



**DEVELOPING A STRATEGY FOR THE IMPLEMENTATION OF  
SUSTAINABLE CONSTRUCTION PRACTICES IN LIBYA**

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## **DEDICATION**

I declare that the work contained in this thesis is my own original work. Where work and ideas or concepts have been taken or adapted from any source, they have been properly cited and referenced.

## **ABSTRACT**

In the 21st century, sustainability has become an urgent concern for the construction industry worldwide. It has been seen as one of the most significant challenges at the present time.

Nowadays, the theory of sustainability is considered as a central part of strategy changes in most parts of the world because of the likelihood of negative effects of particular practices on the environment and society. Whilst sustainability is receiving significant attention in construction companies in developed countries, this seems to be less true for the construction industry in developing countries.

This study explores the level to which the construction organisations in Libya scrutinise and employ viability assessments in construction activities, with a view to developing a strategy for transformation to improve sustainable practices.

The study was carried out using a survey strategy to raise better understanding of the present status. A number of construction companies in Libya were selected for study to ensure the different backgrounds and opinions were included.

The research was conducted in two phases; first, a questionnaire survey was carried out to explore wide understandings of the existing practices and the desire of the participating companies to apply sustainable aspects in their practices.

134 completed questionnaires were analysed by using statistical techniques. The findings from the survey informed the topics for the interviews with 10 participants from the top and senior level management from Libyan construction companies. The interviews were prepared to obtain deep insights into the justification for the existing practices and perceived benefits, as well as the challenges and further recommendations. Interview data were analysed by using the content analysis method.

The outcomes of the research explained the adoption of sustainable construction in Libya, and the data showed that the awareness of sustainability in construction was weak in the practice of several companies. Weakness in awareness of sustainability was found to have been caused by low levels of understanding on the part of principal actors in the entire construction industry, such as the clients, regulatory and construction organisations. The behaviour of the stakeholders is essentially linked to their values, the nature of the construction industry and their sense of sustainability principles.

Additionally, the failure of supporting institutions to create an effective application of sustainability guidelines, lack of stricter legislations, building codes or standards relating to sustainable construction practices were also found to be major challenges to implementing sustainable practices in the industry. This research identifies some significant issues that enhance the use of sustainable practices in the construction industry. It examines various theories of sustainability in order to produce a strategy for a shift in building practices in Libya, to transform them from the traditional practices to new and more sustainable methods.

This research argues that the most vital point for a sustainable approach in Libyan construction is to bring about a change in the current understanding of the role of the construction industry in the development of the country. Such a change of thought and attention requires an increased awareness and adoption of sustainable construction by focusing on its benefits for society, the environment and investors. This calls for more focused education and training, where the risks inherent in non-sustainable practices as well as the benefits of sustainability in construction, functional application of legislation, leadership commitment and improvement of ability to support sustainable construction will be considered in-depth.



# CHAPTER (1): INTRODUCTION

## 1.1 Research Background

The later part of the 20th century has witnessed urgent calls towards sustainable development like never before. This issue relates to social, economic and environmental sustainability and has become one of the topmost agenda on government's policies the world over. Since the later decades of the 20th century, the issue of sustainable development has become urgent due to the growing evidence of the deleterious effects of construction practices on society and on the environment. This urgency is reflected by the prominence being attached to sustainable development by governments throughout the world (Working Group for Sustainable Construction, 2001). However, sustainable development faces the challenge of meeting growing human needs for natural resources, industrial products, energy, food, transportation, shelter, and effective waste management, yet at the same time, conserving and protecting environmental quality and natural resources that are crucial for future life and development. Sustainability, therefore, while meeting long-term human needs, will be impossible unless the conservation and protection of the planet, in terms of natural, physical, chemical, and biological systems, is addressed (Millward, 2000; Baredi, 2013).

Although there is a growing depth to the sense and understanding of the concepts, the terms 'construction' and 'sustainability' are quite complex, with a range of opinions in relation to scope and meaning (Carew and Mitchel, 2008). Generally, in the context of construction, sustainability refers to the principles of viability in terms of practices. It embraces several elements, which include social, economic and environmental matters central to the construction process and its outcomes. It also embraces other dimensions, for example technical matters (Hill and Bowen, 1997; Ashley et al, 2003; Pawlowski, 2008), and social and managerial matters (Ofori, 1998; CIB, 1999) have also been frequently discussed in the literature. Nevertheless, Elkington's (1997) 'triple bottom line' concept of sustainability, which prioritises the economic, environmental and social dimensions, has continued to be central, and is the focus of this study.

Dania et al, (2014) indicated that developing countries were usually struggling with challenges and problems that were different from those in developed countries. These included increased population growth, high levels of migration from rural to urban areas, insufficient infrastructure and housing, persistent poverty, lack of skills, weakness in

government organisations, political crisis, and social disparity (Adebayo, 2002). Taking into consideration that developing countries needed to adopt a different method, Agenda 21 for Sustainable Construction in Developing Countries (SCDC) was announced, which concentrated on the specific perspectives of developing countries (Du Plessis, 2002). Nevertheless, this has provided limited outcomes due to its failure to include a number of important features being combined in the Agenda 21 guide for SCDC.

Following Agenda 21 for SCDC, Du Plessis (2007) proposed a critical model for change in sustainability practices in developing countries. The drivers (catalysts), enablers (factors to help the process) and stakeholders (people in the construction industry) were identified as key factors to enhance change in sustainability. Du Plessis (2002) also identified examples of certain enablers to encourage countries to adopt a more-sustainable ethos. Nevertheless, the framework is broad in addressing all aspects in the adoption of sustainability, and most crucially, it requires there to be an established and professional construction sector with the ability to respond to potential sustainability challenges, a situation that is not present in Libya. For these reasons, the various change initiatives and interventions that have been identified and developed have yielded poor (and few) outcomes in most developing countries including in Libya (Halliday, 2008; Ahmed & Mousa 2014).

At the present time, in Libya, the concerns about environmental dissatisfaction on construction projects have regularly been raised (Elgadi et al, 2016). This raising of consideration drives the government and professional bodies in the country to be more practical in alleviating this issue without limiting the need for development. However, applying sustainable construction practices influenced by the knowledge and involvement of all individuals involved in the industry, will require a more in depth understanding of the sustainability concept for successful application (Abidin, 2008, Omardin et al, 2015).

Unsustainable construction practices and its attendant degradation of the environment for construction purposes is a common phenomenon observed among most developing countries, of which Libya is of no exemption (Karim 2017). The main mitigating influences sustainable construction in Libya are struggle to change, lack of strategies to promote sustainable construction practices, weakness in public awareness and government support among others (Elgadi et al, 2016, Egbetokun et al, 2018)

## **1.2 Rational of the Research**

The role played by construction projects in contributing to global warming as well as its other deleterious impacts on the environment has become an urgent issue. It is essential that stakeholders in the industry should adopt measures based on sustainability principles in order to curtail these damaging effects. In most developing nations, including Libya, researches have shown that principles of sustainability are poorly implemented in the activities of construction organisations (Ebohon and Rhwemila, 2000; Du Plessis, 2007). Authors such as Baloi (2003) and Reffat (2004) have pointed out that, in most developing countries, the evolution of the sustainability movement was still in its infancy. Construction projects progressed without much consideration for longer term impacts of their activities on society or the environment. Baumgartner and Ebner (2016) supported this view arguing that most construction practices failed to comply with sustainability requirements. In Libya, the contribution of most construction organisations to sustainability objectives was considered to be mostly weak especially in terms of policy integration, environmental conservation and social responsibility (Alshuwaikhat & Abubakar, 2017).

Furthermore, most construction organisations are seeking for practical methods to incorporate aspects of sustainability into their projects; this is evident from the prominence given to sustainability in their journals and annual reports (Lacy et al, 2010; Silvius et al, 2014). Recent research in Libya showed that the commitment of construction organisations to sustainability matters was directly influenced by the organisation's strategies, and that organisational support for sustainability greatly influenced how sustainable construction practices were being implemented within projects (Labuschagne et al, 2010; Gareis et al, 2013; Lange et al, 2013). If construction firms understand how to embed sustainability into organisational activities, it will likely enhance their contributions to sustainable development. Nevertheless, because of its complicated and widely interpretive nature, embedding sustainability into the culture of organisations has been challenging. Therefore, it is of pivotal importance for organisations to reach a coherent understanding of what constitutes sustainable practice in order to espouse suitable practice (Ciegis et al, 2015). Anecdotal evidence, with some support in the literature, suggests that issues of sustainability are not receiving sufficient attention in Libya (Elshulcri 2014). This could be attributable to the limited understandings on the part of key stakeholders in the industry in Libya (Baloi,2013 ; Salah & Ramadan 2015).

Du Plessis (2005) showed that stakeholders' commitment to sustainability practices, and their capability of responding through adaptive policies, was greatly influenced by their cognition and understanding, which affected decision-making and the operations undertaken by their organisations. Abo-Gaied (2015) focusing on how the built environment is designed, constructed, maintained and managed within Libyan projects, were based on enduring outmoded practices that were essentially unsustainable under current conditions. Thus, this highlight that there is a need for change, both in procedures and practice, in order to create a sustainable built environment in Libya (Ali, 2016).

Libya is an economy which is experiencing rapid growth and several major development projects were currently under way presenting opportunities to establish a more sustainable development for the future (Elgadi, 2016). Although, in theory, it is possible for sustainable construction concepts to be adopted simultaneously with a project development (Banihashemi, et al, 2017), it is quite difficult to achieve in practice. The challenge remains one of finding the best method of embedding sustainability principles into Libyan construction practices. Studies focused on the assimilation of principles of sustainability into construction projects show that this can be achieved when approached from a methodically conceptual and morally responsible point of view, although it is admitted that it is still an emerging field (Ngab, 2015; Silvius et al, 2017).

Consequently, there is a need to consider and create a practical sustainability method in Libyan construction industry. This research investigates the complexities associated with integrating sustainability in construction sector in Libya, with a sight to developing a practical way forward in organisational approaches and methods to promote practices. This study specifically examines how various construction organisations in Libya apply and integrate sustainability in construction in practice, and discusses typical practice to understand the perceptions of stakeholders and their action or inaction toward sustainable construction.

### **1.3 Aim and Objectives**

The aim of this research is to develop a strategy for the implementation of sustainable construction practices in the Libyan construction industry.

The research aims to achieve the following objectives:

1. To critically review existing sustainable construction practices globally.
2. To evaluate the current status of sustainable construction practices used in Libya
3. To review the benefits of implementing sustainable construction practices in Libya
4. To identify challenges of implementing sustainable construction practices in Libya
5. To conceptualize and validate a strategy for the implementation of sustainable construction practices in Libya

### **1.4 Scope of the Research**

The scope of this research is on how organisations in the Libyan construction industry applied and integrated sustainability in practice,

The research examines the importance and advantages of applying sustainable construction practices to construction industry in general. This is done by assessing developed countries that have adopted the practice and have reaped the benefits from applying this method of construction. The aim will be to identify the major challenges confronting the implementation of sustainable construction and understanding the influence of the Libyan context on the development of sustainable construction practices. The scope of the research is mainly on how to achieve sustainability in the construction industry in Libya.

### **1.5 Contributions of this Research**

The main contributions of this research are, firstly, that a deeper understanding of the current implementation of sustainable construction practices in Libya will be achieved through a literature review; secondly, that the need for establishing sustainable construction practices in the Libyan construction industry will be met; and thirdly, that the successful development of a strategy for the implementation of sustainable construction practices in the Libyan construction industry will enhance construction practice. Although many studies have commented on the weaknesses and challenges to sustainable construction in developing

countries, this study makes a contribution in clearing the way for how economic, environmental and social sustainability can be implemented in a developing country's construction sector through the development of national and local governmental policies and procedures to guide the sector. The current research also signposts future researchers towards various issues which require further exploration in the context of sustainable construction, particularly in Libya.

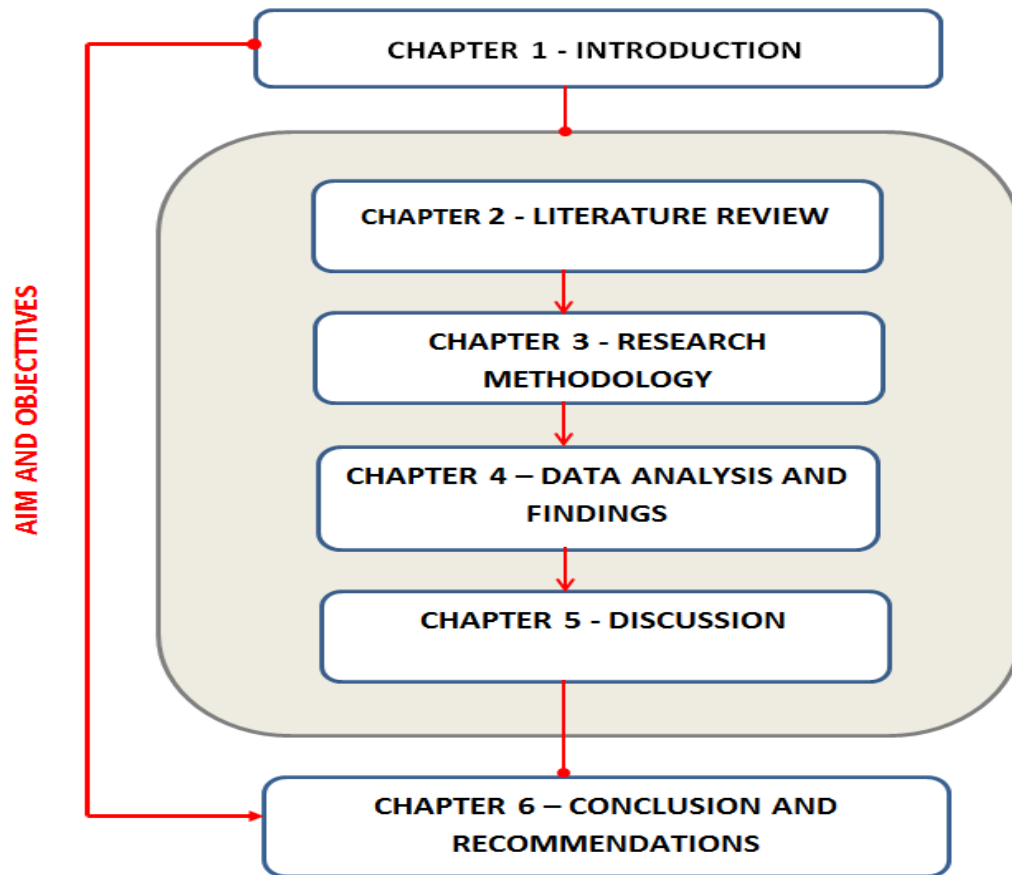
These practical contributions offered by this research point towards solutions to guide professionals in the construction industry to effectively implement sustainable processes across project lifecycles. The study also addresses the issue of the paucity of research into sustainable construction practice in developing countries and considers how such research can raise awareness generally of the need for sustainable practices as well as the benefits such practices can bring. It is also expected that the findings of this study can be helpful in offering guidelines for decision making in the sector.

## **1.6 Structure of the Thesis**

The thesis consists of six chapters; the structure of each chapter is highlighted as follows:

1. **Introduction to the research:** Presents an overview of sustainability and sustainable construction issues, research aim and objectives, research problem and justification, research scope and outline, and structure of the thesis.
2. **Literature review:** This chapter starts with an introduction to the concepts of sustainability and sustainable construction, definitions and the various principles of related terms. The literature review provides the adoption of sustainable construction principles by the overseas construction industries and developing countries. The next section contains benefits and challenges when implementing the sustainable construction practices identified in this chapter.
3. **Methodology:** This chapter discusses all the main steps involved in the research including the research philosophy, approach, choices of data gathering tools and analysis.
4. **Results:** This chapter includes analysis of the data collected during the administration of the questionnaire survey and interviews in light of the research objectives followed by the validation of the strategy.

5. **Discussion:** This chapter discusses the main findings generated from the questionnaires, interviews and validation of the strategy; the discussion is based on the research objectives.
6. **Conclusion:** In this chapter, conclusions and recommendations are drawn from the study based on the main findings in the context of Libya.



**Fig. 1.1 Structure of the Thesis**



## **CHAPTER (2): LITERATURE REVIEW**

### **2.1 Introduction**

This chapter presents a review of rich literature on issues of sustainability, with a particular attention on the terminology, origin, fundamental concept and conventional views on sustainability in general and sustainable construction in particular, among a number of prevailing practices. Furthermore, drawing on the evolving body of sustainability literature, the chapter presents a discussion of the principal issues in sustainable construction, with a focus on its impact on society and the environment.

The literature presented in this chapter was intentionally sampled with the objective of gaining a comprehensive understanding of sustainable construction. This necessitated the collection of information rich literature on numerous sustainability aspects in the construction sector for investigation. Clustered relevant facts in numerous evolving themes, embodied in the several segments of the paper were compared. With regard to the themes that emerged, a continuous selection of literature was carried out until a thorough understanding of each was reached in addressing sustainable construction practices which provided the basis of setting the aim and objectives of this research.

The chapter is divided into six sections: The first discusses a view of sustainability, while the second consists of a discussion of sustainability both in theory and in practice. The third section focuses on examines sustainable construction practice globally particularly in developing countries, followed by a section focused on the benefits of applying sustainable construction practices, and the final section reviews main challenges facing the implementation of sustainable construction practices.

### **2.2 Sustainability - A Historical Overview**

Some scholars differentiate between the abstract concept of sustainability and its more practical applications in terms of sustainable development. One view sees sustainable development as predominantly related to economic progression, while sustainability as a concept tends to be more oriented towards the environment (Waas et al., 2011). Another school of thought emphasises that Sustainability is the situation which sanctions the sustained existence of man, and affords a safe, healthy and productive life in congruence with nature,

native culture and spiritual values, whereas sustainable development is a means to attaining the state of sustainability (Du-Plessis, 2003). Evidently these two definitions complement each other. Nonetheless, the two terms, sustainability and sustainable development are often used synonymously, a situation attributable to the fact that both terms have general positive connotations (Brand, 2004). According to Qto, (2010), a synonymous use of the terms is possible due to the fact that such use is not necessarily connected to their logical construction. Reference is also cited for the German speaking area where sustainability is often used as a short form of sustainable development. All through this literature, the expressions sustainable development and sustainability are employed with no intention of differentiating in meaning concerning the two.

Current understandings of sustainability came into light during the early 1950's at the end of the second world war when economic progression heightened the prospects of a higher living standards all the world over and during the end of the 20th century when remarkable progress in development was observed in many countries (Waas et al., 2011). During the 1950s and 1960s, economic prosperity and increased economic production became the main focus of development. By the early 1970s, the huge and increasing poverty gap in the third world countries, coupled with the inequitable distribution of the benefits of economic growth with these countries led to a renewed attempt and call for more equal welfare dissemination. By the 1980s, the protection of the environmental had become the third major objective of development as it became clear that the stability of the world environment was being threatened by human activities, as a result of unsustainable consumption behaviour, one that portrays extreme disparities (DESA, 2013).

Unsustainable lifestyles also place immense stress on the environment. Towards the end of the 20th century, an epoch of unparalleled scientific and technological advancement, coupled with an exponential population growth which some scholars viewed as humanity exceeding the carrying capacity of the Earth (Rockstrom, 2009) by undermining its environmental state with negative and possibly cataclysmic consequences for current and future generations in many parts of the world (Reid, 2005). Humanity, then became conscious of these imminent threats to the environment, a phenomenon that led to a new orientation with regards to what constitutes economic progression and successful development (Du-Pisani, 2006), and a departure from a laissez faire business as usual exploitative attitude to sustainable development (Waas et al., 2011). In fact, sustainable development came about as a result of new approaches to what constituted progress, environmental protection, economic growth and

development which matured over several decades (Plessis, 2006). The theoretical foundation of modern understanding of the sustainability concept is a product of several scholarly studies, which are interconnected (Waas et al., 2011).

### **2.3 The Concept of Sustainability**

Sustainability has been principally considered from social, economic and environmental perspectives (WCED, 1987; Elkington, 1997), although political and cultural perspectives have also been prominent (Scoones, 2007). However, due to differing theoretical emphases arising from these different perspectives, there are a number of misconceptions regarding the notion of sustainability (Baumgartner and Ebner, 2010; Keeys, 2012; Berardi, 2013). For example, from an environmentalist perspective, sustainability is virtually identical with the maintenance of biodiversity whereas a sociological perspective emphasises issues such as human rights and the development of communities and society at large. An economic perspective gives prominence to the growth of industry and commerce (Ciegis et al, 2015).

Sustainable Development has been defined differently by various disciplines and with different assumptions (the concept embodied therein) about the basic relationship between society and nature (Elliot, 2013). It is believed that there exist more than 200 definitions of sustainable development (Parkin et al., 2003). The numerous definitions of this subject, according to Sourani (2008) arise as a result of increasing recognition of the concept. Nonetheless, there are widespread agreement about the concept's meaning between sustainability scholars and practitioners.

Munier (2005) described this developmental process in the definition above as involving institutions, people, natural resources and the environment, and which is to be implemented collectively and really points towards the future.

Also, and less frequently mentioned is the operational definition of Sustainable Development which defines it as a change process whereby the management of resources, finance, technology and human capital are directed towards a harmonious modus operandi for the benefit of humanity now and in the future (WCSD, 1987).

It could be inferred from the above two definitions that sustainable development takes into account the past, present and the future as a whole system and gives equal emphasis to

human, socioeconomic development and the conservation of natural bio space as observed by Zhou et al. (2006).

However, as shown above, there is currently a plethora of sustainability definitions (Berardi, 2013). Among these is the rather succinct definition given by the Brundtland report as: “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987).

In summary, the glut of sustainability definitions includes many which emphasise certain perspectives but most of which converge on issues of efficiency, equity, long and short-term analysis, intergenerational equity, values and ethics, economic, social and environmental aspects, local and global perspectives. In the following section, the elements of sustainability are addressed.

## **2.4 Sustainability as a Global Demand**

The introduction of the concept of sustainable development by the Brundtland commission in 1987 has been followed by many world events aimed at increasing the awareness on socioeconomic and environmental sustainability (Grober, 2007; Abidin, 2010). The understanding of sustainable development currently embraces the challenges and advantages offered by an increasingly globalised world (Elliot, 2006). Sustainable development currently receives high priority on international agendas as exemplified in the reporting from major UN conferences.

Sustainable development was adopted as a leading development model by the International community at the end of the 20th century (Rogers et al., 2008; Reid, 2005), with operationally directed potential calling for precise orientations of actions. To this day sustainable development has been universally acclaimed as a desirable policy objective among many institutions who are concerned about the future development of the global resources (Elliot, 2006). Furthermore the concept is conceived by many as the appropriate approach to tackle the vast, multifaceted and interconnected environmental and socioeconomic problems and is believed to be an urgent issue in the interest of current and future generations. In the light of this, sustainable development whilst offering a solution for environmental and socioeconomic problems, at the same time it presents a critique of traditional practice and provides guidelines for generating change and achieving positive outcomes (Waas et al., 2011).

There now appears to be a growing commitment to reversing unsustainability (Halliday, 2008). The need for wider consideration in the context of sustainability has now been accepted by governments, organisations, commerce, and the society at large (Abidin, 2010). Sustainable development is now the stated policy of the international community, civil society groups and of much industry and commerce. Sustainable development is also proposed as a major policy goal by international organisations, including the World Bank and the World Trade Organisation. As countries all the world over are striving to make sustainability an integral part of their developmental agenda, businesses are also rethinking the way they operate to minimise their impact on the environment and to be more socially responsible in the setting of economic goals. It is also worth noting that consumers are also showing increased preference for sustainable products and thus green markets are considered to be the markets of the future. Many stakeholders now exercise their power on companies as is evident by the rise in the number of green consumers (Adetunji et al., 2003).

An increasing number of countries are striving to make sustainability a central part of their developmental agenda. A report by the Department of Economic and Social Affairs (DESA, 2013), shows that developing countries have put forward initiatives that are more advanced than those accomplished by their developed counterpart so far. An example is given of Ecuador and the Plurinational State of Bolivia who have enshrined the rights of nature in their recent constitutions. Many third world countries are building their own sustainable lifestyle and consumption behaviour, and offers aspirational models.

In addition, there has been increased awareness among governments and multilateral institutions that it is impossible to disassociate economic development from environmental issues and. Observations have also been made to the effect that many forms of development eat away the environmental resources upon which they founded, and environmental degradation pose a significant threat to economic development. Poverty is regarded as a primary cause and effect of global environmental problems. It will therefore be an attempt in futility to deal with environmental problems without an extensive outlook that incorporates the factors underlying world poverty and international disparity (WCSD, 1997).

However, sustainability is an issue which is being given increasing attention by industry and pressures are increasing for businesses to improve sustainability performance (Belfitt et al., 2011). One of such industry is the construction industry. The section that follows discusses sustainability in relation to the construction sector.

## 2.5 Elements of Sustainability

Due to the complexity and lack of unanimity in its definitions, measuring sustainability becomes problematic even Hamilton et al. (2006) have argued that, if it is to have any coherency as a concept, it must somehow be amenable to measurement.

Apart from the numerous different perspectives on the phenomenon, also involves multiple actors, each of which have their individual interpretations (Carew Mitchell, 2007; Barerdi, 2013).

While sustainable development is by and large regarded as a new development model that became prominent during the late 20th century, the concept in reality, though, is much older (Waas et al., 2011). There exist as many views over the concept as scholars dealing with the subject. According to Munier (2005), the concept is a difficult and complex issue, and an elusive one. His argument is supported by Phillis et al. (2014) who describe Sustainable development as an inherently vague, uncertain, and polymorphous concept whose precise definition and scope still lack extensive recognition.

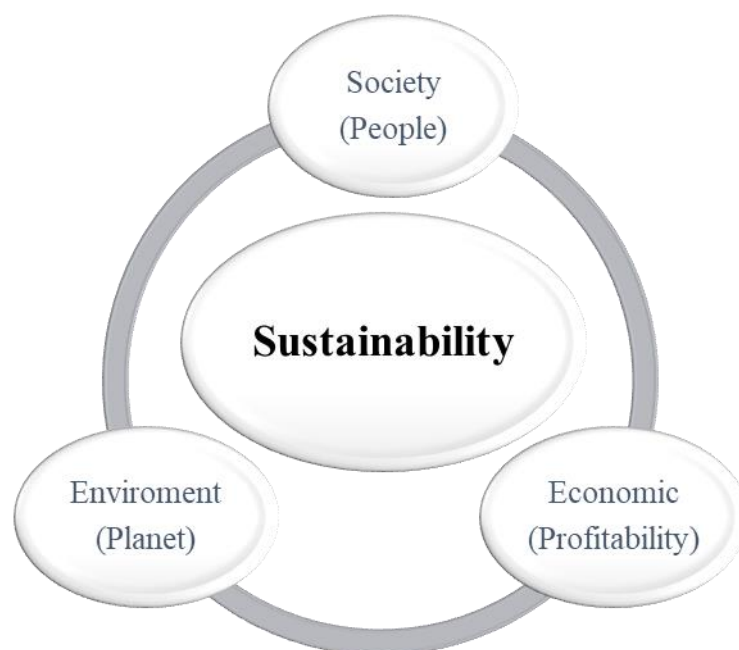
Any approach to sustainability needs to be flexible enough to fit a specific context (Bagheri and Hjorth, 2007; Berardi, 2013). In fact, Brand and Karvonen (2007) have strongly argued for local specificity of sustainable developments, and were strongly supported Placet et al. (2009), who asserted that sustainability strategies needed to be tailored in order to resonate with local interpretations rather than attempting ‘a one size fits all’ approach. Nevertheless, local initiatives should be evaluated using universally accepted sustainability principles.

Despite the many ambiguities associated with understandings of sustainability, it is possible to identify certain key elements or principles. Dyllick and Hockerts (2002) and Keeys et al. (2013) have identified three key elements of corporate sustainability: the integration of social and environmental perspectives alongside economic imperatives into the organisation’s corporate strategy, embracing long-term as well as short-term perspectives, and finally, consuming the organisation’s income but not its capital.

There appears to be great ambiguity in the concept’s interpretation and many reasons have been ascribed to this. As noted by Waas et al. (2011), the normative nature of sustainability, the varied disciplines and professional orientation of scholars dealing with the subject, the scuffle for influence over the concept’s meaning and the applicable means to realize it,

knowing the significance of the concept for future development of society and its prominence in numerous discourse, are all contributing factors.

Nonetheless, most of the concepts developed, however, encompass the idea of three mutually dependent pillars, namely: environmental, economic and social sustainability. This concept is generally referred to as the concept of triple bottom line and have gained wide consensus among scholars of different disciplines and professional background. Barbier (1987, cited in Elliot, 2006) presented these as three interlocking circles. The objective of sustainable development is to make the most of the benefits across all three systems and is demonstrated by the intersection of three circles. Below Figure (2.1) shows the elements of Sustainability.



