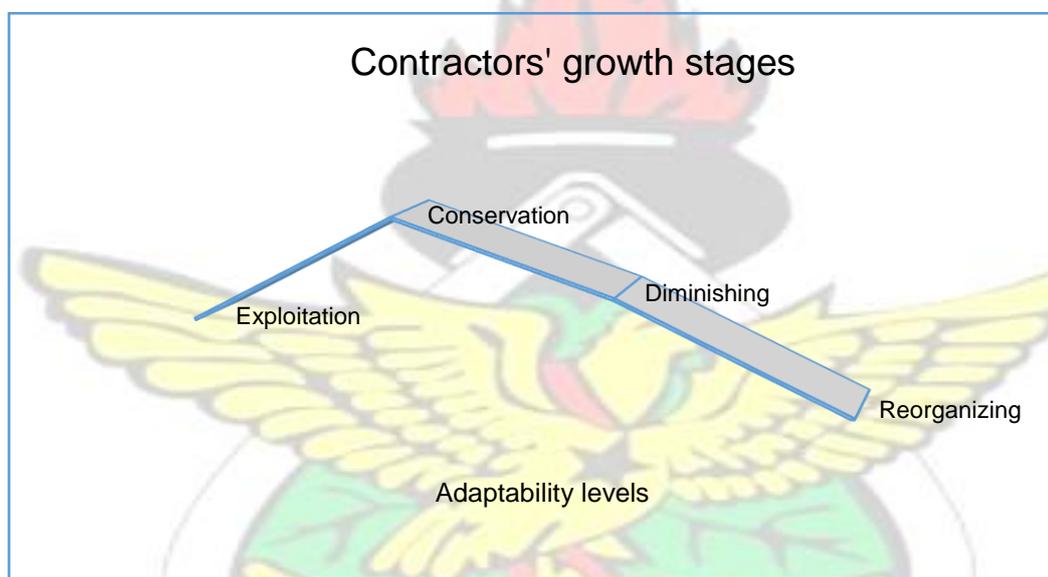
In describing their experiences in the construction industry and the roles they play within the organisations, it was realized that respondents have between 5 and 36 years of experience in the construction industry. Moreover, interviewees indicated that they have had supervisory or managerial experience on at least an internationally competed construction project executed in or outside the country of study, Ghana. These qualities inured to the benefit of the study as the international experiences of the respondents drew in data that would enhance transferability of the framework.

4.4 The growth and adaptability of the organisations

From the semi-structured interview guide, respondents were asked to select specific growth stages that best describe their organisation. Eighteen of the interviewees considered their organisations as either exploiting the construction business or having large conserved resources. One also mentioned that the trend of activities/operations of the organisation indicates diminishing business performance. Organisations at the exploitation stage attributed the phenomenon to short operational period in the construction industry and unfavourable economic conditions. These organisations are unable to secure large or internationally competed jobs for conservation of resources. The exploitation stage of these organisations portrays the r-phase of the adaptive cycle (Walker and Salt, 2006).

The remaining organisations that assessed themselves as having large and conserved resources ascribed this state to long operational years in the construction industry.

From the interviews, another feature that was found to be common with four of these 'highly-resourced' organisations was the presence of foreign roots², as opposed to wholly indigenous contractors, in the organisation. This state describes the K-phase of the adaptive cycle, where adaptability is considered to be high (Pisano, 2012). This phenomenon is recaptured in Figure 4.1 to emphasize the various adaptive cycle growth phases of a social-ecological system.



*Figure 4. 1 Adaptability and growth stages of the contractors
(source: Authors field interviews, 2015)*

4.4.1 Controlling organisational adaptability / adaptive capacity

Further interrogations revealed how organisation's increased growth towards improving adaptive capacity can be controlled/regulated. Growth of a socialecological system from the rapid growth or exploitation phase to the conservation phase would require increasing resources (Pisano, 2012; Walker and Salt, 2006). This is categorized among the adaptability regulators identified from the analysis (see analysis tables in

² An indication that the organization is a subsidiary of a mother organization that is based in another country, mostly belonging to the developed world.

Appendix IV). The adaptability regulators that emerged from the analysis include: access to capital, governmental investment, continuity of jobs, satisfying clients requirement, economic productivity, investment in resources (esp. plant) and modern technology, and creating better company image. Increasing and conserving resources is considered as a way of improving the adaptive capacity of a social-ecological system. These have been revealed in some of the adaptability-increasing factors that were found. The nature of these factors fall in line with Pisano's (2012) explanation about the need for increased capital and other resources to foster growth of adaptive capacity of a system.

In UK, investments are made towards renewables and minimization of carbon emissions programmes by the UK government through the Department of Business Innovation and Skills and DEFRA (Vadera *et al.*, 2008). Lam *et al.* (2010) also noted this observation. However such investments are yet to be initiated in most developing countries. This has been confirmed in the study in Ghana, a developing country. In the absence of such regulations, BE professionals were of the view that environmental management capacity of the construction industry cannot be effectively enhanced. Notwithstanding, it was acknowledged by some of the respondents that internal organisational efforts related to improving company image, through branding or re-branding, could contribute to capacity building. Also endeavouring to satisfy client requirements of good quality and timely delivery of projects is an adaptability-improving measure/strategy, which is within the control of a contractor.

4.5 Contractors' ESC application

To find out contractors' application of ESC processes, it was necessary to observe the ESC knowledge gained and also ability to implement ESC processes successfully. Therefore, interrogations were carried out to elicit more relevant and detailed data on

the knowledge and skills of the contractors in sustainable construction issues. Moreover, construction processes of contractors were observed on construction sites. There was the need to have a look at how contractors' construction practices upheld sustainability principles. From the analysis, as indicated in the final template in Appendix IV, the ESC knowledge and practices of contractors interrogated and observed, fall into the categories of: environmental damage recovery measures; use of ESC modern technology; and means of ESC knowledge acquisition.

4.5.1 Environmental damage recovery measures

All respondents made mention of the fact that the environment has not been damaged beyond recovery, and that it is possible to replenish/regenerate lost ecological resources. Some of the organisations could not point to any regenerative measures or plans put in place to address environmental resource challenges. One of the statements that reflected the inability of a construction organisation to manage environmental challenges was given as:

“...tree planting is good for environmental replenishment, but we are not into that since we are not timber contractors”

These statements reflect that the contractors did not see their organisations to be directly responsible for recovering environmental resources that are lost through construction activities. However, the following were found as the environmental damage minimization measures adopted:

- controlling the entry of pollutants into water bodies and the air;
- changing work schedules to control noise levels;
- replanting of cleared vegetation based on contractual requirements; and
- supporting afforestation campaigns by providing sponsorships.

It was observed that these courses of actions were taken on an ad hoc basis. Also, these actions are sometimes influenced by the contract requirements dictated by contract conditions. These findings are an empirical confirmation of the assertion of Kibert (2012) and DuPlessis (2007) about sustainable construction practices not being established in developing countries. The use of organisational EMP is a practice that is observed as having the potential to increase an organisational capability to deal with environmental challenges associated with construction activities. Tan *et al.* (2011) and Testa *et al.* (2011) have emphasized the importance of contractor's EMP within the construction industry.

4.5.2. Use of sustainable construction modern technologies

Contractor's use of modern technologies that would enable the implementation of ESC processes emerged as one of the themes from the analysis. To reiterate, the Ecological Modernization Theory (EMT) posits that more modernized and affluent societies are more able to ensure ecological rationality. Contractors involved in this study mostly work in a developing country, where industrialization of the construction process is relatively low or sometimes absent. However, there was need to find out the knowledge of the BE professionals in modernized means by which ESC processes could be implemented. Most of the organisations made mention of the under listed as modern technologies they are using or are just aware of but are not using:

- Plastic formwork
- Electronically powered cranes
- Lighter steel trusses
- Modern technical spill kits
- Plastic formwork
- Green building materials
- Non-timber scaffolding and forms
- Underground drainage systems
- Value engineering,
- Retaining wall systems,
- Prefabricated / Precast system

- Water-based eco-friendly staining system used to colour concrete.
- Filters to discharge waste
- Water resistant marine plywood forms
- Geo-panels forms
- Chemical-based building block units

Corroborating the interview findings, field observation carried out revealed that most of the outlined 'ESC' technologies are not applied to facilitate construction activities. However, one particular firm, which have *foreign roots*, was observed to be applying most of the sustainable technologies outlined in this study. Further interrogations revealed that, this particular contractor is committed to international standards, specifically Israeli and American standards, irrespective of the locality within which the organisation undertakes construction activities. This finding relates to a case study conducted by Valente *et al.* (2013) into the green and lean practices of a large construction company. That study revealed a similar organisational commitment to upholding sustainable construction and lean construction principles. This organisational commitment was found to be low or absent among most of the contractors involved in this research. Therefore, the role that organisational commitment/leadership willingness plays towards adaptability to ESC becomes critical.

4.5.2.1 Attributions to non-application of ESC technologies locally

Contractors that were aware of the modern technologies outlined from the analysis indicated that they are unable to apply most of these technologies (see textual coding frame in Appendix IV). This situation was attributed to lack of green building materials manufacturing companies within the local market and high cost of importation of such materials and ESC technologies. The absence of local recycling technologies and outfits and the lack of ESC principles in the designs and specifications produced by project consultants, also emerged as some of the reasons. Foreign-based organisations

that were not applying most of the described ESC modern technologies cited nonavailability in the local market and also the presence of corruption that makes importation costly, as some of the challenges.

In relation to the market conditions emerging out of the study, the normative isomorphic drivers of the Institutional Theory's (IT) is seen to be playing a "negative" role here (Scott, 2008; DiMaggio and Powell, 1983). Thus, due to harsh local market conditions existing in most of the developing economies, practices and values of both foreign-rooted and wholly indigenous organisations could be influenced. The outcome is a diminished capacity of a contractor to adapt to ESC.

4.5.3 Contractors' means of acquiring ESC knowledge

Due to the semi-structured nature of the interviews, further interrogations into the means by which the BE professionals acquired the ESC knowledge became necessary spontaneously. Three main channels through which SC knowledge is acquired by the respondents emerged. These include: academic programmes; continuous professional development workshops and seminars; and personal research and reading.

Specifically, those that indicated academic programmes as the means of obtaining some level of knowledge in sustainable construction, mentioned this with reference to schooling abroad in a developed country. The continuous professional development seminars/workshops were also described by respondents as one off in nature and thus inadequate. It was also realized that some BE professionals used personal efforts and research to acquire knowledge in sustainable construction processes.

However, field observations revealed that, SC knowledge acquired were not being translated into practice for the benefit of the contracting organisation as a whole. It could be gathered from the responses that BE professionals see such knowledge acquired, especially if by means of personal research and reading, to be for personal

benefit. This disconnect between the knowledge acquired and its application in practice was attributed to the lack of tolerance and flexibility on the part of management/leadership of some of the organisation, as articulated in the interview responses, to accept new ideas. In the light of Hofstede's Power Distance (PD) construct, this occurrence is a reflection of greater PD in the organisation of the contractors (Hale and Fields, 2007).

The European Network of Construction Companies for Research and Development, ENCORD, provides a platform for construction organisations to learn about sustainable practices such as carbon reduction strategies (ENCORD, 2010). All respondents were of the view that networking among construction organisations and other colleague professionals is profitable for understanding and practicing ESC. However, interviewees did not reveal an affirmative course of organisational action(s) taken to pursue networking among contractors. The use of social networks among construction organisations as means of acquiring knowledge about ESC technologies and practices was almost absent. However, from the Social Network Theory (SNT), inter and intra-organisational relationships is argued to be one of the effective means of facilitating the understanding and promotion of sustainability practices (Connelly *et al.*, 2010).

4.5.4 Social Network (SN) utilization challenges

It was clear in the view of all respondents, that social networks among construction organisations would be useful for understanding and promoting ESC. Nonetheless, no organisation could confirm being in any inter-organisational network where information about new construction practices or ESC are discussed and shared. Probing further, the inability of contractors to be in social networks was attributed to the following:

- competitive nature of the relationship between contractors;
- the attitude of people in the study area being difficult/ rigid such that there is a belief that mere social and inter-organisational relationships cannot influence change such as governmental regulations and policies would; and
- Organisational priority not being formation of social networks but rather competing and completing jobs to the satisfaction of clients to ensure job security and profit maximization.

A closer look at the above attributes indicates lack of understanding of the benefits associated with learning about ESC through inter-organisational relationships. However, Tan *et al.* (2011) and Porter and Van der Linde (1995) support that the competitiveness of construction organisations improves with adoption and implementation of sustainability principles in daily business operations. This is a benefit which is learnable through inter and intra-organisational relationships (Connelly *et al.*, 2010). Contractors' inability to utilize SN to learn and promote ESC is an indication of inadequate understanding of ESC and its associated benefits.

4.6 Barriers against adaptation to ESC

In spite of the reality of benefits associated with sustainable construction, adaptation has become almost a mirage. This gives clue to the presence of barriers preventing adaption to ESC. Barriers against application of SD principles exist in literature. Adegbite *et al.* (2012), Hakkinen and Belloni (2011) and Fonseca *et al.* (2010) have identified some of these barriers. However, the nature of these barriers lack specificity and context. They have been described as challenges to application of sustainable development principles without specific reference to a given industry or developmental setting. Thus, identifying barriers against adapting to ESC becomes a significant thematic area in this research, which also creates an important foundation towards development of the research framework.

4.6.1 Organisational inflexibility

According to postulations of the Resilience Theory (RT), a social-ecological system should be flexible to smoothen adaptation to changes happening (Gunderson and Holling, 2002). All study respondents were of the positive view that flexibility is necessary for facilitating adaptation to an emerging concept such as ESC. Moreover, with affirmative responses from the BE professionals, there was no indication of an organisation being intransigent regarding adapting to ESC. However, analyses of subsequent responses on the organisational flexibility subtheme revealed that the affirmative positions expressed were mostly conditional. Figure 4.2 categorizes the flexibility conditions emerging from the interview results (see Appendix IV).

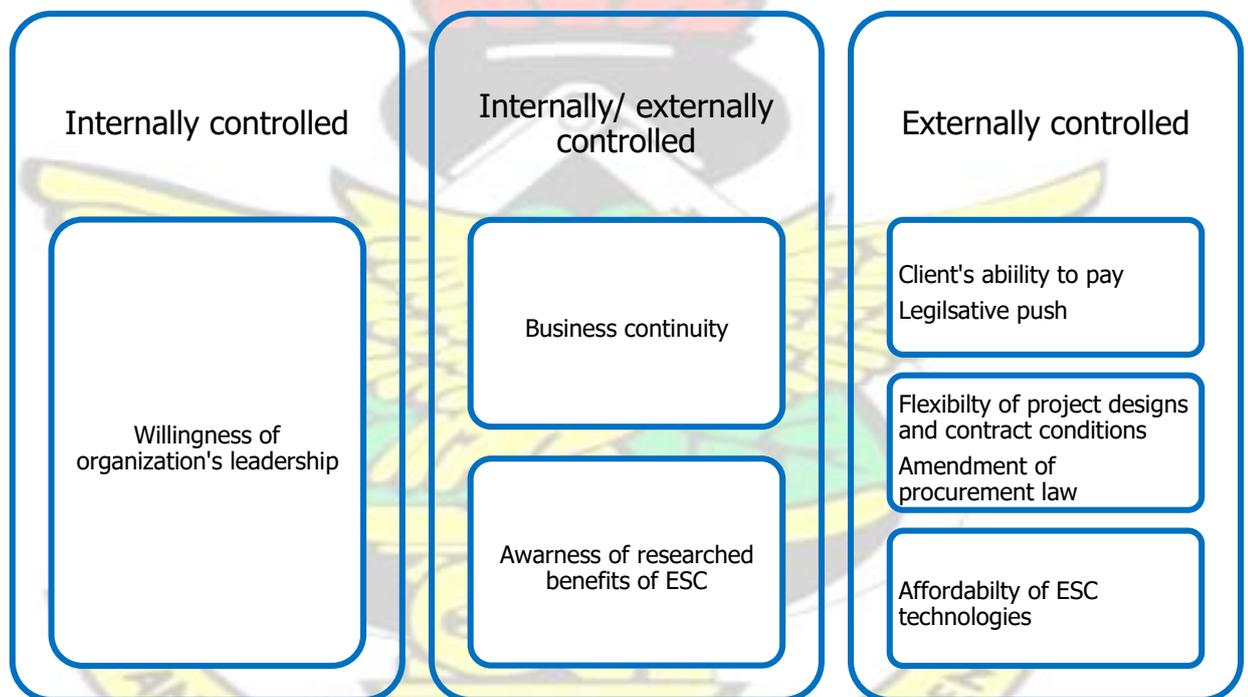


Figure 4.2 Conditions for ensuring organisational flexibility
(Source: Author's field work, 2015)

A closer look at the conditions that organisations' flexibility depends on, yields three kinds: internal, external and hybrid of internal and external conditions. The creation of the external conditions could be seen as those not within the initiation and control of the contractor's organisation. These conditions are under the control of other stakeholders in the construction industry. The internal condition is within the

organisation's control while the creation of the other third category of conditions depends partly on a contractor and partly on external parties/bodies/stakeholders. In the opinion of respondents, the success of adaptability depends on the existence of the external conditions more than the internal conditions.

However, among other determinants of adaptive capacity of a system, Gunderson and Holling (2002) cited creative flexibility in decision making and problem solving. Thus, the ability of a system to create and control conditions internally is primary to developing flexibility. However, as interviewees attributed the ability to practice ESC to the existence of conditions created externally, especially by the government, there is an indication of lack of internal creative flexibility of contractors to adapt to ESC.

4.6.2 Environmental inefficiency of modern technologies

Generally, respondents perceived all forms of modern construction technologies as an effective means of practicing SC. The Ecological Modernization Theory (EMT) also argues that more modernized societies have increased ability to ensure ecological rationality or environmental resource efficiency (York *et al.*, 2010). On most of the construction sites, observations indicated use of the traditional 'unsustainable' processes devoid of modern technologies. From the interviews, it was opined that modern technologies could make environmental management awkward. This could happen in instances where a contractor has inadequate knowledge and training in the use of a particular technology. The lack of willingness of some contractors to get detached from old ways of doing things, also emerged as one of the attributions for non-usage of modern SC technologies. This unwillingness was revealed in the quotation below, which was gleaned from the interview data:

"...you cannot change the winning horse" – R17.

The lack of willingness to change from unsustainable construction processes to contemporary technologies that support sustainability principles in construction, emerged as a barrier against adaptation to ESC.

There is incessant call for movement from anti-sustainable practices to sustainable practices in order to ensure environmental resource efficiency (Ospina, 2012). York *et al.* (2010) and Mol (2001) explain that, according to the EMT, modernization of society comes along with ‘reflexivity’ of society. Thus, society will, by itself, use modern efficient processes for production to ensure ecological rationality. However, out of this study, it is found that some construction organisations find it difficult to adopt requisite modern tools to facilitate adherence to this call. Increasing urbanization in most of developing countries as noted by DuPlessis, (2014) and (2002) should have come with corresponding increase in industrialization. However, an unbending position of contractors to welcome modernized industrialization of the construction processes has become a barrier. This revelation does not reflect the presence of societal ‘reflexivity’ required for achieving sustainability, as posited by the EMT.

4.6.3 Inefficiency and insufficiency of locally available construction technologies

The Agenda 21 for Sustainable Construction in Developing Countries (A21_SCDC) advocates for use of localized or indigenous technologies and resources by the local construction industries in order to ensure sustainability of the construction processes in developing countries. However, from the interviews, the locally available construction methods and technologies are described as being insufficient to deal with environmental challenges. Besides, respondents admitted that, in their understanding, the technologies that have existed and are in use, locally, over the years, are not efficient to support practices of the emerging ESC concept. Additionally, there is weak regulation of entrance and exit of contractors into the local CI yielding amateur contractors who are not bothered about investing into and maintaining modern

technologies required for adapting effectively to ESC. These present a situation that could make adaptation to ESC difficult. Meanwhile, the EMT indicates that increased ability of societies to engender ecological rationality comes with industrialization, characteristic of modernized societies (Rosa, 2003). With the industrialization situation characterizing the local construction industry in this research, technological capability to practice ESC is weak.

4.6.3.1 Technology importation trends in the local CI

There is an over-dependence of the local CI on imported technologies. These already imported technologies are described as insufficient to support widespread practicing of ESC. Interviewees indicated that, indigenous developers, as stakeholders in the CI, have developed interest in importing and using certain building materials that do not suit the local climate and also promote well-being of facility end-users. This trend, which promotes patronization of 'inappropriate' technologies, does not facilitate achievement of sustainability principles in the construction industry. Li *et al.* (2012) found that amidst carbon emissions regulations in UK, importation of building materials still contribute significantly to increasing both embodied and operational carbon emissions. Thus, the absence of construction materials importation regulations weakens further the local CI's ability to control, for instance, both embodied and operational carbon emissions.

Some of the respondents were also of the view that the local construction industry is young. Hence, contractors in the industry are used to operating with traditional construction methods that do not depend on modern sustainability technologies. This then yields a situation where the locally available construction methods are rendered insufficient to facilitate prudent ecological management. This description places the construction industry at the exploitation phase of the adaptive cycle (Walker and Salt, 2006).

4.6.4 External pressures as barriers to ESC adaptation

External pressure, in the context of this study, is understood as all influences not generated within or by actions of a contractor's organisation itself or by network of contracting organisations. Such pressures, which create barriers towards a contractor's adaptation to ESC, have been described in Figure 4.3. The isomorphic coercive driver of the Institutional Theory (IT) is a representation of the governmental rules and regulations that pressurize organisations to improve upon its output (Kraft and Furlong, 2007). The absence of some of these coercive drivers, as indicated in Fig. 4.3, has been described as a source of pressure on a contractor's organisation.

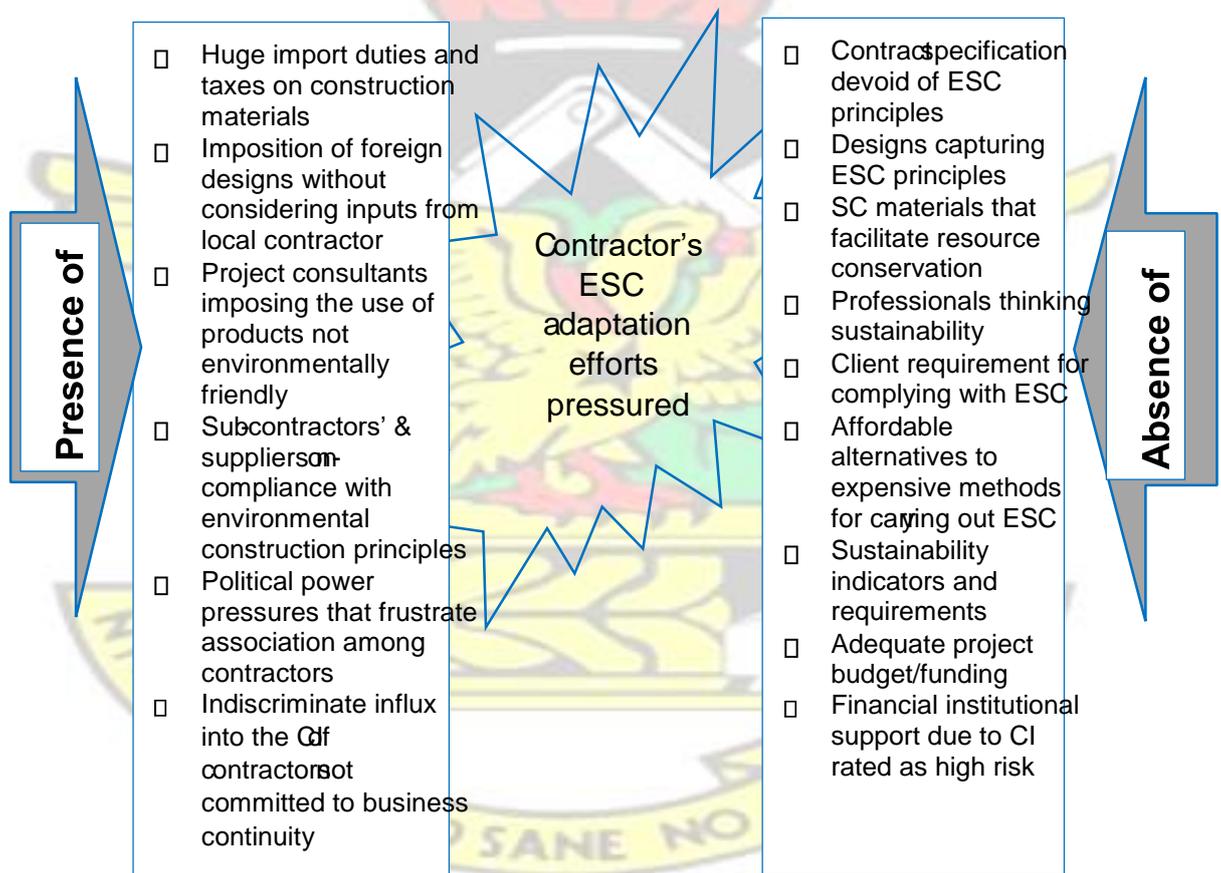


Figure 4.3 External pressures against adaptation to ESC

(Source: Authors' field work, 2015)

With the absence of some of the conditions given in Figure 4.3, contractors find it difficult to pursue sustainable construction since the end results may deplete

organisational resources without the organisation receiving any reward. Consequently, organisational efforts towards adaptation to ESC becomes frustrated. On the other hand, the presence of some conditions also create pressures on contractor's organisation diminishing efforts to even voluntarily practice ESC. Thus, the existing business environment becomes a source of demotivation for contractors to adapt to ESC.

4.6.5 Economic and socio-cultural barriers against ESC adaptation

Conditions that present barriers militating against adaptation to ESC were categorized along the ecological, social and economic aspects of sustainability *a priori*. From the views of respondents, barriers due to ecological conditions of the study area are nonexistent. Rather, interviewees were of the opinion that the ecological conditions (for instance the all-year sunny climate, forest reserves/ resources) favour adaptation to ESC. On the other hand, the social and economic conditions/characteristics, which militate against adaptation to ESC, emerged strongly from the data. Respondents were able to describe peculiar socio-cultural characteristics, which pose barriers against contractors' ESC adaptation efforts.

4.6.5.1 Peculiar socio-cultural barriers

Peculiarity of some of the barriers, especially those due to social conditions, have been indicated in Table 4.1. Some of the socio-cultural characteristics posing barriers against adaptation to ESC were described as being peculiar to the study area. These barriers are related to the societal and cultural values of contractors' organisation as a whole, and the individual workers within an organisation. The discussions in this section focus on these peculiar socio-cultural barriers described by interviewees.

Table 4.1 Economic and socio-cultural barriers against ESC adaptation

ECONOMIC	SOCIO-CULTURAL
<ul style="list-style-type: none"> ▪ Low economic capacity to source for modern technology ▪ High interest rates and delayed payments ▪ Inconsistency in implementing national development plans ▪ Inefficient use of energy and disregard for renewable alternatives ▪ Lack of policies to support wastes recycling and weak environmental law enforcement ▪ No clear budgetary allocation to ESC practice <ul style="list-style-type: none"> ▪ Import-based economy yielding indiscriminate influx of anti-sustainable construction materials ▪ Non-availability or lack of access to business capital ▪ Slow rate of research 	<ul style="list-style-type: none"> ▪ Societal pressure to gain employment status without regard to the associated environmental consequences* ▪ Tend to accept new ways of doing things through social associations more than by regulations, which are impersonal* ▪ Selecting governments not based on performance or soundness of economic policies* ▪ Upbringing or social life-style not encouraging environmental resource conservation.* ▪ Sticking to cost reduction measures more than environmental protection measures* ▪ Nature of upbringing yielding low selfconfidence and oppressing improvement efforts* ▪ Highly conservative due to familiarity with old practices

**Socio-cultural characteristics peculiar to study area*

(Source: Authors' field work, 2015)

Failure to give regard to environmental consequences of construction activities and being only concerned about social status of being gainfully employed is identified as a social attitude that poses barrier to smooth adaptation to ESC. Respondents were of the view that society upholds the employed and disregards the unemployed. Thus, this attitude influences contractors and the individuals therein to be overly focussed on securing jobs irrespective of the environmental implications. Consequently, less regard is given to preserving the environment through construction activities, as what matters

here is that a job is secured. As much as gaining employment is an essential function of social actors, changing attitude in order to meet changing demands of the environment is also essential for adaptation to ESC (Folke *et al.*, 2010; Walker and Salt, 2006).

It was also understood that, contractors' organisations and the individuals therein possess the tendency to easily learn, understand and do new things through social associations more than by regulatory force. Here, 'social networks' concept is identified as positive means of influencing the needed change in construction practices. The position of the Social Network Theory (SNT) about influencing change in organisations through a structure of linkages or inter and intra organisational relationships, as noted by Lee and Kim (2011) and Jones *et al.* (1997), is reflected in this finding. However, most of the organisations, as earlier identified, were not found to be in a social network, where personal association and discussions could be triggered to facilitate effective understanding of ESC. The process of learning, understanding, doing and giving feedback, as far as the new concept of ESC is concerned, through social networks, has not been properly explored by the contractors in spite of its acknowledged potential.

Where the culture of a society does not encourage environmental resource conservation and regeneration, a social barrier to ESC adaptation is encountered. The quotation, which is taken from the interview data, is a description of what the society values. The quotation comes with instances that demonstrate the kind of societal values, which gives less or no regard to conservation and regeneration of environmental resources in construction activities.

"In Ghana as a developing country, socially, our culture does not promote ESC. We are people who believe in living in big houses and we use a lot of imported materials as compared to other developed countries where they live in small houses. And the bigger the houses the more use of environmental resources and the bigger the problems with environment. Ghanaians want more than one house which is not common in Europe or America. In Europe and America people like to renovate. Here, we like pulling down buildings to build. The more and the more

you pull down the more you create wastage and environmental challenges for sustainability. In our society also, everybody wants to own a house. In Europe they prefer to own a flat in a house”. – R07

Also respondent 24's (R24) description depicts the social barriers about resistance to change.

“Socially, the mind set of our clients is abused against new technologies, which do not go by the status quo” – R24

Overcoming these social barriers is critical to contractors' adaptation to ESC. There is the need for contractors to devise strategies for overcoming such socio-cultural barriers. There could be change in this socio-cultural attitude and lifestyle through persistent and consistent awareness creation about ESC. This measure was described by interviewees as means of influencing change in attitude of society to help achieve the reflexivity needed for prudent environmental management. Therefore, the significance as well as the fundamentality of these socio-cultural values to the ESC adaptation course cannot be undermined.

4.6.5.2 Commonality of socio-economic barriers in developing countries

It will be highly doubtful that most of the socio-economic barriers coming out of the study, do not exist in other developing countries. Most of the socio-economic barriers identified in this research would be common to most of the construction industries in developing countries. Authors such as Hwang and Ng (2013), Ofori (2012 and 2000), DuPlessis (2002) and Data (2000) confirm that most construction industries in developing countries face common challenges/problems.

The EMT argues that more industrialized societies, a developmental feature which is more characteristic of developed countries, are more positioned to achieve sustainability. It was therefore significant to find out how this postulation manifests itself in the context of a developing country, where industrialization is relatively low. The economic conditions described in Table 4.1 explains some of the reasons behind the lack of capability of local contractors to deal with environmental challenges. Low

or lack of access to capital required to secure the necessary modern technologies is one of the economic conditions posing barriers against. This economic condition is a problem common to most developing countries. Therefore, there is an indication of the transferability of the findings regarding barriers against ESC adaptation.

The presence of these economic barriers identified in this research indicates that, adaptation to ESC, an emerging concept in most of the developing countries, requires to be given the needed financial support. This will help achieve sustainability in the construction industries successfully. Ofori (2012) has sounded a similar call for support to help improve practices in the construction industries in developing countries. Hence, the framework developed and discussed in the subsequent chapter presents strategies by which construction contractors would be able to elicit the needed support for enabling adaptation to ESC.

4.7 ESC Contractor's Organisational Drivers and Enablers (ESC-CODE)

To enhance the discussion on the enablers of ESC, it is worthy to outline some research works that underpin ESC enablers in this research. Grzybowska *et al.* (2014) conducted a study on modelling enablers of sustainable logistics collaboration. In that study, the authors defined enablers as "...the key elements (or drivers) for achieving successful collaboration. This definition of ESC enablers also conforms to the role that enablers of sustainable construction play in the works of DuPlessis (2007), Shelbourn *et al.* (2006) and Kalfhan *et al.* (2003). On these basis, 'ESC enablers' is operationalized as: '*the key elements/conditions/situations that need to be created to make it possible for contractors to adapt to ESC successfully*'.

'Drivers of ESC' is distinguished from 'Enablers of ESC'. Drivers are the catalysts or agents of change that ensure that the change realized by an entity is sustained. The nature of drivers is gleaned from the study of Murray (2004) and Boswell (2003). From

the study of Shelbourn *et al.* (2006) drivers of sustainable construction were seen as motivating issues/factors that allow clients and/or contractors to steer affairs to lead the construction industry towards achieving sustainability. Based on these and other research works done by Tan *et al.* (2011), Pitt *et al.* (2009), Manoliadis *et al.* (2006), and Parkin (2000), ESC driver has been defined in this study as: '*Factors or motivating issues that force/influence the desired change in the actions of contractors and other relevant stakeholders for adaptation to ESC to happen in a responsible manner*'.

Upon development of the final template of codes, the drivers and enablers appeared in two categories (see final template in Appendix IV). The first deals with those that are related to creative actions and measures of a contractor's organisation or network of contractors' organisations. This is termed as Contractor's Organisational Drivers and Enablers (CODE) in this thesis. The second category deals with those that are not based on the actions of the contractors but other stakeholders in the construction industry. This category is termed as Non Contractor Organisational Drivers and Enablers (NCODE). Under this section, CODE is discussed while the next section discusses NCODE.

4.7.1 ESC-CODE: Regulatory and technical conditions/practices.

From the accounts given by respondents, certain practices emerged as preventive or environmentally restorative in nature. These practices diverged into technical and regulatory issues as outlined in Table 4.2. In view of the fact that these are CODE, some of the issues are intra-organisational, while others are inter-organisational.