**Fig. 2.1 The Elements of Sustainability (Elkington, 2004)**

According to Plessis (2007), the three pillars proposed by Barbier (1987) highlight the multifaceted nature of sustainable development. It is argued further that a sustainable development scheme that provides jobs to the detriment of the environment, or a renewable energy development that ignores the environmental and social impact, displaces thousands of people and reduces biodiversity, is a setback to its own purpose.

Generally it could be argued, as did Plessis (2002), that sustainable development must be viewed as an integrative and holistic principle that strives for agreement and equilibrium between the three circles illustration presented above. The section that follows discusses sustainability in relation to the construction.

## **2.6 Construction and Sustainability**

Having discussed the historical antecedent and uses of the term "sustainability", the objective of this section of the literature review is to deliberate on the concept of sustainability within the construction industry and to advance an understanding of the term "sustainable construction".

### **2.6.1 Overview of Construction**

Construction has been defined as "the broad process/mechanism for the realisation of human settlements and the creation of infrastructure that supports development. This includes the extraction and beneficiation of raw materials, the manufacturing of construction materials and components, the construction project cycle from feasibility to deconstruction, and the management and operation of the built environment" (Du Plessis et al., 2002). The construction industry comprises all who plan, develop, produce, design, build, alter or maintain the built environment. The sector also includes suppliers and manufacturers of construction products and material, clients, consultants, contractors as well as end users of a facility (Baloi, 2003).

The industry is counted among the key contributors of national development, furnishing the requisite infrastructure and physical edifice vital for economic and social activities including business, services and utilities. The sector generates employment opportunities and injects capital into nations' economy through the creation of foreign and local investment opportunities (Agung, 2009).

### **2.6.2 Overview of Sustainable Construction**

Sustainable construction, like its parent model, sustainable development, has numerous definitions with none of these definitions being wholly satisfactory (Plessis, 2002; Adetunji et al., 2003). Generally speaking, Sustainable construction is the application of the principles of sustainable development to the construction sector (Sourani, 2008; Opoku, 2011; Adetunji et al., 2003 among others). This argument is supported by Parkin (2000), who describes sustainable construction as a process that incorporates the basic themes of sustainable development. Sustainable Construction provides a platform for the construction industry to contribute towards the attainment of sustainability goals, taking into account environmental, socioeconomic and cultural issues (Shafii et al., 2006). Du-Plessis (2002, cited in Reffat,



2004) noted that Sustainable construction looks beyond environmentally orientated building designs, but more importantly environmentally friendly construction operation and maintenance procedures. She argued not only for the sustainable production of materials but that the sources of such materials must likewise be sustainable. The definition offered by Du Plessis (2002) takes sustainable construction further than just minimization of negative environmental impact, as seems to be the case for other definitions provided.

Sustainable construction has recently become a prominent issue (Berardi, 2013; Carew and Mitchell, 2008). As both 'construction' and 'sustainability' are terms which have wide ranges of meanings, their combination only increases the difficulty of finding a concise meaning (Du Plessis, 2007). Nevertheless, despite its wide range of connotations the notion of sustainable construction has received extensive attention in the literature (Berardi, 2013; Carew and Mitchell, 2007), even to being considered the sector's analogue to sustainable development (Diana et al., 2014), despite the term's lack of concise definition.

A framework based on principles of sustainable construction has been devised by Hill and Bowen (1997) the main thrust of which was to design buildings based on environmental guidelines and economical use of resources. However, this framework was critiqued by Ofori (2007) for its neglect of issues related to developing countries. It received further criticism by Berardi (2013), and Conte and Monno (2012) on grounds of its overemphasis on environmental factors and its relative neglect of other important considerations. Nevertheless, it comes as no surprise that issues such as the efficient use of energy, water and natural resources, waste reduction and pollution are now major constituents of any framework of sustainable construction (Kibert, 2012; Akadiri and Olomolaiye, 2013).

Du Plessis (2007) conceptualises sustainable construction as being a holistic process which reconciles the natural and built environments. Such construction should be such as would be affirmative of human dignity and not just serving economic interests. However, such noble aspirations are tempered by Berardi's (2013) underscoring of the constraints and uncertainty due to the time, scale, domain and social constraints confronting sustainable construction. A balance has to be struck between the competing demands of concerns for the environment and society alongside the economic imperatives of profitability (Silvius et al, 2013). Although this balance is frequently referred to as the 'triple bottom line of sustainability' (Elkington, 1997), several models have been used to illustrate how these three bottom line elements interact with one another. Mitchell (2013) and Dania et al (2013) represented the three sub-system as three concentric circles where the environmental subsystem was the widest circle enclosing the

social subsystem and with the economic subsystem at the centre. In contrast, Silvius et al (2013) used a Venn diagram to illustrate how the three subsystems were interrelated, with the central overlapping segment representing concurrent social, economic and environmental sustainability. Each of these depictions attempt to convey how sustainability involves some interplay of the three subsystems of environmental sustainability, economic sustainability and social sustainability (Carew and Mitchell, 2007).

Notwithstanding these illustrations and their attempts to convey how sustainability involves an interplay of the three subsystems, the problem of lack of agreed definition remains (Ciegies et al, 2015; Baumgartner and Ebner 2010; Berardi, 2013). Nevertheless, attempts have been made to develop assessment instruments of sustainable construction (CIB, 2007; Cole, 2012). These assessment systems have become frameworks of reference for sustainable construction practice (Berardi, 2013). Construction companies are pressured to adopt proactive sustainable strategies through the use of these frameworks even despite lack of clarity of definition (CIB, 2010; GRI, 2011; Akadiri et al, 2012). It is, thus, no surprise that these assessment instruments have their limitations in tending to be biased towards environmental concerns to the neglect of the other elements (Berardi, 2013; Silvius et al, 2013). Given that sustainability involves a long-term evaluation, multi-scale impact and multi-domain criteria, a new paradigm of sustainable construction is emerging and this represents an important evolution from the simple environmental approach.

Pearce (2006) asserted that a more general all-embracing definition of sustainable construction was required and was supported in this assertion by Du Plessis (2005) and the UK Green Building Council (2009). Thus, the quest for a more comprehensive definition that balances the three main subsystems continues.

### **2.6.3 Dimensions of Sustainable Construction**

Many definitions of sustainable construction in the literature include what are referred to as 'dimensions'. Some definitions contain a strong emphasis on the environment (Hill and Bowen, 1997; Priemus, 2002), to the extent that sustainable construction becomes almost identical with environmentally protective building practices.

Nevertheless, there is a large corpus of literature which emphasises other elements, particularly the triad of economic, social and environmental dimensions, but also such additional dimensions as the political, ethical, cultural and managerial elements (Du Plessis, 2004; Pawlowski, 2008; Silvius and Schiper, 2014).

However, Gibson et al (2013) and, earlier, Ofori (1998) and Placet et al. (2005), have pointed out that the particular prominence given to certain dimensions in a particular understanding of sustainable construction simply reflected priorities within a given project. A summary of the prominence given to certain dimensions of sustainable construction by different authors is presented in table (2.1) below.

**Table 1.1 Dimensions of Sustainable Construction**

	<b>Env.</b>	<b>Economic</b>	<b>Social</b>	<b>Political</b>	<b>Tech.</b>	<b>Culture</b>	<b>Mang</b>
<b>Ref.</b>	Pawlowski (2008)	Pawlowski (2008)	Pawlowski (2008)	Pawlowski (2008)	Pawlowski (2008)	Pawlowski (2008)	
	Hill & Bowen (1997)	Hill & Bowen (1997)	Hill & Bowen (1997)		Hill and Bowen (1997)		
	Persson & Olander (2004)	Persson & Olander (2004)	Persson & Olander (2004)			Persson & Olander (2004)	
	Du Plessis (2002)	Du Plessis (2002)	Du Plessis (2002)		Du Plessis (2002)	Du Plessis (2002)	
	Ofori (1998)	Ofori (1998)	Ofori (1998)			Ofori (1998)	
	Silvius and Schiper (2012)	Silvius & Schiper (2012)	Silvius & Schiper (2012)				Silvius & Schiper (2012)
	CIB (1999)	CIB (1999)	CIB (1999)		CIB (1999)		

#### **2.6.4 Sustainable Construction Practices**

From the previous discussion, it is evident that sustainable construction in practice involves the balancing of various priorities especially in providing stable economic returns, the good of individuals and society and the avoidance of causing long term damaging impacts on the environment (Akadiri and Olomolaiye, 2012; Tseng et al., 2013). Berardi, (2013) listed five

essential elements of sustainable construction: acquisition and planning, relevant laws and regulations, new technology, training and the structure of the organisation. These five elements are designed to keep the project on track in accordance with organisational strategy.

Due to increasing insistence on construction organisations to eliminate harmful impacts on the environment caused by their operations (Akadiri et al., 2012), a number of instruments have been created to assess environmental impacts (CIB, 2007; Cole, 2012). These range from energy and life cycle analysis to systems of total quality management (Berardi, 2013). However, these systems tend to neglect assessment of societal impacts although Dempsey et al., (2011) has called for such an assessment based on ethical principles and local heritage and culture conservation.

Assessment instruments provide robust evidence that the needs of humans and the protection of their environment are not being compromised by construction projects (Du Plessis et al., 2002). This includes a clear understanding of what is meant by quality of life as well as the political, technological and economic systems that uphold the quality of life as well as their interactions on the biophysical environment. Du Plessis (2005) has warned about the dangers inherent in a needs driven environment where construction happens without consideration of issues of sustainability. These dangers are of particular relevance for developing countries where the imperative to modernise may lead to developments without concerns for the issues mentioned here simply due to the lack of knowledge of the longer term deleterious effects.

The following section outlines a number of practices whose application would make the construction industry more sustainable. These practices are divided into the three main 'pillars' of sustainability, economic, environmental and social practices.

#### **2.6.4.1 Economic Practices**

Economic sustainability is concerned with the fiscal gains and profitability which a project returns to investors and other stakeholders and ultimately to society by means of a successful project completion (Parkin et al., 2003; Abidin, 2010; Jones et al., 2010). It also addresses economic prospects such as job creation, competitiveness enhancement, and minimal operation and maintenance costs (Baloi, 2003). This sub-section lists practices of economic sustainability. The economic 'pillar' of sustainable construction practices requires that practitioners seek to:

##### **2.6.4.1.1 Reuse Building Resources**

Reuse building resource practice leads to a reduction in waste with less impact on the life of landfill facilities and reducing the need to select new landfill sites. It also reduces the need for raw materials thereby contributing to the attainment of the second practice of reducing resource consumption (Hoffmann, 2014).

Furthermore, waste could become an alternative source of raw materials where products require less energy resulting in higher levels of profitability. Additionally, it would relieve pressure on landfill sites as well as reducing consumption of new materials (Amponsah et al. 2015).

If buildings are designed so that they can be adaptable for multiple uses, instead of having to construct new buildings, existing redundant buildings can be reuse with some modifications (Varma et al., 2014). Where demolition is absolutely necessary, as much reusable material as possible can be salvaged for other projects (Peter & Walker 2014). The aim should be to reuse as much of the structure as possible on another project and to recycle what cannot be directly reused (Pettifer, 2015).

#### **2.6.4.1.2 Reduce Building Resource Consumption**

This practice addresses the underlying cause of much environmental degradation (overconsumption of resources) and relates to all four generic resource inputs, i.e. energy, water, materials and land (Dyllick, and Hockerts 2013).

At each stage of the project life cycle, a strong emphasis should be placed on conservation of energy, water, materials, and land (Kibert, 2012). This calls for the minimisation of embodied and operating energy (Kim, 2014). Embodied energy of building materials and products is the total energy used in the processes of production, from extraction of raw materials to final delivery. Operating energy includes water and energy sources (Leiserowitz et al., 2015).

De Santoli et al., (2017) have pointed out that the energy performance of a sustainable building could be calculated from its use of insulation, the characteristics of technical systems and installed equipment, the position and orientation of the building in relation to climatic conditions, exposure, its own capacity for renewable energy sources and other factors, such as indoor environmental quality.

#### **2.6.4.2 Environmental Practices**

The Environmental sustainability aspect of Sustainable Construction is concerned with the built and natural environment and how these are impacted by the activities of the construction sector (Abidin, 2010; Adetunji et al., 2003; Parkin et al., 2003). The built environment refers to the activities within the construction project itself, whereas the natural environment refers to the bio-space (Abidin, 2010). Environmental sustainable practices advocate for the prevention of harmful deteriorating and irreversible damage to the environment and the ecosystem through prudent extraction and use of natural resources, waste minimisation and disposal, energy and water efficiency among others, thereby reducing ecological impacts today in order to preserve the environment for the upcoming generations (Jones et al., 2010; Adetunji et al., 2003; Abidin, 2010). According to Baloi (2003), the environmental consideration encompasses the design construction, operation, maintenance and deconstruction phases of the construction activity, all geared towards minimizing the adverse impacts on the environment. This sub-section lists practices of Environmental sustainability. The Environmental 'pillar' of sustainable construction requires that practitioners seek to:

##### **2.6.4.2.1 Minimise Pollution and Negative Environmental Impacts**

Many studies recognised special emphasis has been placed on the attempts for reducing waste generation and improving techniques in minimization of the harmful effects of construction activities on the environment (Zhang et al., 2014). Much research has been conducted into environmental concerns in the construction industry, including impacts of rapid infrastructure growth on the environment (Tan et al., 2011).

Eliminating pollution of air, land and water can be achieved at any stage in a project life cycle and can be either global or local in scope. In terms of global scope, reducing pollutants and harmful emissions can avoid causing further damage to the ozone layer and contributing to global warming. In terms of local scope, conservation can be aimed at minimising noise, dust, odour and vibrations as well sanitary waste during construction operations (Srdic & Selih 2014). Finally, the construction industry needs to consider animals, birds and other creatures and to avoid destroying their habitats and possible extinction due to human activity (Yuan 2012).

##### **2.6.4.2.2 Use Recyclable Building Resources**

Gao et al. (2001) defines a recycled building material as “a material, which can be remade and reused as a building material after the building is disassembled”. By expanding the amount of resources which are recycled waste can be reduced with less impacts on landfill sites as well as on the utilisation of new raw materials (Johnson 2012). Whilst non-renewable resources cannot be used sustainably, their ‘life’ can be greatly extended by the use of renewable alternatives where possible (Amanullah& Ahmed 2015).

### **2.6.4.3 Social Practices**

According to Parkins et al. (2003), many people find it more difficult to get to grips with the social dimension of sustainable construction. The social sustainability dimension of sustainable construction practices involves the responsible execution of business based on the principles of ethics, legal, and moral obligations of the construction industry to its stakeholders such as employees, suppliers and the community in which it operates (Adetunji et al., 2003). It aims at the enhancement of people’s quality of life (Baloi, 2003). Social sustainability takes into consideration human feelings: security, satisfaction, safety and comfort and human contributions: skills, health, knowledge and motivation (Abidin, 2010). Social sustainability also requires that construction undertakings and the design of settlements allows for cultural continuity, social inclusion, and other quality of life issues (Plessis 2002). This sub-section lists practices of social sustainability. The social ‘pillar’ of sustainable construction requires that practitioners seek to:

#### **2.6.4.3.1 Apply Indoor Quality Environment**

Since indoor quality environment considered a critical component of built environment as it estimated that people spent most of their time indoors (Wei et al., 2015). Spending too much time indoors presents risks, because of the overexposure to sometimes unhealthy indoor environments, common indoor pollution sources include combustion gases from oil, gas, wood, and cleaning products (Xiong et al., 2015).

Furthermore, the quality of indoor life is affected by the level of absorption of toxins in the air, as well as temperature and humidity. Apart from risks of developing lung cancer due to toxic air, an illness specific to indoor air quality called sick building syndrome (SBS) has been recognized (Jomehzadeh, et al.,2017).

However, care taken with hazardous or toxic substances can improve indoor air quality (Kibert, 2007). This includes keeping the use of solvent-based finishes, adhesives, carpeting

etc to a minimum (Environmental Building News, undated) as these can all contribute to 'sick building syndrome' (Roodman and Lenssen, 2004). This applies also to the use and disposal of hazardous wastes, such as metal polish, paint thinners, ammonia-based cleaners and chlorine bleach, which should not be discarded down the sink or drain, and the use of pesticides and other persistent toxic chemicals to prevent soil and water contamination (Yap, 2009).

#### **2.6.4.3.2 Site Selection and Planning**

Sustainability in construction can govern site selection by ensuring it complies with local regulations and by avoiding sites which are close to noisy environments (Thomas & Costa, 2017). Additionally, every effort must be made to avoid damaging areas which are scenic or which have architectural or cultural value (Price, 2017). Other steps include reducing or eliminating pollution and energy usage (Brotchie, 2017).

A proper site assessment involves evaluating its land and water potential, alternatives for land use and economic and social conditions in order to select and adopt the best land use options. Its purpose is to select and put into practice those land uses that will best meet the needs of the people while safeguarding resources for the future (Yao, 2016).

Planning sustainable sites is an ethical issue due to obligations to future generations. The loss and depletion of natural resources in combination with the expected increase in population can create many problems for the future (Schaltegger et al., 2017). Land is not a simple commodity that can be stored and replaced, destroyed and remade, or even recycled in the same way as manufactured goods. It is a complex biological system, built up over long periods of time (Bergstrom, 2016). The land could have lost its suitability for construction activities or other uses by means of natural or anthropogenic causes. To restore its capacity for beneficial use while protecting the environment, methods of reclamation has to be tailored to the specific need (Fang, 2015).

## **2.7 Sustainable Construction in Developing Countries**

Sustainable construction is a global issue which affects developing countries more than developed countries. Developing countries are often confronted by the task of providing better infrastructure including roads, water supply and sewage systems. Often people's needs are



being met only inadequately in contrast with developing countries where these needs are often being exceeded (Venkatesh, 2015). Another aspect of the problems confronting developing countries is their lack of expertise in environmental matters which tend to be approached from a technological perspective. The ability to innovate and develop new technologies is a greater determinant of economic success than traditional factors of comparative advantage (Hill and Bowen, 1997). However, Banerjee, (2017) has emphasised that technological advances alone were not sufficient and could not be expected to solve all the mistakes made in the past. In most developing countries, government policies concerning buildings tend to be restricted to economic, environmental and spatial planning as aspects of sustainability. The priorities are poverty alleviation, job opportunities, capacity building, and quality without much concern for environmental issues. Thus, their policies of sustainability are currently somewhat short-sighted. Indeed, in many African countries, sustainability is of relatively low priority (Adebayo, 2002).

### **2.7.1 Libyan Construction Practices**

Libyan construction industry has undergone significant changes over recent decades. In early 1950s, public funding was limited as the country emerged from Italian occupation. Construction was of limited scale and value. In fact, many families did their own construction through skills handed on from one generation to the next (Bahar et al 2004).

During the oil boom of the 1970s, the construction industry in Libya played an important part in the country's social and economic development. There was a huge building programme so huge, that at the end of the 1970s Libya was the world's leading per capita consumer of cement in the world. This trend carried on until early 1980s, when the construction industry suffered several setbacks, including the elimination of local private construction companies and their incorporation into the public sector. The construction industry came to the halt in the mid-1980s due to a decline in oil revenues. In addition, rapid social, economic, political and technological changes occurred but there was a lack of the local managerial, financial and technical capabilities (Ngabi, 2008).

In the last four decades, the Libyan construction industry has gone through three stages, which are described as follows:

- **Period One: 1950-1970**

A limited budget and resources characterised this period at the beginning of independence. Construction was based on local building materials. For instance, Cement production in 1958 was only 60,000 tons, while in 1964; cement was used only in 2% of buildings in Libya (Abdu, 2009).

- **Period Two: 1970-1990**

The stage was characterised by high spending on all sectors including the construction industry to meet the urgent needs of the population for houses, roads, schools, and infrastructures. Radical changes occurred in construction processes and operations. The biggest construction movement began in the early 1970s with the transition to a cement based industry. Cement utilisation reached six million tons annually in the seventies (Salah, 2012). Moreover, more than 97% of the construction in Libya used cement-based materials regardless of location, cost, or environmental conditions. Construction activities changed from indigenous activities based on local and dry construction materials to an industry structured around formal organisations and firms that was managed by professions, formal construction regulations, and standard materials (Ali, 2005).

Furthermore, both the public and private sectors were involved in housing construction during the 1970s. Private investment and contracting accounted for a large portion of all construction until new property ownership laws went into effect in 1978 that limited each family to only one dwelling (Kareem 2012). Despite the decline of privately financed undertakings, the housing sector constituted one of the most notable of the revolution's achievements. By the late 1970s, the hovels and tenements surrounding Benghazi and Tripoli had begun to give way to modern apartment blocks with electricity and running water that stretched ever farther into what had once been groves and fields. In fact, the spread of concrete housing on agricultural land is alarming. These high-rise apartments became characteristic of the skylines of contemporary in the main cities and other urban areas. The social impact of these dwellings on society is tremendous.

- **Period Three: 1990-2000**

This period was characterized by an increasing shortage in the housing sector, with demand of houses more than supply. The estimated shortage in 2000 was about 240000 units (Council of General Planning, 2002). Therefore, plans targeted construction of 60000 housing units to meet the shortage in housing. This plan was financed out of the development budget except

the uncompleted houses from previous plans. The expected schedule in 1996 set target of 10000 units, 20000 units in 1997 and 30000 in 1998 (Mohammed, 2013).

However, In the past a few years offering of the oil and gas fields to international investors, increasing income from oil & gas exports and with its vast investment potential Libya still provides significant construction opportunities despite the global crisis (Al-Maamary el al.,2017). However, Libya has become one of the most attractive countries for the international contractors to invest and operate huge construction projects in order to satisfy the needs of developing the infrastructure and improve the contraction sector in Libya. Also Growing oil income has given it the resources to rebuild roads, railways, ports, industrial areas, schools and hospitals that fell into disrepair during its long isolation under UN sanctions (Miludi, 2009).

## **2.8 Benefits of Sustainable Construction Practices**

Many research studies have highlighted the theme of sustainable construction to increase the developers' awareness of the importance of sustainability (Abidin, 2010). According to Chen, Okudan, and Riley (2014), there is a growing concern about sustainable development and sustainable construction practices. Therefore, the researcher categorizes the benefits of using sustainable construction practices based on the sustainability aspects, which are economic, social and environmental. The next sections will present the three main benefits of sustainable construction practices.

### **2.8.1 Environmental Benefits**

Halliday (2008) cited some environmental benefits that accrue to the industry. These Include reducing waste, savings resulting from waste reduction, reduced time in making good environmental damage, reduced risk of legal costs (fines), better company profile, improved tender opportunities, reduced neighbor disputes and reduced demand for resources. The next sub-sections present the three main Environmental benefits.

#### **2.8.1.1 Reduced Waste Production and Increased Recycling**

Robertson (2015) cited that buildings produce municipal solid waste; much of this can be recycled. Reduce waste is considered as one of Sustainable construction practices, which in turn decreases the strain on landfills.

Moreover, using recycled materials in construction practices encourages development of new industries that produce recycled products, further reducing waste disposal needs and the use of virgin materials (Hoffman & Pearson, 2012). Moreover, Hoffman (2001) mentioned that the main sustainable design principles are to reduce waste include the following: Storage and collection of recyclables. The building design should provide space for collecting and storing materials that will be recycled (Spaargaren & Van Vliet, (2013).

Furthermore, in terms of construction waste management, during construction, the contractor can recycle or productively use construction, demolition, and land-clearing wastes and divert these wastes from landfill disposal (Yuan, 2012). Moreover, designers can select environmentally preferable materials that include recycled materials. (Designers should use standards developed by government agencies or other reliable sources.). Likewise, building designers can eliminate unnecessary finishes and make choices that use standard-sized or modular materials. Also building designers should consider product durability in the design process in order to achieved sustainability purposes. When products need to be replaced less frequently, less demolition waste is produced and fewer virgin resources are needed for replacements (Osmani, & Price, 2016).

#### **2.8.1.2 Increase Production of Renewable Resources**

According to Johnston et al. (2017) stated that many sustainable construction practices help impacts on natural resources and ecosystems. Each source of renewable energy has unique benefits and costs; furthermore, several studies mentioned the benefits associated with these energy technologies used in the buildings.

Additionally, it has been internationally recognized to promote innovative approaches for mitigation of carbon dioxide (CO<sub>2</sub>) emissions due to energy consumption associated with building construction and operation. In view of that, the energy performance of sustainable buildings has an immense effect on the sustainable development of the built environment (Ghose et al., 2017).

These arguments are also supported by Wiersma, (2016) stated that sustainable construction practices is highly intertwined with the deliberation of energy. Therefore, renewable energy sources such as solar, winds, and waves, etc. play a substantial role for sustainable construction; on the other hand, sustainable energy sources including the waste to energy sources are highly influential in the enhancement of sustainability (Omer, 2017).

Nevertheless, use renewable resources in preference to non-renewable resources. This benefit can be obtained of both building materials and energy (John, 2016).

### **2.8.1.3 Maintain integrity of environment**

Environmental benefits from sustainable construction that can be fairly easily estimated is lower air pollutant and CO<sub>2</sub> emissions. Emissions are reduced by decreasing energy use through energy-efficient design, use of renewable energy, and building commissioning (Reddy, 2016). The coefficients also indicate the amount of pollution that would be reduced per unit of energy saved. Reducing fuel and electricity consumption in the buildings also lowers CO<sub>2</sub> emissions (Cullen, 2017). In contrast, applying sustainable construction aspects could support industry to reduce methane emissions to the atmosphere. The negative effects of the build-up of gases in the atmosphere may include weather changes impacts on communities and individual's health (Zerrahn, &Schill 2015). In addition to benefits of received by different stakeholders throughout the building life cycle, sustainable construction practices can produce considerable positive environmental externalities (Cole, 2000). Likewise, considering the use of Sustainable construction practices would highly protect the eco-system and biodiversity by means of sustainable land use (Bianchini and Hewage, 2012). Furthermore, (Zhang, 2015) stated that considering Sustainability in construction would reduce waste and carbon dioxide emissions during construction, operation and demolition phases.

### **2.8.2 Economic Benefits**

The major economic benefits of sustainable construction are reduced operation and utility costs, low maintenance cost, and general improvement in the buildings performance and efficiency. Research has shown that there is a direct and positive relationship between sustainable product and business competitiveness and highlighted that implementation of sustainable construction practice contributes to the improvement of contractors' competitiveness (Baloï, 2003).

Yi and Berry (2017), also confirmed these economic benefits to constructing sustainable construction siting energy cost savings, water cost savings and mechanical equipment slim down. Dobson et al., (2013) also observed that the business benefits of sustainable construction come in the form of capital cost savings, reduction in running costs, higher

investment proceeds, better productivity, staff recruitment and retention, more efficient resource use; better corporate image and marketing spin offs.

### **2.8.2.1 Reduce Overall Building Lifecycle Cost**

According to Miah & Stone (2017) stated that Lifecycle Costing (LCC) quantifies the total “...costs and benefits over the life of a particular product, technology or system”.

Of interest is the fact that Life cycle costing (also referred to as whole life costing) is a popular theme that runs through the concept of sustainable construction. It refers to the cost of an asset throughout its life and takes into account planning, design, acquisition, operation, maintenance and disposal, less any residual value (Higham et al., 2015).

The savings are predominantly realized through reduced utilities costs and savings in operations and maintenance of the building, the calculation for which is a simple act of subtracting the projected utilities and maintenance and operations costs savings over the useful life of the building from the total direct costs associated with the building components and subsystems Utilities Savings - As the cost of energy and water increase, there is more economic motivation by the owner to reduce utilities costs over the lifetime of the building. A reduction in energy use (both gas and electricity) and both internal and external water consumption (including sewerage) may reduce operational.

However, according to Kutnar & Hill (2017) Sustainable construction plays a vital role in the development of the building Life cycle costing. Working Group for Sustainable Construction (WGFSC, 2001) reported life cycle costing was proposed as one of the practices for raising the level of sustainability in construction. Given the objectives of sustainability it could be argued that a built asset that has a low initial cost, but which will result in a high running and maintenance cost to end users is not sustainable. Life cycle cost is, for that matter a necessary tool for the design of assets that are more consistent with the concept of sustainable construction (Liu & Yang, 2017).

### **2.8.2.2 Decreased initial costs for reused and recycled materials**

Renewable resources invariably have even greater benefits if life cycle costs, not simply capital costs, are considered (National Energy Council 1992). Significant gains and cost reductions can be obtained from reclaiming disused materials as well as avoiding placing landfill sites under pressure. This practice has positive impacts on the environment including the minimisation of the risk of water pollution. In fact, even though there is a cost implication

for reclaiming used materials, it is frequently less expensive than purchasing new materials (Bringezu, 2017). Furthermore, construction and demolition waste generators (contractors, dealers, and owners) can expect lower material and disposal costs in the long term. With the development of new markets for their debris, waste generators may also have new sources of revenue. On the other hand, the cost of purchasing salvaged materials is generally lower than that of comparable new products (Dolan et al., 2009). Therefore, waste recovery is considered economically and ecologically the most beneficial approach for the management of sustainable construction and demolition waste (Rhyner et al., 2017).

### **2.8.2.3 Reduce building resources consumption costs**

Dincer et al. (2017) stated that it has become necessary to balance the rising demands on global natural resource consumption with the 'carrying capacity' of the physical bio-space, especially in the light of the conflicting scenario of the rapid depletion of global natural resources and the ever increasing world population. In fact Cost savings through reduced energy and water consumption and lower operation and maintenance costs are the main benefits of using sustainable construction (Rahman et al., 2017).

Furthermore, as energy-efficiency is one of the defining features of using sustainable construction practices, research on cost savings always focuses on assessing the reduction in sustainable buildings' energy consumption compared with conventional code-compliant buildings (Ries et al., 2006). Furthermore the benefits of Sustainable Construction practices are either long-term or intangible, for instance reduction of operation cost during the building service life (Eichholtz et al., 2013; Yung & Chan, 2012).

### **2.8.3 Social Benefits**

Riffa et al. (2016) found that the community can gain from sustainable construction through improved quality of well-being as a result of eco-friendly activities which result in buildings of elegance which enhance the experiences of individuals and the community.

Research into benefits of sustainable construction practices for individuals and the community has highlighted on three issues of special benefit namely: health, comfort, and Productivity. Typically these three issues are intertwined yet involve distinct philosophies and approaches (Zhang et al. 2017).

Issues of health, comfort and Productivity have been addressed by architects and designers with a view to ease of use as well as elegance and ambience This has been the particular

domain of environmental experts, who focused on physiological matters, as well as social psychologists have considered well-being and environmentally related mental health (Chegut et al., 2014).

### **2.8.3.1 Enhance building occupant health and safety**

It is widely agreed that the health benefits of sustainable construction focus primarily on indoor environmental quality, especially air quality. It is a well-known fact that health effects result from environmental stimuli interacting with the body's physical systems, especially respiratory, skin, neural, and visual pathways (Cross & Mayer, 2017).

Additionally, Amasyali and El-Gohary (2016) also recognise that illness symptoms occur because environmental agents (such as chemicals or airborne microbial) affect the operation of the body's physical systems in vulnerable persons. Many studies have found high levels of air-quality problems and occupant illnesses in office buildings. For instance, Zhang et al. (2017) cited studies have begun to assess the causal relationships between the building environment and illness symptoms in three areas, sick building syndrome, asthma and allergies, and communicable and respiratory diseases.

While, A recent study found that occupants in green-certified buildings could score 26% higher in cognitive function tests, report 30% fewer symptoms of sick building syndrome, and enjoy 6% higher sleep quality than those in high-performing but non-certified buildings (Harvard gazette, 2017).

### **2.8.3.2 Improve Satisfaction of Occupants**

Shove et al., (2006) indicated creating thermal comfort for building users is a primary purpose of the sustainable construction practices and this has radical influence on the whole building industry. In addition, Cole et al., (2008) claim that considering sustainable construction practices allow building users to achieve their comfort goal. He added that people adapt more readily to thermal environments with which they are familiar, also the building should therefore be designed to provide a thermal environment that is within the range customary for the particular type of accommodation, according to climate, season and cultural context.

In fact, Psychological effects such as comfort, satisfaction and well-being are generated through perceptual and sensory processes that interpret environmental information in terms of its effect on current needs, activities, and preferences (Collins 2003).



Nevertheless, Building Occupant comfort and satisfaction with building conditions are a main focus of post-occupancy evaluations. As a result, many researches generally showed that occupants' satisfaction with lighting and air quality is higher than their thermal and acoustic satisfaction (Leaman and Bordass 2001). Moreover some assessments have also found that satisfaction with electric lighting increases with reduced glare problems and with increased brightness of vertical surfaces, including walls and cubicle partitions (Collins et al. 2013).

Nonetheless, it is a well-known fact that better daylight is especially beneficial and reduces stress, provide mental relief, improve perceived quality of life, and enhance emotional functioning (Ulrich 2004; Clearwater and Coss 2004).

Markedly, Deuble and de Dear (2012) cited that occupants' satisfaction about the built environment was positively associated with environmental beliefs. Compared with unsustainable occupants, occupants in sustainable buildings were more inclined to overlook and forgive less-than-ideal conditions and thus presented a higher degree of satisfaction

As mentioned previously, researches showed that sustainable buildings significantly outperformed non-green ones in terms of temperature, relative humidity, background noise, and luminance under natural lighting conditions (Zhang et al., 2016).

### **2.8.3.3 Better Individual Productivity of Occupants**

Many researchers use surveys to investigate differences in productivity levels between green and conventional building occupants (Ries et al., 2006; Zhang and Altan, 2011). Sustainable construction attributes of buildings can enhance indoor environmental quality, therefore resulting in better and ultimately more productive occupants (Issa et al., 2010; World Green Building Council, 2013).

With the aim of supporting sustainability features, Ries et al. (2016) studied a manufacturing company who moved from an old conventional facility to a new green facility. A pre- and post-move survey on the employees' satisfaction and productivity was conducted using the Likert scale method. The responses from 45 employees in the company were analysed with paired t-test, showing that employees in the green facility were more satisfied with temperature, humidity, airflow speed, visual conditions and air quality than were employees in the conventional facility (Zhang and Altan, 2011).

Moreover, some studies suggest that application of sustainable practices can be beneficial, especially those that improve productivity of the individuals in the work environment, thermal

comfort and personal control of ambient conditions, result in increasing productivity by 6% to 25% and decreasing absenteeism by 15%-25% (Paul and Taylor, 2008).

Furthermore, some studies showed that certain building features such as daylight, views, connection to nature, and spaces for social interaction, appear to have positive psychological and social benefits. The benefits include reduced stress, increased communication, and an improved sense of belonging (Leather et al. 2012).

Meanwhile, the psychological "interpretation" of the environment has consequences for work performance and productivity stress, and well-being because of the inherent variability in psychological responses; the same environmental conditions can affect different people in different ways as well as affect the same person differently over time, depending on the context (Sieber et al. 2016).

In contrast, Carter (2015) stated that, sustainable construction practice significantly aim to improve comfort and satisfaction of building users because discomfort has negative consequences for work effectiveness, job satisfaction, and quality of work life.

## **2.9 Challenges of Implementing Sustainable Construction Practices**

Following sub-sections will discuss some challenges to sustainable construction implementation.

### **2.9.1 Challenges related to Regulations**

The effects of regulatory challenges relating to the successful application of sustainable construction have been well recorded (Dania et al., 2013). They are widely recognised as **“government policies/support, building codes on sustainability, government commitment, and legislation”** (Rydin et al., 2006). Furthermore, Akadiri (2015) believes that government regulations and **building code** restrictions play a vital role in the influence of sustainable practices amongst construction professionals.

Whilst there are many recognized regulatory challenges, several researchers including Du Plessis (2002) stated that the challenge of enforcement and implementation calls for the need to radically improve the capacity of government institution to play active role in developing and implementing policies and legislations that encourage sustainable construction. Additionally, Rohraher (2001), argue that there is still a need for the construction authorities and other public players in the construction sector to become more involved. For instance,

Djokoto et al., (2004) posit that the concept of sustainable construction could be more successful if stakeholders including the government, were to set up legislation that requires the collaboration and cooperation of sustainability policies. As well as the development of numerous policy documents, thus resulting in the enforcement of sustainability in all parts of the development. Since both the commitment and support of the government and the formation of legislation is vital for the accomplishment of sustainable construction practices Tan et al (2011).

Furthermore, as there are numerous notable advantages related to sustainable design and construction, there is a need for both the governments and agencies to spearhead the campaign through the progressive incorporation of sustainable design and construction practices. By using this new cooperative legislation in construction projects, this could then encourage private companies and individuals to repeat the practices (Djokoto et al., 2014).

The steering of construction by issuing legislation comprises of several types of instruments. Including normative and informative regulatory instruments, economic and market based instruments, fiscal instruments, incentives and voluntary action. The normative regulatory instruments include building codes. While, the informative regulatory instruments are tools such as mandatory labelling. Regarding the economic and market based instruments, examples include certificate schemes. Whereas, fiscal instruments and incentives could be support and taxation. Finally, voluntary action involves programmes including public leadership (Koppel & Urge-Vorsatz, 2007).

Notably, the type of steering applied impacts on the sustainable construction practices. With the promotion of sustainable construction being endorsed somewhat with the support of regulations. Moreover, due to the 'fragmentized nature' of the sector and the considerable number of players involved this could cause a situation, "where regulations are considered as the only possible way to proceed" (Nelms et al., 2005)

Nevertheless, rigid normative steering mechanisms could instigate the implementation of sustainable innovations. There are two types of regulations; prescriptive or performance-based. With the latter method widely believed to be more effective as it supports innovation. Even though, it can be a challenging task to define performance (Meacham et al., 2005).

One of the reasons for the setting of more rigid regulations could be because they are focused on new buildings rather than the present and existing building stocks (Koppel and Urge Vorsatz, 2007). Dewick & Miozzo (2002) argue that 'both innovation and regulation' are

required to push ‘the industry towards a more sustainable future. ‘With fiscal approaches and economic incentives helping to inspire innovation. Thus, generating a call for newer alternatives. Additionally, Pitt et al. (2009) when ranking the importance of eight different topics as challenges chose fiscal incentives and regulations amongst them, as key tools in implementing sustainable construction practices.

On the other hand, Priemus (2005) highlights the significance of institutional challenges. With insufficient ecological incentives in the taxation system and “the fragmentation of responsibility in the construction and real-estate (property) sectors” as main challenges. Furthermore, Häkkinen, & Belloni (2011) stress the importance of sizable strategies and programmes, as tools and building codes to encourage sustainable construction. Specifically, large holders and developers should be goals for such programmes, along with design/build contractors. In terms of required activities, regulations could be adapted such as compulsory statements regarding to the work carried out. Nonetheless, there has already been extensive commitment to management advancement approaches related to sustainable design involving the building trade, researchers and standardization groups.

However, with the aim of supporting sustainability features in marketing, labelling systems have now been developed (e.g. BRE Environmental Assessment Method (BREEAM) (2010) in the UK, Leadership in Energy & Environmental Design (LEED) (2010) in the US and Promis E (2010) in Finland). According to Davidson & Lockwood (2008) the move towards ‘green buildings’ first started in the US, in 2007. Since then it has positively impacted on the market value of properties and decreased environmental risks.

### **2.9.2 Challenges related to Finance**

It is widely recognised that some of the most significant and influential challenges in the implementation of sustainable construction practices are financial. According to Häkkinen, & Belloni (2011), these challenges identify **increased initial investment costs and financial resources** as key components. Furthermore, many researchers have addressed lack of financial resources as a major challenge to provide measures to improve sustainability in construction. Although the advantages in the long haul are identified as an initial investment increment, perceptions of these benefits are not measured in terms of financial return. Instead the focus is on the environmental and social assistance, that recent methodology or technology can help to deliver (Nelms et al., 2005).

**The lack of availability of financial resources** for sustainable projects doesn't support to evade the risks of unanticipated costs and is frequently cited as a challenge for the application of sustainable practices. With financial and incentive solutions encouraging the adoption of sustainable practices, as clients become concerned with the higher risks related to traditional building due to "the lack of previous experience, additional testing and inspection in construction"(Hydes and Creech, 2000; Larsson and Clark, 2000; Nelms et al., 2005).

Moreover, Ala-Juusela et al. (2006) argue that "energy-efficient buildings offer major cost savings during operation", a fact that is frequently overlooked. Demonstrating this argument by using genuine cost data involving a wide array of technologies and design solutions, to produce a cost analysis that opposes the supposition of excessive costs related to energy efficiency. Thus, proving that considerable advances in energy performance could be realised without the added costs normally associated with this field. In addition, Bon and Hutchinson (2015), Hydes and Creech (2000) and Zhou and Lowe (2003) also maintain that core challenges in the execution of sustainable practices, include the preconception of acquiring **higher capital costs** and insufficient market values. While, Hwang (2017) argues that the philosophy of life-cycles cost assessment is regularly overlooked due to a lack of benefits, when being bought upfront or insufficient discounts compared to traditional materials. Furthermore, Bartlett and Howard (2013) believe that there have been miscalculations regarding energy-efficient measurement capital costs, which has simultaneously undervalued the possible savings. With the likelihood of additional reductions arising from either a discount in expert payments or as an indirect saving as a result of the design team and contractor's knowledge of sustainable design methods (Hydes and Creech, 2000).

Furthermore, more up to date studies carried out by Sodagar et al. (2008), Sayce et al. (2007) and Lam et al. (2009) also suggest that, one principal challenge for the wide spread acceptance and use of sustainable building design is the possibility of overcoming supplementary construction and services additional costs. To do this, it is suggested that financial incentives and pioneering fiscal arrangements become readily available, with additional costs being settled by the assistance of financial provisions and/or reimbursed through increased rent at a later stage.

In contrast, Carter (2007) focuses on the economic benefits of producing sustainable buildings; including a reduction in waste, the ability to predict future legislation, capital investment access, and the added benefit of an improvement in reputation and brand. While,

Cole and Sterner (2013) report on the significance of life-cycle costing (LCC) methods in sustainable building projects.

Stating that the reasons for it being overlooked include a deficiency in both motivation and dependable facts, as well as limitations in the methodology. Yet, criticism towards LCC has also been raised, as it does not include areas such as the natural environment, which have no owners (Gluch and Baumann, 2004).

Meanwhile, Kohler (2008) stated that, when a cost-benefit analysis is employed to buildings, the costs and benefits are linked to a range of individual owners and users. However, the buildings could create a 'collective good' by producing additional social costs and benefits.

Therefore, to encourage investment in sustainable buildings, clients should focus on the positive effects such as an increase in market value, as well as the use and value of the building. Although, this could prove difficult to ascertain, as certain features such as energy efficiency and low environmental impacts may not be immediately recognisable. Nevertheless, Waddel (2008) believes that enhanced energy efficiency and its consistent lower operational costs, have become a factor that improves both a building's attractiveness and its market value. With increasingly more financial institutions, beginning to rate both the environmental and social impact of the building as valuable.

Nevertheless, in comparison to the construction of traditional building projects, green developments still involve higher costs. With Tagaza and Wilson (2004) estimating that capital costs are from 1 to 25% higher for green projects. These increases are mainly owed to design complexity, as well as the modelling costs required, to effectively incorporate green practices into projects (Zhang et al., 2011). Furthermore, higher costs are related to green materials and the use of green construction technologies (Hwang and Tan, 2010). As a result, Zhou and Lowe (2003) claim that, the advancement of sustainable construction presents numerous economic challenges because of the misunderstandings of the economic benefits available. Moreover, it is a well-known fact that sustainable construction projects do involve large investment costs, in comparison to more conventional building practices (Hakkinen and Belloni, 2011). However, this shortfall could be resolved with a whole life cycle costing technique, which moves "from cost to value and from short-term to long-term cost perspectives" (Al-Yami and Price, 2006).

Notwithstanding, **financial resources** have been referred to as the most common challenge in the execution of sustainable construction (Sodagar and Fieldson, 2008; Hakkinen and Belloni,

2011). With the perception of it being more expensive in terms of capital costs, acting as a huge barrier towards its implementation (Zhou and Lowe, 2003). Moreover, a focus on price during the procurement stage of products and services, also hinders the process (Adetunji et al., 2003). Therefore, the successful application of sustainable design and construction in the built environment has challenges. With the principal challenge being the requirement of reasonably priced initial construction cost premium compared to that of ordinary buildings.

### **2.9.3 Challenges related to Management**

Good management and leadership skills are essential to the success of sustainable construction practices, with this challenge being identified as **leadership ability and effective communication**. It is a well-known fact that management and leadership of the construction industry and individual organisations play a vital role in accomplishing effective application of innovative strategies (Nelms et al., 2005). With success resting on the commitment of the manager and leader, when developing and executing an effective plan and providing essential resources and support needed to manage deviations arising from it. Importantly, deprived of this support and innovative management and leadership, the process could face many complications (Osaily, 2010).

Possible process-related challenges include “models of cooperation and networking, models of communication, roles of different actors, decision making and management processes, and scheduling” (Häkkinen & Belloni, 2011). Furthermore, both the right timing and presence of all required players, are frequently highlighted as fundamental necessities for project success. With much research stressing the significance of expertise availability and knowledge from the initial project steps. As a significant part of sustainable construction potential could be lost when the possibilities and right design selections are not well-thought-out early enough. Not only is this essential for the building projects, but also for the prior planning processes (Rydin, 2006).

Furthermore, Johnsen, & Drevland (2016) also refer to the importance of early adoption of sustainable construction objectives, along with the selection of an experienced design and construction team and effective communication. Stating that haste should be avoided, as it is far more important that all the team members ‘share the same goal’. Along the same theme, Wiryia et al., (2017) stress that scheduling is vital as, “sustainability in construction is hindered if designers are involved in the process too late. “With Riley et al. (2003) pointing out that construction organization networks should also be involved and part of the team, especially in

the design process, as this would then enable the inclusion of ‘essential estimating services’ during the initial stages.

Another significant factor is **leadership** ability, with Uher (2014) highlighting the resourcefulness that a project manager should have. By emphasizing the fact that the project manager needs to be able to represent the client and establish evaluation processes. In addition, as one of the challenges of process innovation is the end-users’ active involvement in demand specification, competent management of end-user participation is essential. Mills and Glass (2012) recommend some of the skills needed to manage or lead the design of a sustainable building, including “awareness, communication, comprehension, experience, lateral thinking, leadership, negotiation, passion and technical knowledge.”

As mentioned previously, the members of the project team are extremely important and should be chosen wisely, as the implementation of sustainability in construction necessitates effective communication and efficient cooperation. There is a need for strong collaboration and communication between suppliers, professionals and users. This is because for a project to be a success there is a need for all design, construction and user behavior areas, to have significant compatibility. Although models of cooperation can be enhanced using integrated methods and information technological solutions, Sustainable construction also entails the involvement of various players in different process tasks and stages along with real team working. As Rydin (2006) states, “one of the big challenges of sustainable development is that it leads to innovation, new knowledge and learning within organizations.”

Additionally, Horman et al. (2006) also argue about the significance of cooperation in sustainable projects. One suggestion is the usage of design–build–operate–maintain (a method that incorporates all the designers, contractors, operation and maintenance managers, under one contract to the owner). While, Deane (2008) suggests that a preferable design model could be an integrated design process, involving all parties (owner, developer, designers, builder, tenant and facility operator) from the beginning. Stating that there is a need for “intense interdisciplinary collaboration, highly complex design analysis, and careful material and system selection already in early phases of the project delivery process.”

However, Ballard and Kim (2007) call attention to the fact that the power to enforce or actualize a project roadmap is apportioned approximately in the following order: owner, owner agent, process manager (design and construction), specialist (design and construction), and supplier. Even though everyone involved can act, there are limits to their own power, to



generate more value and less waste. Therefore, the present construction sector is distinguished by an intricate supply chain, where the various actors may have competing interests. Notably, as a result this could hamper the consideration of sustainability requirements. However, one suggestion is that the public sector could be used as an example to help initiate a change in the construction supply chain, thus encouraging “better cooperation and joint goals” (Anon., 2007).

Markedly, sustainable practices in construction can be effectively implemented if there is first-rate communication between individual actors and companies as well as management and leadership ability. Therefore, for ecological ideas to be carried out at all organization levels, it is crucial that the environmental key players are authorised with **decision-making** mandates (Stenberg, 2006). Furthermore, Hong-Minh et al. (2001) explain that the strong division of an organization’s department hinders the possibility of it being fully end-customer focused, because “there is no holistic view of the supply chain. “As a result, firms should use and enable the sharing of information as a good practice, to take advantage of learning from the experiences of others. Additionally, Gibson (2006) suggests that knowledge management and sharing are both essential challenges, for innovations in big construction companies.

Nonetheless, communication is particularly crucial for green projects, to carry out the sustainable practices needed. Thus, interest amongst team members is imperative. (Tagaza and Wilson, 2004). This is due to the complex procedures and construction methods that green technologies require (Zhang et al., 2011). When these complications are not fully resolved, this can affect the project manager’s performance. Therefore, Monahan & Clarke (2004) suggest that **technical abilities and IT skills** are two of the key challenges in green construction, which can be gained during the construction development. As the design is generally more intricate than that of a traditional building because of the alternative materials and systems used (Hwang and Tan, 2012).

#### **2.9.4 Challenges related to Technology**

Another key challenge required in the implementation of sustainable construction practise is that of technical challenges, which incorporate sustainable **material information accessibility**, easily available guidance, and technical capability. These challenges are classified as technical as they have an immediate impact on the application of sustainable construction values (Hydes& Creech, 2000).

Markedly, Rydin et al. (2006) state that, construction industry designers are often uncertain and less confident, when confronted with sustainable construction design issues. This would point towards the need for built environment professionals to become more familiar with sustainable construction principles, to fulfil its practice. Moreover, another issue according to Osaily (2010), is the availability of locally sourced 'green' building products, for instance advanced glazing systems, which have proven problematic for many sustainable construction projects. This has resulted in products having to be imported from elsewhere, either through the project team or a locally approved distributor in many cases. As Sabboubbeh & Farrell (2016), states, there is a necessity for technical data in the correct format to be readily available for design professionals, as well as the contractors ultimately accountable for executing the design. Efficient and effective use of this data requires an approach that enables the management and sharing of it.

In addition, a crucial issue required by project teams to affect change, when creating more sustainable construction projects, is mastering the complications of capturing and managing the data (Shelbourn et al., 2006). According to Kohler and Lutzkendorf (2002) decisive issues for design tools include; scope, addressed performance aspects and the grade of integration within the design environment. (Sullivan et al., 2004). As a result, the design stage needs powerful approaches (De Jonge, 2005). Whilst, the present sustainable construction practices rating procedures do provide pointers for designers, as well as service life prediction methods, energy consumption estimation methods and life-cycle assessment tools. However, these approaches require a considerable amount of extra work, with the availability of automatic calculation systems and information accessibility causing further issues (Tucker et al., 2003). Additionally, access to needs integrated methods is also required, so that it can provide product information and allow easy comparison of design options in the initial design stage. One possible solution that will partially address this issue is access to the Building Information Models (BIM) as advocated by Kiviniemi (2010) and Hakkinen & Kiviniemi (2008).

Presently, assessment procedures are normally completed at the final stages of the design project. However, environmental concerns should be investigated and thought out during the early design stages, as instructional changes could prove to be unnecessarily expensive. Moreover, according to Ding (2008) there is a need for assessment tools be modified, so that there is no reliance on unavailable detailed design data. Additionally, environmental and financial problems need parallel consideration as part of the evaluation framework. Notably,

an integrated approach to sustainability can be realised, that recognizes the various aspects in all choices (Sodagar and Fieldson, 2008). An industrialized building process can be defined by two key elements: an efficient information management approach and a building concept-based approach (Hakkinen et al., 2007). Not only are effective tools required in the operational phases of buildings and other construction assets, but also in the operational phases of buildings and other construction assets. Hence, “tools are needed that support understanding about the value, risks, remaining service life, needed maintenance and optimal scheduling of life-cycle operations of buildings” (Vanier, 2001; Lutzkendorf and Lorenz, 2007).

As mentioned previously, the use of green materials can be significantly higher than conventional construction ones, with Zhang et al. (2011) calculating that they cost from 3% to 4% more. Whilst some green materials cost significantly more, for instance “compressed wheat board costs about 10 times more than ordinary plywood” (Hwang and Tan, 2012). These excessive costs impact directly on the project manager, who is accountable for managing and delivering projects within an allocated budget (Ling, 2003). Furthermore, several studies have confirmed that the use of green technologies raise issues for developers, clients and contractors respectively. Eisenberg et al. (2002) suggest two reasons for this, which are inadequate knowledge or technical expertise and inexperience with the products, materials, system, or design. The principal factor is that green technologies appear to be more complex and dissimilar from traditional ones (Tagaza and Wilson, 2004). This concept has also been affirmed by Zhang et al. (2011).

Since a project is delivered by the project manager, according to required client performance specifications (Ling, 2003), a lack of knowledge or **familiarity of green technologies could detrimentally impact on the outcome of the performance**. Also, there are numerous challenges associated with green building materials and products, including familiarity, **availability and green product costs**, as well as trust in the quality of the ecological materials and products (Ojo & Akinlabi, 2014). The central consideration when realising more sustainable construction practices, is the performance of the building. Therefore, the use of correct materials is an essential element in the building sustainability and its contribution to economic success.

It is widely agreed that building materials have a considerable impact on the environment, this is largely due to the huge quantity of non-renewable resources used, and that has the potential to deprive future generations of their resources (John et al., 2005). Likewise, construction materials impact the environment during their life cycles. Through the mining of raw

materials to demolition waste disposal, several types of pollution are formed, with detrimental effects on land, water and the atmosphere. These raw materials then need to be processed to be suitable for use within buildings, with the process frequently consisting of vast amounts of energy utilization and expenditure (Ofori, 2002).

Significantly, (Darko & Chan, 2017) as certain several challenges to integrate sustainability into material selection practices. **Including education and training**, perceived cost, time to source materials, understanding and in-house experts. With material knowledge, authenticity of suppliers, and the understanding of the impact of the materials also recommended.

### **2.9.5 Challenges related to Awareness**

**Good awareness and knowledge** also is a vital challenge for on the success of the implementation of sustainable construction practices (Häkkinen and Belloni, 2011), these challenges were identified as a collective understanding by the stakeholders about “sustainability, professional knowledge and awareness of clients, and **education and training**” (Williams & Dair, 2007).

Moreover, Mousa (2015) identify evidence that a lack of mutual understanding is an experience shared by most stakeholder groups in the construction industry. While, in several cases, stakeholders have admitted to being unaware or unknowledgeable about sustainable measures or alternatives that fell within their remit. Likewise, the installation of sustainable technologies and materials, require new methods of competencies and knowledge. Although it was apparent from the research gathered that not all those with responsibilities in this area had the required experience or expertise to meet the challenge.

As mentioned previously, the construction industry consists of diverse actors with different opinions (clients, consultants and contractors), so it is essential that they come together and work as a team to guarantee the successful completion of a project (Williams & Dair, 2007). Additionally, as the demand and inclination of clients can eventually determine the development of sustainable buildings, they are interrelated to issues such as supply, knowledge, methods, and costs and value. Bon and Hutchinson (2000) state that, few investors deliberately seek to invest or have a desire to own sustainable buildings. As the wide content of sustainable construction increases the difficulty of assessing the profitability or cost impacts of the buildings. (Stenberg, 2006). Therefore, a collective understanding of sustainable practices by the stakeholders could enhance collaboration, in turn improving the creation of innovative solutions.

Rydin et al. (2006) assert that whilst designers in general demonstrate confidence when accessing and using knowledge, this confidence tends to decrease when sustainable practices are adopted. While, Mills and Glass (2009) believe that there is a requirement for the project's brief to be clearly communicated. In addition, Sodagar and Fieldson (2008) indicate that to design a truly sustainable building, it is necessary for the design team to have access to the best available information on products and tools and that this information ought to be transferred and used in the calculations as well.

As discussed in the previous sections, sustainable construction projects need close working interaction with the whole project team, from the design to the completion stage (Riley et al., 2003; Hakkinen and Belloni, 2011). However, many construction organizations related to the implementation of sustainable practices, continue to believe that this will result in increased risks, along with complications to obtaining financial support and an absence in the awareness of market value (Zhou and Lowe, 2003). The construction industry is client driven and this plays a key role in the implementation of sustainability. Hence, one of the main challenges is that, the awareness of clients and their demand for sustainable buildings will impact on the agenda towards sustainable construction (Pitt et al., 2009).

Of interest is the fact that, Landman (1999) identifies one of the biggest challenges in sustainable design and construction as the attention and awareness shown by clients, including owners and developers. This challenge is in correlation to the initial cost premium of a sustainable building and the clients' knowledge and awareness in relation to the available benefits of sustainable design and construction. Whilst, lower innovation levels amongst construction professionals such as architects, engineers, and contractors are known to delay the widespread growth of sustainable design and construction (Richardson, & Lynes, 2007).

Consequently, one of the most crucial challenges with regards to sustainable construction execution is the capability of the construction sector to implement sustainable practices (CIB, 1999). This concept is restated by Häkkinen and Belloni (2011) who suggest that sustainable buildings can be realized by considering collective understanding about sustainability.

### **2.9.6 Challenges related to Culture and Society**

According to Williams and Dair (2007) **cultural change** is one of the key challenges in the application of sustainable construction practices. Whilst, an inclination towards the maintenance of current practices and resistance to change, are additional barriers to sustainable design and construction (Brown, 2006).

Notably, a resistance to change could result in less demand by the clients and stakeholders of construction projects, which could ultimately impact on its eventual supply. In the same vein, Kershaw & Simm (2014) identify a lack of sustainability measures by the stakeholder as the most frequently recorded barrier adding that a lack of demand by the client is a commonly recognized barrier. Thus, these barriers can prove to be substantial drawbacks as a building project cannot be completed along sustainable lines, without the owner or developer's "full support for sustainable concepts" (Ahn et al., 2013).