Table 4.2 Technical and regulatory issues as ESC-CODE

Intra-organisational		Inter-organisational	
<i>Technical</i>	<i>Regulatory</i>	<i>Technical</i>	<i>Regulatory</i>
Methods that reduce cost to the barest minimum		Restoring sand weaning sites	Laws/legislation contractors create and subscribe to
Methods to reduce use of natural resources	Education of construction company workers		Publicity and sensitization of the public about ESC
Company prefabrication workshops	Importing more sustainable technologies		Joint investment in education and training in ESC
Implementing low cost sustainable practices such as: <i>watering dusty roads; washing muddy truck tyres before movement from sites; rescheduling noisy construction activities; supply of human resources to support public tree planting exercises</i>	Policy on regular maintenance of equipment		
Organisation's own research and planning unit on Sustainability			

(Source: Author's field work, 2015)

4.7.2 Regulations-based ESC-CODE

The existence of organisational policies ensure implementation of carbon reduction strategies and sustainability reporting initiatives in some construction organisations in the developed world (Zhou *et al.*, 2013; GRI, 2011; ENCORD, 2010). It is a fact that construction industries in developing countries tend to release far less greenhouse gases than the developed world. However, DuPlessis (2002) acknowledges that, environmental degradation experienced has a more direct and visible impact and presents a more immediate threat to the survival of the poor. Thus, carbon reduction strategies and sustainability reporting policies cannot be ignored in the efforts of contractors to adapt to ESC. However, in most developing countries, the construction industry lack policies and personnel for implementing some of these sustainability strategies (Adegbite *et al.*, 2012; Du Plessis, 2007).

Notwithstanding, the findings shown in Table 4.2 describe interviewees' knowledge in regulatory and strategic actions that can be taken at the intra-organisational or interorganisational level to drive ESC. The organisations involved in the study did not have specific policies on sustainability reporting and carbon reduction strategies in place. However, the presence of these policies and strategies are important regulatory drivers of ESC within a contractor's organisation and among contractors. Having a national regulatory framework that operates among contractors, came up as one of the regulatory drivers of ESC that is inter-organisational. This could involve having a *code of practice*³, to which a network of contractors subscribe in order to foster regulated implementation of ESC processes.

4.7.3 ESC-CODE: Changing existing practices

The quality of resilience of a social-ecological system is manifested in its ability to adapt to changes without changing its basic functions. A resilient system should have the “capacity to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks” (Folke *et al.*, 2010:3; Walker *et al.*, 2004:2). For construction organisations to adapt to ESC, respondents acknowledged that there needs to be radical change in some specific existing organisational practices. Some of the changes in existing practices that need to occur, as outlined by the BE professionals, have been indicated in Figure 4.4. These are the ones that emerged predominant from the coding of the interview results (see Appendix VI). The specific CODE change actions required to be undertaken appeared in three main categories; Technological/Technical, Attitudinal/Cultural and

³ A policy framework that will provide technical requirements and illustrate various methodological choices for ensuring the contractors' construction practices conform to ESC principles. (*Based on Swarr et al., 2011*)

Regulatory. In the view of interviewees, these occurrence of these specific changes in construction organisations would facilitate the construction industry’s movement from the existing non-ESC practices to ESC practices. Action plans on these specific changes require intra-organisational and inter-organisational efforts and initiatives.

Other change actions that emerged out of the interview data have been discussed under

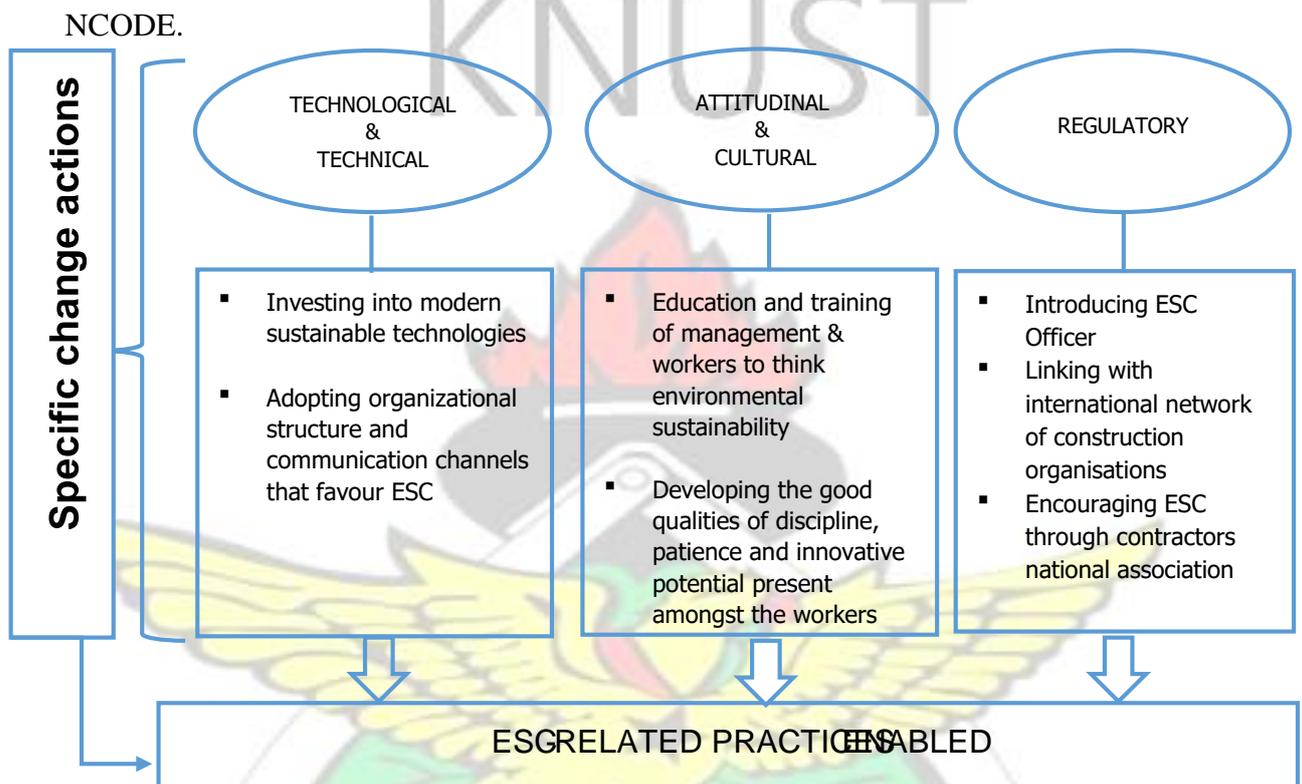


Figure 4.4 Specific CODE changes suggested for adaptation to ESC

(Source: Author’s field work, 2015)

One of the attitudinal/cultural change actions that seem to have been neglected, in the opinion of some of the BE professionals, is the need to utilize good qualities such as discipline, patience and innovative potential of workers within the construction organisations. Du Plessis (2002) noted that, among construction industries in the developing countries, there exists strong grassroots ability for innovation in the use of building materials, settlement development, and institutional structuring. Data (2000) also argue that the labour force in most of developing countries CI is willing and

adaptable to difficult working conditions. Therefore, continued existence of non-ESC practices in the construction industry could be an indication that efforts to tap some of these good potentials of the industry's human resources, are lacking. Adaptation may not be enabled effectively without the contractors first undergoing these attitudinal changes.

Based on the theorizations of RT, an organisation's ability to undergo these specific changes is premised on possessing the quality of resilience. Successful adaptation to ESC can only happen when contractors' ability to undertake the daily business operations is not diminished. Strategies to ensure that contractors possess the needed resilience to undergo these identified changes, without losing the ability to continue with business operations, are needed. The development of the framework in this research focuses on providing such relevant strategies and guidelines.

4.7.4 Individual and Organisational roles

Specific roles of BE professionals, the contractor's organisation as a whole, and the government towards adapting to sustainability practices and technology, have been identified from the interview results. There is an interrelationship between these roles. Such linkages seem to be very important to the adaptation process. An understanding of the relationship on the basis of theories adopted in this research is crucial to advancement of knowledge in adapting to the ESC concept. First, these specific roles are needed to be played as CODE of ESC.

From the field observations, some construction processes that bear SC principles were noted. These include:

- Use of non-timber scaffolding and form works;
- Offsite concrete production and concrete pumping;
- Usage of higher specs and fuel-efficient gen sets for energy production; and □ Reuse of metal, concrete and block wastes.

The reason behind implementation of these processes by some of the contractors relate to: personal or organisational quest for environmental conservation and the need to achieve long term profit and livelihood. These drivers caused voluntary implementation of ESC processes and practices, although in ad hoc manner. This is comparable to the situation presented in the case study conducted by Valente *et al.* (2013). In that study, a contractor voluntarily carried out green and lean practices as part of its organisational policy. It could not be confirmed from the interviews that the adopted practices were activated by organisational policies. Therefore, the gap to be filled by the contractors is to regularize the performance of these ESC processes in an organisational policy.

4.7.4.1 Observing, learning and altering interactions as organisational ESC enablers

To ensure effective adaptation to ESC, internal organisational actions regarding observing, learning, and giving necessary feedbacks to alter interactions are also important to the adaptation process. Wholly indigenous contractors in this study acknowledged having observed, learnt and adopted some SC practices from foreign contractors working within the local Construction Industry (CI). However, these actions of observing and learning were not taken in an atmosphere of established interorganisational relationships. There is therefore no opportunity for feedback and altering actions, which are necessary for continuous improvement in organisational sustainability practices (Folke *et al.*, 2004).

The adaptability construct of the Resilience Theory (RT) indicates that the ability of a social-ecological system to deal with change in its environment by *observation, learning and altering their interactions* is necessary for achieving adaptive capacity (Folke *et al.*, 2004). Where there are no networks or relationships between actors in the social-ecological system, there would be no opportunity to interact and give regular

feedbacks. Social networks are therefore an important medium for contractors to alter their interactions through constant feedbacks in order to enable adaption to ESC.

The sparseness or absence of social networks among the contractors presents difficulty in ensuring the alteration of interactions through feedbacks to enable adaption. This phenomenon is identified as a missing element in the adaptive capacity cycle of enabling actions as depicted in Figure 4.5.

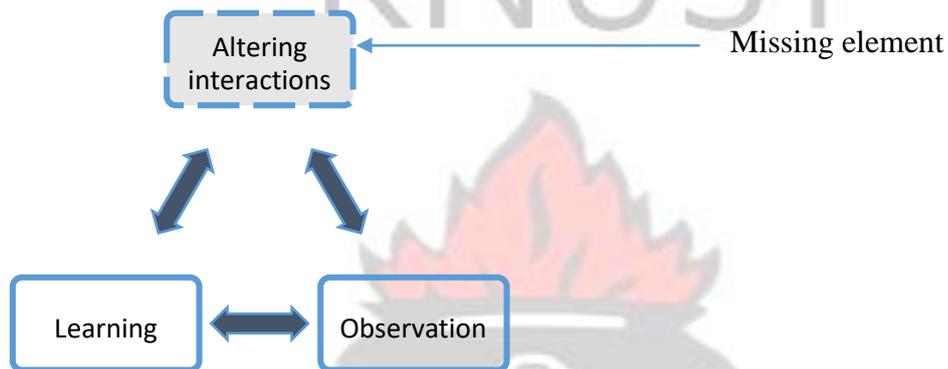


Figure 4.5 *The missing adaptive capacity element needed for enabling contractors' ESC adaptation*

The mimetic isomorphic driver of the Institutional Theory (IT) requires organisational and institutional outputs to be driven by altering organisational practices through imitation of best examples of sustainability practices from other organisations (Aerts *et al.*, 2006). The IT also notes that it is important for the 'learning' organisation to be able to focus on a 'successful' organisation that has similar structure/form. This mimetic driver is important to a contractor's adaption to ESC. However, Scott (2004) indicates that the imitation should not happen in the absence of resilient social structure, which requires the system actors to be able to alter interactions through feedback. The possession of this quality would improve the resilience of socialecological structure/system and ultimately improve capability to adapt to new trends.

Hence, a contractor needs to apply strategies that would help fix the missing adaptive capacity element shown in Figure 4.5. The framework developed in this research addresses this strategy gap.

4.7.4.2 Precursors of contractors' non-performance of ESC processes necessitating NCODE

It has been found that contractors involved in the study are not able to implement some of the ESC processes identified by the interviewees. There are precursors to this inability of the contractors. Subsequently, this situation necessitates the involvement of other CI stakeholders to create ESC drivers and enablers which cannot be created by contractors. Conspicuously, some specific sustainable construction practices that have been explained by Valente *et al.* (2013), Li *et al.* (2012) and Kibert (2012), were missing. These are indicated in Table 4.3.

Table 4.3 Specific non-performed ESC practices and associated precursors necessitating NCODE

ESC practices not performed	Precursor	NCODE suggested
Replanting of trees fell during construction	Considered not to be the responsibility of the construction organisation	Timber felling contractors should take responsibility for replanting trees cut
Use of renewable energy sources	High installation / initial cost	Governmental investment and importation tax exemption/reduction
Recycling	Non-existence of recycling companies	Setting up of recycling companies by government and/or private sector
Reclaiming of sand weaning sites	Non-enforcement of environmental laws	Strengthening of relevant institutions

(Source: Author's field work, 2015)

The World Resources Institute and World Business Council for Sustainable Development, WRI/WBCDS (2013) advocate for businesses in the construction industry to take up the leadership and innovation in pursuing sustainability. This is

crucial in facilitating adaptation of the ecosystem to climate change, which is driven by carbon emissions. In spite of this call, the organisations participating in this study pointed to some specific precursors making this required leadership role difficult. These have been indicated in Table 4.3. In the presence of these precursors explaining contractors' lack of capability to implement some ESC processes, even on ad hoc basis, the need for involvement of other stakeholders in the construction industry to create enablers and drivers of ESC becomes imminent. The next section discusses findings relating to this category of drivers and enablers of ESC.

4.8 ESC Non Construction Organisational Drivers and Enablers (ESC-NCODE)

To reiterate, the ESC-NCODE are drivers and enablers created by other relevant stakeholders in the construction industry, rather than construction contractors. ESCNCODE were considered by the respondents as essential to realizing successful adaptation to ESC in the construction industry. They are complimentary to the functioning of ESC-CODE.

4.8.1 Changes in practices required from non-organisational stakeholders

An observation of the common characteristics of construction industries across the developing world, as indicated by Ofori (2002 and 2012) and Du Plessis (2002) in Table 2.1, reveals a trend of resource constraints, and knowledge, skills, and technological gaps. This trend demonstrates the insufficiency of the sole actions of contractors to enable adaptation to ESC. Interviewees were of the opinion that, the process of adaptation to ESC does not rely on the independent actions of contractors only. Notwithstanding, the ability of contractors to collaborate and elicit essential actions from other non-contracting organisation stakeholders is critical to adaptation to ESC. Table 4.4 outlines these NCODE practices/actions expected from stakeholders who are not contractors.

Table 4.4 Technical, regulatory and financial NCODE actions expected from noncontractors organisation stakeholders

CONSULTANTS		CLIENTS (ESP. GOVERNMENT)		OTHER STAKEHOLDERS	
Technical	Legal/Regulatory	Legal/Regulatory	Financial	Financial	Technical
Sustainable construction designs that make use of energy-efficient appliances	Legislating development of environmental restoration plans before job execution**		Clients' being ready to pay for environmental management measures of organisations		Manufacturing renewable energies locally
Including sustainability requirements in construction contracts and tenders		National strategic plan on environmental impact minimization	Government establishing central plant pool to improve affordability and accessibility		Research and innovation into use of indigenous green building materials
Standardizing building elements to reduce waste		Having incentivizing schemes for contractors like is done in the use of LEED in USA	Investing into Research into use of indigenous green building materials		Reversing imported content trend by increasing the use of local resources
Implementing repetitive building designs		Standardized environmental sustainability framework with which contractors are registered and associated			
	Focussing more on retrofitting**				
		Law enforcement			
	Constant information, training, sensitization, workshops and seminars**				
	Integrating projects into livelihood of communities' by drawing integration plan document and then following with training**				
	Defining indicators of a sustainable construction industry**				

	Having more local contents in construction contracts formation**			
		Reversing imported content trend by improving regeneration of <i>local</i> resources		

**Action required by more than one category of stakeholders

(Source: Author's field work, 2015)

From the accounts of interviewees, findings relating to NCODE actions expected from the other stakeholders to facilitate adaptation to ESC have been outlined in Table 4.4. The other non-contractor organisation stakeholders identified from the study fall into three main categories. While some of the actions are technical in nature, others are regulatory or financial in nature.

4.8.1.1 Technical NCODE

Interviewees indicated that most of the construction practices undertaken by a contractor are dictated by the construction project designs from project consultants. The dominance of design-bid-build contracts over design-build contracts in Ghana, the study country, has been indicated by Ameyaw *et al.* (2011). This form of construction contract creates a situation where projects designs and associated variations are in the absolute control of project consultants. Change in the practice of producing construction designs that do not support sustainability principles, should therefore come from project consultants as part of ESC-NCODE. This does not take away what contractors must also do to ensure sustainable designs in the uncommon situation of having design-build contract. According to Du Plessis (2002) one of the characteristics of construction industries in developing countries is inheritance of certain norms and practices from colonial masters. While the colonial masters, mostly developed countries, are modifying the bequeathed practices, most of the construction industries in the developing countries, which were colonized, prefer maintaining the status quo (Ofori, 2012). This feature is reflected by the dominance of design-bid-build contracts

over design-build contracts in most developing countries in Africa. Relevant changes in unsustainable construction project designs are crucial since the quality of tender documents have serious implications for practice (Laryea, 2011). The situation makes it expedient for contractors to collaborate with project consultants and clients in order to elicit relevant actions on creating NCODE.

4.8.1.2 Regulatory/legislative NCODE

It was found that, government, as a major client of the construction industry, need to have a strategic plan towards achieving sustainability in the construction industry at the national level. Such a plan would drive contractors to regulate their EMP's at both the project and organisational levels. Interviewees indicated that Regulatory/legislative NCODE is critical to successful adaptation to ESC.

It also emerged that the establishment of incentive schemes through governmental policies for contractors who comply with sustainability requirements is essential for driving ESC. The establishment and strengthening of relevant institutions, such as the national green building council and environmental protection agency, is seen as an enabler for ensuring implementation of such incentive schemes. In the account of an interviewee who represented one of the contractors with foreign roots, reference was made to the example of Leaders in Energy and Environmental Designs (LEED), which makes provision for incentive schemes for contractors. This is quoted as follows:

“There has to be education but the contractors have to be incentivized. There has to be incentive schemes set up for the sustainable practices. In about ten years, looking at the use of LEED in USA, the system offered incentives for contractors. The higher you are rated the higher the tax incentive you get”. – R12 (2015)

The institution of Green Building Council of the Pennsylvania state was a strong driver towards achieving sustainability (Kibert, 2012). Considering the study area, the Ghana Green Building Council (GHGBC), which was established in the year 2009 (GHGBC, 2011), seem to have had less influence in the local construction industry. During the semi-structured interview, most of the BE professionals were not aware of a national

green building council, let alone its roles. Strengthening such national institutions, such that ESC awareness can be raised among contractors and other construction industry stakeholders, becomes an important NCODE towards adapting to ESC.

The SNT indicates the dependence of organisational output on inter and intra organisational relationships. The strengthening of Green Building Councils at the National level in developing countries could be facilitated by networking with other green building councils in, especially, developed countries, where sustainable construction is relatively advanced. The World Green Building Council's role in strengthening the Councils in developing countries towards safeguarding expedient adaptation to ESC in developing countries can also not be ignored. These networking between local and foreign Green Building Councils is found as an essential short term enabler of ESC in the construction industry of a developing country (Mensah *et al.*, 2015).

4.8.1.3 Financial NCODE

Inadequate operating cash flow as well as increasing difficulty in accessing financing are common challenges facing construction industries in developing countries (Ofori, 2012; DuPlessis, 2002). Meanwhile, adequate financing is necessary for moving towards industrialisation and a knowledge economy (Ofori, 2012). From Table 4.4, the financial NCODE and the technical NCODE, which are expected from the manufacturing industry and research institutions, as suggested by interviewees, is a confirmation of the challenges faced in the developing world. In the view of respondents, government's involvement in establishing central plant pool, and to a large extent, willingness/ readiness to pay for contractors' environmental management efforts, would be effective ESC enablers. This governmental role is expected to motivate and provide increased access to capital resources required for contractors' adaptation to ESC.

The Institutional Theory (IT) makes mention of the influence of normative isomorphic drivers on organisational output (DiMaggio and Powell, 1983). These drivers relate to client and market situations. In the view of interviewees, the presence of green building materials on the local market is likely to boost contractors' ability to overcome the challenge of constrained resources noted by Ofori (2000). The financial enabler role of the government described in this research can also be regarded as a normative isomorphic driver. This draws attention to the need for discussing specific roles of the government in the light of the SNT and IT. The next section undertakes a detailed discourse on specific governmental roles emerging from the analysis.

4.8.2 Specific governmental role as ESC drivers and enablers

The need for the involvement of government to play specific roles dominated the discussions with most of the interviewees. Therefore, governmental role stands out as one of the thematic areas evolving from the analysis (see coding chart in Appendix IV). Governmental roles that were suggested by interviewees, which are needed for long term and effective adaptation to ESC were also described by interviewees. These include:

- Improvement of economic conditions in developing countries;
- Controlling use of abundant ecological resources;
- The government's financial support through relevant institutions; and
- Establishment and enforcement of governmental regulatory framework.

The governmental role, as an NCODE, can be better understood when discussed under theoretical illumination. Institutional Theory (IT) is regarded as a policy-making theory (Kraft and Furlong, 2007). The coercive isomorphic driver of the IT refers to the pressures that emanate from governmental rules and regulations, and formal and legal aspects of governmental structures to influence organisations. Sarkis *et al.* (2010)

also made the observation that business organisations tend to perform more efficiently when they receive the necessary institutional and regulatory support. Contractors, as social organisations, are also susceptible to these isomorphic pressures (Hasmath and Hsu, 2014). However, these pressures vary from country to country and economy to economy (Martinsons, 1993; Porter, 1990). These could be attributed to the differences in socio-economic and political factors that bind a particular government's institutional structure (Kraft and Furlong, 2007). Therefore, a contextual discussion of the governmental role in a developing country's economy, is relevant.

Considering the potential of the coercive isomorphic drivers to influence organisations and institutions towards adapting to sustainability practices, the governmental role in driving and enabling ESC adaptation became unavoidable in interviewees' accounts. All respondents were of the opinion that it will be difficult for adaptation to ESC to happen, in a developing country's context, without the initial involvement of government. Specific roles that the government is required to play to ensure the establishment of sustainable construction in the local CI were opined by interviewees. These roles appear in two categorical categories; legislative driver and financial enabler. Figure 4.6 depicts these specific governmental roles required to enable and drive ESC.

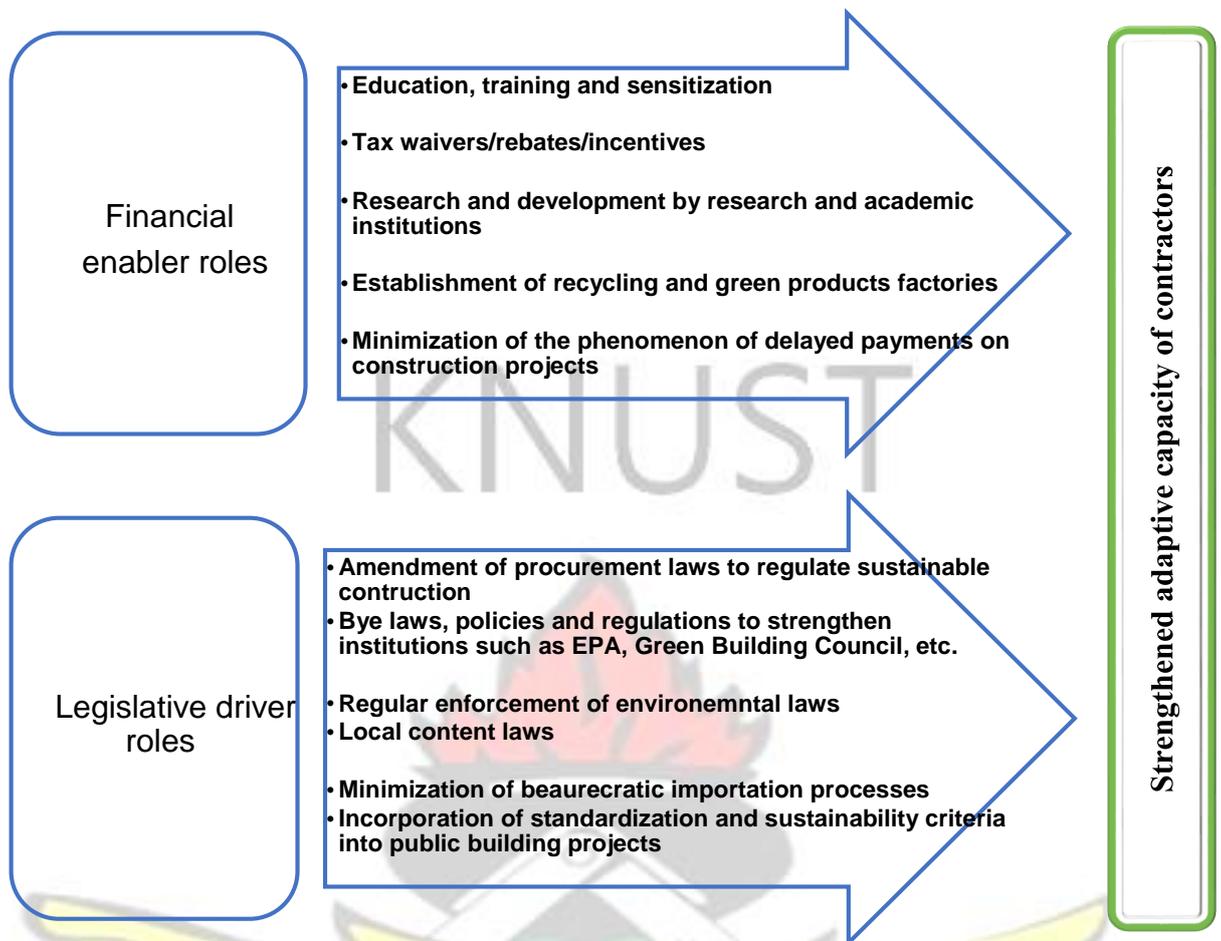


Figure 4.6 Categories of governmental roles towards driving and enabling ESC

The governmental roles identified from the interview findings are considered by interviewees as NCODE needed to be created to strengthen the adaptive capacity of local contractors. These were strongly suggested by interviewees in view of the challenges of resource constraints usually faced by contractors in most developing countries (Ofori, 2012 and 2000).

4.8.2.1 Governmental role: financial enabler

Governmental financial role is considered to be crucial in ensuring the creation of enabling conditions that would enhance contractors' adaptive capacity. Education, training and sensitization of stakeholders in the construction industry towards adapting to ESC seems to be difficult to achieve without government's financial support. Also, the need to offer tax waivers on sustainable/green construction materials and

associated items of plant, was suggested in the interviews. This financial enabler role is considered by the contractors as a major governmental role that would effectively engender the application of sustainable construction technologies within the resourceconstrained economy in which the local CI finds itself.

It was also found that contractors would be motivated when offered incentives by the government. These could be financial or non-financial incentives that are given as motivation for certain sustainability efforts of national and global significance, taken by a contractor. Such efforts may include reduction of carbon emissions and conservation of energy through application of green building principles. Furthermore, most of the interviewees considered recycling, an important but common sustainability/green practice indicated by Valente *et al.* (2013), as beyond their scope and potential. The call for establishment of factories to recycle and also produce green products for supply onto the local market was considered as one of financial enabler roles of the government. With the provision of this enabler, the challenge of contractors lacking access to sustainable construction products on the local market would be minimized.

The production of green building products and materials as well as recycling would require the involvement of research and academic institutions. Thus, government's provision of funding to carry out research into understanding and promoting production and application of sustainable construction technologies and processes, was evident in the interview results. By making provision for the needed funding, government would subsequently exercise authority over research and academic institutions to embark upon intensive research towards promoting sustainability technologies and processes. Thereafter, further collaboration between these research and academic institutions and manufacturers and suppliers could be established by the

government for the purpose of implementing research outcomes towards promotion of ESC.

4.8.2.2 Governmental role: legislative driver

To drive local construction industry towards engendering adaptation to ESC, roles relating to legislative aspects of the governmental structure were also considered to be relevant by interviewees. Similarly, this role is regarded as very crucial in some literature. However, little has been said about the essence of this legislative role for promotion of sustainability in the construction industry. For instance, Brack (2014) found that implementation of procurement policies that eliminated unsustainable and illegal procurement of timber, in most of the developed countries in EU, promoted commitment to ensuring sustainability in the procurement of timber. In this research, the governmental legislative role is defined by interviewees as having strong influence on changing practices in the construction industry (see coding chart in Appendix IV).

4.8.2.2.1 Law amendment and enforcement

The declining trend of procurement performance in developing countries has necessitated some suggestions from some authors calling for further reforms to ensure proper project planning and value for money in the procurement process. Some of these authors include: Ameyaw *et al.* (2012); Jacob (2010); Public Procurement Oversight Authority, PPOA (2007); and Anvuur *et al.* (2006). However, these suggestions for reforms fail to address the issue of sustainability. Hence, this is a gap that characterizes most of these procurement laws in developing countries. Little has been done to eliminate elements of unsustainability in the construction procurement process. Contractor's compliance to sustainability principles has not been given much attention in these procurement reforms. This leaves a gap in the laws regulating construction procurement. Hence, the need for government to amend current construction procurement laws to fill such gaps relating to sustainable construction

practices was found as one of the governmental legislative driver roles. Notwithstanding, in Ghana, the study area, the existing public procurement law has now been amended to cater for some aspects of sustainability during the tendering stage for construction projects (News Ghana, 2016). The lack of capability of contractors to meet these sustainability requirements remains crucial. Hence, the need for the guidelines outlined in the framework developed in this research.

Apart from the need for government to ensure the financial enabler role of introducing tax and import duties/exemptions/rebates, it was also realized that the ability of the government to inject efficiency into existing importation processes is possible. This could happen through optimization of the process for importing green construction materials and products, and associated plant items. Contractors, both those with foreign roots and wholly indigenous ones that have desire to import SC technologies expressed frustrations and discouragement in view of the bureaucratic processes that pose challenges to importation of construction products. In the opinion of interviewees, governmental port policies could be amended to favour ESC.

There is no doubt that government is the largest client of the construction industry in most developing countries. As indicated earlier in this chapter, taking a look at most of the public procurement policies operating in developing countries gives an indication that a lot of public buildings are delivered annually without considering sustainability principles. Introduction of *special policies* to standardize construction of selected public buildings is considered as an effective means through which government can monitor the implementation of ESC processes. Formulation and implementation of such policies buttress the green government procurement (GGP) concept elucidated by Geng and Doberstein (2008). Subsequently, the process of assessing public buildings' compliance to sustainability principles using established criteria, could be institutionalized under relevant governmental agency or ministry.

This governmental role, if properly played, stands as recipe for effective introduction and application of green rating of buildings in the property industry as advocated by the GHGBC (2011).

4.8.2.2.2 Strengthening relevant regulating institutions and agencies

Some governmental institutions and agencies such as the Environmental Protection Agency (EPA), Public Procurement Authority (PPA) and relevant ministries were outlined by interviewees as primary governmental structures for driving ESC. In the case of Ghana, the study country, these relevant ministries were specifically identified as: Ministry of Water Resources, Works and Housing (MWRWH); Ministry of Roads and Transport; and Ministry of Environment, Science and Technology. Most of the respondents were of the view that the role of the relevant institutions and agencies regulating sustainable construction practices in the construction industry has either been suppressed or neglected. Others also discoursed that the role of these institutions is largely skewed towards other industries such as mining sector, to the detriment of the overall management of the ecosystem. An emphasis was therefore placed on the need for governments to rekindle the seemingly dead role of these relevant regulating institutions and agencies in order to drive ESC practices in the construction industry.

4.8.2.2.3 Improving indigenous contractors' capability for ESC

Over the years, the wholly indigenous construction firms in developing countries have not demonstrated enough capacity to execute very large construction projects such as construction of dams, building of national energy generation plant and construction of highways. Foreign construction companies dominate in the execution of such construction projects in most developing countries (Laryea and Mensah, 2010). Most of the interviewees lamented the absence of participation of local construction organisations in such large construction projects where compliance to international standards that promote ESC practices is a prerequisite. Therefore, there is advocacy

for local content law to ensure automatic participation of local construction organisations in projects of such magnitudes. This is viewed as a means of improving the capacity of resource-constrained indigenous contractors in the construction industries of developing countries in order drive ESC practices. This advocacy buttresses the A21_SCDC's support for the use of indigenous resources to foster SC in developing countries (DuPlessis, 2002).

4.9 Integration of CODE and NCODE towards framework development

To ensure that ESC is successfully enabled and driven in both the long and short terms, the CODE and NCODE identified in this research needs to be well established. This requires integrating the two categories, as each complements the other for successful adaptation to ESC to happen.

4.9.1 Utilizing organisational and individual skills/knowledge towards ESC adaptation

It has been found that human resource within the construction industries in developing countries possesses innovative ability. Evidence from this research indicates that little of this ability has been tapped for the purpose of enabling contractors' adaptation to ESC. Since knowledge and skills gap has remained a challenge to the development of the construction industry for over a decade, as remarked by Kaygusuz, (2012), Reid *et al.* (2011), DuPlessis (2009) and Ofori (2000), it is crucial to address this challenge in this research. Acquisition of knowledge and skills by stakeholders in the construction industry has been noted as one of the enablers of establishing sustainable construction in developing countries (Kaygusuz, 2012; Reid *et al.*, 2011; DuPlessis 2009).

However, in the absence of contractors' conscious efforts to continuously accumulate relevant and current knowledge and skills in ESC, successfully enabling and driving adaptation become difficult.

Some of the BE professionals, in comparing current level of skills utilization in postcolonial era to the colonial era, were of the opinion that there has been a downward trend of skills development. Interviewees pointed to a deteriorating quality of workmanship in buildings and other structures as evidence of downward trend of skills development. The description given to the current level of skills utilization level and innovative abilities by interviewees depicts a situation of low capacity and inadequate knowledge in the construction industry. Thus, the knowledge and skills gap cited in literature as a challenge facing the establishment of sustainable construction in the construction industry in developing countries have been ascertained in this study.