Nonetheless, this obstacle can be dealt with, if client demand is high and there is an inclination towards the pioneering of sustainable buildings, as can be countered in the UK, where buildings or properties are frequently acquired by owner- occupiers, who have less limitations or constrictions led by market norms. Additionally, this owner – occupiers tend to have at least an awareness of green construction, which is linked to public awareness of environmental issues (Djokoto et al., 2014).

However, there is still a need for the knowledge and understanding on sustainability to be further improved for all parties, including owners, designers, policy makers, the public and construction personnel. As even though many residents recognize that environmental pollution is a grave issue, other social issues are often ranked higher. An example of this is the China Environmental Awareness Program (CEAP) report, which reported that the public believed that the responsibility for environmental protection was that of local government, companies, and authorities, rather than themselves (CEAP, 2007).

Significantly, Srinivasan, (2007) emphasize the position that civil engineers can play in the "green" initiative, with the aim of increasing social awareness and introducing policy makers to the added environmental and cost benefits related to green design. Whilst, an aversion by industry practitioners to alter the traditional methods and processes is another technical barrier (Meryman& Silman, 2004 ; Shi & Hu 2014)

Moreover, the Toronto Green Development Standard (2006) also recognises that public awareness of green buildings and methods has played a significant part in the higher demand for sustainability. As a result, a continued approach to enhancing public awareness of sustainable concepts in construction and their added advantages could also increase demand for innovative tailored products to suit their needs and requirements. The environmental problems that have impacted the Earth over the last two decades, have aided the public's awareness of 'green issues'. Resulting in the public being influenced more by a company's

reputation with regards to being environmentally conscious, when making purchasing decisions (Li, 2014). Hence, demand for more environmentally friendly products is higher than it has ever been before (Paul & Chaudhari 2014) and consumers are more socially conscious and aware. For instance, the public now take more interest in what companies buy and from who and where (New et al., 2000). Additionally, marketing pressures have also been found to influence green supply chain management (Zhu et al., 2005).

## **2.10 Sustainability and Construction in Libya**

In many parts of the world there is a conscious effort geared towards sustainability which seeks to build on a shared commitment to procure in a more sustainable way and focuses on promoting the business case for better sustainable practices in the public and private sectors (Strategy for sustainable construction, 2008). Thus the practice of sustainable construction provides the means to achieve economic, social and environmental sustainability in procurement without harming the integrity of the process (Ameyaw et al., 2012). In Libya, the concept of sustainability in construction is relatively new (Bruen et al, 2014). Ahmed & Opoku (2015) indicated that the main culprit is the lack of knowledge and awareness of construction of 'green' building and the adoption of sustainable practices accompanied by weak policies and legislation. Indeed, Irurah (2001) and Adebayo (2002) have pointed out how widespread such ignorance is due to the lack of information on sustainable construction issues and solutions, not only in Libya but in many developing countries. The importance of knowledge and awareness of sustainable construction cannot be overemphasised, even in developed countries. For example, Brennan et al (2014) in their research into the UK construction industry found that construction companies were cautious in their activities, due to lack of awareness and uncertainties associated with adopting sustainable practices.

In Libya, the lack of knowledge and awareness has significantly affected the application of sustainable practices and Dania et al (2013) pointed out that Libya was lagging behind other countries in adopting and applying sustainable practices within the construction industry.

In most developing countries, the business case for sustainable construction is still weak. Although Libya is a signatory to the UN development objectives that include environmental sustainability, progress has been notoriously slow. The government of Libya promised to strengthen the Ecological Fund, Environmental Impact Assessment laws and National Environmental Standards and Regulations in order to advance sustainability. However, this

effort have yielded limited results, as evidence suggests that Libya continues to lose forest cover at an alarming rate of about 3.5% per annum. The UN Bureau for Statistics 2014 report reveals that Libya performed less than 50% in their attempts to achieve Millennium Development Goals. Brennan et al (2014) stated that construction clients are the main stakeholder to lead sustainable development practices but in Libya, the Government accounts for being the main client in the construction industry (Oxford Business Group, 2011), and introducing change through demand by the client (Government) for sustainable practices should have been an effective approach to encouraging transition from traditional practices.

Du Plessis (2001) has drawn attention to the main development challenge facing countries such as Libya can be found in the web of poverty, rapid urbanisation, weak institutions, insecurity and resource scarcity. Therefore, in considering sustainable construction in Libya it is significant to include the unique physical and social context. Du Plessis, (2014) pointed out the difference in worldview between developing and developed countries in terms of the priority afforded to issues such as global warming. In developing countries, the environment is lower down the list of priorities which is dominated by the need to eradicate poverty and provide education and healthcare to the people.

## **2.11 Summary**

Based on the literature review, the construction industry has been under pressure to improve upon its operations in line with the principle of sustainability in what is now termed sustainable construction, sustainable Construction practices seek to achieve environmental, economic and social equilibrium in the built environment. The call for sustainable Construction is partly due to the negative impact resulting from the sector's operations such as high resource consumption, waste generation, environmental dereliction, negative social image, poor safety records among other factors. While the developed countries are making headways in the implementation of sustainability in the construction sector, developing countries such as Libya have not fully embraced the concept of sustainable Construction. This phenomenon is attributable to challenges such as perceived high cost, lack of capacity, lack of awareness and understanding of the concept, perceived luxury addition to normal practice, and the lack of integrated research. Nonetheless, Libya has the potential to achieve sustainable Construction goals and the benefits thereof, which includes process paybacks such as material savings, product benefits including higher construction quality, lower life cycle costs, and



safer construction process, major economic benefits as in reduced operation and utility costs, low cost of maintenance among others.

Therefore, due to these knowledge gaps, this research has been aimed to investigate the need to create a practical sustainability method in Libyan construction industry. Also this study considers the complexities associated with integrating sustainability in construction sector in Libya, with a sight to developing a practical way forward in organisational approaches and methods to promote practices. The specifically examines how various construction organisations in Libya apply and integrate sustainability in construction in practice, and discusses typical practice to understand the perceptions of stakeholders and their action or inaction toward sustainable construction.

## **CHAPTER (3): RESEARCH METHODOLOGY**

### **3.1 Introduction**

This chapter discusses issues related to the design of the research and its underlying methodology. The research methodology underpins and guides the design of the study by mapping the research questions to the objectives and anticipated outcomes of the study.

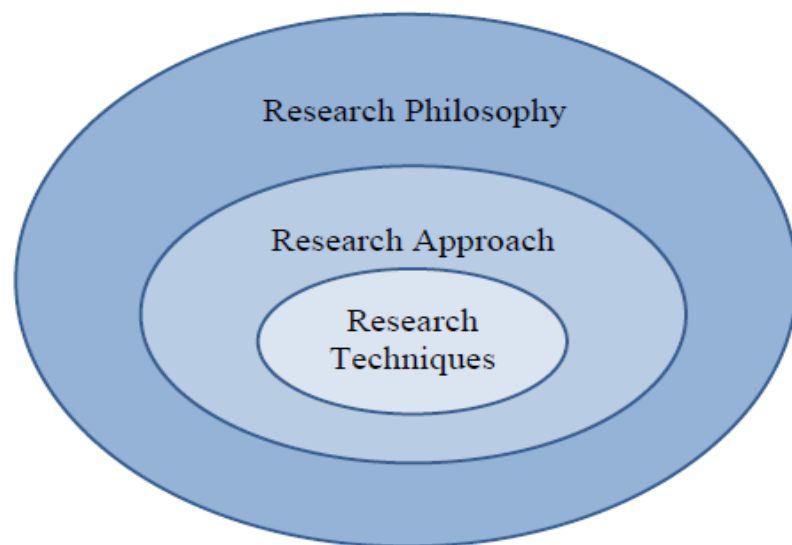
Research methodology is concerned with the blueprint or action plan and procedure which is adopted to guide the course of the research in order to link the chosen methods to the desired results which adequately address the research questions (Crotty, 1998). Indeed, the completion of a rational and coherent piece of research requires the careful choice of an approach, which directs the methods employed to answer the researcher's inquiry. Actually, Blessing and Chakrabarti (2009) define research methodology in terms of an approach, enabling a supportive set of techniques and guidelines that provide a scheme for performing the research. Furthermore, Creswell (2003) also defines research methodology as a systematic approach adopted by the researcher, in order to achieve the research aim. Moreover, Silverman (2009) also states that the researcher's choice of research methodology is a specific approach adopted in order to assist in managing the conduct of the research through all its stages of planning, design, data gathering and data analysis.

### **3.2 Research Conceptual Model**

It is widely known that research methodology represents a key element in any research and therefore, it should be prepared prior to embarking on any course of inquiry in order to provide all the necessary methods and techniques required for accomplishing the academic research successfully. Research methodology refers to the procedures and principles of a logical process that is implemented in a scientific investigation (Fellows & Liu, 2009). In other words, methodology involves a logical procedure, based on philosophical principles, which guides the design of the research so that it validly and reliably achieves its aims and objectives. Collis and Hussey (2009, p.55) defined research methodology as “an overall approach to the research process, from the theoretical foundation to the collection and analysis of the data”. According to Dainty (2008), research methodology does not only refer to the methods in a research, but it also includes the philosophical assumptions which support

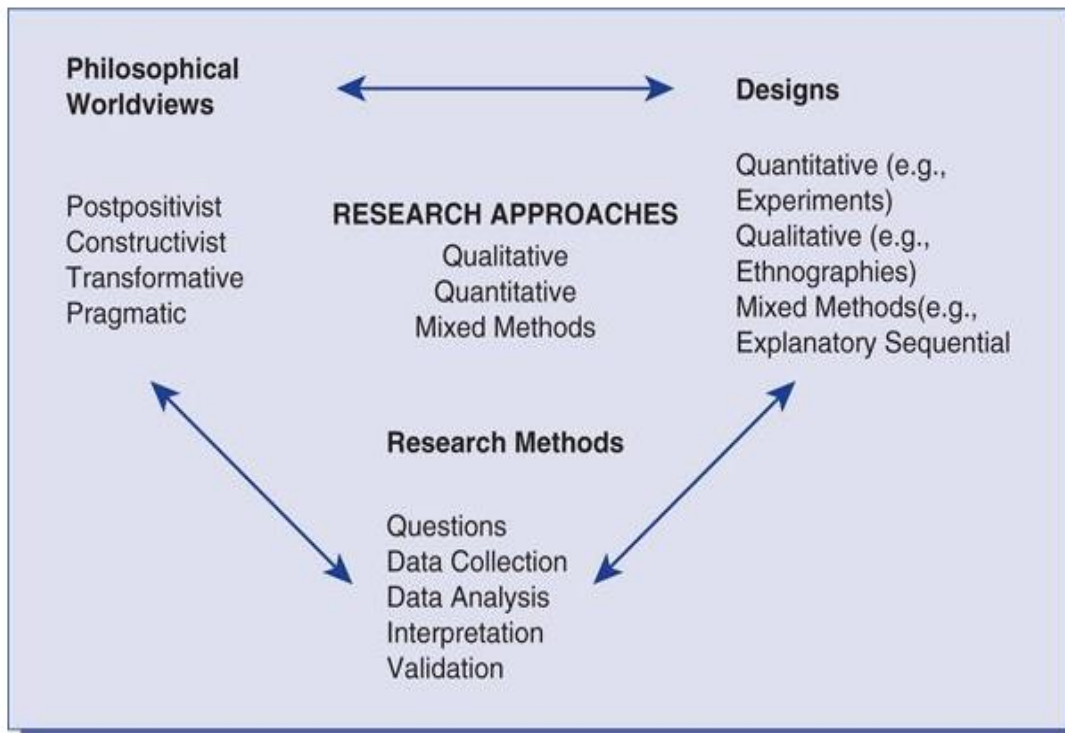
the research study; these influence actual research methods which have been used to examine a problem or to collect and analyse data.

The literature reveals that several of research methodology designs are available, among them the nested model illustrated in Figure 3.1 developed by Kagioglou et al. (2000). The nested model includes three main layers to establish the research methodology. The first layer represents the research philosophy which directs the second and the third inner layers. Research approach refers to strategies of inquiry whereas research techniques refer to specific methods adopted for data collection such as questionnaire, interview, observation and focus group.



**Fig. 3.1 The Nested Research Methodology, (Kagioglou et al., 2000)**

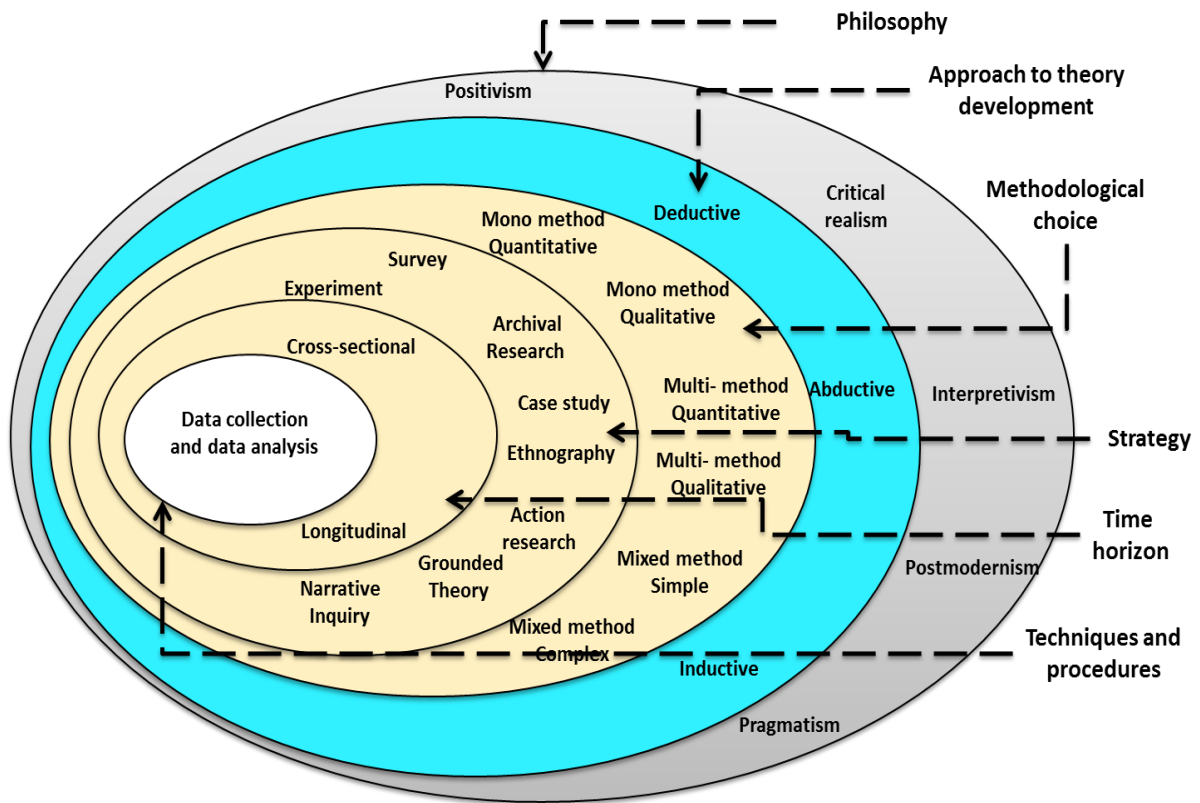
Creswell (2014) presents another model or framework of research design. It also includes three interrelated steps as shown in Figure 3.2. The model begins by identifying the philosophical position guiding the research design. Appropriate and applicable research methods are then selected for data collection and analysis.



**Fig. 4.2 A Framework for Research Design (Creswell, 2014)**

Although the nested model and the research design model each includes three layers, Saunders et al. (2016) introduced the onion model, which contains six steps resembling the layers of an onion. As illustrated in Figure 3.3, these main steps from outer to inner, involve; research philosophy, research approach, methodological choice, research strategy, time horizon, and techniques and procedures. Although, the research onion seems more complicated as it involves more layers, it provides the researcher with a clear direction to establish the research properly and applicably via a series of logical steps. Therefore, in order to clarify the components of a research methodology, this research follows the research onion model of Saunders et al. (2016) as it provides a systematic order of processes beginning from the research philosophy down to the techniques and procedures. In addition, it gives the researcher clear guidelines to become more familiar with up-coming stages thus pave the way to achieve the research aim.

After what discussed above, the structure of this chapter will be based on the sequences of each layer of the research onion model and how these layers support the aim and objectives of this research.



**Fig. 5.3 Research Onion, Saunders et al. (2016)**

### 3.3 Research philosophy

The design of a piece of research reflects the researcher’s own philosophical stance, particularly with regard to the ontological, epistemological and axiological assumptions which form the basis of that philosophical outlook. It is, therefore, useful for the researcher to consider the philosophical stance which has shaped how knowledge about a certain phenomenon has been developed and the nature of that knowledge (Saunders et al., 2016). Moreover, it is also helpful to other scholars if the current researcher explicitly articulates what philosophy and knowledge claims actually underpin the study. Easterby-Smith, Thorpe, & Jackson (2012) have proposed three reasons why an articulation of the researcher’s philosophical stance might be an important dimension of the methodology guiding the study. Firstly, it enables the research design to be outlined with clarity; secondly, it helps in decision-making regarding which research design is appropriate for achieving the aims and objectives of the research and, finally, it can help in the development of innovative research designs. The three constituent assumptions which form the research philosophy are now discussed in the following sections.

### **3.6.1 Ontology**

Within the discipline of the social sciences, ontology is concerned with the extent to which social entities can be regarded as having an objective, mind-independent existence or whether they should be more correctly viewed as social constructs (Bryman, 2004, p.16). However, more generally, ontology is the branch of philosophy which investigates the nature of reality (Saunders, 2016) two ontological positions are possible. Realism is the position that reality is mind independent, to be investigated by scientific observation. This is the objectivist ontological position. The alternative position is idealism which sees reality as largely mind constructed. This is subjectivist ontological position (Saunders *et al.*, 2016).

The current research is rooted in a subjectivist ontology as it is largely principally concerned with the many perceptions, actions and meanings on the part of the actors involved in relation to the phenomenon under investigation. The data of this research is heavily influenced by people's perceptions and will be subjective in nature. Therefore, the study takes a subjectivist ontological stance.

### **3.3.2 Epistemology**

Epistemology is the branch of philosophy which is concerned with the nature of knowledge and the validity of truth claims being made about acquired knowledge. This is an important issue for any research, as it concerns the validity of the findings of the research, Two alternative epistemological positions are possible, namely postpositivism and Interpretivism/social constructivism (Saunders *et al.*, 2016).

Postpositivism (sometimes simply called positivism) holds that knowledge of external reality is possible through the scientific method of observation in which the researcher remains independent of the phenomena under investigation and neither influences nor is influenced by the subject under investigation (Easterby-Smith *et al.*, 2008).

Postpositivism is a departure from the earlier claims to absolute truth implied in the positivist position to a recognition of the limitations of the scientific approach (Mertens, 2014). This limitation of positivism was actually pointed out by a quantum physicist: “the basic components of objects – the particles, electrons, quarks etc. – cannot be thought of as “self-existent.” (D’Espagnat, 1979 cited in The Guardian (20th March, 2009). Interpretivism/Social Constructivism views reality in terms of people's interpretations of phenomena, but the emphasis on understands the significance of those phenomena and the subjective meaning

which people attach to them (Easterby-Smith et al., 2008). Unlike the post positivist researcher, the interpretivist researcher necessarily becomes involved with the participants in order to discover the nuanced meanings and interpretations that people have of the matter under investigation.

### **3.3.3 Axiology**

Axiological concerns are related to how value is judged by the researcher. This value can be seen as being necessary for research. The researcher would definitely want to use his experience in research or it may be included in the study (Saunders et al. 2016). Therefore, the concept of value-free and value-laden research has been argued by social science researchers over the years. In a value-free scenario, the researcher or the respondent has an impartial contribution of feelings and past experiences throughout the study (Hill, 1984). A value-laden research includes studies which add personal emotions, feeling and past experiences of the scientist or respondent.

### **3.3.4 Justification for the research philosophy adopted for the study**

The aim of this study is to develop a strategy for the implementation of sustainable construction in Libya.

Ultimately, the research objectives need to be valid, thus the justification for the research philosophical is tailored to the research objectives. Ontologically, the research leans to realism position. From the epistemological perspective, the investigation of this research is based on a phenomenon that is rooted in the living and workplace environment, it suggests that the research should count the phenomenon under investigation as an independent and single reality in country as Libya. Therefore, this study is of a more positivism position.

Finally, from an axiological perspective, this research leans more towards the value-free and objective nature of research. Nevertheless, part of it is value-laden and of a subjective nature in relation to the interview findings. However, a quantitative method examines people's opinions about sustainable construction aspects and this means that the value is driven by objective-mentality hence value-free.

### **3.4 Research Approach**

In this section, the alternative approaches to research, either through deduction or induction are discussed and a justification is presented for the approach adopted in this study.

#### **3.4.1 The Deductive Approach**

The deductive approach to research is usually a theory driven one. The theory offers a plausible explanation of the phenomenon under investigation. The theory is usually formulated into a number of hypotheses which are then tested by an analysis of the data collected as evidence. The analysis is carried out by statistical tests which lead to acceptance or rejection of the hypotheses. Thus, it is a matter of testing theories in a deterministic way where causes are seen as determining outcomes (Creswell, 2014).

The deductive approach views a research from a broader perspective to the main specific unit of investigation. Losee (1993) noted that the method of reasoning in deductive approach involves the creation of concepts or theories which are then tested via observation.

#### **3.4.2 The Inductive Approach**

The inductive approach, by contrast, is that of an inquiry to understand a social or human problem from multiple perspectives (Yin, 2014), starting with an empirical investigation of a rather under-theorised area or phenomenon in order to develop a corresponding theory. Inductive reasoning begins with collecting data or evidence which may be mostly narrative in nature but could include numerical data. From the analysis of the evidence, a theory or explanation may emerge. This is not to say that some theory is not considered at the outset but rather that unlike induction, the approach is not theory driven (Saunders *et al.*, 2016).

The Inductive approach is the direct opposite of deductive approach. Inductive approach is more flexible compared to deductive approach because it is subjective and allows the researcher to observe, create a hypothesis which is established as theories (Mertens, 2008).

#### **3.4.3 Adopted research approach for the study**

Research approach pertains to the activities which will be carried out in order for the investigator to achieve the research aims and objectives (Easterby-Smith *et al.*, 2008). Saunders *et al.* (2016) opined that research approaches are based on research philosophies. This study will make use of both deductive and inductive approaches; this combination is



known as the abductive (Levin-Rozalis, 2004). By adopting this approach, the researcher aimed at both depth and breadth in the combined findings relating to sustainability in the Libyan construction sector.

Thus, in the first phase of this research the deductive approach was used for the literature review, this was carried out by synthesising the main outcomes of previous research. Though, in the second phase of the research an inductive approach was used during data collection process in order to explore the main challenges and also for the investigation of the findings from the first phase in greater depth with experts in the field.

### 3.5 Research strategy

With regard to the particular strategy of research to be adopted, the deciding factor is the strategy which is most appropriate for addressing the research questions, aims and objective Among the myriad types of available strategies are case studies, action research, experiment and laboratory trials (Easterby-Smith et al., 2002; Yin, 2014; Saunders et al., 2016). The most prominent research strategies are presented in table 3.1 below.

**Table 2.1 Research Strategies, Source: Yin (2014)**

<b>Research strategy</b>	<b>Forms of research question</b>	<b>Requires control of behavioral events</b>	<b>Focuses on contemporary events</b>
Experiment	How, Why?	Yes	Yes
Survey	Who, What, Where, How many, How much?	No	Yes
Archival analysis	Who, What, Where, How many, How much?	No	Yes/No
History	How, Why?	No	No
Case Study	How, Why?	No	Yes

### **3.5.1 Ethnography**

Ethnography is defined as the scientific description of people and cultures with their customs, habits and mutual differences. More precisely, ethnography is described by Harris & Johnson (2000), as cited in Mangal and Mangal (2013) as a portrait of people “a written description of a particular culture - the customs, beliefs, and behaviour - based on information collected through fieldwork”. Literally it means ‘a portrait of people’. The ethnographer generally has a few hypotheses and no structured questionnaire, since the purpose of ethnography is simply to describe a particular culture (Bailey, 2008).

Typical ethnographic research involves three kinds of data collection which are observation, interviews and documents. The term field study is often used almost simultaneously with this method. Gilbert (2008) mentions that it does not necessarily involve a small sample, but because of its emphasis on depth context, it usually does. Also Hammersley and Atkinson (2007) indicate that the ethnography strategy generally focuses on a small scale, perhaps a single setting or a group of people, because it aims to achieve an in-depth study.

### **3.5.2 Experiments**

Experiments are mostly conducted in a laboratory setting under controlled environments in which the experiments may focus on one or two selected variables and assume that the laboratory environment can control all remaining variables outside the scope of interest (Yin, 2014). Experiments are mainly conducted to find causal explanations for a certain phenomenon. They can take place under very controlled conditions (laboratory) or in the natural setting (field) (Saunders et al., 2016). Each of them has both advantages and disadvantages in relation to control variables and confounding variables.

Bailey (2008) describes some advantages of experiments:

- The experiment method in social science is considered to be the best method for establishing causal links between the dependent and non-dependent variables and may only require a brief time period.
- Greater control in experiments causes little chance of errors in data results and hypothesis tests. Also, it means that the investigator can have more faith in the findings.

- Experiments involve the opportunity to study change over time and most likely it deals with longitudinal studies. The researcher in the experiment observes and collects data over a period and measures at more than one interval.

The disadvantages of experiments are as follows:-

- Experimenter effect, in the sense that the experimenter's expectation can affect the results of the experiment, so the experiment can be a reactive method
- Lack of control, the attempt to conduct the experiment in a natural environment (laboratory) is most likely to make it impossible to control all the inessential variables that could threaten the experiment. That is why it is less used in social science than in other disciplines.
- Sample size, the experiment is not applicable for large groups as it is difficult to study it in a laboratory and to control the inessential variables. The experiment is more likely to be used in social psychology than sociology research and to study small samples for small groups.
- The impossibility of having sufficient control of the experiment in a natural environment (Laboratory). This is more likely to be the main problem with using the experiment in social science.

### **3.5.3 Case Study**

A case study is a strategy for studying a new or current set of circumstances within its authentic natural setting (Yin, 2014). It is an appropriate strategy for answering “how?” and “why?” type questions (Yin, 2014) which suggests a qualitative type study although

Saunders et al. (2016) include quantitative methods such as questionnaires. Case studies have been classified as either analytical, descriptive or explanatory (Naoum, 2007).

### **3.5.4 Survey**

A survey is a research strategy that involves the structured collection of data from a large population in an economical way (Saunders et al., 2016, p. 728). The word survey is often used to describe any research that collects data (quantitative or qualitative) from a sample of people (Punch, 2013). Based on statistical sampling, surveys are commonly conducted by means of questionnaires and interviews which vary from highly structured questionnaires to

unstructured interviews (Fellows & Liu, 2009). In surveys, the data can be gathered through the form of face-to-face interaction, telephone interviews, postal questionnaires and increasingly, online surveys (Gilbert, 2008). Also Fowler (2009) states that it is not uncommon to use a combination of data collection in surveys such as; mail, telephone, the internet, personal interviews or group administration. However, most surveys use one data collection by means of a survey method.

With regards to data collection, Forza (2002) remarks that the main methods to collect data in survey research are through questionnaires and interviews, adding that the interviews can be structured or unstructured and can be conducted either face to face or over the telephone. Moreover, the questionnaires can be administered personally, or by email, or by telephone to the respondents.

According to Forza (2002); Fowler (2009); Gilbert and Stoneman (2015), each data collection method has both benefits and weaknesses. For example: -

1. Overall, a self-completion questionnaire is quick and inexpensive and can be either paper-based or completed online. Bias is reduced through this type of method and more reliable and valid responses can be obtained. However, with mailed questionnaires, sometimes a longer period is needed and there can be a low response rate.
2. The overall advantage of survey interviews is that because they are likely to be face to face or over the telephone, the respondents are more likely to provide more thoughtful and honest responses. Hence, the production of better quality data can be achieved.
3. The benefits of using face to face interview surveys can be higher response rates, flexibility in sequencing question details and explanations, and the ability to contact a hard to reach population. However, this way of collecting data can involve higher stress on both the respondents and interviewer, which could lead to interviewer bias.
4. Data can be collected from a large population in an economical way.
5. Regarding the telephone survey advantages, it is inexpensive, there is rapid data collection and large-scale accessibility. On the other hand, there is less credibility, less control over the interview situation and a lack of visual materials.
6. It is easy to administer.

7. A broad range of data can be collected including attitudes, opinions, beliefs and values.
8. The data can be collected in diverse ways, which provides an opportunity for conducting data remotely.

The application of a survey strategy is commonly used in business and management research and is most frequently used to answer the questions “what”, “who”, “where”, “how much” and “how many” (Saunders et al., 2016). In addition, a survey strategy is considered as invaluable, when sorting data about attitudes, trends, values, personal experiences, behaviour and opinions of a population by studying a sampling of that population (Creswell, 2014; Gilbert, 2008). Nonetheless, the development of questions to be asked in the survey research, the ways in which they are phrased and the order in which they are placed will all affect the success of a survey.

### **3.5.5 Justification for research strategy adopted for the study**

Surveys are used to collect data from a large population (Vaus, 2002). This will be suitable for this study because of some objectives which will require gathering a large amount of data which cut across various professions. In addition, according to the philosophical stances this research is lean to positivism and objectivism, therefore a survey strategy is the most appropriate method for this study and surveys will be quantitative and qualitative. Moreover, the survey is appropriate because there is a lack of consensus regarding the perceptions and expectations of adopting the sustainable construction practices. Therefore, the survey strategy provides a good means to develop a consensus from the large amount of data and different respondents. According to Naoum (2012), the survey strategy is suitable when a large amount of data needs to be collected to investigate a respondents’ view and experiences on a phenomenon within a limited time frame. In addition, Saunders et al. (2016) mentioned that the collection of quantities of data and statistics and analysing them descriptively and inferentially can be achieved through a survey strategy. Moreover, data collection using a survey strategy can be used to suggest probable reasons for relationships between variables and to produce models of these relationships.

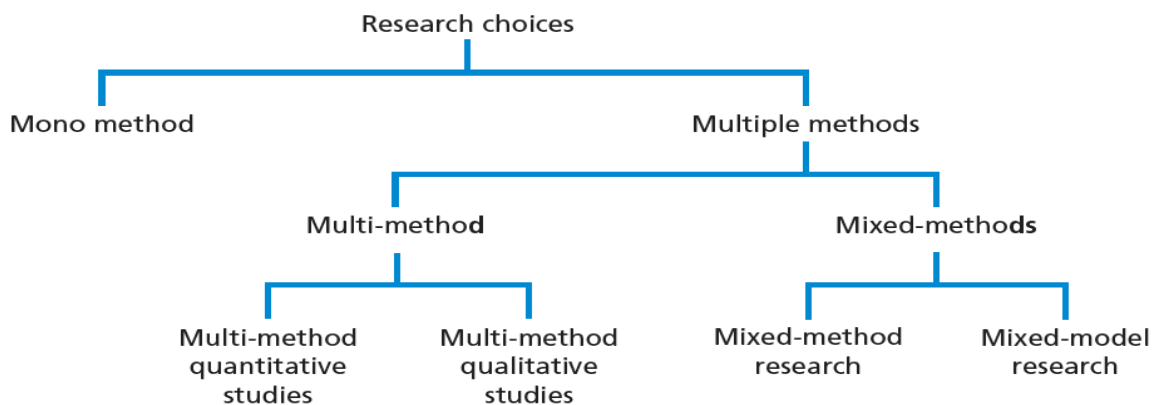
Consequently, a survey strategy was used to achieve objective two, three and four of this research. During the second phase of the survey strategy, the researcher adopted semi-structured interviews as a method to explore detailed information.

### 3.6 Research Choice

Research choices can involve either qualitative or quantitative data or both. According to Saunders et al. (2016), qualitative and quantitative techniques and procedures do not exist in isolation. The authors classified the research choices into two main categories, which are the mono method and multiple methods.

The mono method involves the use of a single data collection technique and its corresponding data analysis procedures, whereas the multiple methods involves the use of more than one data collection and analysis procedure to answer the research questions.

Moreover, the multiple method can be divided into multi method and mixed method study. (Saunders et al., 2016) define the multi-method as the use of more than one method, either quantitatively or qualitatively in a single study and then analysing them in compliance with their related procedures. Additionally, the mixed method involves the use of both quantitative and qualitative data collection techniques and analysis procedures in one research design. Moreover, mixed method research uses qualitative and quantitative data collection and analysis procedures in parallel or in sequential time in a study. It is claimed by Saunders et al. (2016) that the use of mixed methods can enhance the validity and reliability of a study, although there can be a risk that the findings from one method are not corroborated by those of the other method. Figure 3.4 shows Commination Design.



**Fig. 6.4 Commination Design, Saunders et al. (2016)**

### **3.6.1 Adopted research choice for the study**

For this study, a mixed method is the research choice using qualitative and quantitative data collection and analysis procedures in parallel or in sequential time in a study. Notably, the use of mixed methods enhances the validity and reliability of a study (Saunders et al., 2016).

The mixed method approach is the most appropriate strategy for this research, as more than one data collection technique and analysis procedure was used. This is because the use of one method alone to explain the current construction field in Libya would not be adequate to address the knowledge gaps on this type of construction and to obtain the most fruitful findings from the study. This is particularly the case for sustainable construction in Libya, with the difficulties facing this field.

Therefore, both a qualitative and quantitative approach was used in this research to achieve the kind of data required and the research objectives, as a qualitative technique gives deeper details of the problem while a quantitative technique is a way to test research hypotheses. Morgan (1998) states that the sequences decision is not likely to depend on whether the qualitative or quantitative is used first, but whether a complementary method which is either qualitative or quantitative is used as a follow up to the principle method or preliminary input to the principle method. Moreover, the procedures for collecting data with mixed approaches can occur in sequential, concurrent or parallel design (Creswell, 2014).

Firstly, a quantitative method was developed by using the questionnaire to determine one of the objectives of this research, which concerned finding out what challenges were facing the adoption of sustainable construction in the Libyan construction industry. The use of quantitative methodology inclines the researcher towards a positivist perspective of measuring variables and assessing statistical results. A positivist approach is represented through the formulation of hypotheses or causal relationships among constructs and models (Chen and Hirscheim, 2004). In addition, positivism characterises value-free interpretation.

Secondly, there was a move towards subjectivism by adopting a qualitative methodology through semi-structured interviews, which were made either in person, using telephone or skype. The use of interviews can highlight several perspectives and in-depth descriptions about sustainable construction in Libya with all the related aspects in terms of adoption, and challenges the move in the philosophical assumptions from a positivist towards a constructivist or subjectivist position has corresponded to a shift from the questionnaire to the interview method. The most appropriate strategy is to use the two methods of qualitative and

quantitative in sequences, so that what is learned from one adds to what is learned from the other (Morgan, 1998).

### **3.7 Time horizon**

To gain a better understanding of the time horizon, it is useful to look at timeline subdivisions. (Saunders et al., 2016) divided the time horizon into cross-sectional and longitudinal. Since the longitudinal horizon focuses on a particular phenomenon and observes their changes over time (longer period), this study is considered to be cross-sectional because the cross-sectional horizon focuses on a particular phenomenon at a particular time (shorter period). This research adopted the cross-sectional time horizon based on the choice of time frame for the data collection and research strategy.

### **3.8 Research data collection and analysis techniques**

This section presents data collection and analysis research techniques. The analysis and interpretation of data constitutes a main part of this research. Yin (2014) states that analysis involves “examining, categorizing, tabulating and testing data otherwise recombining the evidence to produce the empirically based findings”.

In this study, the researcher’s target was to incorporate both quantitative and qualitative methods to extend knowledge about sustainable construction. The quantitative method through questionnaire surveys was used in the first stage. This was expected to enhance understanding about sustainable construction practices in Libya, and get a general picture about the real situation of this method of construction in terms of level of use, challenges and opportunities.

Its results were used to inform the second approach. This second approach used a qualitative method through semi- structured interviews, to achieve an in-depth understanding of the questionnaire results by exploring the stakeholders’ perspectives of this type of construction and to get a fuller and clearer picture. In addition, some significant and related documents were included. Software such as SPSS was used to analyse the data and present it in an appropriate way.



It was anticipated, that following the full data analysis and findings, a strategy would be developed to enhance the use of sustainable construction practices in Libya. It was planned to validate this strategy through interviews with a number of experts in the field.

### **3.8.1 Questionnaire survey**

The design of the questionnaire is generally based on the type of respondents. Moreover, De Vaus, (2013) noted that the response format of a questionnaire could be designed to be exhaustive, exclusive, nonexclusive, balanced or unbalanced, ranking based, numerical rating scale (this includes Likert scale, vertical rating ladder, Semantic differential or horizontal), binary choice format, multiple choice format, non-committal (multiple attitude statement and numerical response format); respondent initiated; social desirability and acquiescent response sets. De Vaus (2013) further noted that the questionnaire design could influence the answering procedure and the respondents' time.

#### **3.8.1.1 Measurement and Scaling**

The questionnaire of this research was designed to achieve objective two, three, and four. The survey was a self-administrated questionnaire with five-point Likert scale questions, used to measure opinions and attitudes. Likert scales often use a five-point or seven-point scale to assess the strength of agreement about statements, the results are then stated as a summated rating scale (Hair, Wolfinger, Money, Samouel, & Page, 2015). The reply options ranged from "strongly disagree" to "strongly agree" and from "not satisfied at all" to "extremely satisfy". The Likert scale can also measure other perceptions such as importance and the response ranges from very unimportant to very important. Hair et al. (2015) outline rating scales as the use of statements on a questionnaire accompanied by pre-coded categories, one of which is selected by the respondents to specify the extent of their agreement or disagreement with a given statement. Moreover, in delivery and collection questionnaires, the five agreement points on the rating scale, allows respondents to tick the middle 'neutral' or 'not sure', making it less threatening to the respondents than admitting they do not know. By using this type of scale, it became easy for the researcher to determine and evaluate the practices, benefits and challenges identified from the literature on sustainable construction.

#### **3.8.1.2 Layout and Wording**

The researcher has taken into account that the questions had to be simple and easy to understand during formatting the questionnaire, and the sequence of questions was arranged

from general to specific. The researcher divided the questionnaire into four parts. The first part in the questionnaire includes general questions about the respondent's background such as about field study, experience and educational level which helped the researcher to understand the sample and link it to the research findings. The second part presented a list of sustainable construction practices; the third part included the benefits of using these practices, and the fourth part presented a list of the challenges to implementing sustainable construction practices.

### **3.8.2 Semi-Structured Interview**

An interview can be regarded as a conversation or dialogue designed to discover how people behave think or feel about certain issues (Hussey and Hussey, 1997). Interviews can take place in many settings though a quiet and private venue is usually preferred. The interviewers intimately involved and will try to capture the often subtle answers given to contentious issues by noting nonverbal cues and body language.

There are three main types of interview (Fellow and Liu, 2008). The first is a structured type interview which can often amount to being a questionnaire in spoken form the interviewer sticks rigidly to a set of prepared questions which are asked in sequence. At the other end of the scale lie unstructured interviews which take the form of open, non-directive discussion of issues of interest. Their lack of structure can be challenging for an inexperienced interviewer. Finally, in between both of the other types is the semi-structured interview, this is still open-ended but the interviewer does have a set of topics or issues to address although there is great flexibility.

This research adopted the semi-structured interview which was appropriate for this research for many reasons. It provided the researcher with the opportunity to probe answers where the researcher wanted the interviewees to explain or build on their responses. Furthermore, semi-structured interviews often lead the discussion into areas that the researcher had not previously considered but which could be significant for the researcher's understanding and help to address the research questions and objectives. In this study, ten interviewees who were experienced and senior managers were interviewed. The interview process provided an opportunity for the interviewees to express their opinion towards the sustainable practices and the benefits of using them as well as the challenges facing the implementation of sustainable construction in Libya. Appendix B contains the structure of the interview questions for the study.

### **3.8.3 Research Sample**

It is necessary to focus on a sample of the wider population when conducting research (Saunders et al., 2016). Sampling is necessary due to the limitations of resources available. There are two main categories of samples which are probability and non-probability sampling. In the first type, the sample must be randomly drawn so that each member of the population has an equal chance of being selected. In non-probability sampling certain people or groups are purposively selected based on certain criteria. Salant and Dillaman (1994) define a sample size as a set of respondents selected from a large population for the purpose of a survey. Moreover, a sample is a sub-group of the population, which is the focus of researcher's enquiry and is selected in such a way that represents the study population. It is done to save time, money and other resources (Kumar, 2014).

#### **3.8.3.1 Random Sampling Technique**

Random sampling method was adopted for the questionnaire survey. According to Bray and Rees (1995) "random sampling is defined as one for which each measurement or count in the population has the same chance (probability) of being selected".

The research sample frame in this study is within the construction organisations in Libya. This provides a list of construction companies in Libya. However, this list is only an estimated number with the name of the construction companies. The information gathered from the number of construction companies from Ministry of Housing in Libya based on the registration and contact details of the companies.

In this study sixty three construction companies were contacted out of one hundred and fifty which makes up 41% of the overall population of companies for data collection purposes; this is the company sample size. Two hundred and fifty persons in these companies were chosen as the broader sample size in order to cover one-third of the population. In addition, the research questions covering sustainable construction practices and benefits of using these practices, and main challenges for the implementation of sustainable construction. Based on the purpose of this study, the sampling frame consists of people who are involved in construction (e.g. Architects, engineers, project managers, etc.).

Overall, two hundred and fifty (250) questionnaires were distributed to the sixty-three (63) companies, but only one hundred and thirty-four (134) were completed and returned giving an approximate response rate of 54%.

### 3.8.3.2 Purposive sampling

In this study, theoretical or purposive sampling technique for survey interviews provided an advantage for the interviewees to be chosen based on the experience and profession. Ten Middle and senior management members from construction companies in Libya, were interviewed (please refer to table 3.2 for interviewee information). This was based on their knowledge and expertise on construction sector in Libya. The respondent population consisted mainly of engineers, architects and project managers in the construction field in Libya, they have the appropriate experience and knowledge in the industry to be able to contribute significantly to the interviews. The respondents had at least fifteen years of experience in the construction industry and the appropriate qualifications. The drawback of purposive sampling method is that experience and knowledge can be difficult to measure.

**Table 3.2 List of Interviewees for the study**

<b>ID</b>	<b>Job Role</b>	<b>Background</b>
R1	Architect	Heavily involved in practice of architects, designers, and engineers, and worked in various building types.
R2	Senior Civil Engineer	Specialist in engineering design: civil; structural and project management
R3	Senior Project Engineer	Experienced in construction management and Engineering
R4	Project Manager	Core expertise in: a range of development management, project management and construction services. systems and processes
R5	Assistant construction Project Manager	Construction project management assistance
R6	Senior Civil Engineer	Experienced in delivering construction projects, wide knowledge on managing various civil projects.
R7	Senior Project Manager	Experienced in delivering ambitious and innovative construction projects, delivering to both clients and the communities who use them on a daily basis
R8	Site Manager	Specialises in working on the several construction sites activities on a daily basis
R9	Senior Architect	Wide experience of architecture, and building design in all major building types.
R10	Civil Engineer	Working in engineering design. Principle disciplines include: civil; structural; services, such as: highways engineering

### 3.8.4 Parametric and non-parametric tests

Data can be categorised into parametric and non-parametric. Parametric data are data gained from assumption laden probabilistic distribution and inferences are made from such distributions, while non-parametric data are recognised as assumptions free data, and there are fewer assumptions that can be assumed from the data (Field, 2009; Pallant, 2007). The parametric and non-parametric data require different type of tests to be conducted. The reason why is that in any data which is essentially based on ranking requires a non-parametric test. The data which are equally selected with a “YES” or “NO” response are tested non-parametrically because they are nominal variables. Nevertheless, scaled data which have figures to be completed or ticked are tested parametrically. Pallant (2007) presented a list of parametric test and non-parametric test alternatives as shown in the table 3.3 below.

**Table 4.3 Parametric tests and their non-parametric alternatives**

<b>Parametric Test</b>	<b>Non-Parametric Test</b>
Pearson correlation test	Spearman’s correlation test
T-test for independent measure, 2 groups	Mann- Whitney U test
One-Way ANOVA Independent measure,	Kruskal-Wallis test
Paired sample T- test	Wilcoxon test
One way repeated measures ANOVA	Friedman test
None	Chi-square test for goodness of fit
None	Chi-square test for independence
None	Kappa measure of agreement
None	Kendall’s coefficient of concordance

The choice of parametric and non-parametric tests shown above depends on the nature of objectives or research questions. Therefore, this study adopted the required test based on the data collected and the research objectives and questions.

#### **3.8.4.1 Descriptive for the background of the respondent**

Analysis of quantitative data usually entails firstly an overall picture of the sampled group. This is achieved by sets of tables and figures which give an overview of the sample. This could include distribution by age, gender, years of experience, qualifications etc. Often a table of means and standard deviations are produced to give an overview of the responses to the various questions or statements.

#### **3.8.4.2 Data analysis for the first objective**

The first objective, which involved critically reviewing of sustainable construction practices used in the construction industry, was based on literature contents. Literature review synthesis was used for this objective. This is because there are available documents on various sustainable construction practices adopted in the construction industry globally. The analysis was based on the content of the document, targeted at identifying all available, practices of sustainability in construction industry worldwide (See section 2.6).

#### **3.8.4.3 Data analysis for the second objective**

The second objective involved evaluating the sustainable construction practices used in the Libyan construction industry. A mixed method approach employing quantitative and qualitative analysis was used for this objective. The survey strategy utilised questionnaire survey to identify the various sustainable construction practices most adopted by Libyan construction companies.

These practices were documented as part of a survey questionnaire that used the Likert scale to rate their level of use. The Kendall W test was used to rank practices afterwards. Kendall W test is a non-parametric test which can measure the degree of cohesion among the respondents in completing the questionnaire. (Legendre, 2005) Interpreting the results of the test it is first necessary to check the p value which, if it is less than 0.05 indicates that the measure is significant. The W value then represents the level of association between the variables (Mehta and Patel, 2012).

In the context of the current study, this measures the level of use for the various practices which are used by construction companies in Libya.

#### **3.8.4.4 Data analysis for the third objective**

The third objective which is to review the benefits of using sustainable construction practices in construction companies in Libya was analysed using Kendall's W test.

These practices are documented as part of a survey questionnaire that used the Likert scale to rate their level of agreement. The Kendall W test was used to rank practices afterwards. Kendall W test is a non-parametric test.

In the context of the current study, this measures the level of agreement for the various benefits by construction companies in Libya.

#### **3.8.4.5 Data analysis for the fourth objective**

The fifth objective was to identify the main challenges to the implementation of sustainable construction practices in Libya which were extracted from the collected data using questionnaire survey, and analysed by using factor analysis, followed by interview content analysis method.

##### **a) Factor analysis**

**Factor analysis** is a technique that is used to reduce a large number of variables into fewer numbers of factors. Cornish (2007) defined factor analysis as a data reduction through the multivariate method. Furthermore, Pallant (2013) also noted that factor analysis is a combination of various factors techniques with steps for reduction of the principal components. The author further advised that principal component analysis and factor analysis are distinct. Both approaches use the correlation pattern to produce a smaller number of linear combinations. Yong and Pearce (2013) stated that the main purpose of factor analysis was to provide a structure pattern, which made it easier for the researcher to understand the logic behind the relationship. The author also stated that factor analysis could be used for exploratory factor analysis and confirmatory factor analysis. For this study, it was an exploratory factor analysis. The main challenges for the fourth objective were identified using literature synthesis in chapter two (see section 2.9), and the main challenges were listed out and categorised. The categorisation provides the main challenges to the implementation of sustainable construction practices in Libya.

The process of factor analysis starts with the validity of the cases. According to Pallant (2013) 150 cases is the benchmark. However, smaller samples can be considered if the solutions have high loading marker variables above 0.80. Stevens (1996) and Bartlett (1954) as cited by

Pallant (2013) opined that smaller samples with the good reliability of factor structures and the Kaiser-Mayer-Olkin (KMO) measure of sampling adequacy would have an index of 0.6 for a good analysis. Therefore, some variables were to be reduced. The reduction process starts with the reliability of data with KMO. The principal component factor extractor was used for this study; this considers the best factors which reflect the comparison of the variables (Pallant, 2016). Other types of factor analysis extraction are principal factors, image factoring, and maximum likelihood factoring, alpha factoring, unweighted least squares and generalised least squares.

The extraction process is followed by the decision making which can be based on Kaizer's criterion, parallel analysis and scree plot (Field, 2009). The scree plot was used for this investigation. The scree plot displays the eigenvalues of the factors. The factors above the elbow were retained. The factor rotation and interpretation was determined after the number of factors has been decided. This presents the pattern of loadings for easier interpretation.

The main challenges in the literature review were identified before they were rated by respondents in a survey questionnaire. The main challenges were extracted from the literature review in chapter 2. They were classified for data collection purposes. The challenges were analysed using factor analysis.

## **b) Content Analysis**

The content of the interviews was presented as a paragraph text and in table format. This was carried out using manual content analysis method. According to Flick (2009), content analysis can be used to qualitatively to analyse any document or material in any form. Content analysis was used in this report to build up theory using contextual analysis of the responses.

Moreover, Schmidt (2004) highlighted the steps for conducting content analysis as being:

- a) Categorization of the materials which will be carried out by reading through the transcribed interview and identifying individual aspects which are related to the investigation.
- b) The various categories are compiled as themes for the research objective or question.
- c) The compiled themes are broken down into nodes or smaller codes which contain detailed information related to the research objective or questions.
- d) This coded information was linked together to form cases.
- e) These cases are interpreted to give meaning to the research.



The use of content analysis makes it easy to analyse the presence and understanding of challenges to implementing sustainable construction practices within construction industry in Libya, and also identify the recommendations for overcoming these challenges.

The content analysis process of analysing the data began with data collection involved ten (10) highly experienced senior staff having fifteen (15) to (25) twenty-five years of experience in the construction industry in Libya. The respondents also had various and diverse backgrounds in the construction field; the table below shows the interview's profile.

Based on the theoretical sampling approach implemented for the semi-structure interview, the years of experience for each of the respondents was important. Theoretical sampling allows the researcher to develop the required information and knowledge from the experts. This does not depend on the random larger population but on very few experts with in-depth views about the subject. The respondents are top managers and principal partners in construction companies in Libya. Therefore, the principal partners have been interviewed as part of this study. The questions for this interview is based on the need for addressing the second, third and fourth objectives; the second objective involves investigating the current status of sustainable practices used in the Libyan construction industry, while the third objective considers reviewing the benefits of implementing sustainable construction practices in the Libyan construction industry, and lastly the fourth objective involves identifying the challenges to the implementing sustainable construction practices in Libya.

#### **3.8.4.6 Data analysis for the fifth objective**

The fifth objective which is to validate the strategy of implementing sustainable construction practices in Libya was achieved by using semi-structured interview.

Reliability is the re-test of a test aimed at getting the same results. In both scientific and natural research, which adopts quantitative methods, reliability is quite easy to achieve. By contrast, in qualitative research, the achievement of reliability is more difficult as there is a need for more attention in analysing the data gathered from the respondents in order to avoid the misunderstanding.

As Gillham (2005) stated, if two or more researchers use the same method and get the same results, the method is considered likely to be reliable. The researchers should be certain about the validity of their work since validity represents the usefulness of their research endeavour. Any research that does not add any value is useless and therefore considered invalid. In both

qualitative and quantitative research, validation is required. However, in quantitative research, validation is easier than in qualitative research, since objectivity is easily shown in it. In qualitative research, researchers should avoid their subjective opinions on the data and rather follow an objective analysis. According to Creswell (2003), there are various evaluation types in regard to validation. Validation in qualitative research may be achieved by means of a rich and detailed description of the context and background of the research. For Shenton (2004), credibility is increased by adopting a deep description of the research methodology and of the data collection method, in addition to a comparison of the results of the research with the previous researches, as well as clear explanation of the analysis and findings. By using one or a mix of the methods mentioned above, the validity of research is achieved. For quantitative research, many methods are used to achieve the validation such as error levels, statistics measurements and certain instruments.

The validity and reliability of the quantitative and qualitative research depend on two trends of thought. The first adopted the forms of evaluation mentioned above to achieve validity and reliability via the finding of the quantitative and qualitative research. The other current believes that the qualitative research aims at a deep understanding of a certain context; accordingly, the achievement of the reliability or validity of the results may not be easy or even not possible at all (Finlay, 2006). This trend reckons that the aforementioned forms of evaluation are not appropriate to be used for the evaluation of the qualitative research; therefore it may be used only for the quantitative research.

According to what said above, due to the objectivity of the nature of quantitative research in addition to its ability to be extended to a context larger than its sample, quantitative research is easier to dependence generalisability. However, objectivity in qualitative research depends on the ability to transfer the results of the research to another context or group of people. According to Easterby-Smith et al. (2002), the generalisability of the finding of the research means the possibility to apply what has been concluded from the selected sample to a wider population, in other words, the ability to apply theories that have been developed from a certain case to other cases (Robson, 2002).

### **Semi-Structured interview for the Validation**

In order to validate the proposed strategy, a semi-structured interview was carried out. The respondents were experts and consisted of four professionals. Their selection was made on the basis of their experience in construction industry in Libya, as well as on the basis of the age

groups to which they belonged. Some of them had been previously interviewed for the data collection purposes. All of the experts have significant knowledge about the construction field in Libya.

The proposed strategy accompanied by a brief on the research's aim and key objectives were sent by email to all the experts a few days before the interview was carried out by Skype.

The experts were asked to comment and identify the positive and weak points of the proposed strategy, and the related issues such as challenges or recommendations that were not considered; the findings of the experts were used to modify the proposed strategy for the final strategy. Accordingly, the main three themes of the interview were:

- The gaps and the missing points in the proposed strategy.
- The barriers and obstacles that may face the implementation of the strategy.
- The suggestions and modification or any comments regarding the strategy.

### **3.9 Research Validity**

Field (2009) noted that “validity refer to whether an instrument measures what it was designed to measure”. The design of the questionnaire and semi-structure interview questions depends on has to be tailored to the perspective of the sample population and size. The nature of validity as stated by Field (2009) can be criterion validity, which depends on the existing phenomenon, or situation or content validity when the design of the research instruments fulfils the requirement for data collection. In this study, the use of pilot study has helped in assessing the validity of research instruments. Also, the design of the questionnaires includes a brief explanation of sustainability in construction and a participant information sheet detailing the required information to fill the questionnaire. Reliability pertains to the acquisition of the best result under different conditions (Field, 2009). In addition, Saunders et al. (2016) opined that in other to enhance the validity and reliability of a study mixed method approach is vital. This justifies the choice of mixed method approach for this investigation. Triangulation of data, which involve the mixed method approach, was used for objectives two, three and four. In order to ensure the validity and reliability of the data collected, planning the research design from the onset is very vital. Four (4) expert interviews were conducted for validating the sustainable construction strategy; this will point out the errors

and omissions. The various types of validity will be explained in detail in relation to this investigation.

### **3.9.1 Content Validity**

Content validity is a qualitative method of addressing ambiguity in social science research. Content validity ensures that the questions asked in the questionnaires or interviews are related to the basic knowledge level of the respondents. The basic method of conducting content validity is by asking a number of questions about the questionnaire and the judgement of experts with a high level of experience. In this study for the purpose of data collection, the researcher used the term “sustainable construction” as the basic terminology. Moreover, certain concepts relating to sustainable construction practices were asked in the survey questionnaire and interviews.

### **3.9.2 Construct Validity**

According to Miles and Huberman (1994), construct validity is based on the appropriateness of the data collection instruments. In this research, the data collection methods were selected after a review of previous literature (such as previous studies, academic papers and conference reports). Two different data collections including questionnaire and semi structured interviews were carried out to assure that the most appropriate, rich and accurate information was collected for the study. Furthermore, the researcher used a questionnaire, semi structured interviews with experts in order to increase the construct validity of the research.

### **3.10 Research Reliability**

Reliability relates to the consistency of a measure. It deals with the extent to which the data obtained are affected by random errors. When random errors build up over time, it affects the validity of the data. Therefore, errors are unavoidable in data analysis. However, there is a level of reliability, which is acceptable for a good data analysis. There are several ways to determine the reliability of data: this is based on the nature of reliability. According to Drost (2011) there is four types of reliability, they are inter-rater reliability; test-retest reliability, parallel-forms reliability and internal consistency reliability. In this research both Inter-rater reliability and internal consistency reliability were adopted.

### **3.10.1 Inter-rater reliability**

Inter-rater or inter-observer reliability is executed when there is an investigation of opinion, behavior or perception towards a judgement. Thus, there is more than one judgement for the same opinion. This suggests that different participants provide a various judgement on the rating. The level of agreement of this research can be different. The researcher used Kendall's coefficient of concordance to establish the level of agreement from the Likert scale.

### **3.10.2 Internal consistency reliability**

This type of reliability makes use of one single measurement instrument administered to the same population to evaluate reliability. Inter-item correlation within the group of constructs provides enough evidence for a good evaluation of the reliability. Another method of conducting internal reliability is through split-half. Split-half reliability randomly divides the items, which supports the concepts into two. Cronbach alpha is an average of all the possible halves. Pallant (2013) indicated that Cronbach alpha is showed the mean inter-item correlation for the construct. The Cronbach alpha test available on SPSS 23 was used for the reliability of the data for this study.