In the discourse on Resilience Theory (RT), individual resilience is an important quality for facilitation of adaptation. Individual resilience is defined as:

“...the skills, abilities, knowledge and insights that accumulate over time as people struggle to surmount adversity and meet challenges. It is an ongoing and developing fund of energy and skill that can be used in current struggles” (cited in VanBreda, 2001:5)

The efforts towards adapting to ESC in developing countries depicts a journey of struggles. Over two decades since the establishment of Agenda 21 in Rio de Janeiro World summit on SD, sustainable construction still remains a mirage in the developing world while it is considered as the preserve of the affluent society (Shah, 2003). Successful adaptation to sustainable construction in the developing world could be premised on adopting a piecemeal strategy of adaptation at the micro level of contractors' organisations (see York *et al.*, 2010). Therefore, acquisition of individual resilience is an essential step that needs to be taken by contractors in order to enable successful adaptation to ESC.

Figure 4.7 indicates the measures suggested for construction organisations to put in place to improve upon individual and organisational ESC skills and knowledge.

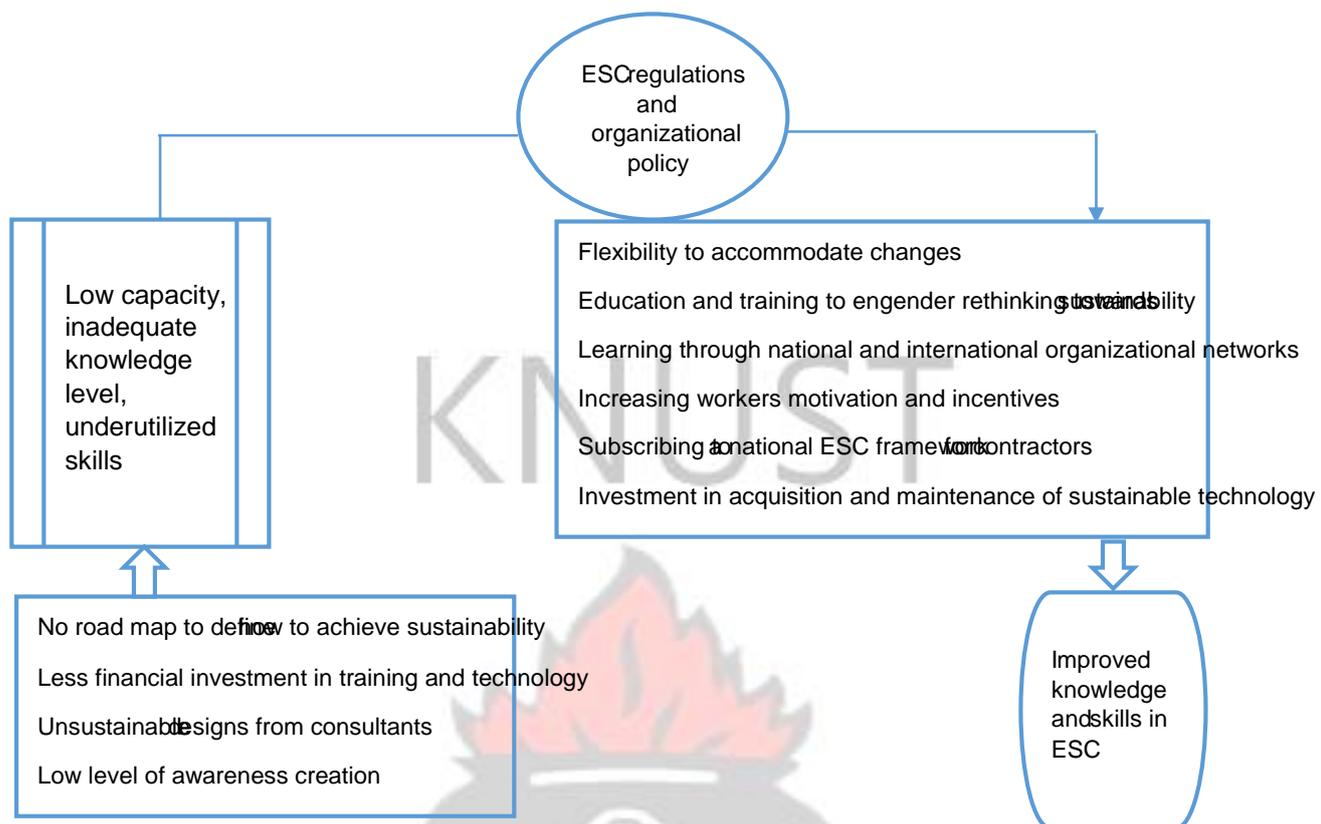


Figure 4.7 Factors for improving construction organisations' capacity, increasing knowledge and optimizing skills

(Source: Author's field work, 2015)

The current ESC adaptation situation within the construction industry, as described by respondents, indicate the presence of low organisational capacity, inadequate knowledge level and underutilized skills. There exist potential and innovative ability of individuals within the construction industry in developing countries to upgrade skills (Du Plessis, 2002). However, Offei-Nyarko *et al.* (2014) have argued that there is skills scarcity in the CI of most developing countries. The authors found that the skills scarcity situation is often due to: irregular and low remuneration; low motivation; varied conditions; and technological advancement, among others. This denotes the presence of underutilized skills in the construction industry, which has been confirmed from the findings of this study.

To improve capacity, increase knowledge and optimize skills of human resource in a contractor's organisation, strategies that propel such a change emerged as suggestions from the interviews. These have been indicated in Figure 4.7. Without strategizing and

formulating organisational policies that propel action on the suggested deliberate changes, interviewees were of the opinion that there would be no commitment of contractors towards adaptation to ESC. Therefore, governmental regulations and contractor's organisational policies and strategies play pivotal role of in the movement from a low capacity state to an optimized state of knowledge and skills. To overcome the conditions leading to low capacity situation, as outlined in Figure 4.7, contractors need to formulate policies and strategies that would propel taking the actions required to increase capability. Wong *et al.* (2013) examined the responses of 50 top international contractors to investigate organisational carbon reduction strategies. The authors found that the presence of organisational policy, which guides each contractor's carbon emission reduction efforts, was key.

4.9.2 Maximizing Efficiency and Profitability through ESC

To ensure that ESC drivers and enablers created work out successfully, contractors should be able to maximize efficiency and profitability in order to ensure business continuity amidst demands of sustainable development. In the discourse on postulations of the Ecological Modernization Theory (EMT), York and Rosa (2003) and Dobbin (1994) have argued that there is the need for governments and institutions to maximize efficiency and profitability and also increase the rate of efficiency in order to achieve sustainability. These findings and argument were made at the macro level of government in modernized and heavily industrialized societies. This study rather looks at understanding aspects of EMT at the micro level of a contractor's organisation. Recommendations raised by York *et al.* (2010) buttress the need for having a research focus on micro level investigation of EMT applicability.

In this research, the findings made reflect an uptake of the challenges raised by York and Rosa (2003) at the micro level of contractor's organisations. Therefore, in this study, contractor's ability to increase rate of efficiency through application of ESC

principles has been looked at. It has been found that, interviewees' perceive application of ESC processes as tantamount to profit maximization efforts. Nonetheless, the additional costs that come with applying green construction principles have been acknowledged by respondents. The contractors involved in this study indicated that clients also perceive initial costs associated with sustainable construction to be high. This reinforces the finding of Shi *et al.* (2013). Also, it was acknowledged by interviewees that maximization of organisational profit could only be possible in the long term. This requires consistency in sticking to sustainability principles in daily operations of a contractor's organisation. Systematic measures for increasing the rate of efficiency to maximize long term profit in the contractor's organisation have been outlined in Figure 4.8.



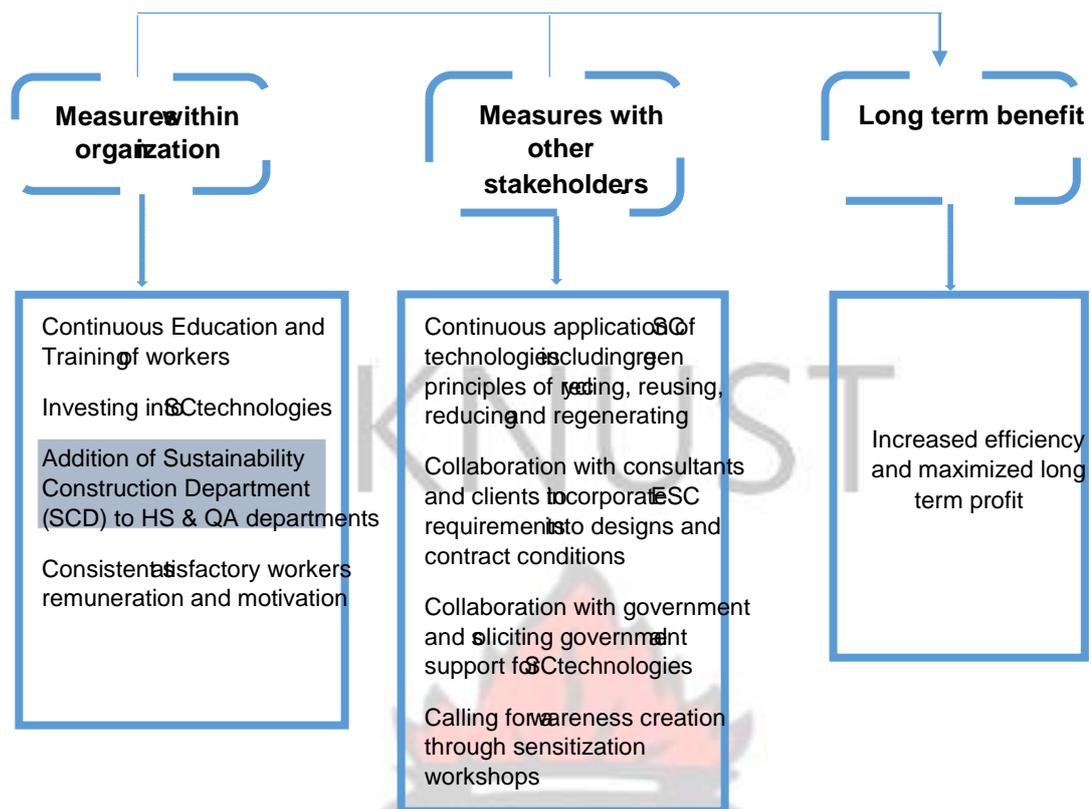


Figure 4.8 Contractors' measures for increasing efficiency rate to maximize long term profit

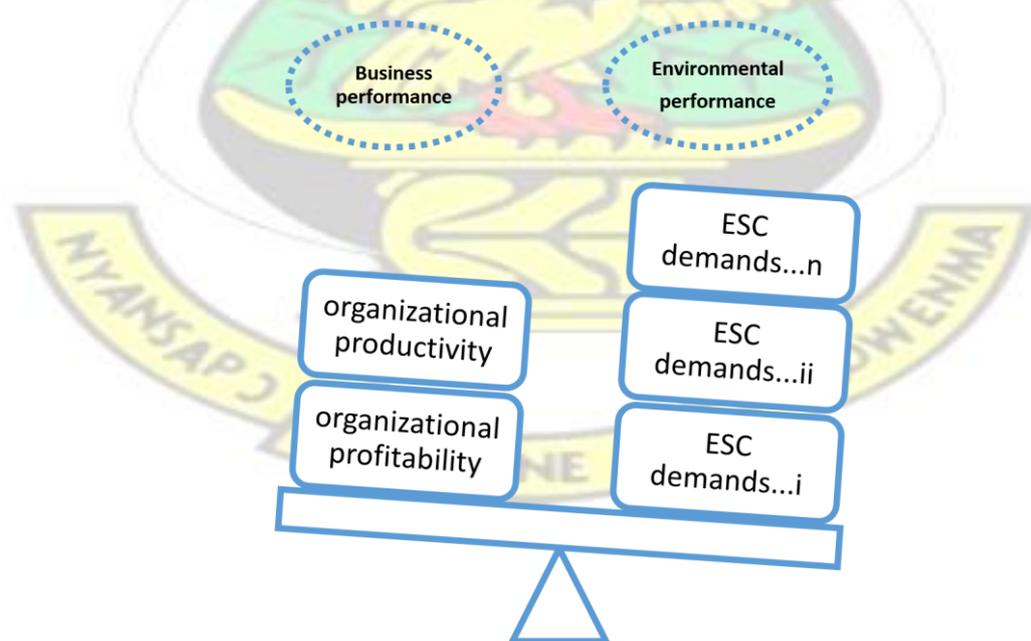
(Source: author's field work, 2015)

For contractors to realize successful adaptation to ESC, increased rate of efficiency and maximized long term profit need to be planned and properly executed through specific measures. From Figure 4.8, a crucial ESC measure that emerged from the interview results was the need for contractors to introduce sustainability department within their organisations. Sustainability issues in the construction industry were perceived by respondents to be very broad. Thus, demand for a new and separate department within a construction organisation to handle ESC planning and execution effectively was suggested in the interview data. Interviewees that expressed this view were of the opinion that this Sustainable Construction Department (SCD) would have a sustainability expert to coordinate the planning, execution and evaluation of all measures towards achieving long term benefits associated with adapting to ESC. The expected huge cost of establishing the SCD was however acknowledged by the

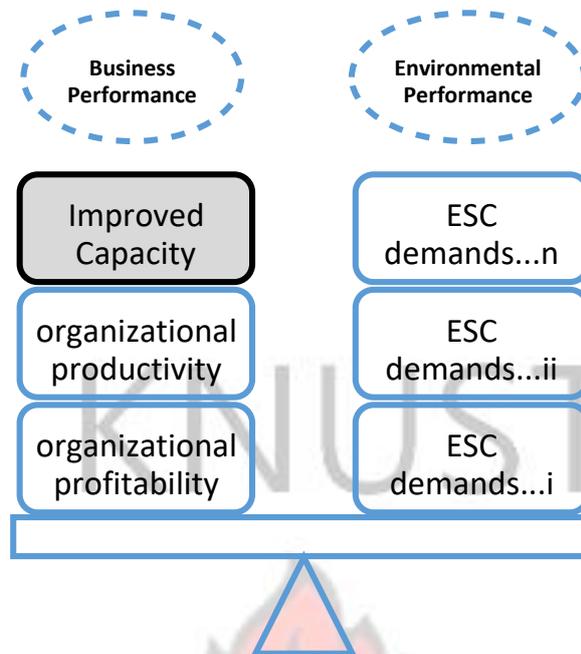
contractors as a challenge. The framework developed in this research addresses the challenge.

4.9.3 Balancing organisational needs and environmental demands

Effective managerial practices that balance organisation's needs with environmental management demands are required to be put in place for successful adaptation to ESC. To sustain adaptation to ESC, business survival/ continuity of contractor's organisation is necessary. Thus, where an organisation fails to put in place managerial measures to balance initial demands that may weigh on the strength of an organisation due to establishment of sustainability principles in daily construction operations, corporate survival may be negatively affected. In implementing ESC processes, business continuity is likely to be affected adversely if a contractor is unable to balance its existing organisational needs with demands placed on the construction industry by SD. Figure 4.9 (a and b) depicts the gap that would cause the unbalanced situation and also indicates the need for creating a balanced situation amidst demands put on a contractor's organisation by sustainable construction requirements.



(a) Unbalanced organisational performance with unimproved capacity



(b) Balanced organisational performance with improved capacity

Figure 4.9 Balancing environmental performance and business performance

It is expected that, in adapting to ESC, a contractor in a developing country should be able to balance demands placed on it by environmental management requirements. Such balancing enables an organisation to perform well in environmental management as well as business productivity and performance. The theorizations of EMT implies that a modernized social-ecological system should be able to balance its environmental performance with business performance and productivity. Zhu *et al.* (2011) have indicated that with countries like China, the concept of Green Supply Chain Management plays a significant role in ensuring that an organisation balances its performance. The situation realized from the field work in this research indicates that most of the participating contractors are unable to and will be unable to balance environmental performance with business productivity and profit if certain measures are not put in place. Figure 4.9(a) depicts the current unbalanced situation existing in most of the organisations due to low capacity.

4.9.3.1 Improving capacity to balance organisational environmental and business performance

Interviewees were of the opinion that with the unbalanced situation depicted in Fig. 4.9(a), contractors may be saddled with the challenge of resource depletion in the face of huge demands placed on the construction industry by SD. Certain managerial practices that could improve the capacity of the organisations to balance business performance and environmental performance emerged from interview data. However, these practices are not happening within the organisations. The absence of such managerial practices, coupled with general resource constraints within the CI, deepens the capacity cracks within a contractor's organisation. To overcome the ascertained capacity deficiency in order to balance environmental performance and business performance within a contractor's organisation, certain managerial practices, geared towards capacity improvement, emerged from the analysis (see Appendix IV). These practices have been outlined in Box 4.1.

Box 4.1 Capacity-improving managerial practices towards balancing environmental performance and business performance

- PROJECT RESOURCE MANAGEMENT
 - Award waste reduction efforts of PMs and workers
 - Optimize project resource usage
 - Overcome resource scarcity/challenges using modern efficient methods and planning
 - Make your workers environmentally conscious
 - Do it right for the first time
 - Communicate among the organisational structures through regular meetings
- ORGANISATIONAL POLICIES AND PLANNING
 - Incorporate Corporate Social Responsibility (CSR) into organisation policy
 - Plan daily to incorporate sustainability principles into all organisation's operations
 - Offer sustainable design, construction and management advice to other stakeholders
 - Develop policies that share long term profit with clients who support ESC
 - Practice according to international standards
 - Comprehensively plan and document how to overcome environmental challenges

The managerial practices appeared in two clear categories: project resource managerial practices; and organisational policies and planning practices. Interviewees were of the opinion that the waste management practices are essential and primary to cost

reduction and profit reservation. The quotation below, highlighted from the accounts of interviewees, indicates a waste management practice that could lead to balancing business productivity and environmental performance.

“...If you want to expand and pay workers more you have to reduce waste and work efficiently to reserve more money” – R07

Some of the project resource managerial practices relate to waste minimization, resource optimization and motivating human resources to think and act in conformity with sustainability principles. Interviewees were of the view that these practices are aimed at environmental resource conservation and organisational resource optimization. This would ultimately enhance efforts to conserve environmental resources and improve capacity to balance environmental performance and business performance.

The theorizations of EMT indicate that more affluent societies of the world are more likely to achieve ecological rationality since there is evidence to support this (Mol, 2001; Mol and Spaargaren, 2000). There is no doubt that the construction industries in the developing world face resource constraints (Ofori, 2012 and 2000; Du Plessis 2002). In the light of EMT, adaptation to ESC seem to be a mirage for the less affluent societies. Notwithstanding, Most of the BE professionals interviewed hold the position that, the collective efforts of construction organisations operating in the developing world to optimize resources through these identified managerial practices can improve organisational capacity to balance environmental performance and business performance.

To avoid ad hoc implementation of the identified project resource managerial practices, certain planning and policy related managerial practices that emerged are worthy to emphasize. These would enable contractor’s effective integration of sustainability principles into daily construction operations. The introduction of these

sustainability-oriented changes into organisational planning and policy could enhance the organisational capacity to adapt to ESC. Eventually, a voluntary implementation of ESC practices, as exemplified in the study of Valente *et al.* (2013), could be pursued by contractors in developing countries. This will be an indication of contractors' ecological reflexivity.

Tan *et al.* (2011) indicate that ability of contractors to incorporate sustainability principles into daily operations yield improvement in the organisation's international competitiveness. Thus, through collective efforts of contractors to consistently optimize resource usage and incorporate sustainability-oriented planning and policy changes, there would be improvement in capacity to ensure prudent environmental management. Ecological rationality, which is theorized to be more easily achieved by the industrialized economies, would become realizable by the contractors operating in less industrialized economies.

4.9.4 Information flow in intra and inter organisational relationships

The SNT posits that organisational output depends on intra and inter organisational relationships (Connelly *et al.*, 2010). Such relationships have been found to be useful for promoting and understanding green principles (Sarkis *et al.*, 2011). DuPlessis and Brandon (2014) have also noted that, besides 'wholeness' and 'change', 'relationship' is one of the main ecological worldview themes required in a framework for engendering regenerative sustainability for producing the built environment. This relationship theme manifested itself in the data. Thus, how the two important features of SNT; relationship density and relationship centrality, interplay to enable and drive ESC, has been discussed in this section of the thesis. The essence of the SNT elements to contractor's adaptation to ESC have been examined in the light of the research findings to provide part of the bases for development of the framework in this research.

4.9.4.1 The importance of Social Networks (SN) to contractors' adaptation to ESC

Without contractors initiating collaboration with other relevant non-contracting organisational stakeholders to stimulate the ESC-NCODE actions, successful adaptation to ESC within a contractor's organisation may be an illusion. The importance of managing relationships between BE professionals in the construction industry towards achieving construction project success has been discussed in literature (Pryke, 2009; Murdoch and Hughes, 2008; Axt, *et al.*, 2006; Humphries and Wilding, 2004). However, the essence of collaboration to contractors' ESC adaptation to facilitate effective achievement of sustainability within the construction industry has not been well explored. To improve on the output of construction organisations in terms of adapting to ESC, building relationships is critical. According to the SNT, both inter and intra organisational relationships influence organisational outputs (Connelly *et al.*, 2010). Here, emphasis is laid on the relationships between the contracting organisation and other stakeholders that are not construction contractors. A look at figure 4.10 shows various networks to which a contractor needs to connect in order to enable adaptation to ESC. However, the interview results indicate that these available networks are not being utilized by contractors.

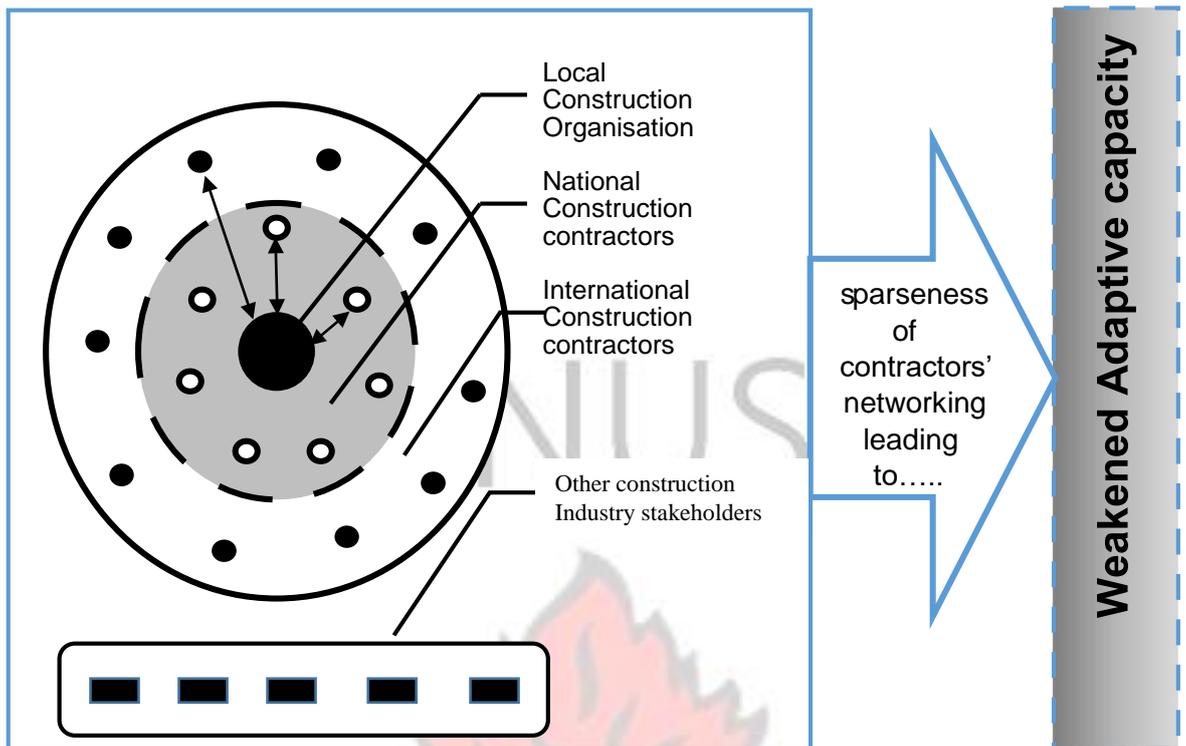


Figure 4.10 Sparseness of contractors SNs existing in the construction industry

LEGEND to figure 4.10:

Sparse link with other organisations	Non contracting organisational stakeholder	National construction contractor	International construction contractor

Respondents acknowledged the Social Networks (SNs) indicated in Figure 4.10 can be utilized to promote understanding and practicing of ESC. However, interviewees admitted that networking amongst contractor's themselves, locally and internationally, is not effective. Similarly, it was accepted by interviewees that establishing a network with other non-organisational bodies for the purpose of promoting ESC was absent. This situation is a reflection of networking gaps. Contractors' collective efforts to fill these gaps are necessary for engendering NCODE actions needed for effective adaptation to ESC.

4.9.4.2 *Intra organisational relationship and socio-cultural influence*

Socio-cultural factors such as experiences, behaviours, beliefs and meanings, have been found to significantly affect people's decisions making even about an essential area like health (Ahorlu *et al.*, 2006). Across the developing world, culture varies from country to country (DuPlessis, 2002). Notwithstanding, culture is important to building relationships for effective construction practices. Thus, the influence of socio-cultural factors in intra-organisational relationships became noteworthy in the findings of this study.

From the interview results, certain characteristics of worker-to-worker relationship were identified (see textual coding frame in Appendix IV). These are described in Table 4.5. These were noted to be useful to ESC adaptation by interviewees. Worker-to-worker relationships were identified as significant to the promotion and understanding of ESC within an organisation. Certain characteristics of the relationships, some influencing adaptation to ESC positively, and some negatively, were described by interviewees. In addition, approaches for utilizing the worker-to-worker intra-organisational relationships effectively were also suggested by interviewees, as indicated in Table 4.5. The worker-to-worker relationships appeared in two categories; *subordinate-to-subordinate* and *subordinate-to-superior* relationships.

Table 4.5 Characteristics of worker-to-worker relationships for understanding and practicing ESC

	Superior-to-subordinate relationship	Subordinate-to-subordinate relationship
Positive characteristics	Prior understanding of management (superiors) triggers discussions at subordinate level	-Cordial and not being antagonistic towards each other making learning effective -Communication and information sharing is regular -Team building on site is interpersonal allowing effective information transfer and understanding - Good working relationships in the Africa/Ghana culture -Use of gang headship facilitate effective learning
Negative characteristics	-Bosses do not accept advice directly -Difficulty in accepting information from newly employed supervisors	-Some not receptive to new ideas -Current trend of engaging subcontractors more frequently than permanent workers
Approaches for utilizing relationships	-Use of 'tool box' meetings to discuss Personal Safety Information (PSI) -Develop organisational culture that rewards compliant workers and penalizes non-compliant ones -Use top-bottom approach to always disseminate policies about ESC -Appointing Environmental Officer to handle all ESC information	

(Source: Author's field data, 2015)

In the light of SNT, the importance of these categories of intra-organisational relationships to the adaptation of ESC cannot be downplayed (Connelly *et al.*, 2010). From Table 4.5, it is clear that interviewees advocate for more attention to be given to the subordinate-to-subordinate relationship category, as a useful intra-organisational relationship for understanding and promoting ESC. This gives evidence of the usefulness of the subordinate-to-subordinate relationship in influencing adaptation to ESC successfully.

4.9.4.2.1 Social cultural values in intra-organisational relationships

The influence of socio-cultural values manifested itself in the interview data regarding the usefulness of intra-organisational relationship in fostering adaptation to ESC.

Kheni *et al.* (2006) and Salm and Falola (2002) have argued that the form of workerto-worker relationship that dominates in most construction industries in sub-Saharan Africa takes the form of master-apprenticeship relationship. This creates a sociocultural behaviour that demands routine respect from subordinates for their masters. This form of socio-cultural behaviour in the superior-to-subordinate relationship manifested itself in the findings as a negative characteristic of the superior-tosubordinate relationship as is stated in Table 4.5. It is a behaviour that has a tendency of not permitting frequent discussions on new concepts and practices such as ESC to foster deeper understanding and appreciation. The subordinate-to-subordinate relationship is rather found to be useful for such discussions. A statement from the interviews describes the influence of socio-cultural behaviour on construction practices in the quotation below:

“In Africa or Ghana, we have good personal working relations with our colleagues. So if some of the leader or headmen or supervisor or ground workers are trained, because of our culture in relating with colleague workers, it will help in transmitting the ESC practices. There must be training of few and our culture will do the rest” – R09

Furthermore, the statement quoted below gives a description of the role that a typical socio-cultural behaviour of people in this study plays in learning and adapting to new ways of doing things.

“Socially, we are more sociable and Africans like to help one another. Here if you are able to convince somebody about the benefits he will do it. But over there [developed countries] they need law to get convinced to do something. Before you can convince them you have to show them a regulatory body that ensures that” – R16

Clearly, people in Ghana, the study country, value social relationships (Salm and Falola, 2002). The quotations above, which were highlighted during the coding of the interview data, indicate the effective way by which most cultures in Africa, which could be contrary to the cultures in most of the developed countries of the west, learn, get convinced and adapt to new ways of doing things. Through explanations from a fellow colleague to whom one is related, a person gets more convinced to change from old to new ways of doing things. Apparently, the indication here is that, by the culture of the respondents in this study, more value is put on information transmitted through social ties than by non-social means. This finding reveals that a mere establishment of ESC regulations and laws without consideration of the socio-cultural tendencies of the people for which the regulations are made, could pose adaptation difficulties. Allowing discussions on ESC issues in a contracting organisation in the context of worker-to-worker relationships is therefore crucial to successful adaptation to ESC.

In utilizing worker-to-worker relationships, proper consideration of these sociocultural behaviours have the potential to minimize bottlenecks in understanding and promoting ESC practices. Thus an organisation's ability to utilize this socio-cultural behaviour in a worker-to-worker relationship appears to be an effective quality for accelerating ESC adaptation.

4.9.4.2.2 Manifestation of Hofstede's power distance (PD) construct in intraorganisational relationship

Power distance is identified as a construct that provides a deeper understanding of the role that socio-cultural values play in utilizing intra-organisational relationships.

Power Distance is defined as:

“...a value that differentiates individuals, groups, organisations, and nations based on the degree to which inequalities are accepted either as unavoidable or as functional” (Daniels and Greguras, 2014:1).

This construct, initiated by Hofstede (1982) has been discussed and its importance in influencing organisational output investigated and emphasized by several authors (Daniels and Greguras, 2014; Murphy, 1999; Bochner and Hesketh, 1994; Bochner, 1994). For instance Bochner and Hesketh (1994) found superior-subordinate relationship construct, among others, to be relevant to influencing group achievement at high and low levels in a multi-cultural organisation in Australia. Other authors have applied the PD construct to investigate into usefulness of intra-organisational relationship. Kuada (2010) argues that culture in Africa affects effective leadership. Hale and Fields (2007) also found that ‘servant leadership’, which is an essential quality of effective leadership, is far significantly less in Ghana (a developing country) when compared to that of USA (a developed country). It is worthy to note that this ‘servant leadership’ quality portrays the Hofstede’s PD construct.

Considering the subordinate-to-superior intra-organisational relationship category, attention is drawn to a form of leader-follower relationship. However, from the interview data, the ability of the contractors, in an African setting, to utilize the subordinate-superior relationship as a tool for facilitating adaptation to ESC, was not explicit. This superior-subordinate channel was regarded by respondents as a channel useful for triggering the transmitting of information meant for ensuring ESC practices within the organisation.

Subordinate-to-subordinate relationship emerged as a more useful channel for deeper understanding and promotion of ESC practices. It was found that subordinate-to-subordinate relationship comes with smaller power distance. With the presence of smaller power distance, subordinates take responsibility and do what is right most of the times. This is unlike the situation realized in the study, where there is greater power distance in superior-to-subordinate relationships in contractors’ organisations. The

strength of this hierarchy is such that subordinates always wait for specific instructions before doing what is right (Hofstede, 1982).

4.9.4.3 Utilization of inter-organisational relationship among contractors

From the data, most of the participating organisations indicated lack of interest in being part of a network of contractors both locally and internationally. The low level of this inter organisational relationships was mostly attributed to the competitive relationship that has been created between contractors in the construction industry. In the view of interviewees, networking with other contractors may cause sharing of organisational 'secrets' that strengthen a contractor's competitiveness. Thus, a competitive advantage could be lost. Tan *et al.* (2011) and Porter and Van de Linde (1995) argue that contractor's international competitiveness can be improved through adoption of sustainability practices. Ironically, respondents see the use of social networking of construction organisations to learn about the emerging concept of ESC, as a threat to competitiveness. In the situation emerging from this study, contractors see the endproduct of networking to be loss of competitive advantage, rather than the possibility of learning and understanding ESC in order to gain competitive advantage. In some existing literature, the use of inter-organisational relationships to foster sustainability practices in most developed countries have been discoursed (Zuo *et al.*, 2012; ENCORD, 2010). Also, the ability of inter-organisational relationships to influence the output of an organisation has been emphasized by the SNT (Jones *et al.*, 1997). The influence of inter-organisational relationships to foster effective adaption to ESC can therefore not be downplayed. To advance understanding of the essence of inter-organisational relationship to enabling adaption to ESC, density and centrality elements of the SNT are discussed in the ensuing sections.

4.9.4.4 Relationship density and centrality of contractors' social network structure.

In this study, a situation of sparse social network, (a network structure with few or no

ties) was realized. The usefulness of social networks to promote understanding and practicing of ESC was clearly acknowledged by all interviewees. However, challenges that face the thriving of such social networks in the construction industry dominated this theme of the interview discussions. These challenges are indicated in Box 4.2.