## **3.11 Research Pilot Study**

Saunders et al. (2016) define the pilot test as a small-scale study to test a questionnaire or an interview to reduce the likelihood of respondents having problems in answering the questions and of data recording problems. Even more importantly, a pilot study allows for some assessment of the questions in terms of validity and reliability of the data that could be collected using those questions in their current formats. In addition, Maldaon and Hazzi (2015) highlight that a pilot study is a vital step in performing a successful research study, whatever the type of research. They added that the role of the pilot study was significant, as it contributed to an improvement of the quality and effectiveness of the main study. Furthermore, as the researcher adopted self-completion questionnaires, a pilot study becomes important for the research because no interviewer is present to clear up any confusion. Also, with an interviewer present, persistent problems which might emerge after a few interviews cannot be addressed (Bell & Bryman, 2007). Therefore, one of the advantages of conducting a pilot study is that it might give warning about where the main research project could fail,

where research protocols may not be followed, or whether proposed methods or instruments were inappropriate or too complicated.

A pilot study for the questionnaire survey and semi-structured interview questions were carried out with a group of experts or colleagues, with previous experience in questionnaire design, interview skills, data collection and analysis. Therefore, the researcher tested the questionnaire on a small size sample targeting several current PhD students and academic staff at the University of Salford and some experts on the topic of the research. The feedback led to some adjustments in the questionnaire. Unrelated questions were removed from the questionnaire and semi-structured interview questions. This facilitated quicker understanding of response time from the respondents in the field. The pilot study led to the data collection process and analysis.

### **3.12 Ethical Issues**

Researchers are required to conduct their study with honesty and integrity whilst protecting the anonymity, confidentiality and data of respondents and participants. In this study, the researcher complied with the University's ethical requirements for the proper conduct of research. Participants were given some information about the study and its aims and objectives, No coercion of any kind was used and consent to participate was on a voluntary basis, However, signed consent was required,

Therefore, the participants were informed about procedures and risks involved in the research before they attended to participate. The researcher gave an introduction to participants about the research topic, procedures, and purpose of the questionnaire, after that the researcher asked for permission from participants to take part in this research. The participants' right to privacy was respected and all data was presented in an anonymous fashion. Data was stored electronically and password protected. Paper based back up material was held securely in a locked cabinet. All these measures were taken to ensure that participants were not exposed to any personal harm or career progression.

### **3.13 Summary**

This chapter highlighted and justified the research philosophy, approaches, procedures, strategies and techniques that were used in this research to answer the research questions in order to achieve the research objectives. Based on the ‘Research Onion’ module this research adopted the social constructivist (interpretivism) epistemological stance, since interpretivism is concerned with understanding the differences between humans in their role as social actors. In addition, subjectivism (ontological consideration) is similar to interpretivism in terms of studying the human phenomena in reality as social actors, thus this research adopted a more subjectivist ontological stance. This research is based on both the deductive approach and the inductive approach. In the deductive approach the research subject has been generated from general to specific, from the available data and literature followed by key factors which are to be tested. On the other hand the research also adopted an inductive approach (in the next phase of the Phd) where it will seek to validate the sustainable construction implementation strategy in Libya.

The researcher will firstly rely on secondary data generated from the literature review followed by primary data which are generated through the adoption of mixed methods of research strategies namely Semi-structured interviews and Questionnaire. The interviews aim to provide the researcher with an initial understanding of the sustainable construction practice in Libya and help in designing the self-administered questionnaire. Following that the researcher aims to develop the sustainable construction implementation strategy which will be tested and validated.

## **CHAPTER (4): FINDINGS AND DATA ANALYSIS**

### **4.1 Introduction**

This chapter presents the findings from the two stages of the primary research. As presented in the previous chapter, based on the nature of the research aim and objectives, it was important to first get a broad view of the current situation and of the complexity associated with sustainable construction in Libya.

The first stage of the primary research involved a survey to obtain a broad view of the current practices and of the organisations and their benefits. The questionnaire survey provided data on the performance sustainability of the participating organisations, and it also identified the level to which the organisations need to improve (See Appendix A). Findings from the questionnaire survey were useful in assessing the current practices of the participating companies and in discovering the benefits derived from using these practices. In addition, the main challenges in implementing sustainable practices in the industry were identified.

This chapter also focuses on the findings resulting from the second stage of the primary research, which involved interviews with top and middle management in the participating companies. Interviews were conducted to get an in-depth understanding of practitioners' knowledge and their interpretations of sustainable construction, how and to what extent it was being adopted in their organisational daily practices, and the rationale for such practices. The interviews aimed at identifying the values that underpinned organisational behaviour and actions. Since sustainability is about factual and value components, an understanding of the practices that influenced the current behaviour of the companies was also obtained.

The interview data provided insights into sustainable practices by identifying the challenges that faced the industry and also what participants would recommend for improving sustainable practices in Libya.

This chapter consists of three main sections. The first provides the professional summary of the respondents. The second section presents the findings from the quantitative data analysis and factor analysis related to the challenges and benefits of current practice, followed by a summary of the key findings from the quantitative data analysis. The third section presents the key findings from the qualitative data analysis which identifies the practices and the benefits of using them as well as the main challenges to the sustainable practices and



recommendations for action. The final section provides a summary of the qualitative data analysis.

## **4.2 Descriptive Statistics of Characteristics of Respondents**

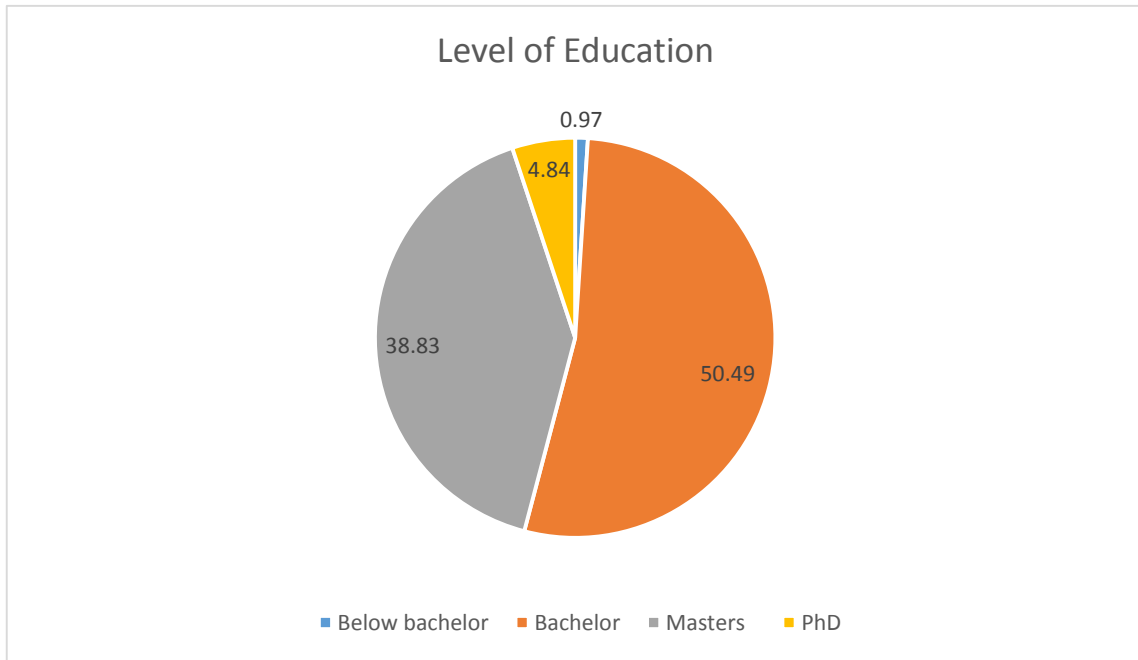
Descriptive statistics refer to the description of the main features of the data in a quantitative (numeric) way. Descriptive statistics include frequency distributions tables of means and standard deviations and, where appropriate, items in rank order. The first part of the descriptive analysis introduces the personal and organisational background information of each respondent followed by a description of the practices of sustainable construction adopted by them. This is followed by their perceptions of the challenges to implementing sustainable construction practices and the benefits of using sustainable construction practices.

### **4.2.1. Personal & Organisational Background**

This section describes the general personal and organisational characteristics as reported by the respondents. All respondents were asked to state their original field of study, their education level, their experience in the construction industry and also their organisational background.

#### **4.2.1.1 Education Level**

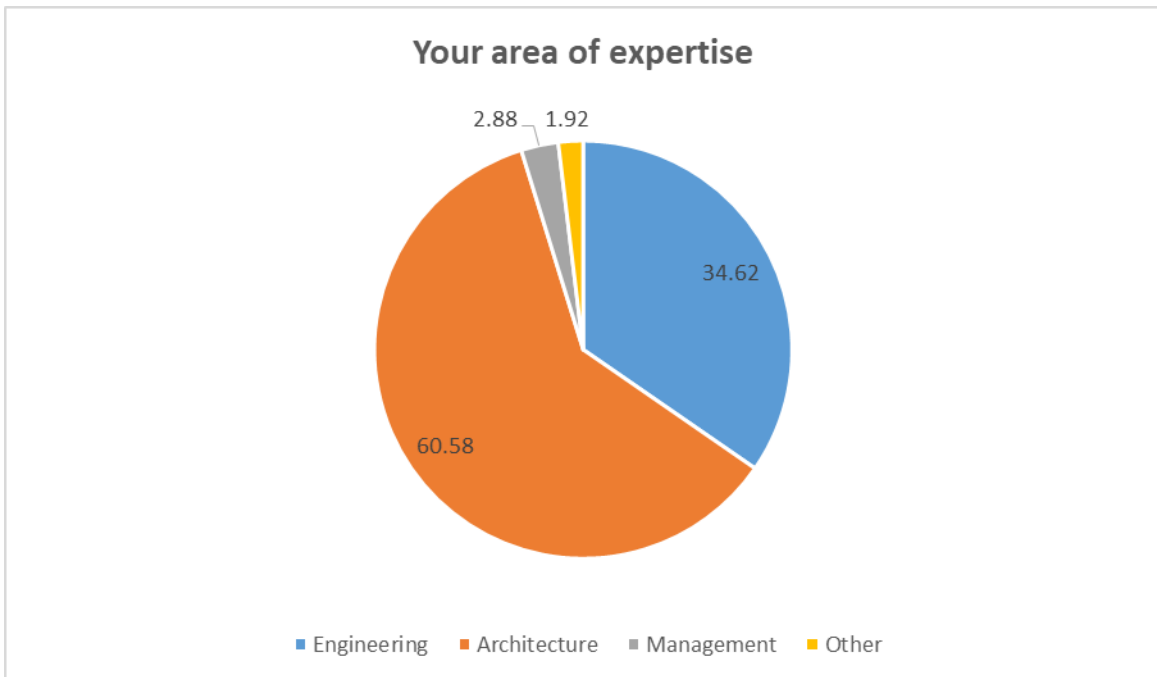
With regard to their highest qualification level, the majority (50.48%) have an undergraduate degree followed by (38.83%) of participants who have a master's degree and (4.85%) who have a PhD qualification. Those without degree education represented (0.97%).



**Fig. 7.1 Level of Education (expressed in %)**

#### 4.2.1.2 Area of Expertise

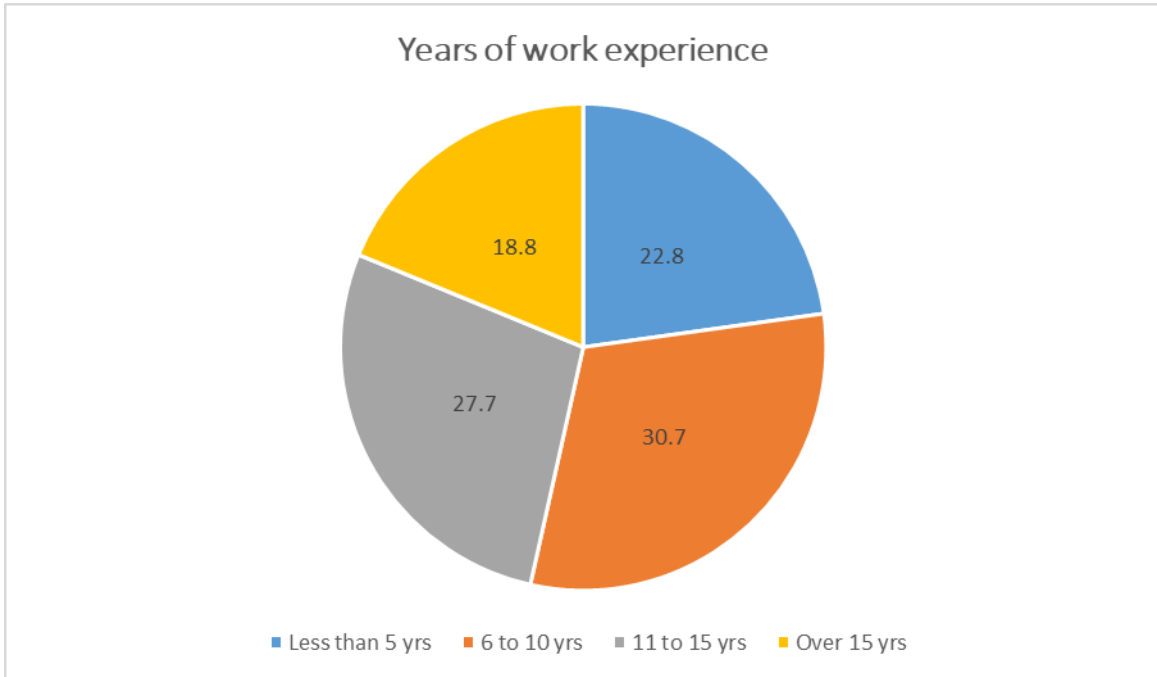
The pie chart in Figure 4.2 below demonstrates the percentage of participants based on their area of expertise. The majority of respondents (60.58%) practiced in Architecture, followed by (34.62%) and (2.88%) in Engineering and Management respectively



**Fig. 8.2 Area of Expertise (expressed in %)**

### 4.2.1.3 Experience in the Construction Industry

The pie chart in Figure 4.3 shows the experience of respondents in terms of years in the construction industry. Most had 6 – 10 years’ experience (30.7%) followed by those who had 11 – 15 years’ experience (27.7%) while those with less than 5 years’ experience (22.8%) was the next group and finally was those with 15 years or more of experience (18.8%).



**Fig. 9.3 Years of Experience in the Construction Industry (expressed in %)**

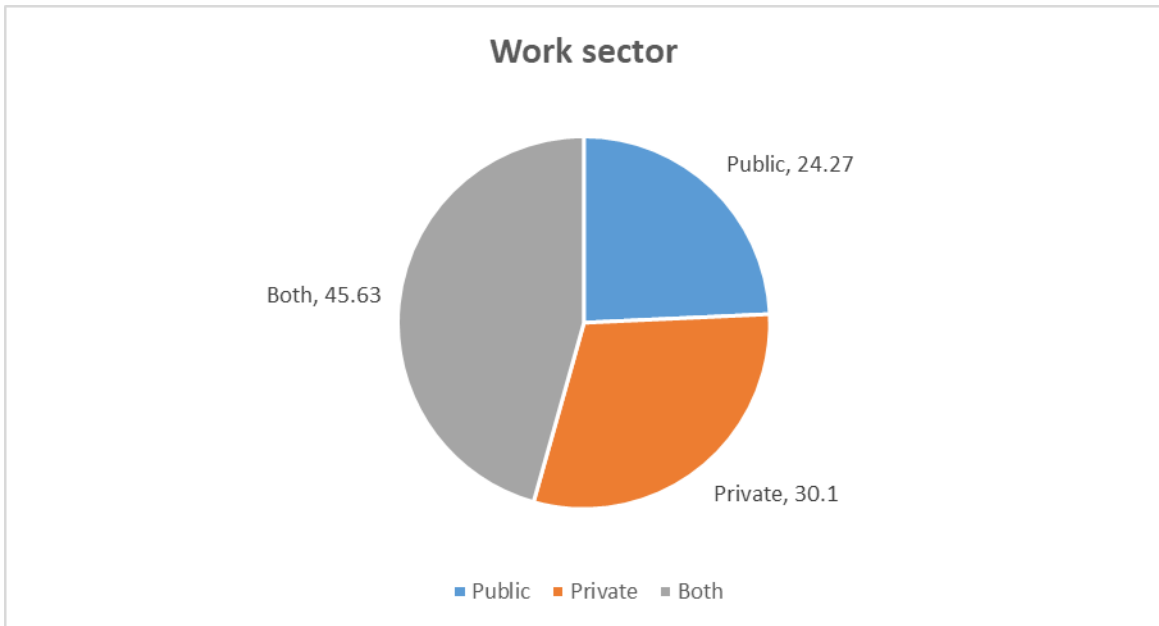
### 4.2.1.4 Organisation Background

Respondents were asked to rank four of their fields of experience in the work place. They were asked to tick the design that they were using or trialling. The most common areas of experience was in residential/housing buildings which was ticked by 78.85% of the participants. This was followed by commercial buildings (32.69%), and industrial buildings (21.15%). Urban design and administration buildings was ticked by 14.42%; and finally infrastructure by 10.58%. These results are shown in Figure 4.4



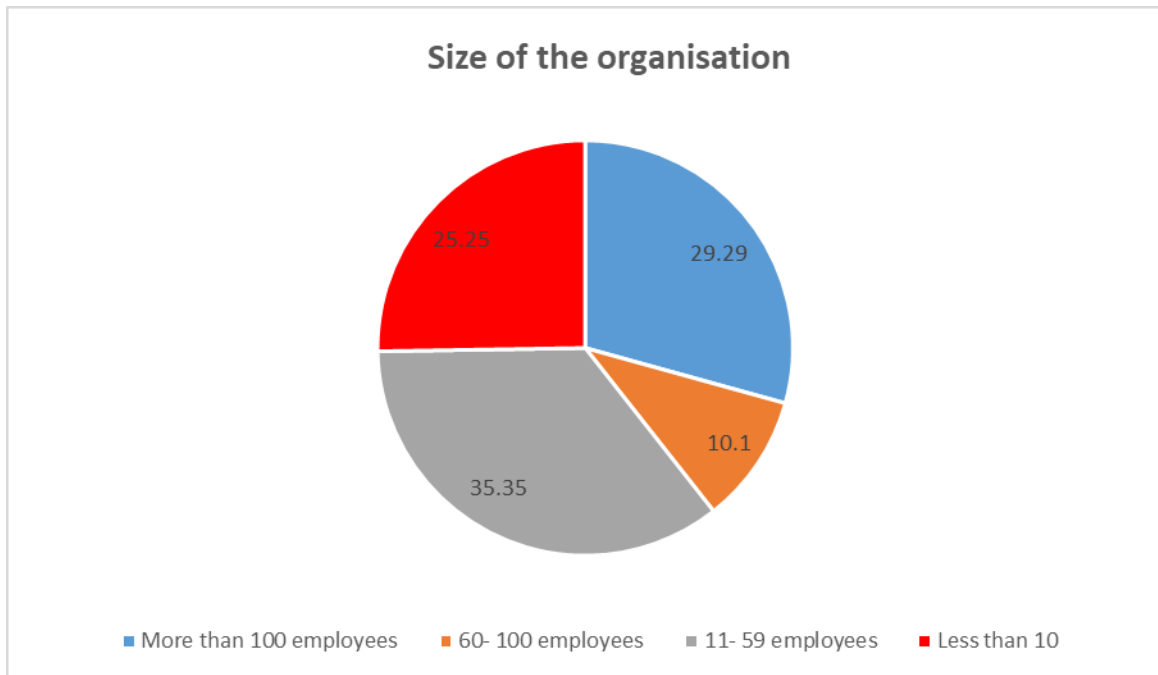
**Fig. 10.4 Work field (expressed in %)**

Respondents were asked to rate their work experience by sector of field of work. The least common sectors were the public sector which was ticked by 24.27% of respondents followed by the private sector (30.10%), and finally, the most ticked by participants was both, (public and private) (45.63%). These results are shown in Figure 4.5



**Fig. 11.5 Experience in Sectors (expressed in %)**

Respondents were asked to rank the size of their work place organisation by ticking the different sizes based on the number of employees. The least common was 60 – 100 employees (10.1%) followed by less than 10 employees (25,25%) then more than 100 employees 29,29%) and 11 – 59 employees 35.35% in ascending order of respondents' ticking. These results are illustrated in Figure 4.6



**Fig. 12.6 Size of Organisation (expressed in %)**

### 4.3 Quantitative Data Analysis

#### 4.3.1 Quantitative analysis of sustainable construction practices used in Libya

This section describes the practices of sustainable construction and respondents' knowledge of the use of practices in order to achieve objective two. In the second section of the questionnaire (See Appendix B) participants were asked to rate the six sustainable construction practices (See section 2.6.4). These are: reduce building resource consumption, reuse building resources, use recyclable building resources, minimise pollution and negative environmental impacts, site selection and planning, and apply building indoor quality environment, on a scale where 1=Never used to 5=Always used.

In order to evaluate the most effective and important sustainable construction practices, Kendall's coefficient of concordance was used for this analysis. This ranks the various

practices in descending order. These practices have more impact on the entire construction projects in Libya.

When looking at the practices that were often/always used it was found that the highest rated of all practices was “reuse building resources” with a mean value of 5.12. This was followed by ‘reduce building resource consumption’ with a mean value of 5.11, whilst apply building indoor quality environment had a mean value of 4.05, followed by ‘site selection and planning’ with a mean value of 3.75. To ‘minimise pollution and negative environmental impacts’ had a mean value of 3.64 and ‘use recyclable building resources’ had a mean value of 3.31. These results are shown in Table 4.1 below.

**Table 5.1 Participants’ Use of Sustainable Construction Practices**

<b>Practice</b>	<b>Never</b>	<b>Rarely</b>	<b>Sometimes</b>	<b>Often</b>	<b>Always</b>	<b>Mean</b>	<b>Rank</b>
Site selection and planning	22	28	40	19	25	3.75	4
	12.1%	21.2%	39.4%	9.1%	18.2%		
Use recyclable building resources	28	25	39	21	20	3.31	6
	20.9%	17.9%	38.8%	11.9%	10.4%		
Apply Building Indoor Quality Environment	21	25	36	23	28	4.05	3
	%12.1	%18.2	%31.8	%15.2	%22.7		
Minimise pollution and negative environmental impacts	22	31	32	28	21	3.64	5
	%11.9	%25.4	%28.4	%22.4	%11.9		
Reuse building resources	18	19	27	22	48	5.12	1
	%7.6	%7.6	%19.7	%13.6	%51.5		
Reduce building resource consumption	20	19	26	26	43	5.11	2
	%7.6	%9.1	%18.2	%19.7	%45.5		

Table 4.2 below shows Kendall's W test for important sustainable construction practices, the purpose of this test is that a number of people have been asked to rank a list of practices, from most important to least important. Kendall's W can be calculated from these data. If the test statistic W is 1, then all the survey respondents have been unanimous, and each respondent has assigned the same order to the list of practices. If W is 0, then there is no overall trend of agreement among the respondents, and their responses may be regarded as essentially random. Intermediate values of W indicate a greater or lesser degree of unanimity among the various responses, the p value returned is  $p < 0.0005$  which indicates that the results are highly significant. However, the Kendall W coefficient is 0.191 which indicates only a weak level of agreement ( $W \leq 0.3$ )

**Table 6.2 Kendall's W test for important sustainable construction practices.**

N	57
Kendall's W <sup>a</sup>	.191
Chi-Square	65.390
df	6
Asymp. Sig.	.000
a. Kendall's Coefficient of Concordance	

### **4.3.2 Factor analysis for challenges to sustainable construction practices in Libya**

The researcher was also interested in understanding the challenges that affect sustainable construction practices in Libya in order to achieve objective four. The questionnaire included 19 possible challenges (See section 2.4) and participants were asked to tick the challenges that existed in Libya. Each respondent was asked to tick only one of the challenges based on importance. This part of the questionnaire was mainly concerned with assessing the challenges affecting sustainable construction in general. Respondents were presented with 19 possible challenges which could affect the implementation of sustainable construction practices in Libya and were asked to rate the importance they attached to each statement. Their importance was assessed based on a 5-point Likert scale (1=Not at all, 2=Low, 3=Medium, 4=High, 5=Very high).

To check the reliability of data obtained from the respondents, Cronbach’s alpha was used. Reliability is very important for data analysis. There are 134 responses of valid data for this analysis. This is 88.99% of the total of 250 responses and only 11.11% of the data is missing.

**Table 7.3 The Cronbach’s alpha test**

Cronbach's Alpha	N of Items
.958	19

The Cronbach’s alpha value is 0.96; this shows a very high internal consistency of the data. According to Pallant (2013), the closer the value of the Cronbach’s alpha is to 1.0, the greater the internal consistency. A reliability of factors from the literature review has been established. The factoring process will reduce and group the factors into the required classes. This starts with the Kaiser-Meyer-Olkin measurement of sampling procedures from the factor analysis. Factor analysis is required for the empirical reduction and classification of the challenges into critical groups.

A number of challenges have been identified using the review of focal literature (See section 2.4). Nineteen challenges were identified (See table 4.4) based on the categories of challenges related to regulations, finance, technology, management, awareness and culture.

**Table 8.4 List of the Challenges**

<b>List of the Challenges</b>
1. Government commitment and support
2. Government policies, legislation
3. Building codes and Regulation on sustainability
4. Initial capital and investment costs
5. Additional cost in construction and services
6. Availability of Financial resources and incentives
7. Life-cycle cost assessment
8. Availability of Green materials information and specifications
9. Accessibility to green materials information, and specifications
10. Cost of green materials and products
11. Adoption and Familiarity with the new technologies
12. Accessibility to integrated design tools and methods
13. Leadership ability and decision making process.



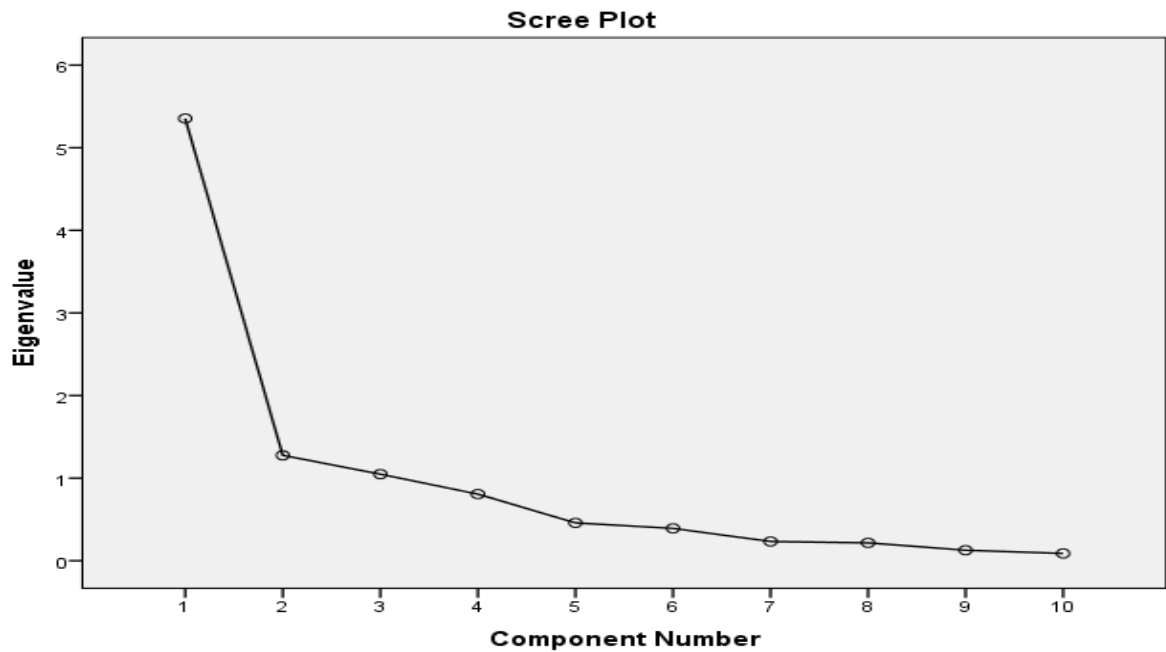
14. Effective communication amongst project team members
15. Technical ability and IT skills
16. Common understanding and awareness by stakeholders on sustainability
17. Professional capacity, knowledge & innovation in sustainability
18. Education and training on sustainability
19. Cultural change resistance

These categories were used to make it easier for the respondents to complete the questionnaire. The critical challenges were tested using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy to assess the adequacy of the data for factor analysis. This is based on the principal components. If the KMO is above 0.6, that indicates that the sampling is adequate and data is reliable for the analysis. Nineteen factors (challenges) were eliminated to give KMO and Barlett's test in table(4.5) below.