Box 4.2 Challenges leading to low density of contractors' social network structure

- Lack of understanding of the collective nature of efforts in sustaining the environment.
- Most of the inter-organizational relationships not actually considered to be beneficial to organizational goals
- Few organisations can be trusted and relied on when in relationship
- Local contractors associations normally turn into a 'one man affair' shrinking interest

The findings from this research also buttressed the relevance of density to fostering understanding of ESC among contractors and other stakeholders. However, ignoring centrality of the relationships could be detrimental to the objectives of the relationship. When relationship centrality is not well managed, it is possible for negative influences to pervade the sustainability goals of contractors within a given social network structure. Investigating the presence and usefulness of the centrality element of SNT in the inter-organisational relationships of construction organisations was therefore an important theme set *a priori* in analysing the interview data. Centrality was faintly recognized among the contractors. This could be emanating from the sparse interorganisational relationships as far as both local and international networks are concerned. Relationships between individual BE professionals in different organisations was however more prevalent than organisation-to-organisation relationships. Principles that can ensure centrality or control in contractors' social network structure emerged from the interview results. These are indicated in Figure 4.11.



Figure 4.11 Principles of ensuring centrality in construction organisations' Social Network Structure

The principles of ensuring centrality, as found from the interviews, aim at increasing organisation's control over both dissemination and sourcing of ESC-related information. In order to facilitate contractor's adaptation to ESC, relationship formed with other organisations as well as the associated information flow should contribute to meeting the goal of achieving sustainability. There is an indication from the interviews that without these principles, centrality could be compromised amidst increased density.

The two important elements characterizing SN structure, relationship density and relationship centrality, brought forth by Rowley (1997), have manifested in the interview results. These have facilitated explaining the usefulness of inter and intraorganisational relationships to adaptation to ESC. The ESC phenomenon is at its infantile stage in most developing countries (Reid *et al.*, 2011). In such a situation, Sarkis *et al.* (2010) advocate for increasing the number of ties in a social network structure in order to increase the chances of learning quickly about the phenomenon.

Maignan and Mcalister (2003) have also argued that the higher the density in a social network structure, the higher the chances of contractors being socially pressurized to adopt sustainability practices. Therefore, creating social network among contractors, both locally and internationally, and increasing the number of social ties within such a social networks structure, seem to have influence in facilitating effective promotion of ESC.

4.9.4.5 Promoting ESC information flow

Sourcing and disseminating SC information were not found to be common activities undertaken by the construction organisations. However, contractors' potential to control the inflow and outflow of ESC information has been realized from the interviews. The importance of comparing sustainability related information to internationally acceptable standards before accepting them into an organisation was acknowledged. This is observed to be a means by which ESC information sourced can be filtered, thus, exercising control over information inflow.

It is indicated in the interviews that there is lack of or low preparedness of contractors to disseminate and source for ESC information. The SNT encourages sharing of relevant information, feedback and application of techniques to achieve effective and quick understanding of sustainability issues. In light of this posit of SNT, Zhu and Liu (2010) have argued that environmental information sharing is a dimension that has the potential to promote sustainability in the construction industry. However it was realized from the interviews that sourcing and disseminating information on ESC was not part of the daily/regular operations of contractors involved in this study. This situation was attributed to features outlined in Box 4.3.

Box 4.3 Attributions of the state of absence of ESC information sourcing and dissemination

- At peer-to-peer meetings, there is dominance of discussion on common problems in the construction industry, especially, delayed payments, to the detriment of understanding topical issues such as sustainability
- Information put on the websites of few of the contractors were normally meant to advertise the organization but not to disseminate information about sustainable construction
- Reluctance to share information about cost saving/reduction strategies for fear of losing competitive advantage
- The general low level of awareness of SC in the construction industry.

However, interviewees were of the view that the introduction of certain features into the structure of a contractor's organisation or amalgamation of contractors' organisations could facilitate effective control of sourcing and dissemination of ESC information. The need to establish a research department within a construction organisation to cater for sourcing for and disseminating information has been suggested from the interviews. However, the challenge of financing the operation of the research department within a single construction organisation was also discussed by interviewees. Further interrogations revealed that this financing challenge could be overcome by adopting an approach where a central research outfit serves an amalgamation or network of contractors. Figure 4.12 depicts how the creation of this central research outfit can enhance ESC information sourcing and dissemination capacity of network of contractors.



Figure 4.12 Central research outfit for enhancing contractors' ESC information control capacity

(Source: Author's own construction)

With the need for a central research outfit, it is proposed, based on the opinions expressed in the interviews, that collective funding of a research outfit is essential to improving organisational ESC information control capacity. Thus, via a social network of contractors, research activity is triggered for coordination of relevant ESC information sourcing and dissemination. This emerging proposal for establishing a common research outfit through inter-organisational relationship is a practical application of the SNT as discoursed by Lee and Kim, (2011) and Jones *et al.* (1997). The establishment of the research outfit appears to play a pivotal role towards the development of the framework for improving adaptive capacity of contractors to adapt to ESC. Eventually, achievement of effective and quick understanding of sustainability issues in the construction industry, towards adaptation to ESC, would be facilitated as advocated by Zhu and Liu (2010).

CHAPTER FIVE DEVELOPMENT AND VALIDATION OF ESC ADAPTATION FRAMEWORK

5.1 Introduction

The framework has been developed on the basis of application of relevant theories, empirical findings from interviews and focus group discussion. The theories used include: Resilience Theory (RT); Ecological Modernization Theory (EMT); Institutional Theory (IT); and Social Network Theory (SNT). Hence, the multi-theory nature of the framework. The thematic areas, related to the research objectives, form the basic parts of the framework. Guidelines and strategies that have been provided in the framework are aimed at enabling construction contractors improve upon capability to adapt to ESC. The guidelines are to enable contractors in the construction industry assess adaptive capacity for ESC. Consequently, the guidelines need to be incorporated into organisational policies to enable and drive improvement of contractors' capability for ESC processes.

The Agenda 21 for Sustainable Construction in Developing Countries (A21_SCDC) advocates for an action plan to be developed both at the national and regional levels (DuPlessis, 2002). The framework focus on taking action at the contractor organisational level in view of the advocacy for giving attention to micro level actions instead of the much more concentrated macro level actions towards achieving sustainability (York *et al.*, 2010). The usefulness of this framework is manifested in its ability to guide contractors to improve capability to adapt to the changes in construction processes as demanded by global efforts to achieve sustainable development in all sectors.

To achieve applicability and transferability, a requirement of qualitative findings (Bell, 2010), the framework has also been fine-tuned via a rigorous validation process. The validation was conducted by means of Focus Group Discussions (FGD) (Kumepkor, 2002; Otoide *et al.*, 2001). Participants of the FDG comprised of Built Environment (BE) professionals working with contractors and other researchers in the BE

profession. The results of the FGD were analysed using data matrix and thematic template analyses techniques (King, 2004; Nadin and Cassell, 2004). The findings have been discussed and applied to improve the framework.

5.1.2 Ensuring framework effectiveness

According to Crick and Koch (2003: 119) framework is “a suggested point of view for an attack on a scientific problem often suggesting testable hypothesis”. It is worthy to note that the goal of the framework in this research is not to suggest testable hypothesis. The social science research methods employed in this research do not focus on testing hypotheses. Neither are they aimed at producing hypotheses for testing. Here, the effectiveness of the framework is paramount. This framework is regarded effective or good if it “...sounds reasonably plausible to scientific data available that turns out to be largely correct” (Crick and Koch, 2003:119). Thus, the findings upon which the framework is based have been corroborated through the framework validation process to ensure plausibility of the framework.

Data produced from the interviews and FGD combine to form basis for the framework. Implicitly, the action plans suggested for improvement of construction contractors’ capability to adapt to ESC are based on an integration of empirical data and theoretical postulations. These steps taken in development of the framework were meant to ensure framework effectiveness.

5.2 Background to development of Framework

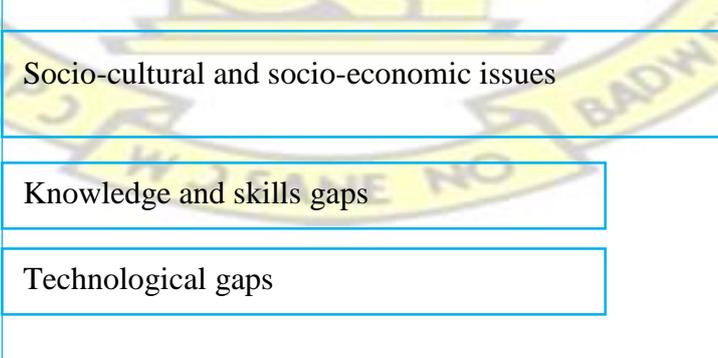
Under this section, detailed explanations of the specific theories and data leading to the development of the framework are given.

5.2.1 Barriers militating against adaptation to ESC.

Effectiveness cannot be achieved in the efforts made to adapt to ESC without identifying barriers militating against the adaptation process. The identification of the

barriers facilitates determination of appropriate strategies to minimize, if not eliminate them. Based on the data available and the postulations of the theories adopted in this study, the framework provides a primary step for contractors to identify barriers preventing adaptation to ESC. Subsequently, action plans for assessing adaptive capacity are provided in the framework.

5.2.1.1 Need for a contractor to establish barriers against adaptation to ESC Barriers that emerged from this study are largely socio-cultural. It was realized that environmental resources in the tropics, where the study was carried out, are considered to be abundant. Hence, society, in its indifferent attitude, gives less attention to protecting these resources. Thus, attitudinal as well as cultural changes are needed to drive regenerative sustainability practices (DuPlessis and Brandon, 2014). The framework guides contractors on the forms of barriers to look out for. It further proposes action plan towards minimizing such challenges in order to adapt effectively. The theories adopted in this study augment explanations on the relevant steps needed to overcome the barriers. Figure 5.1 outlines the different categories of barriers militating against adaptation to ESC.



Socio-cultural and socio-economic issues

Knowledge and skills gaps

Technological gaps

Figure 5.1 Categories of barriers against adaptation to ESC

From the research findings a lot of descriptions given by respondents on barriers militating against adaptation to ESC related to socio-cultural and socio-economic issues. However, none of the categories of barriers can be marginalised. There is the need for a contractor to be guided by these categories of barriers indicated in Figure 5.1 when identifying barriers militating against adaptation efforts. This would facilitate development of effective means of minimizing these barriers.

Beyond the contractor, other stakeholders have roles to play in minimizing/overcoming these barriers identified. These stakeholders include construction project consultants, clients, manufacturing companies and research and academic institutions. The role of stakeholders such as the academic and research institutions becomes crucial in closing the existing knowledge and skills gaps. The manufacturers and suppliers also have roles to play in minimizing/closing the technological gaps. Practicing BE professionals also have roles to play in ensuring that building designs and accompanying contractual arrangements and agreements are also prepared in a manner that will support contractors to implement the principles of sustainable/green building during construction. This is expected to contribute to closing the technical and technological gaps. This is particularly important since respondents as well as participants from FGD confirmed that building designs that are handed over to contractors to construct do not uphold principles of sustainability.

Here, relevant reference is made to the cradle-to-cradle design concept argued by Ankrah *et al.* (2013) for overcoming the challenge of unsustainable building designs. Buildings and other structures are therefore required to be designed to adapt to the changing ecological conditions rather than only finding ways to minimize the negative

effects on the environment (DuPlessis and Brandon, 2014). This is where regenerative sustainability is advocated, going beyond ordinary sustainability.

5.2.1.2 Assessing organisational flexibility

A social-ecological system would not be able to adapt to changes in a changing environment without possessing the quality of flexibility (Gunderson and Holling, 2002). From the study, it was found out that flexibility of a contractor to adapt to ESC relates to certain external and internal conditions shown in Figure 5.2.

From Figure 5.2, it can be observed that as an organisation relies more on external conditions for adaption to ESC to occur, unwillingness of leadership is demonstrated. Thus an existence of inflexibility of the organisation becomes evident. The path of flexibility occurs when the leadership of the organisation takes initiative to create internal conditions required for adaptation to occur. With such initiatives, flexibility of a contractor is demonstrated.

In spite of the quality of flexibility having dependence on contractor's willingness and ability to create internal conditions, a contractor needs to also play some indirect roles. This role would involve professional collaboration with project consultants, manufacturers, academic and research institutions and relevant governmental and corporate clients. This indirect role is crucial to enhancing organisational efforts towards establishing ESC principles in the construction industry.

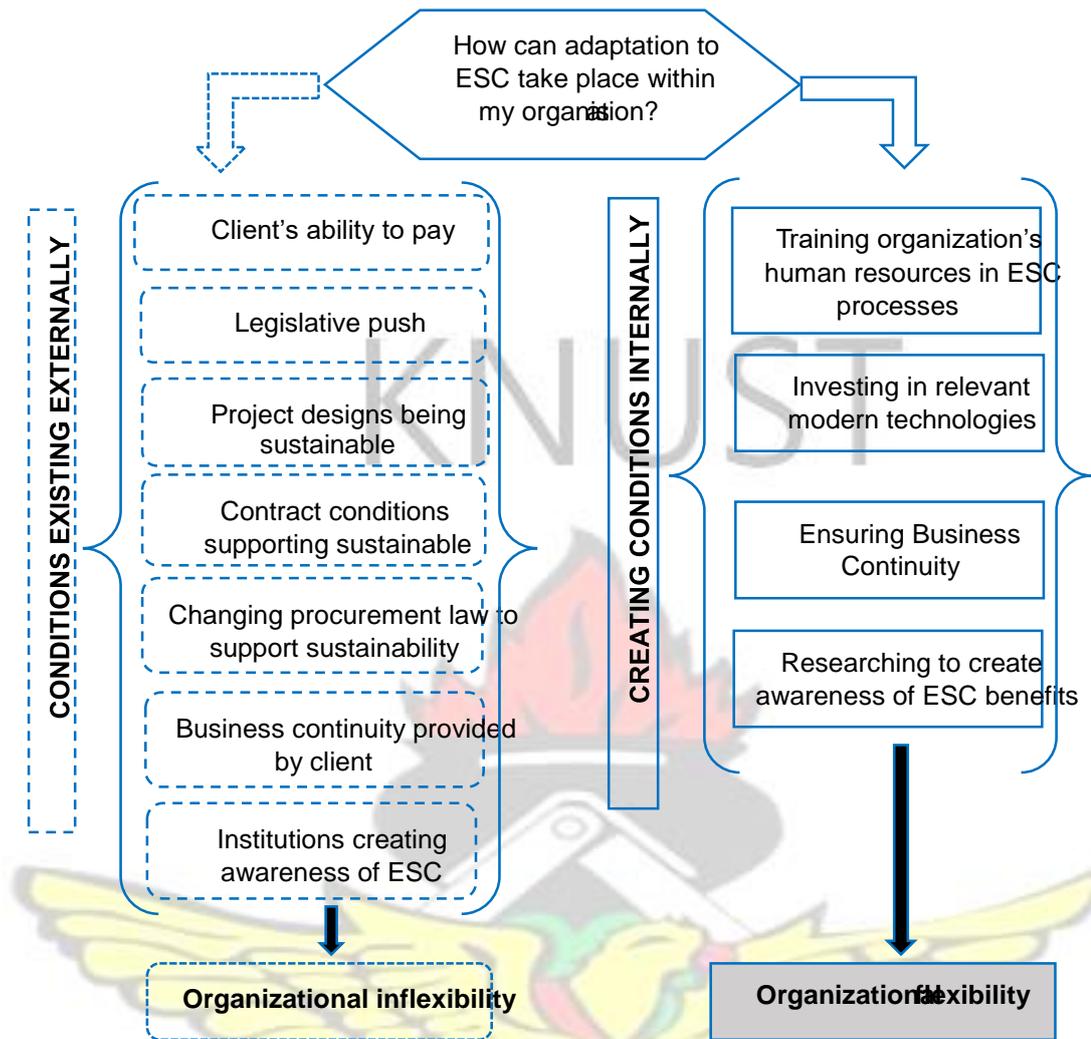


Figure 5.2 Conditions of organizational flexibility vs. inflexibility

The intransigence of a contractor's organisation to adapt to ESC would be a barrier in itself. It would result in perpetuation of the socio-economic/socio-cultural, knowledge and skills gaps and technological/technical gaps. Subsequently, contractor's adaptive capacity becomes weakened. Figure 5.3 shows how the interrelationship between the direct and indirect roles of contractor towards minimizing barriers play out to show the contractor's flexibility.

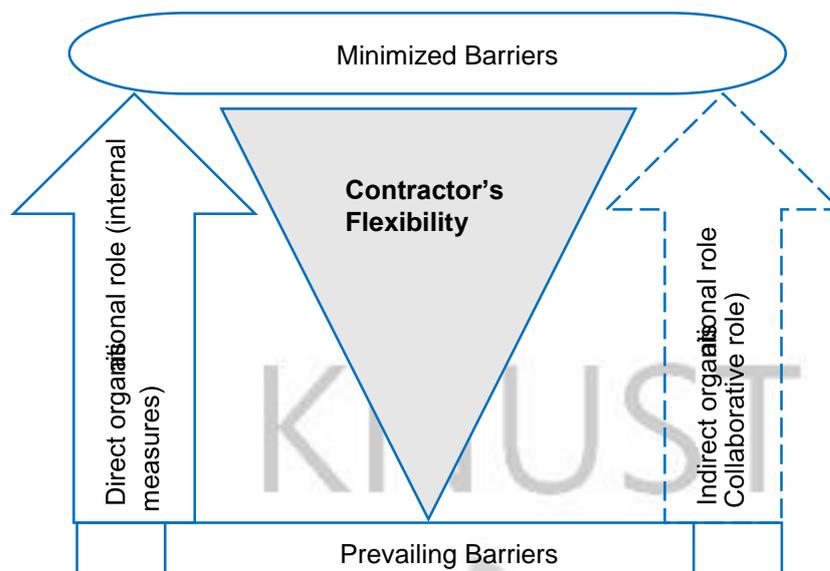


Figure 5.3 Interrelationship between contractor's barrier-minimizing roles and flexibility

(Source: Author's own construction)

5.2.1.3 Controlling external pressures against the practicing of ESC

As identified in this study, the absence of some conditions and the presence of some situations create pressures against contractors' efforts to practice ESC (see Figure 4.3 in chapter four of this thesis). Since the source of these pressures is external, a contractor seems to have no direct role in the emergence and existence of these pressures. The outcome of these external pressures is contradictory to that of the isomorphic drivers of the Institutional Theory (IT). According to Kraft and Furlong (2007), these isomorphic drivers of IT could influence an organisation to adopt green supply chain management principles. The authors identified such drivers to be favourable market conditions and positive governmental regulations that support sustainable construction practices in the construction industry. These drivers are the normative and coercive isomorphic drivers.

In the light of the position of IT on the function of such external pressures, these pressures should be driving construction contractors' efforts to adapt to ESC, when properly directed. Therefore, contractors' collaborative initiative with relevant non contracting organisation stakeholders is primary, as far as minimizing conditions that

pressurize and militate against adaptation to ESC is concerned. Figure 5.4 explains how contractors can collectively minimize the external pressures found to be militating against adaptation to ESC.

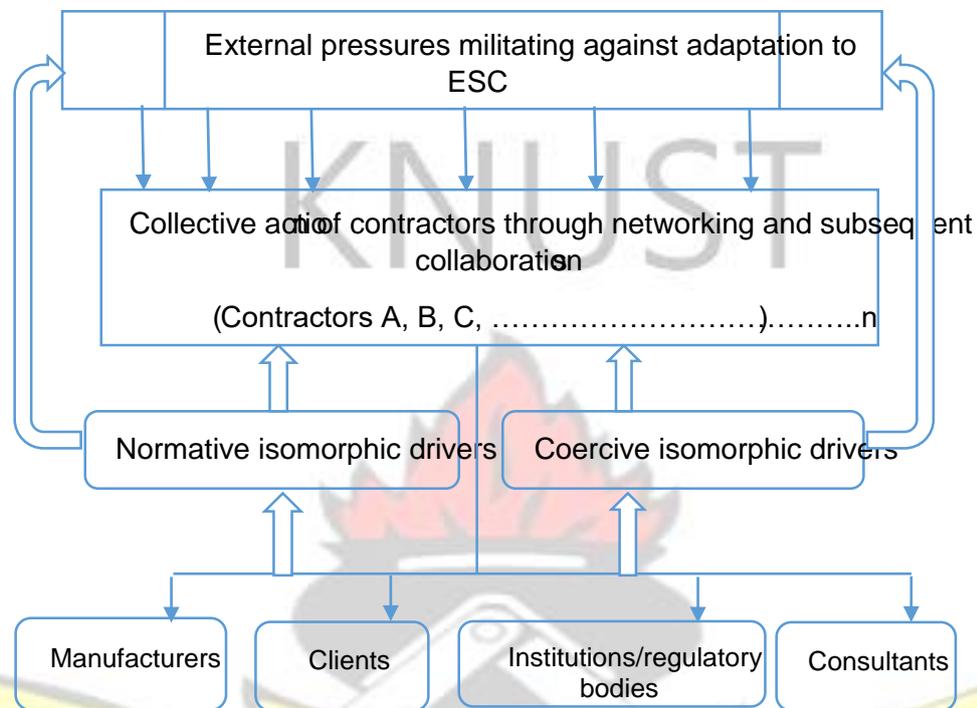


Figure 5.4 Collaborative initiative of contractors to overcome external pressures

(Source: Author's own construction)

Also, the SNT emphasizes the importance of inter-organisational relationships in influencing outcomes. BE professionals interviewed were of the view that it would be difficult to solely initiate collaborative efforts with the relevant non construction organisation stakeholders when making efforts to promote sustainability in the construction industry. Therefore, in such a situation, construction contractors' ability to utilize inter-organisational relationships to trigger the collaborative initiatives with other stakeholders is primary to stimulating the isomorphic drivers. In the effort of contractors to counteract the external pressures, the isomorphic drivers that become relevant are the normative (client and market conditions) and the coercive (supportive governmental regulations and policies) (Zhu and Liu, 2010; Kraft and Furlong, 2007; Scott, 1995; DiMaggio and Powell, 1983).

The survival of construction contractors has even been linked to their abilities to form mergers, which is possible with the formation of inter-organisational relationships (Scott, 1995). In developing countries, where there are many small scale enterprises, it has been argued that the use of joint ventures enables growth of indigenous construction firms (Zhu and Liu, 2010; Laryea and Mensah; 2010). Thus, with the establishment of social networks, formation of joint ventures or mergers becomes easier. Subsequently, the capability of the network of contractors to initiate collaboration with relevant stakeholders towards promoting ESC, is enhanced. Through such collaboration, contractors could effectively implement strategies to elicit the creation of relevant isomorphic drivers from the relevant stakeholders.

5.2.2 Adaptive capacity of a construction contractor

5.2.2.1 Identifying Adaptability level

The adaptive capacity cycle of the RT indicates the need for a social-ecological system to adopt the K negative feedback strategy in order to attain a high level of resilience (Gunderson and Holling, 2002). At that state of high resilience, adaptability or adaptive capacity correspondingly becomes greater.

Knowing the adaptability level of an organisation facilitates determination of readiness to adapt to ESC. Effective assessment of adaptability level would inform the formulation of appropriate strategies to be put in place for development of capability to adapt to ESC. Also, being informed of adaptability level facilitates strategizing how to increase resilience to prepare for change as a responsible response to changing practices stemming from the demands of sustainable development. Resilience is required to increase the adaptive capacity of a social-ecological system (VanBreda, 2001). The accumulation of these elements of resilience (learning, interaction, and feedback) facilitate maximizing adaptive capacity (Folke *et al.*, 2004). Thus, organisation's role of learning, interacting and giving and receiving feedback are

necessary to fill the knowledge, skills, technological and technical gaps. From the findings, the description of the organisational operational experience and resource capacity given by most of the interviewees indicate presence at the exploitation stage or r-phase of the adaptive cycle. Resilience is low at this stage and rather high at the K-phase or conservation stage (Walker and Salt, 2006).

According to Gunderson and Holling (2002) the K negative feedback strategy, which is required for increasing resilience, involves conservation of resources. The resourceconstrained nature of the construction industry in developing countries, as noted by Ofori (2012), was confirmed by most of the BE professionals. These respondents acknowledged that their organisations are at the exploitation stage. The attributions to this situation have been discussed in chapter four of this thesis.

In Figure 5.5, the contribution of the K negative feedback to increasing resilience of a construction contractor’s organisation has been demonstrated.

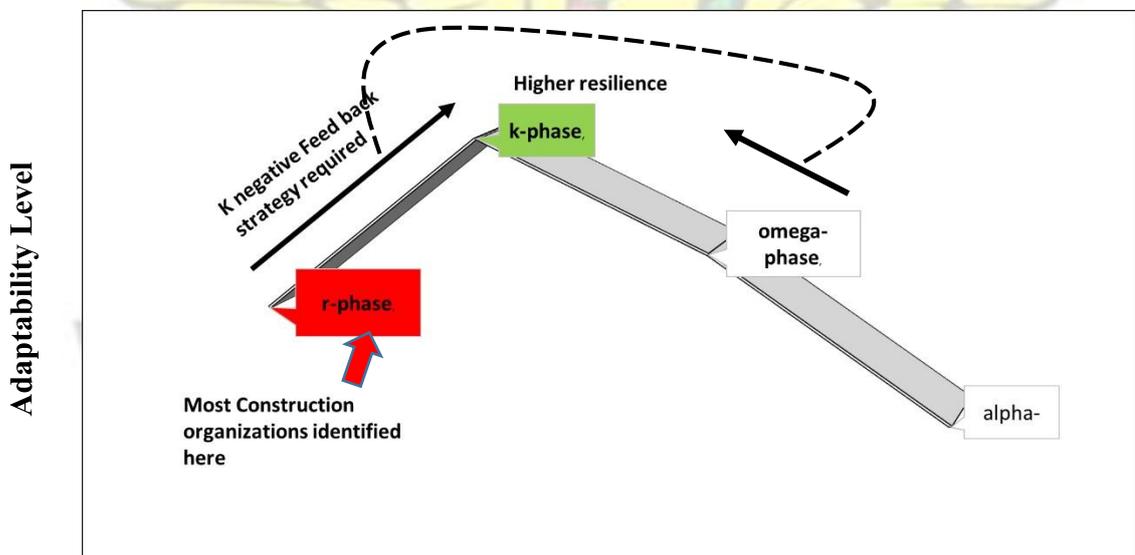


Figure 5.5 Strategy for increasing resilience to raise adaptability level

(Source: Author’s own construction based on (Walker and Salt, 2006; Gunderson and Holling, 2002))

5.2.2.1.1 Adopting the K Negative feedback strategy

In the development of the framework, one of the objectives is to focus on devising a strategy that will facilitate conservation of the relevant resources for increasing resilience and subsequently raising adaptive capacity level. Hence, the need for a

construction contractor to adopt the K negative feedback strategy demonstrated in Figure 5.5

From the interview data, most of the BE professionals indicated that deliberate efforts towards drastic minimization of waste is necessary for conservation of resources. This is an essential principle of sustainable construction. However, this was not the practice of most of the construction contractors. Also, most of the contractors could not show any organisational policy statements on waste management; an indication of lack of commitment to reduce waste. It is observed that the green building principles of reusing, reducing and recycling, as noted by Valente *et al.* (2013), fall in line with the K negative feedback strategy that facilitates conservation of relevant resources of a contractor's organisation. Inclusion of such principles in organisational policies would be an indication of commitment to uphold ESC principles.

For a construction contractor to undertake construction of a green building, for instance, there would be the need for adequate availability of human resources that have the requisite knowledge and skills. Additionally, modern plant resources that incorporate sustainable technologies should be part of the organisation's resources. It is the absence of such resources that places most of these construction contractors working in developing countries at the r-phase of the adaptive cycle.

A strategy that focuses on amalgamating with well-resourced or even other organisations of equal capacity is likely to yield a synergistic effect for improving an organisation's adaptive capacity. Therefore, such strategy should focus on finding appropriate ways of forming relevant mergers. Such mergers would facilitate utilization of huge resources that could have taken a low-capacity contractor long years of operation to acquire. A construction contractor at the r-phase stands a chance of improving capacity by adopting this approach of amalgamating with other

construction contractor(s) to execute construction projects.

Acquisition of the relevant knowledge and skills are necessary for improving human resource capacity for the purpose of effectively adapting to ESC. Based on the SNT, organisations stand a higher chance of understanding and promoting ESC practices through intra and inter-organisational relationships. Amalgamation has been discussed and proposed as an arrangement for improving upon resource generation and utilization in order to achieve resilience. However, the absence of Social Networks (SN) in the form of inter-organisational relationships, as identified from the study, makes the amalgamation strategy difficult to implement. A construction contractor needs to show commitment to establishing inter-organisational relationships for the purpose of acquiring knowledge and skills to improve upon human resource capacity. Thus, formation of SN needs to be part of contractors' organisational policy.

However, the tendency of being derailed as a result of being in an inter-organisational relationship that is not useful for attaining adaptive capacity, exists. Thus the centrality element of the SNT, which advocates for exercising control over the kind of relationship as well as the kind of information that flows, needs to be given the due attention as a contractor strategizes to raise adaptive capacity through interorganisational SN.

5.2.3 Drivers and enablers of adaptation to ESC

The ultimate goal of the framework is to provide guidelines and strategies for contractors to assess capacity and further develop capability to adapt to ESC. This goal cannot be achieved only by overcoming the barriers that militate against adaptation to ESC and/or by assessing organisational adaptability and flexibility. Beyond these, adaptation must be enabled and driven. This requires creation of enablers and drivers

of ESC. An important thematic area of the framework is to provide strategies that will lead to the creation of relevant drivers and enablers of ESC

The creation of these drivers and enablers cannot happen by the sole efforts of construction organisations. Thus, two main types of drivers and enablers that have been identified from the analysis come to play. These are the CODE and the NCODE representing the Contractor's Organisational Drivers and Enablers, Non Contractor Organisational Drivers and Enablers respectively. The theoretical foundation of these types of drivers and enablers are also articulated to explain the underlying principles of the framework and its development process.

5.2.3.1 Intra and inter-organisational relationships and information flow as CODE of ESC

It is argued that the presence of social networks has high tendency to influence organisational output towards adopting sustainability practices (Lee and Kim, 2011; Connelly *et al.* 2010). Within a contractor's organisation, employees' effective commitment is likely to be influenced by the intra-organisational relationships inherent in intra-organisational social networks. From the study, two main intraorganisational relationships were identified: superior-to-subordinate relationship and subordinate-to-subordinate relationship. The subordinate-to-subordinate relationship was found to be more preferable by construction organisation employees as a social network for understanding and promoting ESC. This can also be explained by the

Power Distance (PD) construct of Hofstede (1982).

According to Hofstede (1982), when there is small PD, subordinates expect to be consulted. On the other hand when there is large PD, subordinates expect to be told what to do before acting. In a study conducted by Hale and Fields (2007), the PD existing in most organisations in Ghana, a developing country where this study is being conducted, is found to be larger than USA, a developed country. Examining the

cultural behavior of employees, Hale and Fields (2007) further argued that ‘servant leadership’, which also portrays small PD, was far less significant among Ghanaian workers when compared to USA workers.

The flow of information between contractors and among workers within a construction organisation is also considered here, as part of the CODE of ESC. Two main elements of the SNT: relationship centrality and relationship density prevail (Rowley, 1997). These elements play useful role in explaining how both intra and inter-organisational relationships can effectively foster adaptation to ESC by contractors.

Ensuring centrality requires taking a better control of the relationship such that the purpose, which is adapting to ESC, does not become unachievable. This was found to involve control of information flow, in terms of content, source and destination of flow.

From the interview responses, it was gathered that the establishment of a research unit/department to take charge of ESC information flow both at the intra-organisational and inter-organisational levels, would play a significant role in ensuring centrality. However, the establishment of such a research unit single-handedly by an organisation is considered to be expensive by the respondents. Therefore, suggestions given by respondents indicated that a network of contracting organisations could combine resources. This is seen to be necessary as it would facilitate efforts aimed at ensuring relationship centrality, which is essential for effective adaptation to ESC.

5.2.3.2 Accumulating and utilizing knowledge and skills as CODE and NCODE of ESC

Van Brenda (2001) supports the argument that accumulation of knowledge and skills becomes fund of energy that gives an individual or a system the needed resilience to adapt to a changing environment. It cannot be overemphasized that resilience is a primary requirement for ensuring adaptability of a system. Knowledge and skills gap

was identified as one of the challenges depriving contractors of strength to adapt to ESC. Thus, accumulating and utilizing the relevant knowledge and skills is a crucial step in building resilience as well as closing the knowledge and skills gap in order to enable and drive ESC within a contractor's organisation.

Intensive awareness creation, education and training are measures that have been suggested to close the knowledge and skills gap. These particular enablers and drivers are achievable through the actions of contractors and non-contracting organisations as stakeholders in the construction industry. Thus, both CODE and NCODE of ESC are imperative.

Awareness creation is considered to be an activity to be undertaken by all relevant construction industry stakeholders, as far as adaptation to ESC is concerned. These stakeholders have been mentioned earlier on. It is worthy to reiterate that the role of the National Green Building Council (in this case, Ghana Green Building Council (GHGBC)), which was not recognized by any of the respondents, cannot be overlooked. The awareness creation, primarily among the major industry stakeholders and subsequently among the general populace, in this case at the national level, can be spearheaded by a national green building council. This can be done through workshops, seminars and sensitization programmes. In this study, triggering the need to intensively create awareness about ESC and its benefits is considered to be one of the important activities of the construction contractor or network of contractors.

Appropriately, education and training are also considered as enablers that should be created by academic and research institutions. These two enablers of ESC appeared in the responses of all interviewees. They are therefore considered crucial to the course of adapting to ESC. Unlike education about ESC, training is seen to be possible within and outside the contractor's organisation. Through international social networks with

construction contractors who have advanced in the practicing of ESC or green construction practices, a local contractor has the opportunity to obtain the requisite training for its workers at an accelerated pace. With these efforts, social networks would ensure understanding and promotion of sustainability within the construction industry (Connelly *et al.*, 2010). Through such international networks, the local contractor could mimic robust structure of advanced contractors in order to ensure effective adaptation to ESC. Thus, the role of isomorphic mimetic driver in promoting ESC among contractors, becomes evident (Zhu and Liu, 2010; Aerts *et al.*, 2006; Scott, 2004)

5.2.3.3 Balancing environmental performance and business performance

To be able to drive and maintain capability to practice ESC, it is important for a construction contractor to balance environmental performance and business performance. This is an essential quality of a resilient system in the face of heavy demands such as those emanating from sustainable development.

Theorizations of EMT implies that a society or system that is modernized and well positioned to achieve sustainability, should be able to balance business performance and environmental performance (Zhu *et al.*, 2011). Thus, a contractor's efforts to adapt to ESC should not be at the expense of business profitability and productivity.

Otherwise, adaptation to ESC cannot be continuous. To be able to balance these performances, the contractor should be able to improve upon organisational capacity through certain managerial practices. These practices have been identified as CODE in the study and are outlined in Box 4.1 in chapter four. These managerial practices, which are required to balance environmental performance and business performance of a contractor, occurred under two broad categories: project resource management; and organisational planning and policies. In developing the framework, these managerial practices have been considered.

5.2.3.4 Increasing efficiency rate and long term profitability as CODE of ESC In the discourse on EMT, York and Rosa (2003) argue that the EMT fails to address the issue of how to increase the rate of efficiency. This challenge has been addressed in this research. Achieving efficiency and increasing the rate of efficiency in a contractor's organisation would be essential to successful adaption to ESC. This is also expected to result in maximizing long term profit. Systematic steps required to increase the rate of efficiency and maximize long term profit have been incorporated into the framework.

5.2.3.5 Specific roles of contractors and other stakeholders

To achieve effective adaptation to ESC, specific roles of contractors and other relevant stakeholders have been incorporated into the framework. These roles relate to:

- Organisational and individual motivation
- Access to and utilization of sustainable construction technologies
- Benchmarking best ESC practices
- Improvement of economic conditions in developing countries;
- Changing undesirable socio-cultural attitudes and behaviour;
- Making good use of abundant ecological resources and favourable climatic conditions;
- Institutionalization of relevant governmental financial support; and
- Establishment and enforcement of governmental regulatory framework.

It was found that two main roles expected from the government (a major client in the construction industry); financial driver and legislative enabler, have not been created. Interviewees were of the view that these governmental roles are very crucial to adaptation to ESC. These governmental roles are in the category of NCODE and they stand out as significant components of the framework. Most of the interviewees asserted that without these governmental roles, adaptation to ESC within the context of the developing country, where most of the contractors are resource-constrained, will be difficult.

5.3 Finality of framework development

In finalizing the framework, the foundation of the framework have been conceptualized to provide clarity. Further, the framework components need to be systematically integrated in order to provide the needed understanding and ensure ease of applicability by contractors. These would contribute to achievement of the required objective of reliability of the framework, as a product of this qualitative research.

5.3.1 Conceptualization of overall framework

The framework has a purpose of aiding a construction contractor to assess its capability to adapt to ESC. The purpose is to provide action plans to support contractors' efforts at improving capacity to adapt to ESC. Aspects of the framework have been developed and integrated based on the thematic areas in the research. Also, the guidelines and strategies proposed for contractors to assess capacity and further develop capability for effective adaptation, are premised on the theories employed as well as the research findings.

A relationship of themes and theories of the framework is presented in Figure 5.6. This shows a conceptualization of the theoretical background and thematic areas underpinning the development of the framework.

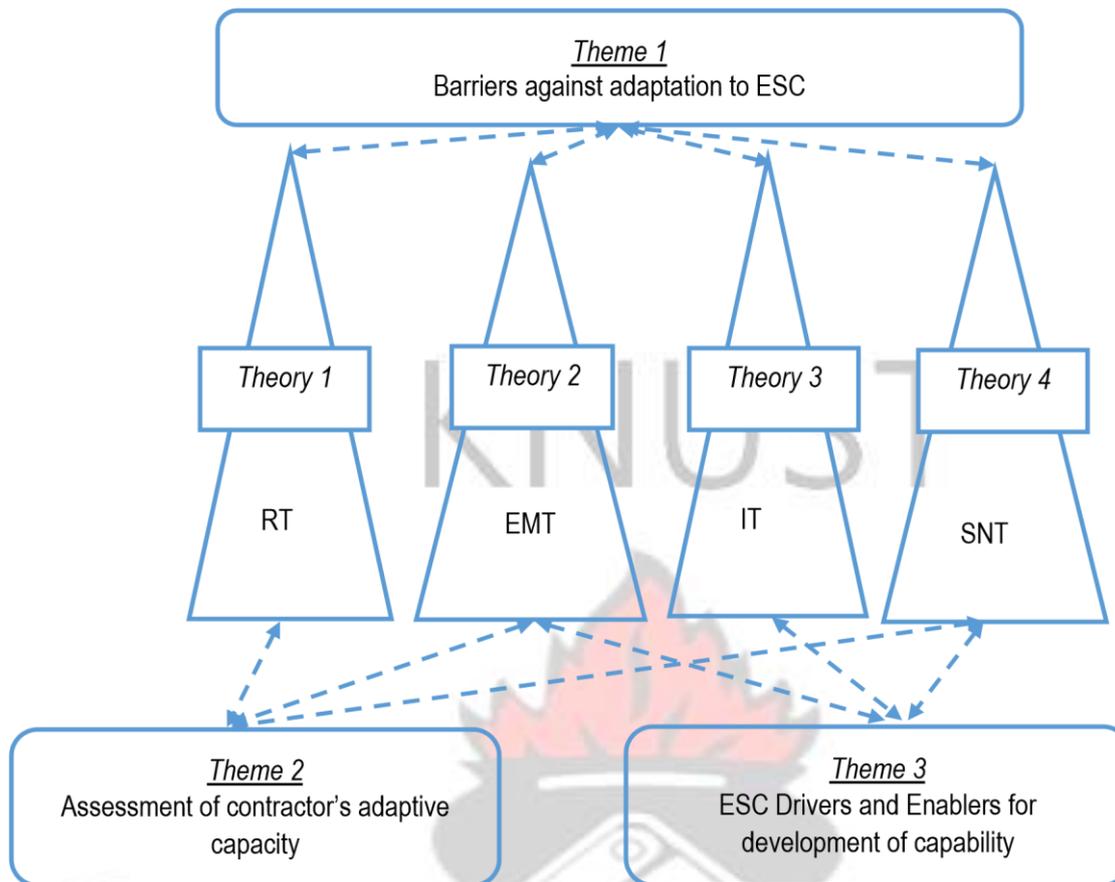


Figure 5.6 Relationship between themes and theories underpinning framework development

5.3.2 Establishing CODE and NCODE

With regards to CODE, it was found that the practices required to be undertaken to drive ESC within contractors' organisations fall into the categories of: technical/technological; attitudinal and cultural; and regulatory. Categories of practices required to be carried out as NCODE also included technical, regulatory/legal and financial. The major stakeholders responsible for creating NCODE were identified as: construction industry consultants; construction industry clients; manufacturers of construction industry materials and plant items; academic and research institutions. Most of the construction organisations were ignorant about the existence of a national

Green Building Council, an important stakeholder as far as the effort to adapt to ESC is concerned. Thus, the framework incorporates the role of the Council and other relevant regulatory bodies in creation of NCODE.

The Resilience Theory (RT) specifically indicates that, for adaptation to occur, there must be a change that is in tune with changing environment but without loss of functionality, identity and structure of the system undergoing adaptation (Folke *et al.*, 2010; Walker *et al.*, 2004). On this basis, specific change actions to be taken by contractors to drive adaptation to ESC have been identified in this research. The sole efforts of construction contractor(s) to create drivers and enablers of ESC is practically difficult and could affect the productivity and profit of the contractor as a business organisation. Thus, establishment of created CODE and NCODE is crucial to successful adaption. This integration has been considered in the development of the framework.

On the basis of SNT, establishment of intra and inter-organisational relationships as social networks to influence understanding and promotion of ESC, are also considered as CODE of ESC. The social network supports relationship between contractors and other stakeholder and also facilitates the establishment of CODE and NCODE proposed in the framework as a strategy for developing capability.

5.3.3 The Contractor's ESC Adaptation Framework (CESCAF) before validation

The framework has been conceptualized. The theories, themes and research findings underpinning the development of the framework have also been elucidated. Explanations on how the components of the CESCAF are integrated are given in succeeding sections. Figure 5.7 shows the abridged version of the entire framework prior to validation.

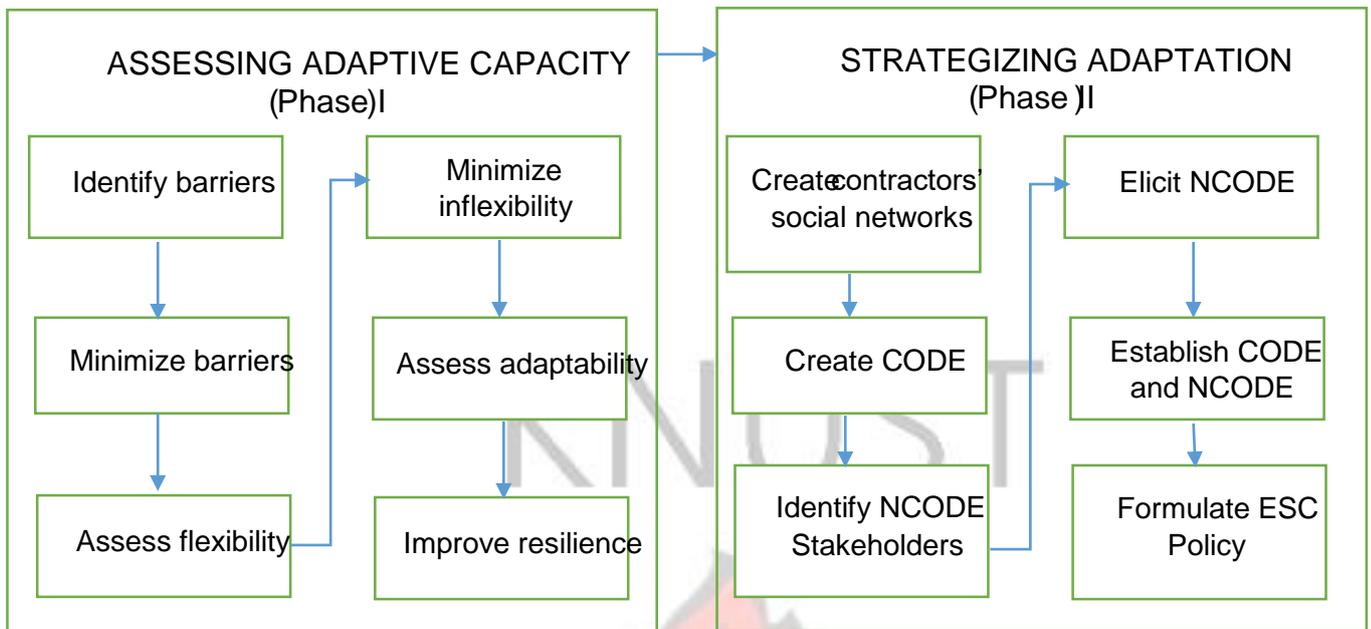


Figure 5.7 CESCAF prior to validation

This proposed framework comprises of two phases. Phase I comprises the guidelines and strategies for assessing organisational adaptive capacity. Phase II proposes the strategies to be employed in developing capability for ESC. It is worthy to note that, upon validation of the framework, findings emerging have facilitated fine tuning the framework. This is shown in Figure 5.8. The subsequent section reports on the validation process and findings and the explanations on how to effectively implement the framework to incorporate the findings from the validation.

5.4 Validation of framework

This section explains the purpose and objectives of the validation. The process for carrying out the validation has also been described. The findings from the validation have been presented as the basis for implementing the guidelines and strategies provided in the framework. The limitations and the implications have also been indicated.

5.4.1 Purpose of validation

The purpose of the validation was to assess the possibility of the framework achieving its intended objective. Bell (2010) explains that validity of a method or product depends on its ability to achieve its intended purpose. The validation was used as process to find out whether the findings and the impressions formed by the researcher are consistent with impressions of the respondents (Bryman, 2004). Specifically, this validation facilitated ascertainment of framework's ability to guide contractors to develop capability to adapt to ESC processes.

It is worthy to also note that the type of research employed to develop the framework in this research is wholly qualitative. The product of qualitative research proves itself to be valid and reliable based on its transferability and applicability but not generalization as the purpose is in quantitative research (Golafshani, 2003). Transferability is a way of determining whether the results obtained can be replicated in a context similar to that in which the study was carried out (Golafshani, 2003; Winter, 2000). Therefore, the validation provided a medium for ensuring that the framework meets the qualities of transferability and applicability.

5.4.2 Validation objectives

The validation had the following objectives:

- To discuss how the research product (framework) would meet its purpose;
- To ascertain how the research findings capture and reflect interviewees' responses; and
- To obtain information on how the framework can effectively be implemented in practice.

Pursuance of these validation objectives facilitated confirmation of whether the research questions outlined in section 1.6 of Chapter one, have been answered.

5.4.3 Validation Process

Details and justification of the approach adopted for validating the framework are given in Chapter 3 of this thesis, which discusses the research methodology. Focus Group discussion was the tool used for collecting data during the validation. The participants were, purposively selected. In all, 10 participants were involved in the FGD. These were BE professionals and researchers. They had some amount of time to assess:

- The completeness of the framework in enabling contractors develop capability to adapt to ESC processes;
- The suitability of the framework and the ease with which it can implemented; and
- The disposition of contractors to implement the guidelines and strategies in the framework.

After incorporation of the comments from the FGD to authenticate the findings and improve the framework, participants were accordingly informed of the changes through e mails. Responses from the participants indicated that the comments and suggestions that emerged from the FGD had been incorporated to fine tune the framework.

5.4.4 Discussion of findings from the validation

The data from the FGD comprised two forms: an audio recording of discussions among participants; and written answers summarizing main points coming out the discussions. It is worthy to note that, in view of research ethics, the audio recording was taken based on the prior consent of participants. The FGD addressed issues/themes relating to the research objectives outlined in section 1.8 of Chapter one of this thesis.

5.4.4.1 Participants' assessment of reliability of research findings

Participants assessed the reliability of the research findings presented to them by confirming whether the findings were congruent with their impressions and with practices in the construction industry. Tables 5.1 and 5.2 show a summary of the discussion of the reliability of the research findings presented. The relationship between the findings and research objectives are also indicated.



Table 5.1 Analysis of FGD comments on research findings on objectives 1, 2 & 3

	Objectives	Summary of findings presented to participants	FGD emerging issues	Remarks on issues
1	To find out contractors' understanding and application of environmentally sustainable construction processes	<ul style="list-style-type: none"> ▪ Little understanding knowledge and skills, among contractors, in environmentally sustainable construction (ESC) practices ▪ There is a disconnection between the little knowledge in ESC and application in construction processes ▪ The few ESC processes happen in ad hoc manner. 	<p>“That this refers to construction practices that conserve environmental resources ensuring that materials are not depleted and environment not affected negatively. Also present generation meets their needs and future generations too would be able to meet their needs”.</p>	An understanding was demonstrated by a participant. This showed relation to sustainable development principles. No other additional description of ESC was given.
2	To explain the reasons contractors ascribe to lack of capability to adapt to ESC processes within a given context	<ul style="list-style-type: none"> ▪ Socio-cultural and socioeconomic barriers ▪ Knowledge and Skills gaps ▪ Technological and Technical gaps 	<ul style="list-style-type: none"> ▪ Lack of legislation ▪ Lack of enforcement of some environmentally related regulations ▪ Clients position that do not support ESC processes ▪ Low bid situation in tendering, which does not consider ESC requirements ▪ Failure of some contractors to join existing contractors' associations, which also lack legal backing 	These represent additional barriers described by participants for inclusion in findings
3	To describe the enablers and drivers of adaptation to ESC processes from the perspectives of contractors	<ul style="list-style-type: none"> – Organisation investing in sustainable technologies – Investing in education and training of human resources – Formation of organisational and inter-organisational policies on conservation of environmental resources ○ Tax and import duties waivers or concessions for contractors 	<ul style="list-style-type: none"> ▪ Sustainable designs from consultants and clients ▪ Including sustainability requirements in tender selection criteria ▪ Enforcement of legislation 	These ESC drivers were discussed for inclusion in findings and for consideration in fine tuning of the framework

	<ul style="list-style-type: none"> ○ Making building and civil designs supportive of sustainable construction requirements ○ Researching and manufacturing of green building materials 		
		<ul style="list-style-type: none"> ▪ Improving knowledge of clients in ESC processes ▪ Awareness creation 	These ESC barriers were discussed for inclusion to findings on drivers and for consideration in fine tuning of the framework

LEGEND FOR TABLE 5.1

–	Contractor Organization Drivers and Enablers (CODE)
○	Non Contractor Organization Drivers and Enablers (NCODE)

Table 5.2 Analysis of FGD comments on research findings on objectives 4 & 5

	Objectives	Summary of findings presented to participants	FGD emerging issues	Remarks on issues
4	To develop guidelines to assist contractors assess organisational adaptive capacity for ESC processes	<ul style="list-style-type: none"> ▪ Identify and minimize barriers ▪ Assess flexibility and minimize inflexibility ▪ Assess adaptability and improve resilience 	<ul style="list-style-type: none"> ▪ Additional barriers emerging from discussions to be included in framework Planning, motivation and constant practice also ▪ foster flexibility to adapt Short term benefit ▪ motivates organisation to be flexible ▪ Formulation of ESC policy Sharing of information on ESC at toolbox meetings 	Issues are to be considered as additional guidelines to be included in the framework to guide contractors to assess adaptive capacity.

5	To propose strategies for contractors to develop capability to adapt to ESC processes based on the enablers and drivers	<ul style="list-style-type: none"> ▪ Create contractors' social networks to facilitate creation of CODE ▪ Identify and collaborate with other stakeholders to elicit NCODE ▪ Establish CODE and NCODE ▪ Formulate organisational ESC policy 	<ul style="list-style-type: none"> ▪ If there is a legal backing, then contractors association can be used to ensure SN. ▪ Collaboration would ensure a level playing field for all. ▪ Drivers and enablers can be created through seminars and group/forum discussions to share knowledge among contractors ▪ Network of contractors is to be first ensured ▪ Consider the following: <ul style="list-style-type: none"> ▪ Incentive; requirement in tender documentation; Improving the knowledge of the client ▪ Financial bodies to be considered as stakeholders: Financial Institutions (both public and private) and Insurance companies ▪ Legislation, Education and sustainable design ▪ Regulatory bodies to be considered: Environmental Protection Agency; Minerals Commission; Standards Authority; Local Government Authority; and Town and Country Planning Unit. 	Comments are to be considered in proposing of strategies contractors would adopt to enable and drive adaptation to ESC
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The usual criteria for selecting contractors in tendering is low bid price. This was seen as a strong barrier since the situation offers no level playing field for contractors to incorporate sustainability issues in tenders. It is established from the discussions, that, inclusion of sustainability criteria in selection of tenderers would be a major driver of ESC. An amended public procurement law in the Ghana, indicates that sustainability criteria need to be considered in the selection of contractors and suppliers (News Ghana, 2016). The Public Procurement Law in the country had been in operation for twelve years but had not considered conformance of contractors to sustainability issues in construction contracts. With the 2015 amendment, public procurement law in the

country can be regarded as a driver of ESC at the tendering stage. Structures need to be put in place to ensure conformance also, during contract management stage.

Consequently, contractor's lack of capability to ensure ESC process in construction projects, would make conformance to some of these laws practically difficult. Overcoming or minimizing such difficulties is what this research addresses.

There are existing contractors' associations in the country of study, and participants were of the view that this should be made clear in the research. The activities of such associations include the organisation of periodic workshops on topical issues in the construction industry. However, participants confirmed that most contractors in the country do not patronize the activities of such associations. It was confirmed that the fear of becoming less competitive through sharing of ideas with other colleague contractors at association meetings, contribute to the situation of low patronization. The absence of legal backing for the association in order to be nationally recognized and authorised, do not also auger well for effective patronization of the activities of the contractors association. These were regarded as challenges that would make contractors' networking practically difficult.

However, participants admitted that, the challenges faced in the operation of contractors' associations can be minimized through securing of legal backing for operations of the contractors' association(s). Subsequently, patronization would be boosted engendering effective networking among contractors. The existence and running of such networks would then enhance contractors' efforts to create the CODE.

Contractors are implementers of construction plans and designs. However, participants confirmed that the construction designs handed to them do not normally support ESC principles and this poses barrier to ESC. Therefore, working with construction designs that support ESC processes would be a significant driver. Participants agreed that, the

position and perception of most construction project clients do not support ESC therefore improving the knowledge of clients in ESC would be an enabler. Moreover, awareness creation was also confirmed as an important enabler of ESC. It also emerged that existing regulatory bodies overseeing operation of environmentally-related laws, have roles to play as stakeholders, in creating the awareness enabler.

Throughout the discussions and the written comments, lack of sustainability-related regulations and lack of enforcement of existing environmentally-related regulations in the country of study, emerged as tough barriers militating against adaptation to ESC. Participants were of the view that establishment of relevant sustainability regulations, nationally, and the enforcement of such regulations, would be significant driver of adaptation to ESC processes within the construction industry. To augment discussions on this important issue of the FGD, the relationship between existing environmentally-related laws and sustainability practice of contractors have been examined and presented in Table 5.3. From Table 5.2, it can be observed that certain regulatory bodies who are non-contractor stakeholders, have been strongly suggested for specific indication in the framework. The roles of these regulatory bodies in relation to physical development projects, are outlined in Table 5.3.

Table 5.3 Examination of environmentally-related regulations in Ghana

Regulatory body	Relevant Role(s) in relation to physical developmental project activities	Clarity in regulating construction contractors' activities?	Clear guidelines on ensuring environmental sustainability?	Source (Law)

Environmental Protection Agency (EPA)	<ul style="list-style-type: none"> -Regulate technical and practical aspects of the environment -Coordinate and control the generation, treatment, storage, transportation and disposal of industrial waste -Collaborate with other governmental agencies, authorities and institutions to ensure quality of the environment -Issue of environmental permits to control substances dangerous to the quality of the environment -Prescribe guidelines in relation to pollution of environmental resources such as land, air and water bodies -Ensure compliance with laid down Environmental Impact Assessment procedures relating to developmental projects -Promote studies, research, surveys and analyses to ensure improvement and protection of the environment and ensure maintenance of sound ecological system -Build environmental database to inform the public about the environmental protection 	NO	NO (However, Act dwells more on protecting the environment from hazardous activities)	EPA Act, 1994 Act 490
Ghana Standard Authority (GSA)	-To provide for promulgation of standards, for ensuring high quality of goods and for related matters in industry and commerce promoting efficiency, industrial welfare, health and safety	NO	NO	Standards Authority Act, 1973 NRCD 175
Ghana Minerals Commission	<ul style="list-style-type: none"> -Regulate activities of organisations with mineral rights -Ensure organisations/persons holding mineral rights obtain approvals from Forestry Commission and EPA in order to ensure environmental protection 	NO	NO	Minerals and Mining Act, 1996 Act 703

Table 5.3 (continued)

Regulatory body	Relevant Role(s) in relation to physical developmental project activities	Clarity in regulating construction contractors' activities?	Clear guidelines on ensuring environmental sustainability?	Source (Law)
Forestry Commission	-Regulate the utilization of forest and timber resources -Manage the nation's forest reserves and protected areas -Assist the private sector and the other bodies with the implementation of forest and wildlife policies -Undertake the development of forest plantations for the restoration of degraded forests areas, the expansion of the country's forest cover and the increase in the production of industrial timber	NO	Promotes some elements of sustainability but does not make specific mention of sustainability	Forestry Commission Act, 1999 Act 571
Forestry Commission	To provide for the grant of timber rights in a manner that secures the sustainable management and utilisation of the timber resources of Ghana and to provide for related purposes	NO	NO (But in relation to ONLY timber resources)	Timber Resources Management Act, 1998 Act 547
Town and Country Planning Department	To ensure the orderly and progressive development of land, towns and other areas, to preserve and improve their amenities and for related matters	YES	NO	Town and Country Planning Act, 1945 Cap. 84
Local Government Authorities	Establishes District/Municipal/Metropolitan Planning Authority responsible for: -approving and permitting physical development (including construction activities) -Enforcement against unauthorized development -Managing human settlement and the environment and preventing activities that cause nuisance to the environment	YES	NO (Only the prevention of nuisance to the environment is indicated)	Local Government Act, Act 1993, Act 462
Public Procurement Authority	Including sustainability criteria in selection of tenderers	YES	YES (recent amendment considers sustainability in tendering)	Public Procurement (Amendment) Act 2016, Act 914

From Table 5.3, most of the laws do not make clear demand for compliance to Environmental Sustainability requirements. It seems there is an assumption that the existing provisions in the various regulations automatically take care of sustainability requirements. However, close examination reveals that sustainability requirements are not clearly provided for in these environmentally-related regulations.

Most of these governmental regulatory bodies, especially the EPA, are required to ensure that the public is adequately informed of the requirements of environmental protection. However, there seems to have been a relaxed effort in this regard. Thus, awareness creation is adversely affected among the general public and other private organisations such as contractors, whose activities have impact on the environment. The roles of some of the regulatory bodies, include promoting research works related to environmental protection. The EPA and the GSA are found to have specific roles in relation to promotion of relevant research works. This function, if well performed, would be a useful enabler of the construction industry's adaptation to ESC processes.

Further examination of the laws indicate that there is lack of clear guidelines on how contractors are to ensure environmental sustainability in construction activities. Most of the laws do not specifically describe how construction contractors' activities are to be controlled to ensure compliance to environmental standards. It is not clearly provided that contractors are required to obtain licences or rights to carry out construction activities after satisfying certain environmental sustainability requirements. This has the tendency to raise challenges in the monitoring of contractors' activities and in the enforcement of any penalties in relation to breaching environmental protection requirements.

However, the past Public Procurement Act, 2003, Act 663, in the country, has been amended (News Ghana, 2016). The amendment calls for the inclusion of sustainability criteria in the selection of tenderers, contractors and suppliers (The Parliament of Republic of Ghana, 2015). Hitherto, no consideration was given by the Public Procurement Law to sustainability in procurement of construction works. Therefore, this amendment is considered as a major driver of ESC in the construction industry. Thus, the need for contractors to increase their capability in order to ensure ESC processes becomes paramount. This confirms the relevance of the framework developed in this research.

5.4.4.2 Participants' assessment of framework validity

An assessment of the applicability and ease of implementation of the framework was made by participants. Through this exercise, participants commented on how easy it is for practitioners to implement the framework as a guide for developing organisational and inter-organisational capability to adapt to ESC processes. Assessment of how clear the framework presents the guidelines and strategies was also carried out by participants. These contributed to fine tuning the framework to ensure its authenticity, applicability and transferability.

Participants found the guidelines and strategies proposed to be understandable and generally implementable. However, some practical difficulties regarding the adequacy of some aspects of the strategies in the framework were pointed out by participants. Comments on how to improve the applicability and ease of implementation of the framework were also made. These particular concerns and comments have been captured under Table 5.4 and have been incorporated in finalizing the framework.

The comments made during the discussions for assessing the validity of the framework have been accordingly incorporated for fine tuning the framework. Discussions

concerning the clarity, adequacy, applicability and ease of understanding and implementing the framework unearthed the issue of difficulty in achieving the networking strategy proposed. Besides inadequacy of non-contracting stakeholders emerged as shortfall of the framework. The relevant non-contracting stakeholders that needed to be considered in the framework were given during the FGD. These have been indicated in Table 5.2

Table 5.4 Issues relating to framework applicability and ease of implementation

Areas of Assessment	Comments on framework clarity and adequacy
Guidelines on identifying barriers	OK.
Guidelines on assessing organisation's flexibility to adapt to ESC	OK.
Utilizing intra-organisational relationship to promote ESC within organisation	OK.
Utilizing inter-organisational relationship in a social network (SN) to promote ESC	Clear but practically difficult
Strategy for creating enablers and drivers within the organisation and among organisations	OK.
Strategy for eliciting drivers and enablers of ESC from other stakeholders	OK (But consider the roles of additional stakeholders)
Applicability of Framework	<ul style="list-style-type: none"> ▪ It is practical but require legislation and strict implementation. ▪ Framework is good. Legislation backing is needed for all stakeholders so that framework can work perfectly. ▪ It is a workable framework. ▪ It is fairly applicable. Legislative backing needs to be given to ensure that it is universally applied. ▪ Framework is applicable to ongoing construction project that has not incorporated ESC.
Ease with which framework can be followed and implemented	<ul style="list-style-type: none"> ▪ Merge the phases in order to ensure ease of flow and interpretation. ▪ Framework has to show what happens beyond improving capability; consider making it cyclical ▪ Easily understandable and flow is OK. But create a link between the two phases ▪ Framework is quite easy to follow for managerial level personnel

	<ul style="list-style-type: none"> ▪ The flow is OK. But consider the other strategic stakeholders who control the environment.
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Participants expressed strong view that establishing a network to create platform for contractors to discuss strategies for ensuring ESC processes would be practically difficult. The fear of becoming less competitive by sharing organisational “winning strategies” was considered as a factor that would make the networking undesirable. However, to force the formation of this network, participants revealed that there would be the need for relevant regulations that demand compliance to ESC processes to be put in place.

Other issues that emerged related to addressing the applicability and ease of understanding the framework. These issues, as indicated in Table 5.4, have been incorporated into the framework shown in Figure 5.8.

5.4.5 Validation limitations and implications

The approach used for the validation allowed larger concentration on BE professionals who took part in the interview (acquaintances) (Morgan, 2013). This was necessary in view of the objectives of the validation. The approach allowed minority participation of discussants that did not form part of the interviewees (referred to as strangers) (Morgan, 2013). Due to the busy schedule of BE professionals, a much longer period could not be used for the discussions. Hence, future efforts of contractors to improve upon capability to adapt to ESC would need a much longer period for extensive discussions at fora and workshops. An implication of the focus group discussion approach used for the validation process is that contractors can create a platform for

the purpose of discussing how ESC processes can be implemented collectively. Details of the limitations of the findings from the validation have been provided under the research limitations section in chapter 6 of this thesis.

5.5 Framework implementation processes

The framework, as already conceptualized, has three main themes and two basic stages. The relevant research objectives are also reflected in the framework. The interrelationship between the framework themes, stages and research objectives are indicated in table 5.5.

Table 5.5 Interrelationship between aspects of framework

Themes	Main stages	Relevant research objective
Identifying barriers; Assessing adaptability and Flexibility	Assessing adaptive capacity of contractor's organisation	Objective 2 – Explaining contextual barriers
Driving and enabling adaptation to ESC	Strategizing adaptation to ESC	Objective 3 – Finding out enablers and drivers of ESC

The various actions specified as guidelines towards assessing adaptive capacity and strategizing adaptation to ESC are guided by the underlying theories adopted. An assumption that needs to be highlighted, as far as the operation of this framework is concerned is that ecological barriers against adaptation to ESC are non-existent within the geographical context of the study area. This assumption is based on the study findings in which interviewees were of the opinion that barriers due to ecological conditions of the area where the study is being carried out do not exist to militate against efforts to adapt to ESC.

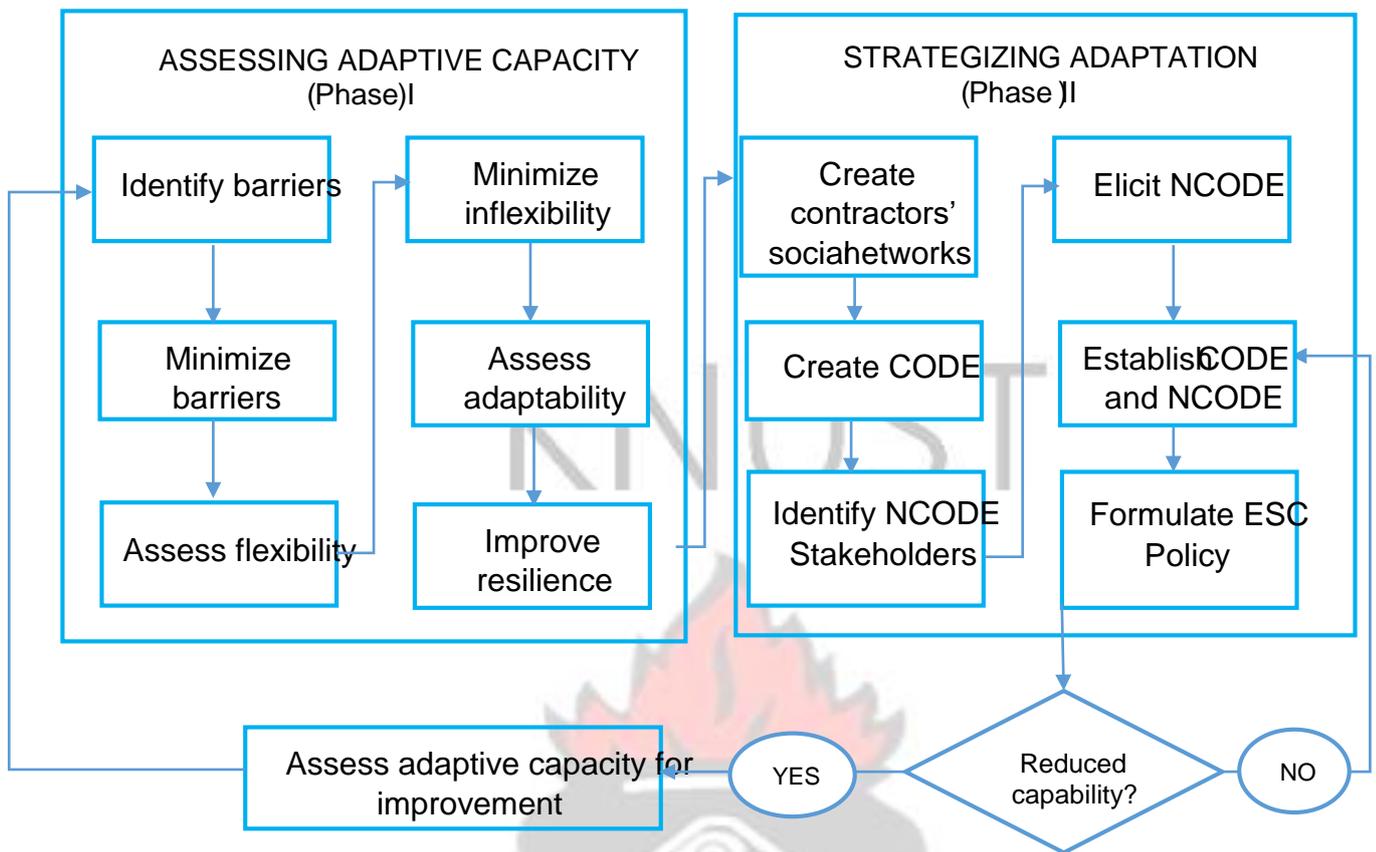


Figure 5.8 Validated framework

5.5.1 Assessing adaptive capacity of contractor’s organisation

5.5.1.1 Identifying and minimizing barriers

In development of framework, there needs to be a relation to the data available and the associated findings from analysis of the data (Crick and Koch, 2003). This stage of the framework comprises of the contractor identifying barriers that militate against organisation’s efforts to adapt to ESC. Steps have been taken to ensure that the framework possess the quality of a good framework.