**Table 9.5 KMO and Bartlett's test after the final iteration**

Cronbach's Alpha	N of Items
.958	19

Some factors therefore must be eliminated; factors with less than 0.4 coefficient in the correlation matrix were eliminated. An eigenvalue of 1 was used for the principal components. The findings of a scree plot for the nineteen factors which were later reduced to 8 factors for KMO adequacy provided three major categories from the elbow of the curve. See Figure (4.7) below shows the scree plot with the eigenvalues.



**Fig. 13.7 Scree plot with the eigenvalues**

Three eigenvalues  $\geq 1$  were identified. These values are above 1.0. The component transformation matrix was produced using the three identified challenges. See Table (4.6) below shows the Component Transformation Matrix.

**Table 10.6 Component Transformation Matrix**

Component	1	2	3
1	.649	.629	.428
2	-.727	.679	.104
3	-.225	-.378	.898

The component transformation matrix from the principal component extraction also made use of the Varimax with Kaiser Normalisation rotation method. The method extracts the 3 major components. The three components identified from the scree plot extraction method were correlated with each other for further analysis to prove their correction. The rotated matrix provided the coefficients of the factors, which are categorised into the three categories. These are presented in Table 4.7 below which is the Rotated matrix table for the factors analysis.

**Table 11.7 The Rotated matrix for the Factors Analysis**

	Component		
	1	2	3
Awareness of Stakeholders about Sustainability	.908		
Government policies, and legislation	.867		
Adoption with the new technologies		.827	
Capital and investment costs		.816	.
Cost of green materials and products		.749	
Availability of Green materials information and specifications		.729	
Leadership and decision making process			.903
Technical ability and IT skills			.740

The extraction method was based on the principal component analysis. The rotation method employed Varimax with Kaiser Normalization. The rotation converged in 12 iterations. The three factors extracted with an eigenvalue greater than 1.0 were used to re-categorize the challenges into three major components, as listed in the table above. The values of the factors which appeared in different components were selected based on the highest value. The overall categorization of the twenty challenges is named and presented in the table below. Table (4.6) below shows the categorisation of the factors into challenges.

**Table 12.8 The categorisation of the factors into challenges**

Challenges in	Knowledge & steering	Technology & Costs	Organisation & Technical
Sub- Challenge	Awareness of stakeholders about sustainability	Familiarity with the new technologies	Leadership and decision making process
		Capital and investment costs	
	Government policies, legislation	Cost of green materials and products	Technical ability and IT skills
		Availability of green materials information and specifications	

The eight sub-challenges have been allocated to the critical challenges based on the pattern matrix. The names given to the categories were based on the similarities between the challenges. The most important challenges in each category were now tested for their level of

importance using Kendall's test for concordance. The three main challenges were Steering and Knowledge, Technological and Cost and, finally, Organisational and Technical challenges. These are discussed in the following sub-sections:

#### 4.3.2.1 Assessing Knowledge and Steering Challenges

In assessing the challenges for knowledge and steering, Kendall's coefficient of concordance was used to address the major significance and mean rank of the challenges.

Awareness of stakeholders about sustainability ranked highest with a value of 4.14. This challenge also had a very high significance value of  $p = 0.004$ . Government policies and legislation was ranked second with a value of 4.12. The mean ranks were also compared and the asymptotic significance value should be  $p \leq 0.05$  for a level of significance. The most significant challenge was awareness of stakeholders about sustainability ( $p = 0.004$ ) while government policies and legislation had a significance value of  $p = 0.018$ . Table (4.9) shows significance and mean values for knowledge and steering challenges

**Table 13.9 Significance and mean values for knowledge and steering challenges**

Challenge	Organisation & Technical	Asymp Sig.	Mean	Rank
Sub-challenge	Awareness of stakeholders about sustainability	0.004	4.14	1
	Government policies, legislation	0.018	4.12	2

#### 4.3.2.2 Assessing Technological and Cost Challenges

The mean ranking for familiarity with the new technologies was 3.89. The asymptotic significance is  $p = 0.001$ . Capital and investment costs was ranked second with a mean value of 3.83 and a high significance of  $p = 0.006$ . Cost of green materials and products was ranked third with a mean value of 3.79 and a significance value of  $p = 0.018$ , while last ranked was availability of green materials information and specifications with a mean value of 3.64 and significance of  $p = 0.037$ . Table (4.10) below shows the significance and mean values for the challenges in technology and costs.

**Table 14.10 Significance and mean values for technological and cost challenges**

Challenge	Technological and Cost	Asymp Sig.	Mean	Rank
Sub-	Familiarity with the new technologies	0.001	3.89	1

<b>Challenge</b>	Capital and investment costs	0.006	3.83	2
	Cost of green materials and products	0.018	3.79	3
	Availability of green materials information and specifications	0.037	3.64	4

#### 4.3.2.3 Assessing Organisational and Technical Challenges

The two main sub-challenges, in terms of organisational and technical challenges were leadership and decision making process, and technical ability and IT skills. The mean value for both of them is 4.16 and 3.64 respectively. The first significant challenge for these challenges is leadership and the decision making process with a value of  $p = 0.047$  while technical ability and IT skills ranked second with a value of  $p = 0.011$ . Below Table (4.11) shows significance and mean values for organisational and technical challenges.

**Table 15.11 Significance and mean values for organisational and technical challenges**

<b>Challenge</b>	<b>Organisational and Technical challenges</b>	<b>Asymp Sig.</b>	<b>Mean</b>	<b>Rank</b>
<b>Sub-Challenge</b>	Leadership and decision making process	0.047	4.16	1
	Technical ability and IT skills	0.011	3.64	2

#### 4.3.3 Quantitative analysis for benefits of using sustainable construction practices in Libya

In the context of Libya, participants were asked to tick or show agreement with the three main benefits for using sustainable construction practices in Libya in order to achieve objective three. Overall they were provided with 9 benefits to choose from (See section 2.8).

The table below shows the percentage and the frequency of respondents' answers. Their agreement was assessed based on a 5-point Likert scale (1= strongly disagree, 2= disagree, 3=neither agree nor disagree, 4=agree, 5=strongly agree). This section presents the highest agreement and the lowest statements based on the agreement mean.

The main benefit behind using sustainable construction practices according to the respondents, based on agree and strongly agree answers, showed that the first benefit was to

“Reduce building resources consumption costs’ which received a mean value of 4.98, this benefit was followed by ‘Increase production of renewable resources’ receiving a mean value of 4.62, while third ranked was “Enhanced building occupant health, comfort & Safety” with a mean value of 4.22, followed by the fourth ranked benefit which was ‘Reduced waste production and increased recycling’ with a mean value of 4.05. The fifth ranked benefit was ‘Improve satisfaction of occupants’ with a mean value of 3.95 and this was followed by ‘Maintain integrity of the environment’ with a mean value of 3.94 as the sixth benefit ranked.

On the other hand, the benefit “Better individual productivity of occupant” was ranked seventh with a mean value of 3.70, and finally both benefits which are “Reduce overall building lifecycle cost” and ‘Decreased initial costs for reused and recycled materials’ had a mean values of 3.30, 3.21 respectively. Further details about all the benefits and their rank can be seen in the table (4.12) below.

**Table 16.12 Frequency of the most common benefit for the use of sustainable construction**

<b>Benefit</b>	<b>SD</b>	<b>DA</b>	<b>N/D</b>	<b>A</b>	<b>SA</b>	<b>Mean</b>	<b>Rank</b>
Reduced waste production and increased recycling’	19	17	20	42	36	4.05	4
	5.2%	3.4%	10.3%	46.6%	34.5%		
Maintain integrity of environment	18	17	21	44	35	3.94	6
	5.2%	1.7%	10.3%	48.3%	34.5%		
Increase production of renewable resources	3	1	2	24	28	4.62	2
	5.2%	1.7%	3.4%	41.4%	48.3%		
Improve satisfaction of occupant	18	18	19	44	35	3.95	5

	3.4%	5.2%	6.9%	50%	34.5%		
Decreased initial costs for reused and recycled materials	19	21	23	44	27	3.21	9
	5.3%	7%	15.8%	50.9%	21.1%		
Reduce overall building lifecycle cost	28	30	27	42	29	3.30	8
	3.6%	7.1%	19.6%	46.4%	23.2%		
Reduce building resources consumption costs	1	3	3	20	31	4.98	1
	1.7%	5.2%	5.2%	34.5%	53.4%		
Enhanced building occupant health, comfort & Safety	18	16	20	44	36	4.22	3
	3.4%	1.7%	10.3%	48.3%	36.2%		
Better individual productivity of occupant	18	19	22	45	30	3.70	7
	3.4%	6.9%	12.1%	51.7%	25.9%		

The Kendall W score of 0.077 shows only a weak level of agreement for the most agreed sustainable construction benefits and the respondent's ranking on the Likert scale even though the significance was very high at  $p < 0.0005$ . Below table (4.13) shows the Kendall's W test for important sustainable construction benefits.

**Table 17.13 Kendall's W test for important sustainable construction benefits**

<b>N</b>	54
<b>Kendall's W<sup>a</sup></b>	.077
<b>Chi-Square</b>	33.135
<b>df</b>	9
<b>a. Kendall's Coefficient of Concordance</b>	

#### 4.3.4 Summary of Quantitative Analysis

The questionnaire survey analysis gives a broad view on how construction companies in Libya apply sustainability in their practices. Findings from the survey provided information on the extent to which environmental, social and economic sustainability were considered and applied in construction processes.

The data resulting from the survey showed the sustainability performance of the participating company and this serves as a scoping review for construction practices in Libya. The survey indicated that the level of sustainability that was embedded in practice was relatively low, with economic and social and sustainability having the highest performance respectively. Economic and social values were identified as the main concerns of the companies' construction practices.

The study relied on a questionnaire survey (134 respondents) from different backgrounds within the construction industry. It was important to study the current use of sustainable construction practices in Libya, by testing the respondents' knowledge and understanding of the practices and possible benefits that helped the use of sustainable construction practices.

This research used six sustainable construction practices which were Reduce building resource consumption, Reuse building resources, Use recyclable building resources, Minimise pollution and negative environmental impacts, Site selection and planning, and Apply Building Indoor Quality Environment. It was found that the most used practices were "Reuse building resources" as this was ranked first, with a mean value of 5.12. This was followed by 'Reduce building resource consumption' with a value of 5.11, while the Building Indoor Quality Environment was third with a mean value of 4.05.

The 19 challenges (dependent factors) which were derived from an extensive literature review were tested by using factor analysis. 8 Sub-challenges were found to be most significant and it was useful to examine their influence on implementing sustainable construction practices in Libya.

The following assessment describes the benefits of using sustainable construction practices in Libya and examines these benefits individually. The main benefit of using sustainable construction practices in Libya according to the respondents was to 'reduce building resources consumption costs' with a mean value of 4.98, this was followed by 'increase production of renewable resources' with a mean value of 4.62, whilst the third ranked was "enhanced building occupant health".

In the next section the researcher provides the findings from the qualitative data whilst focusing on the main significant challenges including the recommendations for actions that could help design the implementation strategy for sustainable construction practices in Libya.



## **4.4 Qualitative Data Analysis**

As pointed out in the previous section and in Chapter 3, following the survey, it was important to recognise and understand the existing knowledge and application of sustainability in the Libyan construction sector. To do so, interviews were carried out to gain a better understanding of how sustainability in construction can be applied in practice within the organisation (See Appendix B). The interviews were mainly focused on recognising the rationale for the current practices, the challenges to implementing sustainability into the construction processes as well as some recommendations being made by the interviewees for overcoming these challenges and further actions to take. There were 10 interviewees who were either in middle or senior management from different construction companies.

### **4.4.1 Profile of Interviewees**

The following table outlines information concerning the company and the interviewees who took part in the 10 semi-structured face-to-face interviews which were conducted.

After extensively reading the interview scripts the researcher analysed the main answers with regard to the current application and understanding of sustainable construction practices.

From the questionnaire findings, the drivers for the implementation of sustainable construction practices in Libya were investigated qualitatively to achieve objective four. The interview process was analysed using the content analysis method.

### **4.4.2 Level of Awareness**

Part of the challenge of maintaining sustainable practices is the level of awareness. The data from the interviews indicated that the level of understanding of sustainable construction amongst interviewees was not high. Most of the interviewees were unfamiliar with aspects of sustainable construction. The participants' response to the question based on their understanding of the concept of sustainable construction showed that their level of awareness was relatively low among the participants in the industry. According to R2:

*“Overall, our people here do not have much knowledge of sustainable construction. We deliver construction projects following the traditional method that has been established”*

Similarly, R4 expressed his opinion about the sustainability concept:

*“... Sustainability is not a cultural matter here, it’s very rare people mention it, people do not consider it as major issue. ‘I think it is necessary to have more clarification to generate better awareness amongst workforce”*

In support to above, respondent R7 mentioned that:

*“...as far as I am aware, by sustainability you are discussing being able to make a project sustainable. I think, sustainability is very significant in construction. The reason is that when a project is undertaken and it is sustainable, it is important for two reasons. First for the client, the project lifespan will last longer and stand the test of time, while for the contractor it will be a topic of reference due to the good quality”*

Regarding sustainable strategies issues, and according to respondent R4:

*“At the initial stage of our projects, we consider sustainable strategy and this is often when we take the brief and concept formulation. Nevertheless, there is a key challenge in having users collaborate because it’s not really related to our culture, and there are no policies issued by the government or organisation supporting this”*

Some other views relating to the interviewees’ understanding about sustainable construction, included participant R1 who asserted that:

*“...We don’t actually understand what sustainable construction means yet, unfortunately we are still adopting the traditional approach and this is the way we carry out our projects”*

In support of above, participant R5 added:

*“Applying sustainability in construction is not a very common practise in Libya. Apparently, we don’t know much about it”*

Moreover, participant R5 further commented about the importance to sustainability in construction as it would add different values to the organisation:

*“Sustainable construction is a major issue, a project that is sustainable has a longer lifespan, it helps the reputation of the company due to the high build quality and the client is well satisfied”*

In summary, the awareness level was poor, and applying sustainable practices in the Libyan construction companies will be a major challenge. The interviewees admitted the need to establish greater awareness of sustainability issues within the construction industry following specific matters on sustainable practice and comments linked to their application.

### **4.4.3 Qualitative analysis of sustainable construction practices used in Libya**

Sustainable construction practices as based on questions in appendix (B) covers the broad knowledge and application of sustainable construction practices among participants in order to achieve objective two. The main practices they were questioned on are given below. Further, the participants were asked if they had any other practices that were currently used in Libya.

- Reduce resource consumption
- Reuse building resources
- Use recyclable building resources
- Minimise negative environmental impacts
- Site selection and planning
- Apply building Indoor Quality Environment

#### **4.4.3.1 Reduce building resource consumption**

Participants were asked specifically about the process of reducing building resource consumption. All the participants acknowledged the priority of energy efficiency and energy emerged strongly as an influential issue in all the conversations.

Participant R3, a senior project engineer in the company, considered the reduction of building resource consumption in buildings in Libya as an imperative process for both the industry and clients:

*“Reduction of building resource consumption such as energy use is an essential process. It is for all the projects of government, businesses and individuals, especially at the present moment in the construction industry. We are fully aware of the potential we have to play a major role in meeting the uses of this practice in the work place”*

Therefore, the designers were well aware of the financial position of the social buildings tenants and appreciated the need for reducing fuel bills by providing more energy efficient buildings. Participant R9, one of the senior designers believed that:

*“...Energy is probably the number one for us because most of our clients are on low incomes so they look at the bills of the house and we need the rent to be paid. We can give the government the energy efficient houses which they want”*

In summary, in terms of addressing the economic values and energy saving of the buildings in Libya, participants have been involved in this process particularly during the design phase. The influence must be a broad one ranging from developing and implementing innovative technical energy solutions that building occupiers used effectively, to the designing and constructing of the projects to minimise energy consumption and save costs.

#### **4.4.3.2 Reuse of building resources**

Respondents were asked to specify the process of the reuse of building resources such as materials. It was considered to be one of the knowledgeable processes by the majority of the participants interviewed.

The participants stated that waste reduction methods were mainly useful for economic purposes According to respondent R1:

*“We make sure that waste is decreased by checking that each segment of the construction is activated based on a plan. For example, on construction sites we have tools available and do measurements to guarantee waste is minimised. We also reuse our building materials on the site although this is mainly for the company's benefits”*

A couple of the participants R3 and R4, who were senior managers, both shared similar opinions regarding building material disposal. R3 stated that:

*“The main issues are the use of materials and processes that create disposal difficulties, the use of materials that have no potential for future reuse or recycling, the use of wasteful materials, and the use of designs and details that result in excessive waste when executed at the job site. We try to focus on methods to reduce the load on landfills by concentrating on several points of waste generation”*

In summary, the participants mentioned that waste reduction methods were mostly used for economic interest. In terms of considering the reuse of building materials in Libya, participants have been involved in this process particularly during the disposal phase.

#### **4.4.3.3 Use of recyclable building resources**

Participant were asked specifically about the process of using recyclable building resources and the majority considered it as one of the more knowledgeable processes of using sustainable materials as an approach to new housing provision in Libya. It was also mentioned as an example of choosing building materials. Participant R10 indicated that:

*"... We try to source local materials as far as possible, and we also tried to look at the extent to which the building components and materials themselves could be recycled when the building comes to the end of its use"*

One participant R1 was enthusiastic about highlighting the relationship between the sustainable materials and the energy needed to produce them:

*"Materials, I would suggest, link to energy issues as well. The energy used in manufacturing materials and the resources to produce are actually using up natural resources"*

The participants agreed on the point that it is difficult to provide elements obtaining sustainable materials in their specification which provides guidance to designers and specifies the environmental impacts of common specifications used in the buildings. Participant R3 explained that:

*"... We, as engineers in the company, are usually concerned with the use of recyclable materials, I think the types of the materials and specifications are very important, but the issue we always face is a lack of availability of these products in the Libyan market and it's also too costly to provide"*

As the results show, in terms of addressing the use of recycled building materials, participants considered selecting sustainable materials in their building; the only issue they had was the difficulty in ascertaining some of material specifications.

#### **4.4.3.4 Minimise pollution and negative environmental impacts**

Participants were asked specifically about the process of minimising pollution and negative environmental impacts resulting from the buildings in Libya. It was considered as one of the knowledgeable processes by the majority of the participants interviewed.

*"Overall goal of our design team is to decrease the harmful environmental impact of a building or community; these environmental concerns are a key driver behind the sustainable design process"*.

Additionally, participant R7, a senior project manager, explained his opinion about the relationship between building energy consumption and its impact on the environment in Libya, he commented that:

*“... I think energy consumption is actually the major negative in terms of environmental impact; we try to focus deeply on energy efficiency. Building energy consumption should be reduced in all ways in Libya. For instance, improved insulation of a building to prevent heat dissipation, or increasing ventilation to remove polluted indoor air, incorporating passive solar building designs, and the installation of renewable energy sources”.*

In support of this view, the consideration was about having energy systems with a low average of carbon emissions, participant R4 highlighted that:

*“Currently, as a company we are planning to promote the use of solar energy to reduce pollution. That is mainly relating to the power situation in Libya where electric power supply is not always available. Our own power generating set is the only source we have, they are not cheap to run, and therefore we are now encouraging using solar systems as a method of minimising waste and energy costs over time”*

#### **4.4.3.5 Site selection and planning**

The interviewees were invited to make their comments on the importance of site selection to the project and they were very candid in their comments regarding the significance of the right selection of the site on receiving projects. One of the participants, R8, who works as a site engineer in the company highlighted the importance of the site selection practice:

*“.... Site selection has a long-lasting impact on the flexibility of life within any sustainable community; the importance of the site comes from its ability to provide the required services for the tenants. It is very important to find a site, which is close to most of the local amenities, such as schools, shops, and bus routes... etc”*

Furthermore, in terms of the relationship between site location of the building and the potential pollution, participant R3 noted that:

*“Location is important in terms of the condition of the land and the pollution of the land. If you construct in a brown field site I would guess pollution will be less”*

Despite all the confirmations from the majority of the interviewees on the importance of the good location of the site, the reality showed that choosing good sites was very difficult. It was

very hard for small housing associations located in big cities, which needed additional houses, to find a good site to build because of the limitations in the choices. Participant R3 stated that:

*“It is very difficult and it is not up to us, we have to look for that site wherever it is available, however, site selection is a nice issue to think about but I think that is for big housing associations... But generally for a small housing association who is working in our field, we have to work in the site that they can obtain rather than having a choice to choose it”*

#### **4.4.3.6 Apply Building Indoor Quality Environment**

In order to examine the knowledge of the respondents about the process of applying building indoor quality environments in Libya, one of the participants (R1) described indoor environmental quality (IEQ) thus:

*“Generally, I describe it as the conditions inside the building. It contains air quality, also access to daylight and views, nice acoustic conditions, and occupant control over lighting and current comfort in the building”.*

In the context of using the space of the building and creating a better environment particularly inside the building in Libya, participant R10 added a further explanation that:

*“It includes the purposeful features of space such as whether the layout delivers easy access to tools and people when needed and whether there is appropriate space for residents. Project managers can raise the satisfaction of buildings residents by considering all of the aspects of IEQ rather than closely focusing just on the heating or air quality alone”*

Participants R5, R7 and R10 in support the above had similar opinions, R5 stated that:

*“Some occupants spend most of their time indoors; not surprisingly, my own experience has indicated an increase in people productivity when enhancements are made to a space’s IEQ”*

#### **4.4.4 Qualitative Analysis of benefits of sustainable construction practices**

Sustainable construction benefits were based on questions in appendix (B). This section was related to the nine main benefits of using the sustainable construction practices in Libya in order to achieve objective three. Below the main benefits are listed followed by participants’ opinions:

- ***Environmental benefits:*** Reduced waste production and increased recycling, increased production of renewable resources, maintain integrity of environment.

- **Economic benefits:** Reduced building resources consumption costs, decreased initial costs for reused and recycled materials, reduce overall building lifecycle cost.
- **Social benefits:** Enhanced building occupants health, comfort & safety, improving satisfaction of occupants, better individual productivity of occupants.

#### **4.4.4.1 Reduced waste production and increased recycling**

Participants noted the benefits of using sustainable construction practices in their projects. The majority believed that sustainable construction practices could improve the reduction of building waste production and increasing recycling in Libya Participant R6 stated that:

*“Addressing sustainable practices early at design stage would guarantee less in waste production such as during the construction and operation phase, and that is what appeals to us as a company and to our clients”*

The participants stated that reducing waste methods was mainly considered for financial profits. According to participant R1:

*“We decrease waste and use natural resources efficiently because it is beneficial to the firm, particularly in reducing costs, however, based on some requirements and specifications, we order our material in order to minimise waste. Companies in Libya also try their best to reuse any excess to save valuable costs which is very valuable”*

Relating to water saving and recycling processes that can be used in the buildings, participant R10 added that:

*“...Recycling rainwater and grey water for purposes like urinal flow and irrigation can preserve potable water and yield significant water savings which means we can conserve water in our future buildings in Libya. This is very valuable and beneficial”*

#### **4.4.4.2 Increase production of renewable resources**

Utilising sustainable construction practices according to the participants can increase the production of renewable resources in Libya. One of the participants, R5, who is one of the assistant project managers in the company stated that:

*“In order to increase the benefits of using sustainable purposes in our projects, our company is working on promoting the use of solar energy to save energy and reduce pollution. That is mainly because of the power situation in Libya where electric power supply is not always*



available during the day. We mostly use our own power generating sets which are very expensive to use, thus we are now encouraging the use of solar systems which efficiently reduce waste and energy costs over time’

In terms of using renewable energy as an alternative in the construction projects in Libya, participant R8 commented that:

*“Due to the high costs of high technology use, we don’t very often rely on all renewable energy resources such solar power, hydro-power and wind power which are used for the heating and electricity and to support and improve the indoor air quality, We are as a company working on emerging and organising effective ways of bringing renewable energy at scale to our clients, empowering them to achieve sustainable projects”*

#### **4.4.4.3 Maintain integrity of environment**

The majority of the participants saw that using sustainable construction practices was very beneficial in terms of protecting the environment in Libya, according to participant R6 who stated:

*“Sustainable construction practices in Libya should be seeking to reduce the combined environmental impacts during the production of building, and throughout the construction phase, likewise throughout the lifecycle of the building such as heating and cooling systems and electricity use etc.”*

In the same context, participant R1 had his opinion about sustainable practices in Libyan construction and the environment; he commented that:

*“It can be very beneficial to consider during design, construction and operation phases, the aspects of protecting the environment by reducing key carbon issues that need to be monitored and addressed across the building sector in Libya to enable carbon reduction to be realised”*

#### **4.4.4.4 Reduce building resources consumption costs**

According to the participants utilising sustainable construction practices in Libya can also reduce building resources consumption costs of the building, however, participants R1 and R3 shared the same opinion. Participant R6 highlighted that:

*“The reduction is in the resource efficiency provided by sustainable design and construction in Libya leading to drastic reductions in operation costs that quickly recoup any additional*

*project costs and continue to offer dramatic long-term savings Money previously directed toward utility costs may be used for other purposes ”*

Similarly, R3 remarked:

*“Generally, economic benefits to occupants provide cheaper operating costs since energy bills will be lower”*

In terms of considering the energy costs of the buildings in Libya, participant R8 stated that:

*“In my opinion, addressing the building resources consumption enables more sustainable living, for example, our company always appreciates economic costs such as electricity and water bills and the impacts on the client, and more essentially the benefits of a general approach to all solutions”*

#### **4.4.4.5 Decreased initial costs for reused and recycled materials**

The respondents shared their agreement that utilising sustainable construction practices can decrease the initial costs for reused and recycled materials in Libya.

In terms of reducing initial costs for the materials, participant R2 stated that:

*“... From my knowledge sustainable buildings are designed to be built from natural, non-toxic and recycled materials that don't cost much such as bamboo, straw, recycled metal or concrete.... etc.”*

In the same context respondents R10 added that

*“ .. By using more recycled and reused materials on your construction project, you can reduce your overall costs. I think there are two sources of potential cost savings in Libya, which are reusing construction, demolition and excavation materials, and importing recovered and recycled material”*

#### **4.4.4.6 Reduce overall building lifecycle cost**

The participants agreed that utilising sustainable construction practices can also reduce overall building lifecycle cost in Libya. R6 and R9 highlighted that

*“In the construction projects in Libya, cost effectiveness plays a crucial role. The Life Cycle Cost (LCC) analysis provides a method of determining the entire cost of a structure over its expected life along with operational and maintenance costs”.*

In the same context R4 explained that

*“Financial benefits associated with energy use can also be calculated using LCC analysis. LCC can be improved by adopting alternative modern techniques without much alteration in the building”*

R4 explained further regarding the benefit of considering building lifecycle cost, adding that:

*“I think that LCC effectiveness can be considered at several stages of whole span of the building. Likewise this provides our project managers with the financial information needed for maintaining, improving, and constructing facilities which is very important”*

#### **4.4.4.7 Enhanced building occupants health & safety**

One of the clear advantages stated by R2, R3 and R7 concerned the fact that sustainable construction practices involved occupants’ health, comfort and safety. Furthermore, R2 commented that:

*“The good thing about sustainable construction practices is that they mainly focus on ventilation and non-toxic, low release materials that produce healthier and more comfortable working and living atmospheres for the occupants”*

In the same context, participant R3 further explained how poor quality environment impacted on the occupants:

*“Unfortunately, we suffer from poor indoor environmental quality in most buildings in Libya. That reflects negatively on the health and the safety of the occupants. This is the result of insufficient air flow, poor lighting, temperature variances, toxic adhesives and paints, and a high concentration of toxins”*

In the support of this, participant R5 added:

*“... Considering the aspects of sustainability in construction Libya will certainly improve the indoor living conditions, in terms of the air, lighting and also the safety of the occupants, I see that really beneficial and positive issue if it can be addressed well in our projects”*

#### **4.4.4.8 Improve satisfaction of occupants**

Participants agreed that the use of sustainable construction practices improved the satisfaction of the building occupants. Three of the participants R1, R2 and R4 believed that:

Participants R2 and R8 had similar opinions, for example R2 stated that:

*“.. Satisfaction of the occupant is all about providing as much possible a comfortable working and living environment, which what sustainability in construction concerns”*

In the support of above, R1 added that:

*“... Majority of the individuals spend most of their time indoors, it's extremely important that provision of indoor environmental quality that will achieve the highest level of resident satisfaction and the lowest impact on the environment”*

#### **4.4.4.9 Better individual productivity of occupants**

Participants were generally agreed that the use of sustainable construction practices could improve the productivity of occupants. R3, R6 and R9 had similar opinions; R3 highlighted that:

*“... I think most of buildings here such as schools and universities in Libya are subject to poor environmental conditions that compromise the health and learning of students. The healthier environment and atmosphere in school buildings utilizing sustainable design and construction principles is shown to lead to significant improvement of occupant's satisfaction in Libya”.*

In the same context, respondent R5 added:

*“... The occupants' workplace environment has a direct impact on their well-being and self-assessed productivity. When they are not satisfied with the work atmosphere there is a low level of self-assessed productivity”*

#### **4.4.5 Qualitative Analysis of challenges to the implementation of Sustainable Construction Practices in Libya**

The questionnaire findings regarding the challenges for the implementation of sustainable construction practices in Libya were also investigated qualitatively in order to achieve objective four. The interview process followed the content analysis of the three main challenges which included eight sub-challenges resulting from the questionnaire factor analysis (see section 4.3.2).