In assessing organisational adaptive capacity the barriers explained from the findings need to be minimized. Therefore, guidelines for identifying the nature of barriers as well as overcoming/minimizing them have been given in the framework. Fig. 5.9 outlines the categories of barriers. This is to guide contractors on what kind of barriers to be looking out for.

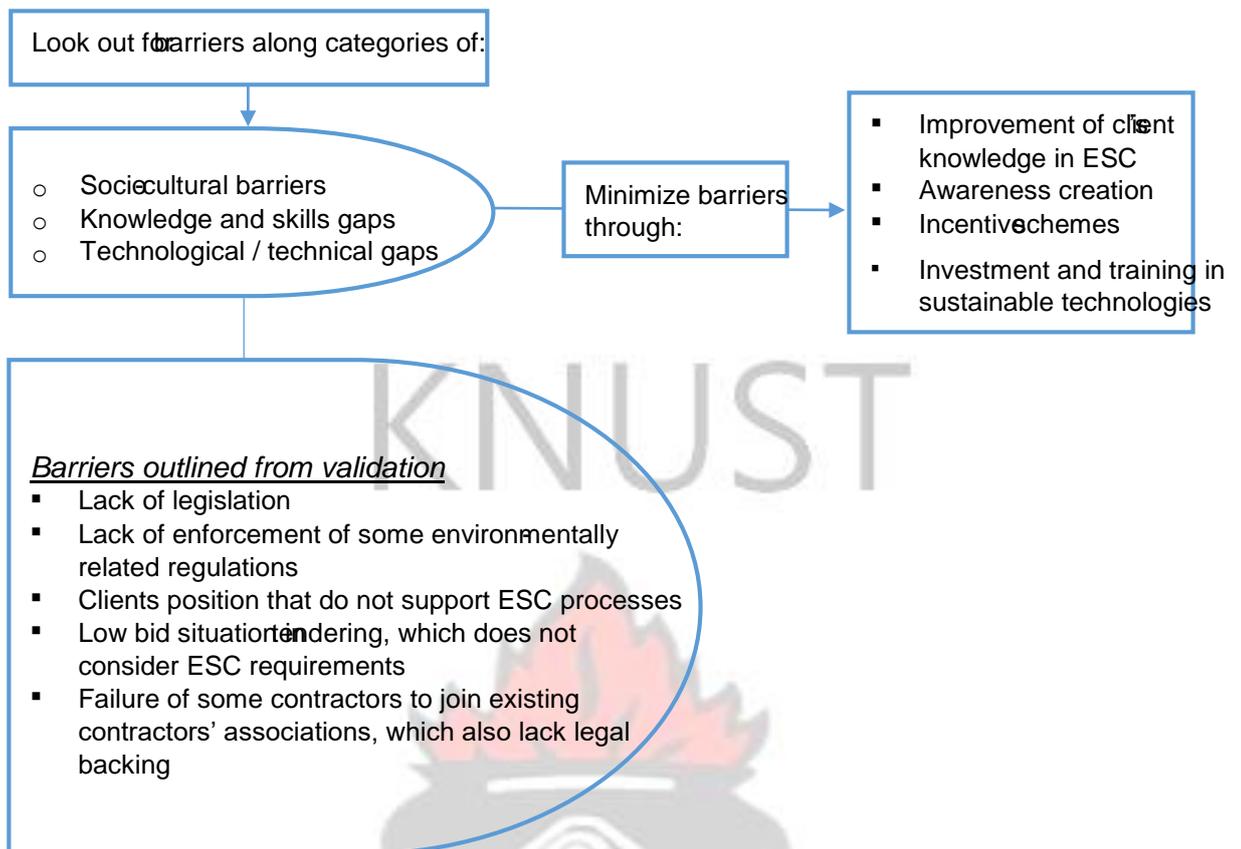


Figure 5.9 Guidelines for identifying and minimizing barriers

Steps that have to be taken by the contractor's organisation to minimize these barriers include: creating awareness about ESC within the contractor's organisation; introducing organisational incentive schemes to encourage positive attitudinal changes towards thinking sustainability; and investing in sustainable technologies. During the FGD, participants indicated that there is the need for the knowledge of clients to be also improved through awareness creation.

According to the EMT, industrialized and modernized societies are more likely to achieve sustainability in the construction industry (Lockie *et al.*, 2013; Spaargaren *et al.*, 2009; Rosa, 2003). The need to invest into modern sustainable technologies has therefore been specified at this stage of the framework to ensure that the technological gap can be closed by a contractor. It may be difficult for a contractor to carry out this step single-handedly due to the associated challenge of high initial/installation cost of sustainable technologies (Shi *et al.*, 2013; Opoku and Fortune, 2011).

5.5.1.2 Assessing organisational flexibility and adaptability

Creative flexibility of a system is essential to adaptation (Gunderson and Holling, 2002). Hence, the framework provides guidelines for a contractor to assess organisational flexibility and minimize any element of inflexibility identified. From the study it was found out that conditions that favour ESC practices, fall into two main categories; external and internal. These have been indicated in Figure 5.2. The leadership of a contractor's organisation should be able to take action on establishing the necessary power structures that will support all workers within the organisation to uphold sustainability principles. The inability to establish internal conditions to create the power structures for carrying out ESC processes portrays inflexibility. The presence of inflexibility would indicate a low adaptability level of a contractor.

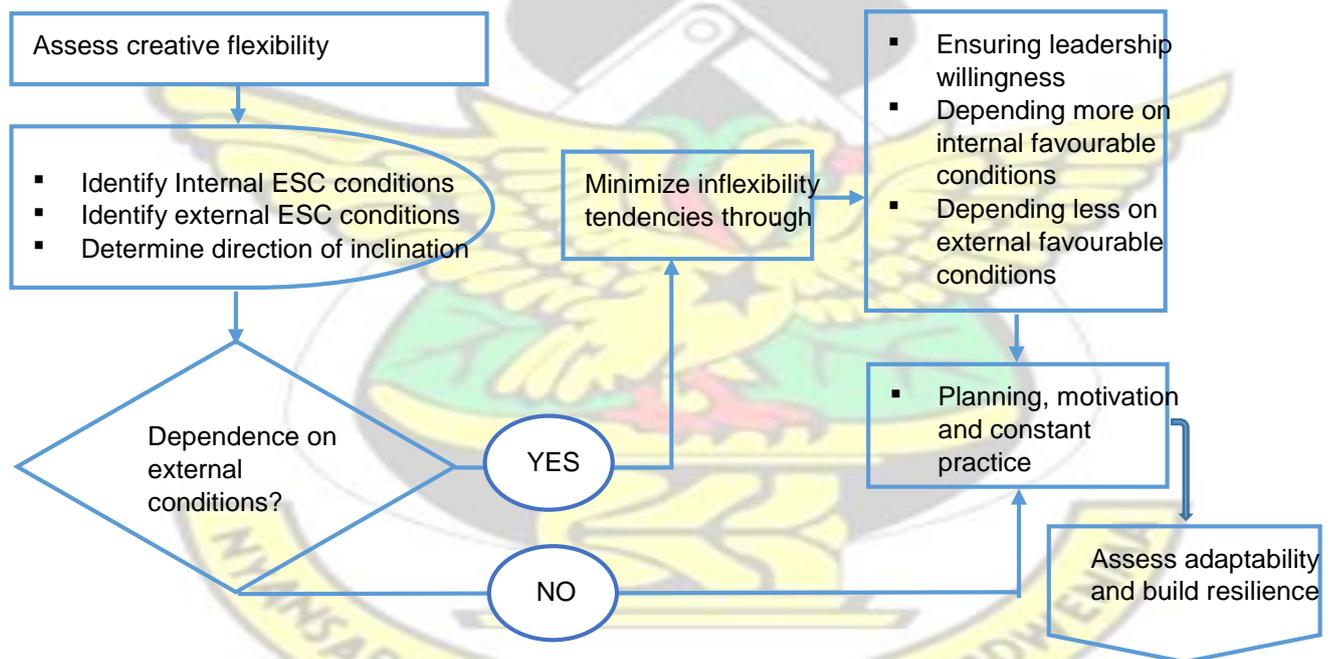


Figure 5.10 Guidelines for assessing flexibility and minimizing inflexibility

Gunderson and Holling (2002) affirm that the level of adaptability of a socialecological system is a measure of the extent to which its adaptive capacity structure are built and

how flexible it is. Figure 5.10 demonstrates measures that can be taken to minimize any inflexibility tendencies observed from the assessment.

5.5.1.3 Assessing organisational adaptability and building resilience Before development of strategies, important steps to be taken in the assessment of the contractor’s adaptive capacity are the determination of the adaptability level and development of resilience. From the adaptive capacity cycle of the RT, a socialecological system at the r-phase, where resilience is low, is resource-constrained (Pisano, 2012; Walker and Salt, 2006). The description given by BE professionals indicated low organisational operational experience and the inadequate resources. This description is a reflection of the low-resilient stage of a contractor as a social ecological system.

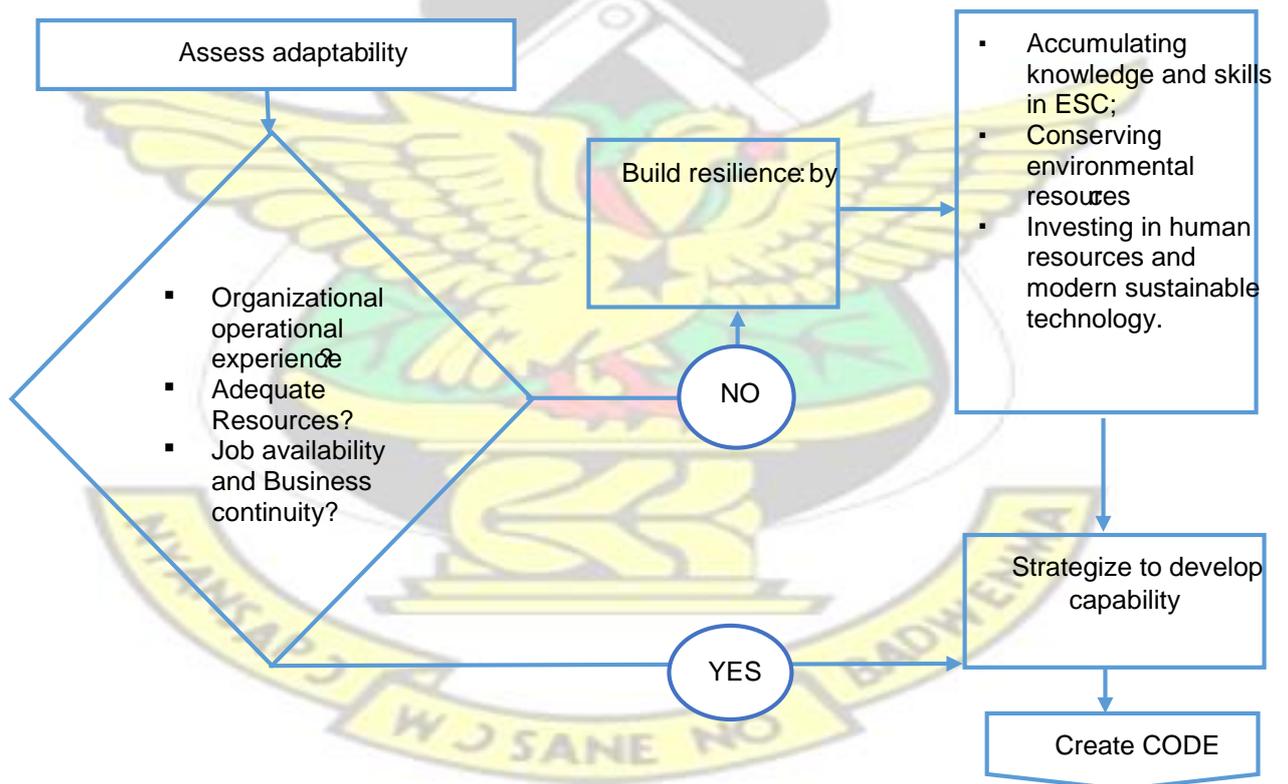


Figure 5.11 Guidelines for assessing organizational adaptability and building resilience

Therefore, to attain high level of adaptability where resilience is high, appropriate schemes should be devised and implemented by a contractor. This is where the K negative feedback strategy specified by Gunderson and Holling, (2002), which

prescribes resources conservation as a means of getting to the K-phase of the adaptive cycle, becomes important. Figure 5.11 details these adaptability assessment and resilience development guidelines.

5.5.2 How framework operates: Strategizing to achieve capability for adaptation to ESC

The second phase of the framework focuses on proposing guidelines for contractors to strategize development of capability for adapting to ESC. At this stage of the framework, the focus is on guiding contractors to create CODE of ESC, elicit NCODE of ESC and integrate CODE and NCODE to enhance both organisational and interorganisational capability for adapting to ESC.

5.5.2.1 Creating CODE of ESC

In view of the high initial cost of implementing ESC processes and the difficulty of a contractor single-handedly establishing ESC processes within a construction organisation, the formation of social networks is primary to the development of capability to adapt to ESC. In the discourse on SNT, Connelly *et al.* (2010) draw attention to the importance of both intra and inter-organisational relationships in promoting sustainability in the construction industry. Thus, the contractor should be able to establish and sustain cordial relationship among workers within the organisation. Similarly, attention should also be given to a mutually beneficial relationship with other contractors. To achieve a purposeful and effective relationship in these efforts, it is important to manage relationship density and centrality also, as explained by Sarkis *et al.* (2010) and Rowley (1997). Figure 5.12 outlines the strategies for contractors to create CODE.

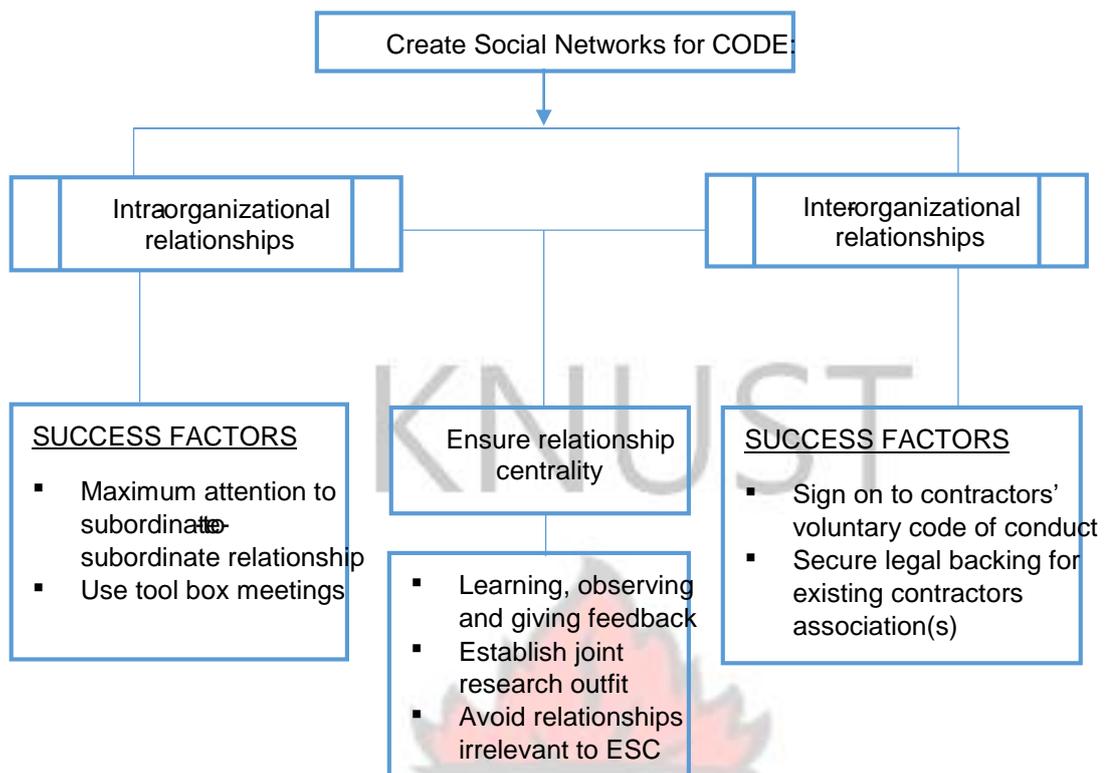


Figure 5.12 Strategies for creating CODE

In forming intra-organisational relationships, attention is to be given to the subordinate-to-subordinate relationship. This relationship kind was described by respondents as providing a more effective social network for understanding and promoting sustainability within a contractor's organisation. Notwithstanding, the superior-to-subordinate cannot be completely discarded. This relationship kind was found to be useful for initiating information flow within the organisation to trigger subsequent ESC discussions at subordinate-to-subordinate level.

The use of Personal Safety Information (PSI) and Project Hazard Analysis (PHA) toolbox meetings were found to be existing means through which promotion of ESC within a subordinate-to-subordinate relationship can be triggered. As these toolbox meetings become part of a contractor's organisational Environmental Management Plan (EMP), ESC becomes driven within the organisation. Wilson and Koehn (2000) in their study into problems encountered in safety management, recommended toolbox

meetings between foremen of general contractors as a way of finding solutions to safety problems on sites.

It is important to note that environmental sustainability in the construction industry goes beyond safety and hazards issues only. It is therefore proposed that such toolbox meetings could be held under the umbrella of Project Environmental Sustainability Information (PESI) “toolbox” meeting. This proposed “toolbox” meeting is expected to deliver information about the environmental sustainability requirements of a given construction project, which must be noted and adhered to by all workers.

The ‘research outfit for network of contractors’ concept, explained in chapter four, has the tendency to minimize high establishment cost that would be associated with a single contractor’s efforts. With this proposal for a research outfit, the framework possesses the quality of providing strategies to minimize the high initial costs usually associated with installing sustainability practices within a construction industry. With this strategy, ESC would be effectively enabled.

5.5.2.2 Eliciting NCODE of ESC

Contractors’ capability for adapting to ESC is not dependent on only CODE. Without NCODE, strategizing and improving upon capability for adapting to ESC may turn out to be an abortive mission for the contractor. Before stimulating the NCODE to work in favour of contractor’s adaptation to ESC, the social network of contractors would serve as a collective platform for identifying the various non-contracting organisation stakeholders in the construction industry. The initiation and sustenance of collaboration with these stakeholders is necessary for facilitating creation of the NCODE of ESC.

Such a collaboration establishes a relationship between contractors and the relevant stakeholders. To achieve effectiveness of such a relationship, the density and centrality principles of the SNT, as indicated by Sarkis *et al.* (2010), need to be considered. The essence of providing strategies for eliciting NCODE, as illustrated in Figure 5.13, is to suppress certain conditions and behaviours that have the tendency to frustrate the collective efforts of contractors in identifying and collaborating with the relevant stakeholders.



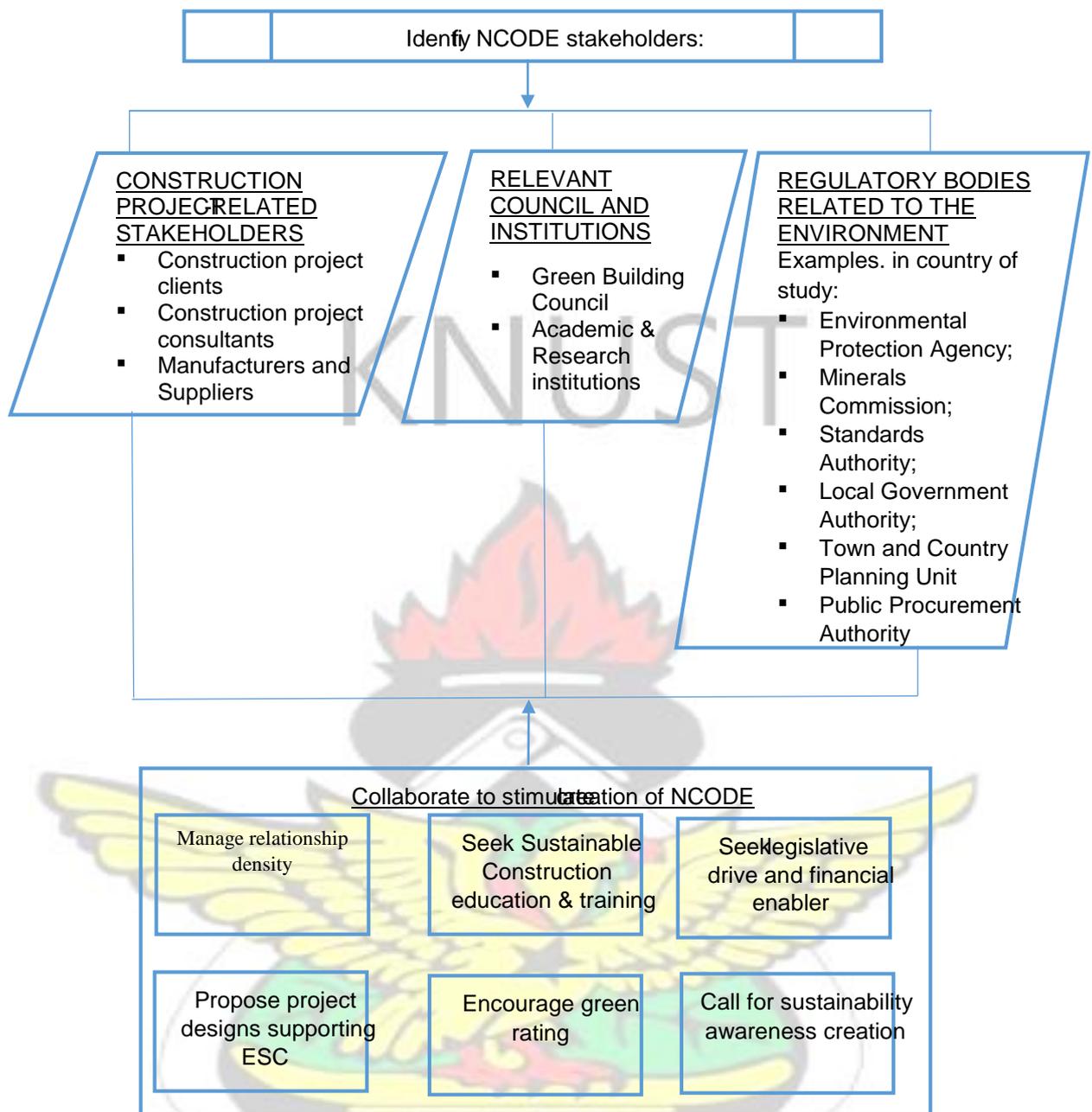


Figure 5.13 Strategies for stimulating NCODE creation

The important stakeholders to note, as identified from this study, have been outlined in Figure 5.13. Additional stakeholders pointed out for inclusion when validating the framework, as shown in Table 5.2, have been incorporated. The relevant roles of these stakeholders, which are outlined in Table 5.3, need to be identified by contractors in order to direct the collaboration effectively. For instance, the Green Building Council is found to play ‘green rating’ role, which drives competitiveness with respect to sustainability, in the construction industry (Kibert, 2012; GHGBC, 2011). Therefore,

contractors need to be consciously be aware of the Green Building Council and its roles. This would contribute to a successful working out of the strategies. The ability of these stakeholders to drive and enable ESC among contractors is informed by the function of the coercive and normative isomorphic drivers of the Institutional Theory (IT) (Kraft and Furlong, 2007).

5.5.2.3 Establishing CODE and NCODE of ESC

To solidify the strategies outlined for development of contractors' capability for adapting to ESC, the framework points to the aspect of establishing CODE and NCODE of ESC. This aspect of the framework can be achieved through certain steps given in the framework. One of the steps relate to the initiative of a contractor to accumulate ESC knowledge and skills at the organisational or inter-organisational level. The need to accumulate ESC knowledge and skills is important to building resilience as a fund of energy for adaptation to occur (VanBreda, 2001). Through teaming up with stakeholders such as: national or international Green Building Council(s); consultants; and research and academic institutions, a network of contractors would be able to accumulate ESC knowledge and skills.

Also, it is worthy to note that, accumulating the necessary knowledge and skills enhances the ability to increase the rate of efficiency in organisational operations towards achieving long term benefits of ESC. York and Rosa (2003) argued that EMT does not address the challenge of how to increase efficiency rate in pursuing sustainability. In spite of this argument, the authors addressed the challenge at the macro level of pursuing sustainability. York *et al.* (2010) also argued that this needs to be addressed at the micro level. In this study, this challenge of increasing the rate of efficiency at the micro level of contractor's organisation is addressed by undertaking specific internal and external measures as outlined in Figure 4.8 of chapter four. This is also taken into account in providing capacity-improving strategies in the framework.

The RT puts emphasis on a system possessing the needed resilience to prevent or minimize loss of functionality when adapting to changes (Walker and Salt, 2006). Also, from the discourse on EMT, an organisation is expected to balance business performance and environmental performance in order to achieve sustainability effectively (Zhu *et al.*, 2011). Subsequently, managerial capacity needs to be improved to facilitate balancing environmental performance and business performance of the contractor's organisation. This aspect is also considered in the framework

The commitment of organisation's leadership as well as the entire workers is essential to adapting to ESC. Therefore, the guidelines/action plans provided in the framework must essentially be integrated into an ESC organisational policy. With such organisational policy in place, a contractor would be committed to enhancing capability to adapt to ESC. This extends to network of contractors. From the validation, it was realized that, periodic assessment of capability of a contractor would be necessary to ensure continuity in implementing ESC processes. Thus, with any indication of reduced capability, a contractor should assess its adaptive capacity to be able to realize areas where improvement would be needed in order to restore capability to implement ESC processes.

5.6 Merit of Framework

It is worthy to acknowledge that, other frameworks have been developed by other researchers for promotion of sustainable construction in developing countries and emerging markets. For instance, the framework developed in the Agenda 21 for Sustainable Construction in Developing Countries focuses on research and development (R & D) agenda. This agenda indicates the need for technology enablers, institutional enablers and value-system enablers to foster sustainable construction in developing countries (DuPlessis, 2007 and 2002).

Also, in a strategic framework for sustainable development in developing countries, developed on the basis of the A21_SCDC, DuPlessis (2007) indicated that there is the need for further research into how to prepare well for these adverse effects of climate change. This points to lack of clear guidelines on how stakeholders need to develop capability for adaptation. Ofori (2012) and Kayguzus *et al.* (2011) have asserted that, capability of stakeholders to mitigate and adapt to required changes in construction practices, in view of the demands of sustainable development, is clearly lacking.

Furthermore, Price and Ochieng (2007) also developed a framework for managing sustainable construction in emerging economy. In that framework, the elements required for sustainable construction to be successfully managed in emerging economy were given. Although sustainable construction is not established in most developing countries, the focus of that framework was not specifically on developing countries. Also, Price and Ochieng (2007) looked at how to manage sustainable construction without giving much attention to how stakeholder(s) can develop capability to adapt to SC.

The framework developed in this research addresses the aspect of development of capability of stakeholders, which is primary to adapting to and managing sustainable construction in developing countries. The other frameworks developed do not provide, guidelines on development of capability of a stakeholder in the construction industry in developing countries. It is important to note that the effects of climate change have caught up with the ecosystem. Therefore, resilience of both the ecosystem and socialecological systems such as the construction industry, is crucial to adaptation to the physical and systemic changes. The framework developed in this research fills this gap by providing guidelines and strategies for stakeholders (contractors in this case) to develop capability to adapt to ESC processes.

CHAPTER SIX CONCLUSIONS

6.1 Introduction

This chapter contains the overall summary of the research work. The motivation for carrying out the research, knowledge gap identified and significance of the research have been highlighted. The research question, aims and objectives, key findings, contributions made to knowledge, limitations encountered and future research directions have been highlighted. Reflections on the achievements in the research are outlined in the research epilogue. It is worthy to emphasize that the key research question that has been investigated is: How can construction contractors develop capability for adapting to ESC?

6.2 Achievement of research aim and objectives

It is worthy to recap the aim and objectives of this research. The aim was to ‘develop a framework that will guide contractors to develop capability to adapt to ESC processes’. The objectives of the research are as outlined in Section 1.8 of chapter one of this thesis. The interrelationship between these objectives, aim and research methods are indicated in Table 6.1.

Table 6.1 Research objectives and methods of achievement

Research aim	Research objective	Methods and techniques for achieving objective	Related chapter in thesis

The aim of this research is to develop a framework that will enable and drive contractors to build ESC processes adaptation capability.	To find out contractors' application of ESC processes	Face-to-face semi-structured interviews of 24 BE professionals and field observations	Chapter 4
	To explain the reasons contractors ascribe to lack of capability to adapt to ESC processes within a given context	Face-to-face semi-structured interviews of 24 BE professionals working in 24 contracting organisations	Chapters 4 and 5
	To describe the enablers and drivers of adaptation to ESC processes from the perspectives of contractors	Face-to-face semi-structured interviews of 24 BE professionals working in 24 contracting organisations	Chapters 4 and 5
	To develop guidelines to assist contractors assess organisational adaptive capacity for ESC processes	Back-and-forth iteration between Theories, comparing with empirical results from interviews and FGD with BE professionals and researchers	Chapters 4 and 5
	To develop strategies for contractors to build capability to adapt to ESC processes based on the enablers and drivers	Back-and-forth iteration between theories, comparing with empirical results from interviews and FGD with BE professionals and researchers	Chapter 5

6.2.1 Finding out contractors' application of ESC processes

6.2.1.1 ESC understanding and application

BE professionals that were interviewed had some level of knowledge in ESC. Knowledge in ESC are mostly acquired through: academic programmes (usually from schooling abroad in developed countries); continuous professional development seminars and workshops; and personal research and reading. However, interviewees have acknowledged that the knowledge and skills in sustainability issues are inadequate and needs to be enhanced in order to improve upon understanding and practice of the ESC concept.

Some of the interviewees indicated understanding of environmental control mechanisms and modern technologies required for undertaking ESC. However, field observations of site construction activities showed lack of practical measures put in place to implement ESC processes. Also, interviewees could not confirm that their organisations have specific policy on ESC. This is an indication that some few ESC processes observed, such as waste minimization practices, were not backed by organisational policies. Therefore there is an ad hoc implementation of sustainable construction processes.

It is worthy to note that, construction contractors' ability to improve understanding and application of ESC processes relates to acquiring construction jobs that operate on the principles of sustainable construction. However, the lack of adaptive capacity enablers such as: economic productivity; accumulation of ESC knowledge and skills; and investment in sustainable construction technologies and training, affects implementation of ESC processes. Thus, to improve upon adaptive capacity of contractors, contractors need to build resilience through increasing capital and other organisational resources. Also, it is imperative for government to establish the relevant institutional and regulatory structures. These are in line with the postulations of RT and IT. RT advocates for conservation of resources for raising the adaptability level of a social-ecological system while IT also advocates for coercive isomorphic drivers for fostering sustainability practices in the construction industry.

Lack of willingness to be in a social network has been expressed by study participants during interviews and focus group discussions. This shows lack of understanding of the collective nature of implementing ESC processes. Moreover, this is also an indication of little understanding of the benefits associated with adapting to ESC. Therefore, subscribing to a voluntary code of conduct would be one of the means of

triggering the social networks. Another trigger for the social networks, as found from the study, relates to securing legal backing for existing contractors association(s).

Awareness of the short and long term benefits of implementing ESC processes need to be created by relevant regulatory bodies such as: Environmental Protection Agency (EPA), Ghana Standards Authority (GSA) and Public Procurement Authority (PPA).

6.2.1.2 Lack of organisational ESC policy

Based on the interviews and observations, the ESC practices that have been adopted by contractors fall into the categories of environmental damage recovery mechanisms and ESC modern technologies. These practices have been adopted on *ad hoc* basis. This finding is a confirmation of the assertion of Kibert (2007) and DuPlessis (2007). None of the organisations did show commitment to regularizing the observed ESC processes practiced on *ad hoc* basis. The absence of contractor's organisational Environmental Management Plan (EMP) is an indication of non-committal posture towards conservation of environmental resources. Other stakeholders such as Timber Felling Contractors and Environmental Protection Agencies (EPA) were named as being responsible for replanting trees and controlling construction industry's damages to the environment respectively. However, contractors need to take responsibility for protecting the environment.

6.2.2 Averting barriers leading to contractor's lack of capability for ESC

6.2.2.1 Overcoming organisational inflexibility and external pressures

The flexibility of an organisation to make creative decisions towards adapting to changes is found by Holling and Gunderson (2002) as an important quality for adapting to ESC. This kind of flexibility was not observed among the contractors. Organisations hardly have the willingness to create internal organisational efforts to adapt to ESC. On the other hand, solely depending on the efforts of other stakeholders

outside the contractor's organisation would not be useful for occurrence of resilient adaption to ESC. Thus, dependence on a hybridized form of internal and external flexibility conditions would enhance contractor's creative flexibility. With such organisational orientation, there would be the need for collective efforts of contractors and research institutions in ensuring creation of awareness of researched benefits of ESC. Furthermore, ensuring business continuity through the mutual efforts of contractors and clients (especially government, who is the largest client in most developing countries), would also be imperative for enhancing flexibility of contractors.

It was also found that, the lack of contractors' investment and training in the application of modern technology brings difficulty in successfully implementing ESC processes. The need for governmental regulatory and financial support to facilitate increased contractor's awareness and accessibility to the needed sustainable technologies is hereby emphasized. Another significant effort that is needed to encourage contractor's investment in modern sustainable technologies is the regularization of entry into and exit out of the construction industry. This is due the phenomenon of entrance into the CI of contractors lacking commitment ensuring business continuity. Such contractors are therefore not interested in making long term investments into modern sustainable construction technologies. Without this regularization of entry into and exit from the CI, indulgence in traditional unsustainable construction practices by contractors would perpetuate in the local construction industry.

It has been found that there are external pressures that create adverse business environment, which disables contractors from adapting to ESC successfully. Since the generation or elimination of these pressures is outside control of contractors, it is

advocated that the stakeholders responsible for such external pressures should first be identified by network of contractors. Subsequently, strong collaboration, between the network of contractors and such stakeholders, aimed at overcoming the pressures that militate against smooth adaptation to ESC, needs to be established and strengthened.

6.2.2.2 Guarding against socio-cultural and socio-economic barriers

From the findings, socio-cultural and socio-economic barriers against adaptation to ESC have emerged. The socio-cultural barriers depict the kind of attitude and social bringing that give less regard to prudent environmental management. It has also been found from literature that such attitude is common across most developing countries. Formulation of regulations and policies towards ensuring compliance to SD principles within the construction industry should therefore take into account the socio-cultural behaviour and attitude of the setting for which such laws or amendments are made.

This research has identified positive socio-cultural characteristics such as the tendency of people to learn new things through social relations more than by regulations, which is impersonal in its operation. Also, another cultural dimension that was confirmed from the study is the presence of greater power distance within the social setting of contractor's organisation (Hale and Fields, 2007; Hofstede, 1982). Therefore, formulation of strategies, policies and legislation for regulating ESC activities of contractors must consider such socio-cultural barriers and values. This would facilitate overcoming some of the institutional and value-system difficulties that make application of policies ineffective in a given setting.

6.2.2.3 Filling ESC Knowledge/skills and Technical/technological gaps

Low level of awareness and lack of education and training in sustainable construction in the local construction industry have been confirmed in this study. Collaborative efforts between contractors and educational/research institutions is necessary for

overcoming the ESC knowledge/skills deficiency. The local construction industry also needs to intensify efforts in networking with clients (especially government) and manufacturers and suppliers for establishment of appropriate sustainable technology within the local construction industry.

In the light of EMT postulation, as given by Rosa (2003), the local CI can be described as lacking the necessary industrialized processes and modernized construction methods required to overcome environmental challenges. This points to the need for governmental regulations and support to the local CI. The provision of financial and logistics support for contractors to execute ESC processes can facilitate prudent management of environmental resources. Furthermore, the introduction of tax waivers and import duties exemptions on sustainable construction technological tools and materials is imperative for creating conducive market environment for manufacturers and suppliers of green construction materials and plant.

6.2.3 Creating and establishing enablers and drivers of adaptation to ESC

The ESC drivers and enablers described in this study fall into two categories: CODE and NCODE. Since the creation of CODE lies within the absolute control of contractor's organisation or network of contractors, primary attention is required for this category of drivers and enablers. Contractors need to create the CODE through ensuring technical changes in construction processes that do not support ESC processes such as waste minimization, reusing, recycling and regenerating environmental resources. These changes need to happen at both the intraorganisational and inter-organisational levels. Thus, formation of social networks would play significant role in the creation of these CODE of ESC.

The NCODE are to be created by stakeholders such as construction project consultants, clients (esp. government) and other allied industry stakeholders. A strong driver of

ESC identified from the study is the presence of legal and regulatory framework. The government is identified as the stakeholder responsible for creation of the legislation driver. The legal/regulatory framework for driving ESC would involve the operation of the relevant regulatory bodies/institutions. Examples of such bodies in the country of study are the Environmental Protection Agency (EPA), the Ghana Standards Authority (GSA) and the Public Procurement Authority (PPA). Besides, financial/logistics enabler also needs to be created by the government and other private financial institutions. ESC awareness creation could trigger this kind of enabler, which also emerged strongly from the research.

6.2.4 Development of guidelines for assessing contractor's adaptive capacity

Assessment of the organisational adaptive capacity of a contractor's organisation is found to have primacy over development of strategies for actual adaptation. Assessment of adaptive capacity paves way for devising appropriate strategies for a given organisation or network of contractors' organisations to develop or improve upon adaptive capacity. The assessment guidelines developed for a contractor's organisation involve: minimizing any identified barriers to ESC; minimizing and inflexibility observed; and improving upon organisational resilience to increase adaptability level.

In looking out for barriers against adaptation to ESC, the contractor has to be guided by the categories of barriers identified in this study. Steps that need to be taken to minimize the identified barriers include: awareness creation among workers; knowledge and skills acquisition and institution of incentivized schemes. To assess flexibility and improve upon any inflexibility observed, contractor should be able to examine whether the organisation is inclined towards creating internal conditions or external conditions for adapting to ESC. To overcome any form of inflexibility

realized, the leadership of a contractor's organisation should exhibit willingness to invest into education, training and acquisition of sustainable technologies.

Assessing the organisational adaptability level involves assessing the level of resources conserved by a contractor's organisation. Ability to conserve more organisational resources, amidst business continuity and favourable economic conditions, gives an indication of high organisational adaptability level. The Resilience Alliance (RA) and the adaptive capacity concepts of the Resilience Theory (RT) offers theoretical background to these organisational flexibility and adaptability level assessment guidelines provided in the framework.

6.2.5 Developing strategies for building capability to adapt to ESC

In the development of the framework, strategies for development of contractors' capability to adapt to ESC have been provided towards achieving objective 5. The strategies include: creating ESC-CODE through social network of contractors; eliciting the ESC-NCODE through identification and collaboration with relevant stakeholders; establishing ESC-CODE and ESC-NCODE; and integrating entire guidelines and strategies into a contractor's organisation policy.

Formation of Social Network (SN) of contractors, which is found to be lacking among contractors, is a key aspect of the strategy required for attaining capability to adapt to ESC. Contractors were of the strong opinion that formation of a SN is practically difficult. To overcome the associated practical difficulties of networking, triggers of the networking have emerged from this research. Social network triggers recommended include securing legal backing from government for operating existing contractors' association(s). Network between construction contracting and noncontracting stakeholders of the construction industry and allied industries is also important. The SN should not necessarily be between contractors only.

6.2.5.1 Utilizing intra-organisational and inter-organisational relationships In creating ESC-CODE, contractors need to utilize more of subordinate-to-subordinate intra-organisational relationships for dissemination of ESC information. Toolbox meetings have been proposed as a means of relaying ESC information to workers on a particular construction project. Frequent discussions of ESC information at the subordinate-to-subordinate level need to be encouraged at toolbox meetings. The subordinate-to-subordinate level discussions would be effective in promoting ESC practices in view of the great PD confirmed among contractors in the study.

An important aspect of CODE creation by contractors, which has emerged out of the study, relates to creation of joint research outfit to serve network of contractors. It was found that this aspect of the strategy, as provided in the framework, would enhance centrality of inter-organisational relationships. Also the high cost associated with a single contractor establishing such ESC research unit makes the use of centralized research outfit for a given network of contractors a viable measure for controlling ESC information. The research outfit is necessary for coordinating the resilience-increasing functions of observing, learning and giving feedback regarding sustainability issues in the construction industry.

The main stakeholders involved in creation of ESC-NCODE have been identified in this study. These include: construction project consultants, clients (largely, government), academic and research institutions and investors in the manufacturing, recycling and supplying of sustainable/green building materials. Other important stakeholders that need to be involved in the collaboration to create NCODE are regulatory bodies as outlined in Table 5.2 in chapter five of this thesis. Before eliciting NCODE of ESC, network of contractors need to identify these stakeholders responsible for ESC-NCODE. In stimulating the creation of ESC-NCODE, contractors need to strengthen collaboration with these stakeholders.

A significant mark that will ensure the effectiveness of the strategy provided in the framework is contractors' ability to establish CODE and NCODE of ESC. This would involve the accumulation of needed knowledge and skills through investment in sustainable technologies and practices. This establishment of the drivers and enablers would also encompass improving upon efficiency rates within an organisation. The aim of a contractor increasing efficiency rate is to achieve better project performance, with regards to implementation of ESC processes (Ping et al., 2009) and long term profit (Shi *et al.*, 2013). Furthermore, the effort of a contractor to strengthen the CODE and NCODE created embodies balancing environmental and business performance always.

6.2.5.2 Regularization of guidelines and strategies

A contractor's ability to integrate the ESC adaptation guidelines and strategies into organisational policy is a manifestation of commitment to implementing ESC processes. Formulation of ESC policy is regarded as an important step to be taken by a contractor in order to avoid the tendency of practicing ESC in an *ad hoc* manner, as described by Kibert (2012) and also observed in this study. As indicated by IT, which is a policy-making theory, sustainability in the construction industry can be driven by the presence of coercive drivers in the form of governmental regulations and policies (Kraft and Furlong, 2007). The ultimate goal would be attainment of capability for adapting to ESC.

6.3 Contributions of the Research

The research contributions are categorized into two: theoretical contributions and contributions to practice. These are outlined in this section.

6.3.1 Theoretical Contributions

Sustainability concept is complex. Therefore, its adoption in the construction industry needs clearer understanding not only in practice but first in theory. To realize effective

conceptualization of the complexities surrounding sustainable construction, a multitheory approach was adopted in this study. Four theories used in sustainability studies have been employed in this research to explain the dynamics surrounding contractors' adaptation to ESC. The theoretical contributions are outlined below.

1. Resilience is an important quality required for successful adaptation to new and relevant changes such as that due to sustainable construction, which is an emerging concept in the study area. Therefore, stakeholders require clearer understanding and appreciation of the intricacies involved in adapting to such a new concept. This research has outlined means by which contractors could acquire resilience, not as an ecological system, but as a social-ecological system. The multidisciplinary nature of RT has been exploited in this research. It has been revealed that the possession of resilience by contractors relates to accumulation of ESC knowledge, skills and both technological and other organisational resources and experience useful for operation.

Also, it has been found that increasing resilience does not only depend on accumulation of knowledge but optimization of relevant skills. This is achievable through education and training of organisational human resources. Besides, learning and observing through national and international networks with advanced contractors also contribute to attaining resilience. Motivating workers through introduction of relevant incentive schemes that promote ESC practices is found to lead to optimization of skills for successful adaptation to ESC within an organisation.

2. EMT posits that the achievement of sustainability is attainable by more affluent societies. This research has created awareness about how important a focus on industrialization of the traditional construction process is to adaptation to ESC in

less developed countries. At the micro level of construction organisation, this research draws attention to the need for contractors in less affluent societies to balance environmental performance and business performance. This balance can be achieved through project-resource and planning and policy related managerial practices. Without this, the reflexivity of the construction industries in developing countries, would not be realized; prudent ecological management may not be achieved.

3. Flexibility is an essential quality for adaptation to occur. It has been found in this research that contractor's tendency to depend upon conditions external to the organisation for adaptation to occur, portrays inflexibility. Therefore, the willingness of contractor's organisation to create internal organisational structures that support ESC processes plays essential role in overcoming inflexibility tendencies. Apart from taking steps to accumulate resources, demonstrating organisational willingness to depend on internal organisational conditions for adapting to ESC, is an additional quality found in this research as being primary to possession of flexibility and increased adaptive capacity of a contractor. Besides, it has been indicated by the resilience theory that flexibility of a social-ecological system is necessary for adaptation to ESC to occur. However, in sustainable construction studies, little has been said about assessment of flexibility and the adaptability level of stakeholders such as contractors. The means by which contractors could assess flexibility and adaptability level have been provided in this research.
4. Socio-cultural characteristics have been found to pose strong barriers to adaptation to ESC. The focus of this research is on environmental aspect of sustainability in the construction industry. However, the dominance of social barriers against adaptation to ESC, as found, reveals the strength of the social-ecological link in

the discourse on adaptation to ESC. Little attention has been given to the need to contextualize barriers to implementation of sustainable construction within a given social setting. This research draws attention to the contextual nature of barriers that act against adaptation to sustainability in the construction industry.

5. The isomorphic drivers of IT are expected to promote sustainability within a given economic sector. However, it has been found in this research that, isomorphic drivers, especially normative and coercive, could also hinder efforts of stakeholders to practice and promote ESC. Contractors, as social-ecological entities, need to possess capacity to absorb perturbation while undergoing changes (Folke *et al.*, 2010; Walker *et al.*, 2004). The specific changes required to be undergone by contractors have been identified and categorized into technological/technical, attitudinal/cultural and regulatory.
6. Beyond adopting the Resilience Alliance (RA) K negative feedback strategy for increasing adaptability level, an additional kind of strategy for contractors to attain capability for adapting to ESC has been proposed in this research. This strategy involves creation and eliciting of drivers and enablers of ESC through social networks. The social network occurs in two forms: among contractors; and between contractors and non-contracting organisations who are stakeholders in the construction industry and allied industries. Such social network is necessary for providing platform for relevant stakeholders to collaborate effectively for ESC to happen. Hence, in this research, the application of the theories has been broadened by extending them to ESC in the CI.

6.3.2 Contributions to practice

1. For a contractor to obtain increased knowledge and skills in order to attain resilience, a contractor should put in place schemes to ensure investment in

education of workers within the organisation. Such a scheme can be pursued through collaboration with relevant academic and research institutions as well as networking with international contractors who are advanced in the practicing of sustainable construction. To be able to institute such a scheme, the willingness of the leadership of a contractor's organisation is important.

Greater Power Distance (PD) characterizes the leadership style of most of the contractors in this study. Therefore, tool box meetings that disseminates Project Environmental Sustainability Information (PESI) should be used to trigger subordinate-to-subordinate level discussions. This activity, proposed for implementation in practice, is underpinned by the position of SNT, which indicates the influence of intra-organisational relationship to promote sustainable construction practices.

2. This research has revealed that there is the need for contractors to regularize strong incentive scheme that awards efforts of workers who ensure waste minimization, resource usage efficiency and resource regeneration. Such scheme would ensure that the social barriers that do not support prudent environmental management are minimized. These would enhance attainment of successful adaptation to ESC.

The intransigence of most contractors in embracing changes has emerged strongly out of this research. It has been found that most contractors are inclined towards adhering to 'the winning way', which is tantamount to traditional construction practices that do not support sustainable construction principles. These

'unsustainable' construction practices are being upheld in view of the difficulty of contractors to acquire technologies that would enable sustainable construction within the local CI. To circumvent this hurdle, there is the need for an initial collaboration between network of local contractors and the project clients,

especially government, who is the major client. The purpose of such a collaboration is to improve upon the knowledge of clients in ESC processes. This would lead to creation of ESC drivers and enablers such as legal framework and technological support, which are within the control of clients. Eventually, contractors' capability to adapt to ESC would become enhanced.

Ensuring that project designs conform to ESC principles as well as including sustainability-related criteria in tendering processes is important for implementing ESC processes. Incorporating ESC sustainability principles at the planning, design and contract management stages of construction project cycle is advocated in this research. This is to ensure that sustainable construction principles are manifested in a project cradle-to-cradle.

3. To build the resilience of a contractor's organisation towards adapting to ESC, establishment of operational resources such as prefabrication workshop is important. This will facilitate minimization of wet construction processes that relatively generates more site waste. Waste minimization is a conspicuous feature of successful ESC processes.

To facilitate regeneration of natural resources, such as timber for construction works, there would be the need for contractors to form a social network to facilitate establishment of a code of conduct to provide guidelines on how replanting of trees used for construction work can be done. Reclaiming of sand weaning sites, which is an important measure for ensuring regeneration of lost natural vegetation, is an important resource regenerative activity that can be sanctioned by the code of conduct aforementioned.

4. In a study by (Wong *et al.*, 2013), the authors found that contractors do establish an assessment system within an organisation to check compliance to sustainability

standards and also report on sustainability. Subsequently, this research has revealed that a contractor should be able to assess organisational flexibility and adaptability levels. This has to be done through identification of the kind of barriers that militate against practicing of ESC and determination of type of condition that an organisation relies on for ESC to happen. An examination of contractor's conserved organisational resources and accumulated organisational operation experience would aid in assessment of adaptability level. For effective assessment to be done by a contractor, a designated ESC officer/unit should be set up within a contractor's organisation.

5. As found in this research, contractors need to consider research as an important component of organisational structure and operations. The need for establishment of joint research outfit for enhancement of relationship centrality, as found in this research, is an indication of the need for contractors to attach significance to research and information flow. The establishment of a joint research outfit for network of contractors is an important step recommended for minimizing the high-initial-cost challenge associated with the practicing of ESC (Qi *et al.*, 2010). Moreover, it is a measure that is purported to ensure relationship centrality, which is an essential element for achieving successful information control in a social network of contractors.

To ensure commitment to the ESC adaptation guidelines and strategies provided in the framework, contractor's organisation need to formulate ESC policy for integration into overall organisational policies. Adoption of the framework developed in this research is essential to contractors' capability to adapt to ESC. Therefore, it is worthy to reiterate that, governments must establish the necessary regulatory framework to drive ESC within the construction industry.

6.4 Research Limitations

Traditionally, Sustainable Development (SD) has three pillars. In this study, the focus is on the environmental sustainability pillar. This pillar is found to be foundational to the building of the other two traditional pillars. This focus was particularly taken since the ESC concept is an emerging one in the study area and needs to be appropriately tackled systematically by concentrating on the primary aspects first; a holistic consideration of all the pillars at the infantile stage would not yield effective outcome. Thus, the research findings do not exhaust all aspects of sustainable construction.

It is worthy to also indicate that the study was carried out in a developing country setting. The time within which the research was carried out could not allow multiple country in-depth study of ESC practices and barriers. The focus is on achieving transferability and applicability of the findings thereof in a developing country with similar construction industry and economic challenges (Ofori, 2012 and 2000; Datta, 2004; DuPlessis, 2002).

Contractors involved in the study fall into a particular financial classification as categorized by the classifying body in the study country. There was not a wide survey of opinions from all classes of contractors. Thus, findings are based on perceptions and experiences of building and civil engineering contractors of the highest financial classification in the study country. Small scale contractors were not involved in the study. Therefore, some of the findings may not be applicable in the organisational setting of small-scale contractors.

Another limitation was the inability to get respondents on time for the face-to-face interviews and FGDs. The extremely busy schedule of contractor's BE professionals prolonged data collection period and also limited wider involvement of practitioners in the Focus Group Discussion (FGD) workshop. Therefore, the findings from the

validation have direct relevance to the organisations of the participants. The findings from the validation provide the participants with guidelines that can be applied within the context of operating contractor's organisation. Therefore, the guidelines and strategies coming out of the framework validation process are applicable in a particular context.

6.5 Future Research Direction

It is worthy to reiterate that environmental sustainability assumes primacy over other traditional SD pillars. This necessitated zeroing in on ESC. Nonetheless, in view of the ever worsening economic situation of the African continent, which manifested in this research in the form of 'negative' normative and coercive drivers, future research into economic aspect of sustainability in the construction industry would be beneficial. Economic sustainability cannot be tackled without giving due attention to social pillar of sustainability. The direct effect of poor economic conditions on the lives of people living in less affluent societies necessitates investigation into social sustainability in the construction industry. The global direction is to achieve sustainable development goals by the year 2030. Hence future research directions in these other pillars of SD is relevant to successful pursuance of the SDGs nationally, regionally and globally.

The subject area of this research is sustainable construction, which rests on the principles of SD. The effective building of the individual SD pillars would facilitate their collective action needed to achieve the overall SDGs. However, in view of the complex nature of SD making its definition even difficult to accept by all researchers, an outside-the-box perspective of SD should be considered for future research. Here, it is specifically, recommended that an investigation into the complementarity of a fourth SD pillar to the collective action of the three traditional SD pillars needs attention. This is viewed as a significant step towards successful achievement of the

SDGs, which would trickle down to successful adaptation and improvement in SC in the construction industry.

The research type adopted in this research is wholly qualitative. The need to undertake an in-depth study of the research phenomenon, which is an emerging trend in the study area, appropriated the use of social constructivism stance, the philosophy into which qualitative methods fit. Future research could focus on a quantitative survey to determine the extent of diffusion and practicing of the ESC concept among wider section of stakeholders in the construction industry. With such future direction, the perceptions and assessments of small scale contractors, construction project consultants and clients could be captured. The quantitative study may not be able to achieve an in-depth descriptions of practices and industry understanding of the ESC concept as it has been achieved with qualitative methods in this research. However, the story of extent of ESC concept diffusion could be better told to facilitate measurement of ESC adaptation levels in the construction industry.

6.6 Epilogue

Little has been done in employing theories to advance studies into SD and green building issues in the CI (Sarkis *et al.*, 2011; Cabesaz, 2002). The ramifications of not adapting to SD principles are enormous for our ecosystem. Also, there are complexities surrounding adaptation to an emerging concept, such as ESC. However, through application of an abductive research approach, four theories have been reviewed and integrated in this research for demystification of these complexities. Subsequently, there has been an improvement in understanding of a social-ecological system's adaption to ESC. Thus, the findings of this research are a contribution to advancement of studies into sustainable construction through exploitation of relevant theories. Also, conformance to SD principles in various sectors of an economy, including the construction industry, would culminate in the achievement of the SDGs.

The link between construction industry stakeholders' adaptation to ESC and ultimate achievement of SDGs has been highlighted in this research.

The role that knowledge acquisition and skills optimization play in imparting resilience needed for a social-ecological system, such as that of a contractor's organisation, has been emphasized in this study. Contractor's flexibility and adaptability are required for adaptation to occur. The guidelines for assessing and achieving these important adaptation qualities have been provided in this research.

Barriers exist to militate against successful adaptation to an emerging concept such as sustainable construction in a developing country context. However, researchers had done little in carrying out an in-depth study to empirically determine these barriers. Barriers have been empirically identified in a given context in a developing country. It is an important step that would contribute to devising of appropriate strategies to overcome such barriers. This research has contributed to the A21_SCDC's aim of getting sustainable construction successfully established in developing countries. This contribution is manifested in the determination of contextualized barriers, drivers and enablers of ESC, and the provision of guidelines and strategies for developing contractor's capability to adapt to ESC.

Constructing the capability of relevant stakeholders for building sustainable cities, especially in the developing world, is a contemporary global concern. This concern has been partly addressed in this research through the provision of guidelines for assessing contractor's flexibility and adaptability as a primary step towards enhancing capability. To strengthen the contribution of the research in this regard, and to ensure the comprehensiveness of the adaptation framework developed, relevant feasible guidelines and strategies have been provided.

The contribution of this research is that studies directed towards achieving sustainability in construction industry have been advanced through application of relevant multidisciplinary theories. The significance of this study is that, in line with the ‘Agenda 21 for Sustainable Construction in Developing Countries’ recommendation, guidelines for contractors to attain capability for sustainable construction have been provided.

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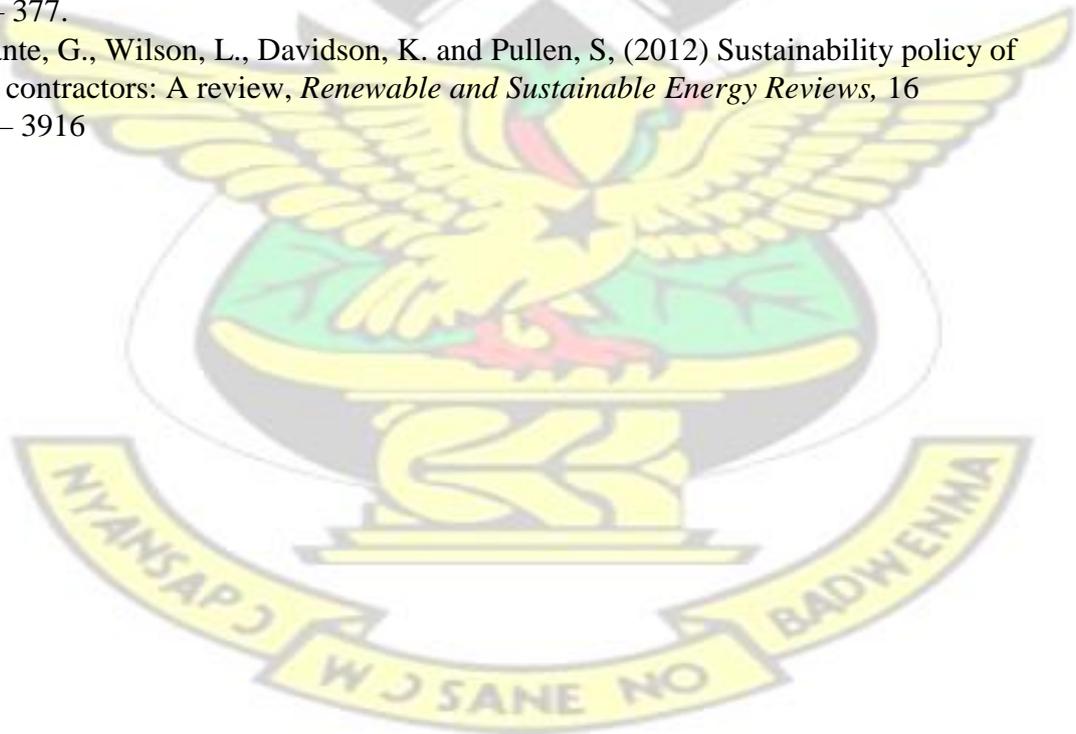
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APPENDICES

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Appendix 1 - Semi-structured interview guide

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DEPARTMENT OF BUILDING TECHNOLOGY
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12th February, 2015.

Dear Sir/Madam,

PHD PROJECT WORK INTERVIEW

The bearer of this letter, Sarfo Mensah is a PhD candidate of the Building Technology Department, Kwame Nkrumah University, Kumasi. He is carrying out a research work into the "Development of framework for construction organizations to practice environmental sustainable construction in Ghana" under the lead supervision of Professor Joshua Ayarkwa.

The Department deferentially requests for the assistance of your organization to provide person (specifically, built environment professional) space and time for the conduct of an interview thereof.

The professional's answers/responses to the interview questions are highly needed for the achievement of the aim of this research, which is eventually expected to enhance the issue of sustainability in the Ghanaian Construction Industry. All confidentiality required is assured.

Thank you.

PROF. JOSHUA AYARKWA
SUPERVISOR

INTERVIEW GUIDE FOR PhD RESEARCH RESEARCH
TOPIC:
CONTRACTORS' ADAPTATION TO ENVIRONMENTALLY SUSTAINABLE
CONSTRUCTION PROCESSES

TO THE BUILT ENVIRONMENT PROFESSIONAL,

The above research topic is for a PhD project being undertaken in the Building Technology Department of Kwame Nkrumah University of Science and Technology (KNUST). The purpose of this interview is to solicit information for the development of a framework that will enable construction organisations in Ghana to establish Environmentally Sustainable Construction (ESC) Practices.

ESC is a subject arising from the broader concept of sustainable development, which has become a global concern. Various sectors responsible for development of an economy have roles to play to ensure that the goals of sustainable development are achieved. Sustainable Development (SD) calls for the application of efficient methods and technologies that will ensure that any developmental project being undertaken meets the needs of the present generation as well as avoid the situation where the ability of future generations to meet their needs is compromised. ESC is based on this principle of SD, but puts maximum emphasis on achieving environmental sustainability, one of the three traditional pillars of SD, within the construction industry.

Your responses are very relevant and indispensable for the achievement of the aim of this research. The research has the significance of feeding the Ghanaian Construction Industry (GCI) with the requisite information that will facilitate effective practicing of ESC. This will provide reliable grounds for improvement of competitiveness and international performance and recognition of the GCI.

Data being gathered via this interview is to help answer the following specific research questions, which is also the foundation for the interview questions. The main research question from which the others emanate is:

“How can construction contractors develop capability for adapting to ESC?” Other research questions include:

- How do contractors understand ESC processes?
- Why do *some* contractors in developing countries have no capability to adapt to ESC processes?
- How can contractors drive and enable organisational adaptation to ESC processes?
- How will a contractor assess organisational capacity to adapt to the ESC processes?
- What strategies can guide a contractor to develop organisational capability to adapt to ESC processes?

Please note that the interview will last for, averagely, an hour. Also, to facilitate effective post-interview reference and data analysis, it will be necessary to carry out audio recording. You are assured of confidentiality.

Thank you.

Sarfo Mensah (Researcher, Tel. no. 0244871717 / 0501379464)

INTERVIEW GUIDE

Theme: Understanding of Contractors in ESC

1. In terms of adapting to changes in construction practices, in which of the following states would you classify your organization?
 - a. Exploiting construction business with high potential for growth[]
 - b. Increased potential and conserved resources []
 - c. Diminishing performance and losing conserved resources []
 - d. Re-organizing to start up collapsed business []
2. Why do you classify your organization in the above chosen state?
3. What do you think will enable your organization to attain a status where you have high potential and conserved large resources and capital to be able to establish ESC practices?
4. Do you think that the ecosystem has been damaged beyond recovery as a result of construction activities of your organization? Explain.
5. Are you aware of any modern technologies that enable construction organizations to practice ESC successfully? Please describe if you are aware.
6. How have you been able to learn about ESC practices? If you have not, how do you think you can effectively learn about ESC?
7. What is your opinion about the use of social networks for promotion of ESC practices among Construction contractors in Ghana?

Theme: Barriers to application of ESC processes

8. How flexible is your organization to accommodate changes in order to practice ESC?
9. Do you think modern technologies are helping you to perform efficiently? How? If No Why?
10. Do technologies available for use in the Ghanaian Construction Industry (GCI) prove insufficient to deal with environmental problems that arise from the construction activities of your organization? Explain your answer?
11. Are there any external pressures that influence your practices? If yes how have these pressures built barriers against the practice of ESC in your organization?
12. How are ecological, social and economic conditions in Ghana different from those prevailing in developed countries and how do they affect the practice of ESC by your organization differently?

Theme: Drivers and enablers of ESC

13. Are there any variables that could drive your organization to practice ESC? Explain these variables?
14. How do modern construction methods/technology applied by your organization facilitate environmental resources conservation, regeneration and usage efficiency?
15. How have you utilized any network with international organisations to influence ESC practices in your organization?
16. How can the study of the practices of other construction organisations help you to drive the ESC practices in your organization?
17. What role can the government play in promoting voluntary practice of ESC?

18. Are there any market or client situations/conditions that can drive ESC practices in your organization? Please describe such situation/condition.
19. Do you use solutions observed from other organisations to deal with environmental problems that arise from your construction activities? Explain with example.

Respondents' understanding of research subject as input for framework development

20. How will your organization be able to utilize available construction methods for the prevention of disturbance to the environment?
21. How can ESC practices, if carried out by your organization, facilitate restoration of the disturbed environment as a result of organizational construction practices?
22. What changes do you think should be introduced into your organization in order to ensure that you can easily apply ESC practices?
23. How can skills possessed by individuals in your organization be utilized to ensure that ESC is effectively practiced to minimize environmental challenges?
24. Can the knowledge and skills possessed within your organization enable you to enhance your capacity to adapt to changes in construction practices as a result of demands of sustainable development? Please explain.
25. How have you modified your organizational practices for the purpose of overcoming or minimizing environmental challenges posed by construction activities?
26. Can ESC practices help you to maximize efficiency in your construction activities and practices without negatively affecting profit of the organization? Explain how?
27. Do you think your organization applies efficient measures in delivering construction works? If any, how has organization ensured that the rate of efficiency achieved is maintained or improved?
28. What management practices have been established to ensure that satisfying internal organizational needs and satisfying demands of prudent environmental management are balanced?
29. How do you exercise control in sourcing and disseminating information concerning ESC to or from other construction organisations?
30. Are you able to limit the intensity of relationships you have with other organizations and bodies in order to control external influences that do not facilitate effective environmental management? How do you achieve that?
31. Do you think worker-to-worker relationships within your organization is useful for understanding ESC? How have you achieved that so far?

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Appendix II – Focus Group Discussions (FGD) questions





DEPARTMENT OF BUILDING TECHNOLOGY
FACULTY OF BUILT ENVIRONMENT
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DBT/S.G/VOL.9

4th May, 2016

Dear Sir,

INVITATION TO PARTICIPATE IN A FOCUS GROUP DISCUSSION

In view of your expertise in Environmentally Sustainable Construction (ESC) processes, you are respectfully being invited to participate in the above exercise. Your participation is recognized as your contribution to promotion of research work in the University.

The confirmed date and time for the focus group discussion are **11th May, 2016 and 9:00am** respectively to be held at the Building Technology Department, KNUST, Kumasi.

The researcher and bearer of this invitation letter, Sarfo Mensah, is a PhD Student of the University. His research work is into **Contractors' adaptation to environmentally sustainable construction processes.**

Your rich experience and knowledge are highly important to validating the research findings and successfully authenticating the framework developed.

Thank you.

Sincerely,

Professor Joshua Ayarkwa
(Supervisor)

**KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
COLLEGE OF ART AND BUILT ENVIRONMENT DEPARTMENT
OF BUILDING TECHNOLOGY**

PhD CONSTRUCTION MANAGEMENT

**A MULTI-THEORY FRAMEWORK FOR CONSTRUCTION CONTRACTOR'S
ADAPTATION TO ENVIRONMENTAL SUSTAINABLE CONSTRUCTION**

**VALIDATION OF FRAMEWORK
FOCUS GROUP DISCUSSION QUESTIONS**

Supervisors:

Prof. Joshua Ayarkwa and Dr. Gabriel Nani

Candidate:

Sarfo Mensah

February, 2016

VALIDATION OF FRAMEWORK

FOCUS GROUP DISCUSSION QUESTIONS

1. Does the framework provide adequate guidelines on identifying challenges to adaptation to ESC? If YES, how is this indicated in the framework? If NO please explain why. Subsequently, briefly describe how this can be achieved?

2. Does the framework provide adequate guidelines on assessing organisation's flexibility to adapt to ESC? If YES, how is this shown in the framework? If NO please explain why. Subsequently, briefly describe how this can be achieved?

3. Does the framework provide adequate guidelines on how a contractor's organisation can utilize an intra-organisational relationship to promote ESC within the organization? If YES, how is this demonstrated in the framework? If NO please explain why. Subsequently, briefly describe how this can be achieved?

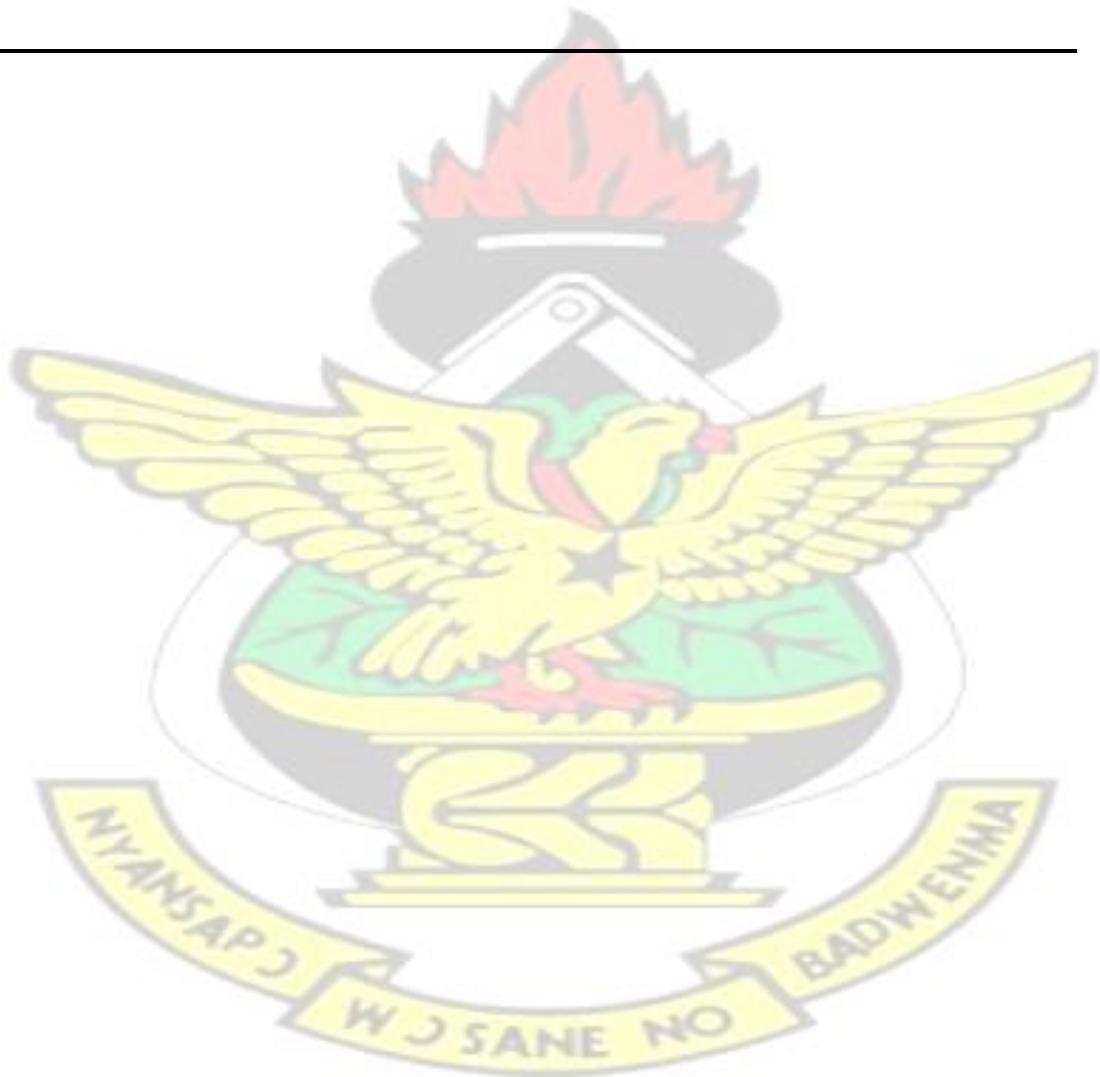
4. Does the framework provide adequate guidelines on how construction contractors' organisations can utilize inter-organisational relationship in a social network to promote ESC? If YES, how is this shown in the framework? If NO please explain why. Subsequently, briefly describe how this can be achieved?

5. Does the framework provide adequate guidelines on how a contractor can create enablers and drivers within the organization and among network of contracting organisations If YES, how is this demonstrated in the framework? If NO please explain why. Subsequently, briefly describe how this can be achieved?

6. Are adequate guidelines on how to elicit drivers and enablers of ESC from noncontracting organisations provided? If YES, how is this shown in the framework? IF NO, please explain why. Subsequently, what additional can be done to draw out drivers and enablers from these other stakeholders?

7. What is your assessment of the applicability of the framework?

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Appendix III – Excerpted sample of field notes

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FIELD SITE OBSERVATIONS

Site No. 19

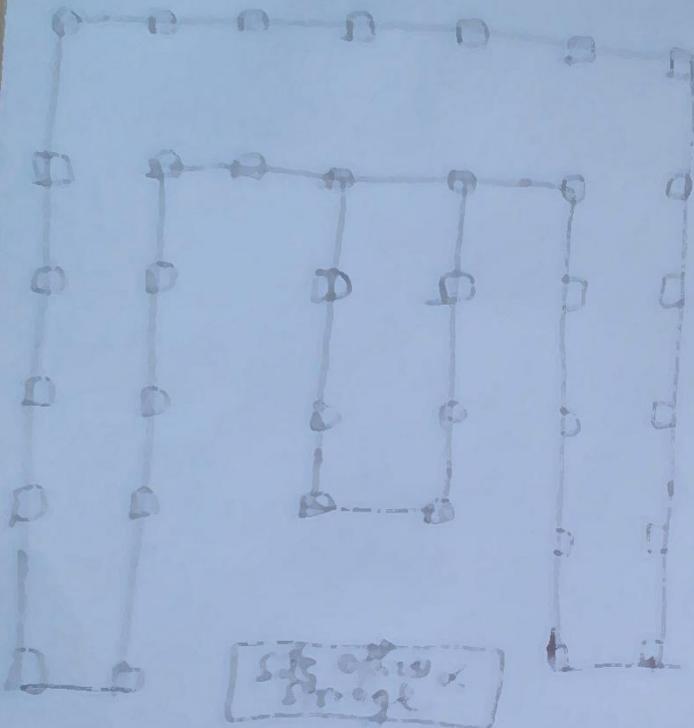
Date: 04 April 2015

Time: 3:00pm - 4:45pm

Place: Eastern region of Ghana

(Hard vegetation)

NOTES



Sketch of Ground Floor plan of a proposed 4-story block of classrooms and office

Progress

Laying of reinforced bars in suspended slab for ground floor

Type of structure:

Reinforced concrete framed structure with sandwich blocks shell

Materials used for formwork

Timber formwork with timber props and dacking. Timber products for all concrete elements formwork.

Treatment of site/building area

- Timber formwork waste spread on site including nails and pieces of iron rods.
- Site office built with timber.
- Trees cleared from larger portions of site and dumped in nearby forest. No signs of topsoil preserved for future use.

RESPONSES TO ALTERNATIVES

BE professional expressed knowledge about some modern technologies such as geo-panels and metal paps (adjetallo) for formworks. When asked why these are not used, He, together with ^{General} foreman on site, complained about the managing director's unwillingness to invest in these modern technologies that facilitate preservation of natural environmental resources. The BE professional himself acknowledged that the initial cost of these technologies are very high.

In describing working relations with the subordinates at site, he indicated that, as project manager he tries to create cordial relationship by always ~~communicating~~ ^{communicating} in local language with them. This was observed and it made them feel comfortable. However, for formal ~~and~~ instructions, the PM uses the English language to communicate mostly through the General foreman. This was seen as creating some distance between the PM and the subordinates.

Appendix IV – Analysis tables and chart
Initial template developed for the thematic template analysis

CATEGORIES FORMING HIGHER ORDER CODES	THEORY-DRIVEN CODES SET <i>A PRIORI</i>
Organizational ESC Adaptability	Adaptability stage
	Growth factor
	Growth Enabler
ESC knowledge and practices	Environmental damage recovery mechanisms
	SC modern technologies
	ESC learning means
	Social networks utilization
ESC barriers	Organizational flexibility
	Ecological efficiency of modern technology
	Locally existing construction technology sufficiency
	External pressure barriers
	Local peculiar ecological barriers
	Local peculiar social barriers
	Local peculiar economic barriers
ESC drivers	Specific organizational ESC driver
	Environmental resource conservation, regeneration and usage efficiency technology driver
	Organizational Networking influencer
	Benchmarking organizational best practices
	Governmental role
	Market or client situations /conditions
ESC Framework enablers	Environmental disturbance prevention construction methods
	Environmental restoration construction methods
	Ability to introduce specific changes in unsustainable practices
	Individual skills utilization to minimize environmental challenges
	Overall organizational capacity enhancement
	Modifying existing practices purposefully to minimize environmental Challenges
	Ability to maximize business profit while practicing ESC
	Improving rate of efficiency thru ESC
	Balancing environmental management demands and internal organizational needs

ESC information sourcing and dissemination control
Ability to control inter-organisational relationships
Creating and utilizing intra-organisational relationships

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Textual Coding Frame

THEME	CODES (set <i>a priori</i>)	CODED TEXTS IN INTERVIEWS DATA
Organizational ESC adaptability	Stage of growth	Exploiting High potential Diminishing
	Reason for stage of growth	Commenced business not long ago Long years of operation Doing a lot of businesses around Lack of job Poor economic conditions No jobs forthcoming Using conserved resources to run jobs
	Growth enabler	Access to Capital Government investment Continuity of jobs Satisfying clients requirement Economic productivity Investment in resources (esp. plant) Creating better company image Adopting modern technology
ESC knowledge and practices	Environmental damage recovery mechanisms	Landscaping Conscious effort to replenish Organizational Environmental Management Plan Providing for green environment Planting more grasses. Landscaping Don't allow pollutants to go into the water bodies and air Change of work schedules to control noise levels campaign on afforestation tree and grass planting

ESC Modern Technology Enablers	Plastic formwork Electronically powered cranes Lighter steel trusses Modern technical spill kits Plastic formwork Green building materials Non-timber scaffolding and forms Underground drainage systems Value engineering, Retaining wall systems, Prefabricated / Precast system Water-based eco-friendly staining system used to colour concrete. Filters to discharge waste Water resistant marine plywood forms Geo-panels forms Chemical-based building block units
ESC Learning means	Schooling abroad Personal research From other organisations
Utilization of social networks	Social networks promote ESC social networks sells more quickly than the rest of the medium network create bigger platform for sharing ideas about 10 of us can come together to put ideas before government

THEME	CODES	CODED TEXTS IN INTERVIEW RESULTS
Barriers	Lack of flexibility to accommodate changes	Not flexible in short term Flexibility Depends on client being able to pay If that will keep us in business Flexible but needs to be pushed by legislation Training and getting abreast with this technology will make us flexible Management's willingness Change of current procurement law needed to make us flexible Awareness of researched benefits of ESC will make us flexible Job continuity will bring in flexibility Flexibility of project designs Flexibility of contract conditions Flexibility depends on availability of funds to invest
	Environmental inefficiency of modern technologies	Used to old ways of doing things. Lack of adequate training in use of modern

<p>External pressures against ESC adaptation</p>	<p>Architects do not think about ES. We do what is specified in contract Huge import duties and taxes on construction materials Non availability of SC materials that will facilitate resource conservation Designs do not capture Professionals not used to ESC concept Intimidation from powers (authorities) against application of principles Complying with design team and client requirements Absence of client requirement for complying with ESC Lack of finance to undertake costly ESC Imposition of foreign designs without considering inputs from local contractor Non availability of affordable alternatives to expensive methods for carrying out ESC Project consultants imposing the use of products not environmentally friendly Sub-contractors non-compliance with environmental construction principles Inadequate resources and lack of sustainability indicators and requirements Inadequate project budget/funding Political power pressures that frustrate association among contractors Lack of financial institutional support due to CI rated as high risk Indiscriminate influx of quark contractors</p>
<p>Ecological, social and economic barriers of locality</p>	<p>Ecologically we are more conserved but it does not necessarily create barrier Climatic conditions seem more favourable supporting plant and human life Poor economic conditions: R&D lower in developing countries and thus ESC not promoted Low economic capacity to source for modern technology Inconsistency in implementing national development plans Inefficient use of energy and not looking for renewable alternatives Lack of policies to support recycling Clear budgetary allocation for to support ESC Economy is import based; anything is accepted Non-availability or lack of access to business capital High interest rates and delayed payments</p> <p>The societal pressure to gain employment status without regard to the environmental consequences of the job, Social upbringing does not support resource reservation for future generation</p>

		<p>Do not easily change ways of doing things Not inclined to resource conservation.</p> <p>Low or lack of environmental laws enforcement</p> <p>Low self-confidence at work place to insist on what is right</p> <p>Selecting governments not based on performance or soundness of economic policies</p> <p>Cultural or social life-style not encouraging environmental resource conservation.</p> <p>Culture of focussing on cost reduction measures more than environmental protection measures</p> <p>Tendency to learn and do through social associations more than by regulations</p>
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THEME	CODES	CODED TEXTS IN INTERVIEW RESULTS
Enablers of ESC adaptation	Environmental disturbance preventive methods	<p>Methods that reduce cost to the barest minimum</p> <p>Methods to reduces use of natural resources</p> <p>Laws/legislation to ensure these methods work</p> <p>Restoring sand weaning sites</p> <p>Manufacturing renewable energies locally</p> <p>Publicity and sensitization of the public about ESC</p> <p>Legislating development of environmental restoration plans before job execution</p> <p>Clients' readiness to pay for environmental management measures of organisations</p> <p>Education of construction company workers</p> <p>National strategic plan on environmental impact minimization</p> <p>Sustainable construction designs that making use of energy-efficient appliances. Focussing more on retrofitting</p> <p>Education, awareness and training</p> <p>Having incentivizing schemes for contractors like is done in the use of LEED in USA Standardized environmental sustainability framework with which contractors are registered and associated</p> <p>Including sustainability requirements in construction contracts and tenders</p> <p>Company prefabrication workshops</p> <p>Organization's own research and planning unit on ESC</p> <p>Importing more sustainable technologies</p> <p>Construction organisations/contractors association</p> <p>Forming bye laws/policies</p> <p>Government establishing central plant pool to improve affordability and this increase accessibility</p> <p>Policy on regular maintenance of equipment</p> <p>Implementing low cost sustainable practices such as: watering dusty roads; washing muddy truck tyres before movement from sites; rescheduling noisy construction activities; supply of human resources to support tree public planting exercises Bye laws</p> <p>Using Indigenous building materials</p>

<p>Specific changes in construction practices</p>	<p>Standardizing building elements to reduce waste More use of modern technologies Getting environmentally conscious management Education Training workers to think environmental sustainability Clients developing ESC consciousness Linking with international network of construction organisations Change manager to steer adaption to ESC Increasing motivation of the organisations Law enforcement Reducing use of timber Constant information, training, sensitization, and workshops and seminars Attitudinal change to accept new ways of doing things</p>
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	<p>Change in concrete production procedures Disposal of waste into landfills Reusing building material wastes Descent sanitary facilities for workers Reward the implementation of the policies Reversing downward trend of skills Using designs to drive ESC Making use of existing resources Having incentive programmes Encouraging ESC through contractors association Take advantage of the presence of discipline, patience and potential amongst the people Investing into sustainable technologies ESC officer Using more plastics Organizational structure and communication channels that favour ESC Green Building materials; recyclable, renewable construction materials Integrating projects into livelihood of community's integration plan document and then training follows. Indicators of a sustainable construction industry. We should have more local contents in our contract formation in the CI Reversing imported content and increasing the use of local resources Implementing repetitive designs Change in clients' attitude by using more BE professionals services</p>
<p>Utilizing individual and organizational knowledge and skills</p>	<p>Proper direction Education and training to engender rethinking towards sustainability Re-engineer the way individuals think No capacity, knowledge level inadequate International networks Financial investment in training and technology Increasing motivation Flexibility Resource person for training Education and training from tertiary institutions Designs from consultants Awareness creation Use of contractors association to improve skills Exposing contractors to framework that promotes ESC Learn and adopt from other organisations Road map to define how to achieve sustainability Training in use and maintenance of sustainable technology</p>

	
<p>Improving rate of efficiency</p>	<p>Profit will not be negatively affected but will be maximized in the long term Have many Scenarios and choose low cost activities that satisfy environmental requirements. Continuous application of sustainable technologies Putting effective management structures in place Satisfactory remuneration of workers Continuous planning, education and training Establishing quality assurance system Investing more into efficient technologies Minimizing turnover rate of employees Standardizing Project cost and methods evaluation Compensation from government for environmental management efforts. Motivating individual workers Regular replacement of old equipment and unsustainable technologies/methods Concentrating on the green principles of recycling, reusing and reducing Consultants coming out with designs and bills that cater for ESC requirements. Sensitization workshops Forming Health, Safety and Environment Department within organization</p>

		<p>Prior assessment of whether construction method is green before executing Standardization of designs Governmental support on high cost construction plant</p>
<p>Balancing environmental requirements and other organizational needs</p>		<p>Make your workers environmentally conscious Awarding waste reduction efforts of PMs & workers Reducing waste and working efficiently to reserve money to meet organizational needs Including CSR in organization policy Optimization of resources; e.g. using filling materials from site instead of from borrow pits Do it right for the first time Policies that share long term profit with clients that support ESC Incorporating sustainability principles into daily operations Communication among the organizational structures in through regular meetings Offer sustainable design, construction and management advice for all types employed construction workers Overcome resource scarcity/challenges using modern methods and planning Practicing according to international standards</p>

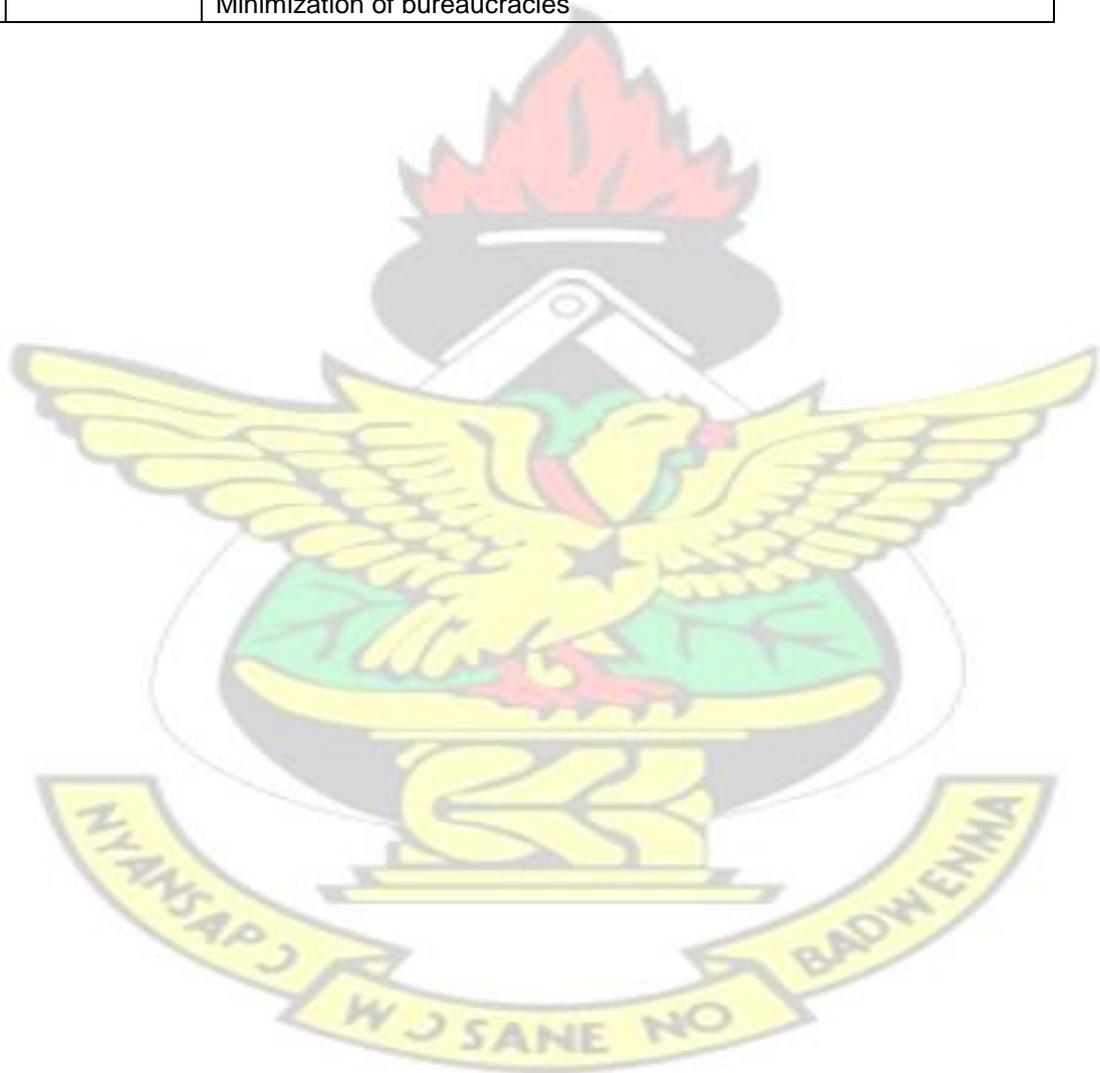
	<p>Comprehensive planning and documentation to overcome environmental challenges</p> <p style="text-align: center; font-size: 2em; opacity: 0.5;">KNUST</p>
Intraorganisational relationships	<p>SUPERIOR-TO-SUBORDINATE Bosses do not accept advice directly Suggestions from contractors are not accepted by consultants Management level can influence not down Use of 'tool box' meetings to discuss personal safety information PSI before starting work Performing JHA. Job hazard analysis for every job to determine environmental impact Organizational culture of rewarding compliant workers and penalizing non-compliant ones Policies about ESC can be disseminated down so it is at top-bottom approach Environmental officer handling all environmental information Management must first understand ESC and then train subordinates Distribute leaflets and have PSI or tool box meeting every morning before work begins</p> <p>SUBORDINATE-TO-SUBORDINATE Cordial and not being antagonistic towards each other Share information during break time and leisure hours. We build teams on site so interpersonally for easy information transmission In Africa/Ghana culture, we have good working relationships Information transmission is faster at this level than from supervisor to subordinate Understanding a matter is faster at the colleague-to-colleague level. Difficulty in accepting information from newly employed supervisors Learning can be very effective with cordial relationship Some are not open to new ideas and headship at various worker levels will facilitate learning. Regular communication. Use of subcontractors becoming more frequent than permanent workers; use of worker to worker relationship to learn is difficult.</p>
Interorganisational relationships	<p>We only get into relationships beneficial to our goal Have relationship with only those that you can trust and can rely on We opted out of contractors association because it became a one man affair Not in relationship due to the lack of understanding of the collective nature of efforts in sustaining the environment.</p>
	SOURCING

	Organizational Information sourcing, dissemination and control	<p>We do not discuss ESC information at our peer-to-peer meetings but government discussion</p> <p>Information on our website about organisations are doing We do not share information due to competition. We do not share because we don't want people to know how we save</p> <p>if info is mainly from journals and magazines not from other construction</p>
		<p>There should be a research department within the organization that would deal with sourcing and disseminating such information about the sustainability</p> <p>INFORMATION CONTROL</p> <p>Looking for those that have similar goals to associate with</p> <p>Making double sure that information is sent to the right people always</p> <p>Brainstorming information available and adopting what suits your organizational practice. Be ready to accommodate practices or technology that will be widely accepted</p> <p>Education of the people to know the right thing so as to prevent negative influences.</p> <p>Assess whether new information meets certain desired objectives before adopting</p> <p>Compare information outside to standards before applying</p> <p>Signing MOUs and NDAs with organisations with whom info is shared</p> <p>We can share technologies and ideas; competition is about your mark-up</p> <p>Check whether information conforms with organizational goals and policy</p> <p>External organization must be on the same level with you in terms of your organizational beliefs and principles before your enter into relationship.</p>
	Modern Technology benefits enabler	<p>Timber conservation</p> <p>Future Sustainable designs</p> <p>Easy maintenance and replacement</p> <p>Waste reduction</p> <p>Metal and plastic scaffolding</p> <p>Offsite concrete and concrete pumping</p> <p>Higher specs, fuel-efficient gen set</p>

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THEMES	CODES (set a priori)	CODED TEXTS IN INTERVIEW RESULTS
Drivers of ESC	Organizational ESC driving elements	<p>Education</p> <p>Designing sustainable buildings</p> <p>Legislative framework</p> <p>Organizational environmental manager</p> <p>Client environmental policies</p> <p>Taking on large size projects</p> <p>Organizational quality assurance system</p> <p>The desire to make profit</p> <p>Competition</p> <p>Conformance to international standards</p> <p>Social change</p> <p>The desire to preserve the environment and conserve energy</p> <p>Livelihood</p> <p>Business continuity</p> <p>Long term competitive advantage</p>
	Organizational networking influence	<p>No Networking</p> <p>Contractor's and Real Estate associations exist but do not attract active participation and promote sustainability</p> <p>Networking with foreign-based organisations</p> <p>Apply international standards</p> <p>Learning from other organisations</p> <p>Practices benchmarked are not ESC</p> <p>No benchmarking, observing, learning,</p> <p>Applying some observed practices but no feedback.</p>

Government's roles	No economic/legislative drive to practice ESC Legislation, bye laws, policies, regulations Educating, training, sensitization EPA, MWRWH Financial support Tax rebate/waiver Procurement law to enforce ESC Adopt framework from researchers and give it legal backing Criteria to test sustainability of designs Standardization Financial incentives/compensation for emission reduction efforts Establishment of recycling and green products factories Minimize delayed payments Funding for monitoring, regulating and enforcement Local content law Minimization of bureaucracies
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Tree Nodes in NVivo

ESC Adaptation Analysis II.nvp - NVivo

File Edit View Go Project Links Code Tools Window Help

New [Icons] Sort By [Dropdown]

Code At [Dropdown] In [Dropdown]

Look for: [Dropdown] Search In: Tree Nodes Find Now Clear Options X

Nodes

- Free Nodes
- Tree Nodes
- Cases
- Relationships
- Matrices
- Search Folders
- All Nodes

Sources

- Sources
- Nodes**
- Sets
- Queries
- Models
- Links
- Classifications
- Folders

Tree Nodes

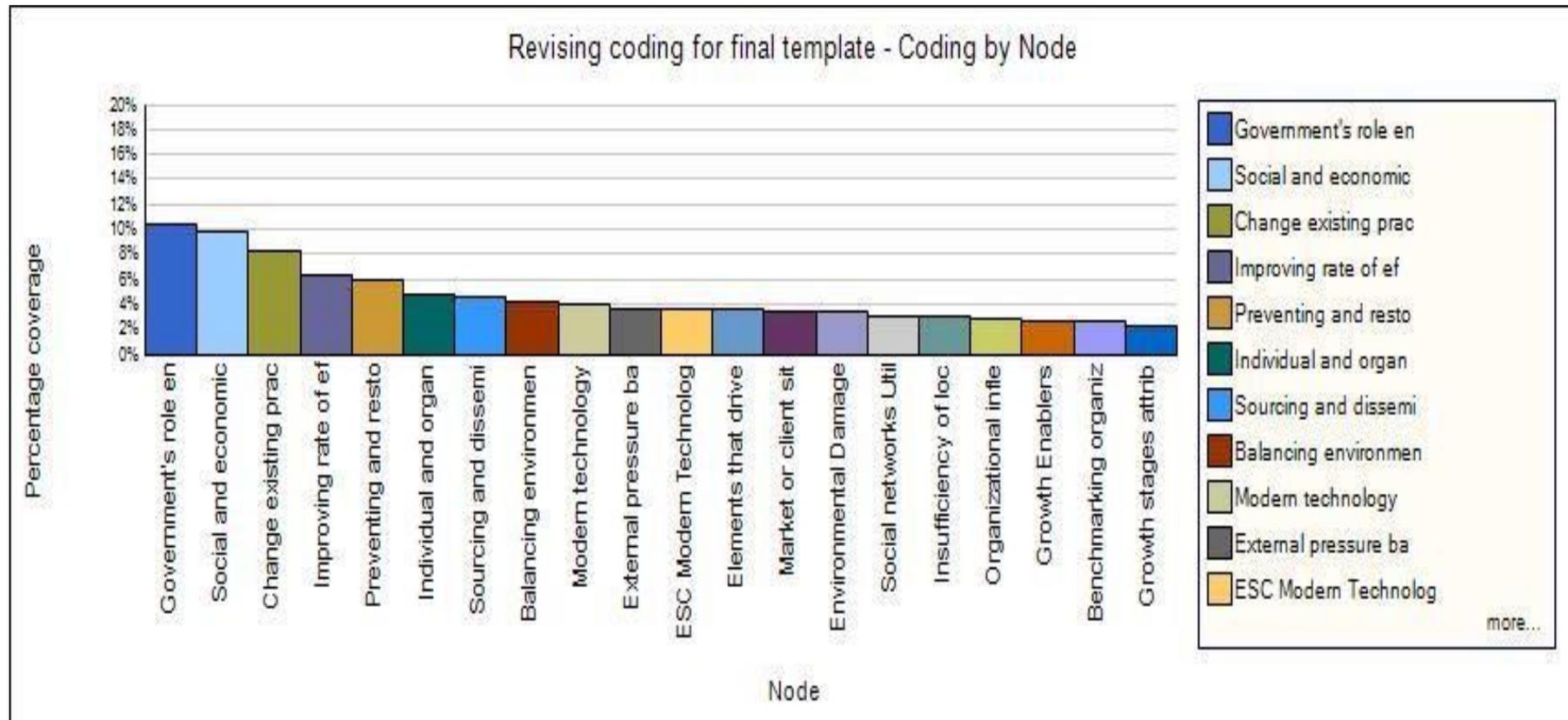
Name	Sources	References	Created On	Modified On	Modified By	Created By
Higher and lower order codes	0	0	24/07/2016 14:31	24/07/2016 14:31	SM	SM
BARRIERS TO ADAPTING TO	1	1	24/07/2016 14:31	24/07/2016 14:31	SM	SM
External pressure barriers to	1	1	24/07/2016 14:31	24/07/2016 14:31	SM	SM
Inefficiency of environmental	1	1	24/07/2016 14:31	24/07/2016 14:31	SM	SM
Insufficiency of locally availabl	1	1	24/07/2016 14:31	24/07/2016 14:31	SM	SM
Organizational inflexibility to a	1	1	24/07/2016 14:31	24/07/2016 14:31	SM	SM
Social and economic barriers	1	1	24/07/2016 14:31	24/07/2016 14:31	SM	SM
DRIVERS OF ESC	1	1	24/07/2016 14:31	24/07/2016 14:31	SM	SM
Benchmarking organizational	1	1	24/07/2016 14:31	24/07/2016 14:31	SM	SM
Elements that drive ESC pract	1	1	24/07/2016 14:31	24/07/2016 14:31	SM	SM
Government's role enabler	1	1	24/07/2016 14:31	24/07/2016 14:31	SM	SM
Market or client situations ~co	1	1	24/07/2016 14:31	24/07/2016 14:31	SM	SM
Modern technology	1	1	24/07/2016 14:31	24/07/2016 14:31	SM	SM
Organizational Networking infl	1	1	24/07/2016 14:31	24/07/2016 14:31	SM	SM
Studying other organizations'	1	1	24/07/2016 14:31	24/07/2016 14:31	SM	SM
ENABLERS OF ADAPTATION	1	1	24/07/2016 14:31	24/07/2016 14:31	SM	SM
Balancing environmental requ	1	1	24/07/2016 14:31	24/07/2016 14:31	SM	SM

SM 62 Items

712, 0243 204 578, 0246 939 446

14:33 24/07/2016

NVivo Item coding chart



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Final (Revised) Template

CATEGORIES FORMING HIGHER ORDER CODES	THEORY-DRIVEN and DATA-DRIVEN CODES
ORGANIZATIONAL GROWTH AND ADAPTABILITY	Adaptability growth stage
	Adaptability regulators
ESC KNOWLEDGE AND PRACTICES	Environmental damage recovery measures
	ESC modern technology enablers
	ESC Knowledge acquisition
	Social network utilization
ESC CONTEXTUAL BARRIERS	Organizational flexibility
	Modern technology efficiency
	Efficiency and sufficiency of locally available technologies
	External pressures
	Socio-economic barriers
ESC ORGANIZATIONAL DRIVERS AND ENABLERS	Organizational and individual skills and knowledge
	Efficiency rate and profit maximization
	Balancing organizational and environmental performances
	Intra and inter organizational relationship and information flow
	Interrelationship between drivers of adopted organizational SC practices
ESC NON ORGANIZATIONAL DRIVERS AND ENABLERS	Technical drivers and enablers
	Government Financial enabler role
	Governmental Legislative/regulatory driver role

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340 PUBLICATIONS

Refereed journal paper

1. **Mensah, S.**, Ayarkwa, J., and Nani, G. (2015). Towards enabling construction organisations' adaptation to environmental sustainable construction in developing countries. *Advances in Social Sciences Research Journal*, 2(10), 84 - 100. URL:<http://dx.doi.org/10.14738/assrj.210.1516>.

Peer reviewed conference papers

2. **Mensah, S.** Ayarkwa, J. and Nani, G. (2015) Adapting to environmental sustainable construction in developing countries: a multi-theory conceptualization, 2015 *Smart and Sustainable Built Environment (SASBE 2015)*, 9 – 11th December, 2015, Pretoria
3. **Mensah, S.** Ayarkwa, J. and Nani, G. (2015) Understanding contractors' environmental sustainable construction practices in Ghana, 4th *International conference on Infrastructure Development in Africa* (web.knust.edu.gh/icida/pages/index.php?siteid=icida)
4. **Mensah, S.** Ayarkwa, J. and Nani, G. (2014) Framework for modeling sustainable construction practices towards low carbon construction *In: Laryea, S. and Ibem, E. (Eds) Proceedings 8th Construction Industry Development Board (cidb) Postgraduate Conference*, 10-11 February 2014, University of the Witwatersrand, Johannesburg, South Africa, 293-303.
5. ****Mensah, S.** (2014) Application of sustainable construction principles on a hostel construction project, *International Conference on Applied Science and Technology (ICAST) 2014*, (www.events.kpoly.edu.gh/event/icast) **

Peer reviewed doctoral workshop paper

6. **Mensah, S.** Ayarkwa, J. and Nani, G. (2016) Barriers against contractors' adaptation to environmentally sustainable construction processes. *Association of Researchers in Construction Management (ARCOM)*, 27-28 July, 2016, Ashesi University College, Accra, Ghana.

***Published during the PhD research but not directly out of the thesis.*

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