##### **4.4.5.1 Knowledge and Steering Challenges**

Steering and knowledge refer to regulatory and awareness matters which have an influence on implementing sustainable construction practices in Libya. Participants were interviewed about

identifying these challenges related to steering and knowledge in detail, and what recommendations could be taken into account in order to overcome these challenges successfully.

#### **4.4.5.1.1 Awareness of the stakeholders about sustainability**

This section presents the challenges facing sustainable construction practices in Libya in relation to the awareness of the stakeholders about sustainability, and this is followed by some recommendations from respondents. There were some significant points raised as follows:

According to the findings of the interview data analysis, with regard to the main challenges of implementing sustainable construction practices in Libya, according to the majority of participants, unawareness about sustainability by the stakeholders was considered as a main challenge.

From the point of view of respondents, several of them thought that changing the current situation in education in Libya required raising awareness about sustainability. According to R2:

*“...unawareness or a weak knowledge of professionals is the key matter, awareness on sustainability needs to be raised among all construction organisations in Libya, this is the way that how we can implement sustainable construction practices in small and big construction projects”*

This view was shared by R5

Furthermore, R8 concurred with R2 and R5 adding that:

*“...there is a lack of awareness of the majority of the stakeholders in the industry as such the clients, especially their knowledge of benefits of considering it, ignorance or misunderstanding about sustainability in the whole industry”*

Moreover, in terms of challenges that prevented awareness and common understanding about sustainability in Libya, R7 stated that:

*“...the one of the challenges is due to a lack of understanding and basic experience in the sustainability from most stakeholders involved in the construction industry in Libya, especially the clients and contractors, they don't pay must attention”*

To sum up, the level of awareness by the stakeholders seems to appear as a key challenge to applying sustainable practices in the construction organisation in Libya. The various

participants appreciated the need to raise awareness on sustainability aspects within the Libyan construction industry.

### **Recommendations:**

According to the findings of this study, the interviewees put a number of recommendations forward; generally which are commented on in this section.

The majority of the participants agreed that unawareness of the stakeholders in the industry was a very important matter to consider for implementing sustainable construction practices in Libya. R3 and R8 concurred with R1 who suggested that:

*“.... having a good knowledge and information and solutions on sustainable construction practices is a major key success that needs to be reached in Libya. In order to achieve this, it will involve interventions at levels of education, ongoing education programmes for professionals and specialists working in the industry”.*

Additionally, in terms of transferring knowledge and bringing better understanding about sustainability in the industry, R5 suggested that:

*“.....It is essential to create enhanced mechanisms and techniques to allow transference of information from research organisations to the marketplace in order to promote the application of sustainability aspects in the industry”*

In the support of this, R10 added:

*“... It's necessary to provide funding support for innovation researches on sustainability and establish schemes for educational bodies to increase awareness”*

Moreover, R10, referred to the education of practitioners and all the parties engaged in construction to increase their level of knowledge about sustainability; he stated that:

*“... In order to implement sustainable construction practices successfully would be to get sustainability aspects on the strategies and plans for our public and private educational institutions such as colleges and universities sufficient educational programs related to Sustainability applications”*

In the same context, R11 added:

*“... Improving the knowledge and level of awareness of sustainable applications should start from the government organisations that could make a large impact on their projects to*

*become more sustainable, this could be achieved by introducing discussions, seminars, training, and workshops on sustainability for government officials and politician”*

To sum up, the construction industry in Libya has different actors with various opinions of stakeholders who work together as a team in order to ensure the successful completion of any project; the main challenge for sustainable construction practices application would be to get sustainability terms involved in strategies and plans in educational institutions and public organisations to raise awareness of stakeholders.

#### **4.4.5.1.2 Government policies and legislation**

This section presents the main challenges facing sustainable constructions practices in Libya in the relation to government policies and legislation, and this will be followed by some recommendations of the participants. There were some significant points raised as follows:

According to the findings from the interview data analysis, with regard to the main challenge of implementing sustainable construction practices in Libya, it appears that weakness in government policies and legislation is considered as a major challenge which was referred to by most participants.

R4 highlighted some difficulties related to the regulation and standardisation applied in the industry:

*“... I think government regulations and making rules to help sustainable construction are not fully applied, which allows qualified designers to conduct their practice in ways that does not consider the principles of sustainability”*

R5, in agreement with R10 about building codes and standards used in Libya, stated that:

*“...there is no specific and strong official building codes and standards that consider sustainability in construction in Libya, therefore experts tolerate their designs according to their schooling or background leading to a wide variation of ideals across the industry”.*

Similarly, R2 remarked that:

*“... In my point of view, the governing authority is ineffective enough. Even the familiar standards are in existence, but generally they have not been applied. Unfortunately, the Libyan authorities are not actually paying attention to control these processes”*

Thus, the success of implementation of sustainable construction in Libya requires considering the regulations and policies correlated with sustainability. However, there are further elements

that shape the implementation of sustainable construction if stakeholders especially government officers put in place legislation that will need cooperative sustainability policies and similarly the development of various policy forms to implement sustainability in all aspects within the industry.

### **Recommendations**

According to the findings of this study's interviews, a number of recommendations have been put forwards by the interviewees: In terms of the government organisation role toward supporting their staff and members, R5 suggested that:

*"... Increasing the capacity of government and local authority at all levels would be generating specific legislations, codes and standards relating to sustainable construction practices in order to enhance the current legislations"*

Both participants R2 and R9 mentioned the importance of the role of government policies and steering mechanisms in the construction sector to achieve sustainability:

*"... In my opinion, government agencies and authorities need to put more effort and pay more attention, they should embark on applicable policies to provide critical support to help sustainable construction feasible"*

To this end, R3 mentioned the importance of increasing the knowledge of the stakeholders by using the government activities:

*"...training, seminars, discussions, and dissemination, also workshops about sustainable construction should be taking place in Libya, and their importance should be introduced to the stakeholders in the industry; there is the need for government to present some fiscal incentives"*

Moreover, in order to ensure the successful implementation of sustainable construction practices in Libya in relation to codes and standards procedures, R2 added that:

*"... Government sectors in Libya with the support of stakeholders in the construction industry should come up with some different modernization regulations policies take into consideration sustainable construction practices, such as instruments are used for steering. These include normative regulatory instruments which include building codes, informative regulatory instruments such as mandatory labelling, economic and market based instruments for example certificate schemes, fiscal instruments and incentives including taxation systems, and voluntary action such as public leadership programmes"*



To sum up, the interviewees indicated that poor implementation of current guidelines and inappropriate organisation of construction activities throughout the industry were among the key challenges that accounted for the existing behaviour of construction organisations and main parties in the industry. Interviewees stated that ineffective implementations, weakness in policies as well as the fragmented and non-standardised construction processes were the key challenges to implementing sustainable construction practices in Libya.

**Table 18.14 Knowledge and Steering challenges in Libya**

<b>Knowledge and Steering challenges</b>		
<b>Challenges</b>	Awareness of stakeholders on sustainability	Government policies, legislation
<b>Sub-Challenges</b>	Unawareness by stakeholders about sustainability	Weak government policies, legislation
<b>Recommendations</b>	<ul style="list-style-type: none"> <li>*Involvement on sustainability such as education programmes for professionals</li> <li>*Increase public awareness by raising programmes for government officials and politicians.</li> <li>* Develop mechanisms to allow transfer the knowledge</li> </ul>	<ul style="list-style-type: none"> <li>*Create strong government legislations and standards.</li> <li>* Embark on applicable policies to provide serious support to make sustainable construction feasible.</li> <li>* Modernization codes and systems related to sustainability</li> </ul>

	<p>from research institutions to the Libyan market.</p> <p>*Provide support such as funding for innovation researches and establish schemes for education bodies.</p>	
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#### 4.4.5.2 Technological and Cost challenges

Technological and Cost challenges referred to use of technology and finance aspects which had an influence on implementing sustainable construction practices in Libya. Participants were interviewed in detail on challenges of technology and costs, and what recommendations could be made in order to overcome these challenges successfully.

##### 4.4.5.2.1 Adoption of new technologies

This section presents the main challenges facing the application of sustainable construction practices in Libya in relation to familiarity with the new technologies, and this is followed by some recommendations made by participants. There were some significant points raised as follows:

Based on the findings from the interviews with regard to the main challenges of implementing sustainable construction practices in Libya, unfamiliarity with the new technologies was considered as a major challenge according to the majority of participants.

The participants generally agreed that there was a fear of adopting and using new technologies which was a challenge for implementing sustainable construction practices in Libya.

Moreover, R2 stated that:

*“.... Using new technologies in construction industry in Libya are still at an early stage of application, where technologies are often more complicated and are totally different from conventional technologies that we know. In addition, it appears in the industry that there’s lack of wide knowledge and unfamiliarity with the green products, materials, and design”*

In terms of the experience of using new technologies by the building designers, R6 highlighted that:

*“... In the Libyan construction industry, we have kind of lack of experience in using new technologies and uncertainty of the success of the construction process, this is considered as important challenge to the industry for the implementation of sustainable strategies and specifications. Also there is a clear unfamiliarity of the designers and contractors with sustainable design approaches, and lack of knowledge and understanding of using green technologies effectively”*

Also in relation to the client and technological performance, R10 commented that:

*“... the client’s demand regarding to green technology is very low, they always think that unfamiliarity with the performance of green technologies and products might affect the performance outcome, the reasons for that is lack of existing information, and adoption of unfamiliar techniques in the market”*

According to all the above, it has been shown that green technologies appear to hold certain challenges for the clients and contractors; the main challenge is that green technologies are usually more complicated and are different from conventional technologies, unfamiliarity with the performance of green technologies may affect the performance outcome.

### **Recommendations:**

The participants have put forward a number of recommendations for this challenge generally, that is shown from their answers as follows:

One of the participants, R6, explained his opinion regarding familiarity with the new technologies in Libya:

*“... Clearly, there’s a need to transfer the new green technology and information regarding to sustainability into the Libyan construction in order to influence the use of them more often and meet the sustainability requirements in the industry”*

Furthermore, R2 added his own comment about the increasing the knowledge and encouraging the use of new technologies:

*“... Raising the knowledge using the new technologies by improving the access to the modern technological information and methods about sustainability, such as improving the internet services and the telecommunication in general”*

In the same context, R9 mentioned that the level of investment by the clients by using the new technologies in Libya:

*“... After the recent growth of new technologies, we must to take into consideration that some of the public here are on low income with very limited investment capacity and these technologies that represent increased costs will not easily be adopted due to various reasons”*

Summing up, it has been suggested by the respondents that green technologies in Libya need to be more carefully considered by the clients and contractors. Some actions have to be taken such as the development of new technologies locally, and increasing the investment capacity, promoting the use and sharing the benefit of the performance of green technologies in order to affect the outcome of the building efficiently.

#### **4.4.5.2.2 Capital and investment costs**

This section presents the main challenges facing sustainable constructions practices in Libya in relation to capital and investment costs, and this is followed by some recommendations of respondents. There were some significant points raised such as the following:

With regard to the main challenges of implementing sustainable construction practices in Libya, the high capital and investment costs are considered as a challenge according to the majority of respondents.

According to participants R2:

*“... Sustainable buildings usually have higher initial capital costs than any other conventional buildings, which means there’s sort of hesitation and uncertainty of higher investment costs by the clients and investors”.*

R3, and R6, had similar opinions about the capital and investment costs of sustainable buildings.

Furthermore, respondents R4 explained the main interest of clients and their concerns:

*“ ... Client’s main concern and interest is making profits without long Pay-back period which causes doubts about profitability so that can be a major challenge, also the additional*

*financial cost of providing methods to expand the sustainability in construction has been a challenge too”*

Moreover, participants R4 and R9 both mentioned a good point about the current status of the investment in construction in Libya in relation to sustainability. This was spelt out by R4:

*“The type of additional investments in the construction industry here more likely comes from cost increases on new materials, use of technologies, fees and high expenses for the professional development of the contractors, managers, consultants and design team”*

In the light of these comments, clearly, the long-term benefit is worth the initial increase in investment; the expected long-term benefits are normally not expressed in terms of financial return but focused instead on the environmental and social benefits that the client believes the technology or practice could provide but that might be too costly.

### **Recommendations:**

A number of recommendations have been put forward by the participants, generally it is apparent from their answers that:

According to R3 who suggested that:

*“...the industry needs to develop fiscal incentives by the government and procurement systems; this will provide an opportunity for contractors in start tendering for public projects; that will assist and support ecologically responsible building practices; and that will assist low income investors and those in the informal sector to access funding for housing and house developments”*

In support of the above, R3 shared opinions about financial support and the cost of the investment in Libya:

*“...initiatives of sustainable construction applications need to start first from the financial institutions. Alternatives from financial institutions such as banks and other official institutions, this would provide funds and cash flow to support the construction projects”*

R6 concurred with these ideas from R3.

Furthermore, it is important for the designers to overcome complexity that would reduce costs for them to have a better understanding about sustainability in construction aspects, one of the participants, R1, believed that:

*“.. As designers, we always try to avoid complexity during design phase, that reduce initial design costs in the sense of solving many aspects at the same time and combining aesthetical, technical and economical solutions in a comprehensive way”*

Thus, in the light of these viewpoints, the long-term benefit is worth the initial increase in investment; the expected long-term benefits are normally not expressed in terms of financial return, but focused instead on the fiscal incentives by the government. Alternatives from financial institutions would help avoid the high costs of the sustainable buildings.

#### **4.4.5.2.3 Cost of green materials and products**

This section presents the main challenges facing sustainable construction practices in Libya in relation to the cost of green materials, and this is followed by some recommendations from respondents. There were some significant points raised as follows:

Based on the findings of the interviews, with regard to the main challenges of implementing sustainable construction practices in Libya, the high cost of green materials and products in the industry is considered as a major challenge according to the majority of participants.

R1 and R5 raised similar points about the cost of green materials and products that can be used in the Libyan construction industry; R1 highlighted that:

*“ ... there is shortage of imported green material and equipment in the Libyan market, the materials to use for such buildings can be difficult to find especially in urban areas where preserving the environment is not the people’s first option, however, shipping these materials from other countries can be more costly than using usual materials for a standard building”.*

Additionally, in the same context, R8 raised a similar point; he highlighted that:

*“... There’s hesitation in adoption with using green material and equipment, we face resistance among specialists to help the change from conventional building materials to green, availability of conventional construction materials will fall considerably short of their demand despite improved productivity, also it is essential to develop alternatives for them”*

#### **Recommendations:**

A number of recommendations have been put forward by the respondents as follows:

R5 suggested some points regarding the high cost of building materials in Libya:

*“.. Reduce to cost of the green materials by producing them locally, it is the best way to extend the production”*

Furthermore, R3 raised his opinion on reducing the cost of green materials in Libya; he suggested that:

*“.. Decreasing taxation fees on exports would reduce cost, increase availability of green products and promote them. That will encourage the investment by the suppliers in the industry”*

Summing up, when green materials are compared on a simple item-by-item basis with conventional alternatives, they can be and often are too costly. However, this approach requires ending solutions in which a green product can be used to replace multiple standard products, or lower-grade green products can substitute satisfactorily for high-end non-green products.

#### **4.4.5.2.4 Availability of green materials information and specifications**

This section presents the main challenges facing sustainable construction practices in Libya in relation to the availability of green materials and information, and this is followed by some recommendations from participants. There were some significant points raised as follows:

Based on the findings from the interviews, with regard to the main challenges of implementing sustainable construction practices in Libya, limited availability of green materials information in the industry was considered as a major challenge according to the majority of respondents.

In the content of the information about green materials, R2 stated that:

*“... limited information and shortage of green materials specifications in the local market is a major challenge for the stakeholders in the industry, other vital challenge is the uncertainty among industry clients in the performance of these products and materials and therefore their cost effectiveness this due to lack of details and specification”*

Additionally, in the same context, R2 stated:

*“... There’s hesitation in adoption with using green material and equipment, we face struggle among experts to support the change from conventional building materials to green, availability of conventional construction materials significantly due to short of their demand, however it is essential to develop alternatives for them”*

R8 concurred with R2’s comments about the reluctance to adopt green materials.

From another perspective, R6 commented on the link between green materials and the Libyan construction market:

*“.. In my opinion building materials should be all classified, and have all information about them, practically in terms of their impact on the environment, or whether they can be recycled or reused. Unfortunately in Libya we do not have all details and specifications towards sustainable buildings”*

R8 had similar concerns.

Summing up, it is essential to develop alternatives for conventional construction materials; it is also required to support local suppliers on how to adopt traditional materials and construction methods by incorporating modern processes and technology. However, building construction stakeholders need information about different kinds of building materials, so as to be able to assess and choose building materials during the design process.

### **Recommendations:**

A number of recommendations have been put forward by the respondents as follows:

R9 suggested some points regarding the suppliers and building materials in Libya:

*“.... the Libyan construction market should be supplied with green materials and products including their specifications by importing them from developed countries. We need to create and develop systems that can identify and classify our building materials in the relation to sustainability”*

In the same context, R6 added his opinion about selecting green materials, he suggest that:

*“....In this context, and with the growing movement towards more integrated approaches to selecting building materials, it is significant to use guidelines, systems, and databases for building material specifications, that acts as a central repository for information on all aspects of local and sustainable building materials and as acknowledge exchange for most building professionals”.*

R10, commented on the role of the top management in specifying building materials:

*“... This issue can be addressed in Libya at the management level by putting a number of initiatives in place to offer training, professional development and information on sustainable issues for the industry professionals, this will contribute the professionals an idea and*



*knowledge of the data available for each material option by considering a wide spectrum of factors or variables”*

Summing up, the development of new green materials needs to take into consideration that the common knowledge of the people is poor with very limited investment capacity and the materials specifications that represent increased costs will not easily be implemented in Libya.

**Table 19.15 Technological and Cost Challenges in Libya**

<b>Technological and Cost Challenges</b>				
<b>Challenge</b>	Adoption and Familiarity with the new technologies	Initial capital and investment costs	Cost of green materials and products	Availability of green materials specification and information
<b>Sub-Challenge</b>	Lack of adoption and unfamiliarity with the new technologies	High Initial capital and investment costs	High cost of green materials and products	Lack of Availability of green materials specification and information

<b>Recommendations</b>	<p>*Create technology transfer channels on from other countries productivity in sustainability.</p> <p>*Raise the awareness of the public by promoting new technologies.</p> <p>*Improve the telecommunication in infrastructure</p>	<p>*Fiscal incentives by the government.</p> <p>*Alternatives from financial institutions</p> <p>*Avoid complexity in design phase to reduce costs</p>	<p>*Manufacturing green materials locally</p> <p>*Reduce import taxes on green materials</p>	<p>* Apply Guidelines, systems, and database on specifications.</p> <p>* Initiatives such as training, professional development</p>
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#### 4.4.5.3 Organisational and Technical Challenges

Organisational and technical challenges refer to managerial and technical skills matters which have an influence on implementing sustainable construction practices in Libya. Respondents were interviewed about these challenges related to organisational and technical details, and also what are the recommendations that can be taken into account in order to overcome these challenges successfully.

##### 4.4.5.3.1 Leadership and decision making process

This section presents the challenges facing sustainable constructions practices in Libya in relation to leadership and decision making processes, and this is followed by some recommendations from respondents. There were some important points raised as follows:

With regard to the main challenges in implementing sustainable construction practices in Libya poor leadership and decision making processes were considered as a challenge according to the majority of respondents.

The relationship between the leadership and the application of sustainable construction practices is reflected in the statement of R4:

*“... Good management skills has a big effect on implementing Sustainable Construction practices in Libya, the main challenges that we face is lack of effective leadership and decision making, which is important and factor to the adoption of sustainability aspects”*

In addition, R1 expressed views about the leadership role in achieving sustainable strategies in organisations:

*“...The construction industry therefore needs leaders that can develop a culture that supports, promotes and rewards organisational strategy towards sustainability. The leadership of individuals in our organisations in Libya now required to necessarily changing the way we operate from focussing on the short-term maximization of shareholders value to paying attention to the economic, social and environmental effects of our operations”*

Furthermore, R5’s opinion on the decision making process and sustainability was expressed as follows:

*“... Construction organisations in Libya need high skilled decision makers who are able to deliver the direction, shared vision, strategy towards the common aim of a sustainable future”*

Summing up, from the respondents answers, leadership within construction organisations faces challenges in an attempt to effectively implement sustainable construction practices in Libya. Common challenges include poor leadership processes within organisations and project teams and lack of decision makers’ ability.

### **Recommendations:**

A number of recommendations have been put forward by respondents, as follows:

R7 in agreement with R9 stated that:

*“....the improvement of internal leadership regarding to sustainability issues there’s a need to grow the knowledge and internal skills, that can be gone with an effective plan and adequately providing the required training resources and support to manage changes their attitude and style”*

Additionally, in terms of having leadership skills at the management level, R2 suggested that:

*“There should be a support and innovative management and leadership skills in implementing sustainable construction practices as the concept implementation face numerous managerial difficulties in Libya”*

In the context of communication processes in the organisation between project team members, R10 highlighted that:

*“... obtaining great leadership skills includes managers being able to clearly and specifically communicate your vision, goals, skills, intentions, and expectations to others, this needs strong communication among all project team in our organisation, as well as support of senior management is a critical component of successful for our projects, also the need for collaboration between researchers, designers and facilities management employees is really vital for recognising the design and construction of high-efficiency buildings in order to achieve sustainability in our projects”.*

Summing up, poor communications among all project teams in the organisation of the construction industry in Libya, as well as support for project managers and decision makers were impediments towards the success of most projects; also the need for collaboration between designers and management project teams has become extremely urgent for sustainable construction.

#### **4.4.5.3.2 Technical Ability and IT skills**

This section presents the challenges in relation to technical ability and IT skills, and this is followed by some recommendations from respondents. There were some significant points raised as follows:

According to the participants, the role of the technical ability and IT skills should be aimed at supporting the implementation of sustainable construction projects in Libya.

R3 stated his opinion about the design skills of the designers in his company that:

*“...there's a lack of technical ability of the staff in our organisation, chronic in design skills are major challenge to the implementation of sustainable construction in Libya”*

Another challenge in relation to technical ability was mentioned from the perspective of R1:

*“...We have some difficulties not having exemplary projects which consider technical difficulties; also our designers in our workplace are not confident enough when the matters of sustainable design issues appear”*

In the same context, respondent R3 further explained about green technologies and the function of technical skills in delivering their projects successfully in Libya that:

*“...Usually, green technologies require complicated techniques and construction processes. If complexities in the techniques aspects are not addressed well, now that might affect the performance of our projects delivery”*

Summing up, technical skills are the abilities and knowledge needed to perform specific green design issues. They are often related to IT skills that include knowledge of tools and technical skills. Technical skills are often most important to overcome complexities in the techniques aspects in construction projects in Libya.

### **Recommendations:**

A number of recommendations have been put forward by participant as follows:

R2 suggested that:

*“....Providing software design training courses to the staff members to increase their skills and overcome these technical difficulties during the design phase. Likewise, design can be more complicated than that of a conventional building due to the evaluation of alternative materials and schemes”*

Moreover, R5 extended this recommendation by putting it in the context of the design process by stating that:

*“... Some designers and professionals within the organisation need to be fully acquainted with the principles, in order to implement it specialized, and skilled technical staff in design should be increased”*

Further support for these opinions was voiced by R6:

*“... It is significant that adopting new software tools as technical information on sustainable construction is made available to design professionals in an appropriate format, and to the contractors ultimately responsible for implementing the sustainable design, that can be solved by providing the staff with some training courses on integrated design tools and methods such as software design”*

Furthermore, it is important for the designers to have access to information sources that will help them to have a better understanding about sustainability in construction issues; one of the participants, R1, believed that:

*“... in the Libyan construction industry, there’s a need of further development of building design assessment tools to be considered, tools which are used now are not efficient, that can be solved by using easily accessible guidance for design tool and methods”*

From these viewpoints, it can be concluded that, for better use of new software tools, further development of existing assessment tools should be considered in order to allow project managers to access the best available information on technologies and tools. Designers and professionals within the organisation of the construction industry in Libya do need to be fully acquainted with the integrated design tools and methods, training courses and the development of skills and ability are key to improving the technical skills and ability of staff.

**Table 20.16 Organisational and Technical Challenges in Libya**

<b>Organisational and Technical Challenges</b>		
<b>Challenge</b>	Leadership ability	Technical ability and IT skills
<b>Sub-Challenge</b>	Lack of leadership ability and decision making process	Lack of the technical ability and IT skills
<b>Recommendations</b>	-Provide training courses for the management decision makers -Use efficient communication methods	- Provide software design courses to the users. -Use technical information and integrated design tools

	-Develop the current management systems and frameworks.	-Provide easily accessible guidance for design tool and methods
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#### 4.4.6 Summary for Qualitative Analysis

The researcher used a semi-structured interview (10 expert respondents). The analysis of the interviews clearly demonstrated the use of sustainable construction practices as named in the above chapter. Furthermore, the interview results provided details on the current application of sustainability in the Libyan construction industry. The results suggest that the performance of the construction practitioners is linked to their understanding and awareness of construction. The participants' views of construction knowledge in terms of the structure and procedures in the construction industry are connected to the clients and key stakeholders. On the other hand there are some regulations and policies; however, the implementation of these policies in construction practices in Libya is weak. The weakness of application can be recognised from some causal factors such as coordination difficulties, poor regulations, and lack of commitment and political spirit from the government and main actors to challenge sustainable construction plans. The results specify major challenges such as steering, technology, and management, all of which considerably affect the current practices of construction companies in Libya. Moreover, it was highlighted that there is a need for support from the government organisations and better plans to be taken in education on sustainability to raise awareness. Further issues have touched on the importance of the use of technological aspects and providing financial resources in order to fully implement sustainable construction practices and, on the other hand, it was explained that there is an obstacle to accessing green materials in Libya. A final issue was shown to be in the management capacity; this needs to show greater efficiency compared to traditional methods used while it also requires improved communication. It was also shown that to improve technical skills would enhance performance of the projects. In the next chapter, discussion and findings from the results will be presented.

## **CHAPTER (5): DISCUSSION OF FINDINGS**

### **5.1 Introduction**

This chapter discusses the findings from the analysis of the questionnaires and semi-structured interviews data with reference to previous research and related literature.

This research aimed at assessing the extent to which sustainability was considered and incorporated into the projects within the Libyan construction sector. The survey aimed at investigating the extent to which sustainability was considered and applied in practice in the selected organisations which were studied in this research. The interviews were designed to explore the issue of sustainability in greater depth focusing on the challenges experienced by key stakeholders and managers in the construction sector. The key findings were expected to facilitate the development of a strategy for the implementation of sustainable construction practices in Libya.



The research findings discussed in this chapter are presented as follows:

- The practices of sustainable construction used in Libya
- The benefits of using sustainable construction practices in Libya
- The challenges that face the implementation of sustainable construction in Libya
- The conceptual strategy based on the practical findings
- Validation of the findings related to the conceptual strategy
- Validation of the conceptual strategy and developing the final strategy

## **5.2 Research objective two: Sustainable construction practices used in Libya**

The second objective of this study was to evaluate the current practices used for the implementation of sustainable construction practices in Libya. The evaluation of these practices was carried out using Kendall's coefficient of concordance in chapter four. The findings reveal that there are three practices; consequently, this section discusses each practice in turn by introducing the key findings that emerged from the analysis of the data from both the questionnaire and semi-structured interviews, and discussing these findings in the light of the relevant literature (see section 2.6.4). These used practices are presented in the following three subsections:

It is widely acknowledged that the process of reuse building resources such as building materials is concerned with reducing waste and building a more vibrant and sustainable local economy by marketing reusable building materials. In addition, reused construction materials practice is considered to be sustainable because it decreases landfill waste, reduces the need for raw materials, lowers environmental impacts and energy use and reduces air pollution.

The primary findings from the analysis of questionnaire data, as illustrated in section (see section 4.3.1), indicated that practice of reuse building resources was ranked first as the most used in Libya based on Kendall's coefficient of concordance test.

Moreover, the primary finding from the interview data analysis (see section 4.4.3.2) clarified that building resource reduction processes were primarily applied for financial purposes in Libya; these findings resonated with findings in a number of studies such as Amponsah et al. (2011) which stated that the economic profits gained by reusing building materials were quite

evident. Besides avoiding the need for landfilling, these practices reduced the extraction and refining of raw materials, satisfying the materials demand in the construction industry.

These findings from both the questionnaire and interviewees' opinions are concordant with the findings of various previous studies (see section 2.4.6), for instance, Hoffmann, (2004) who asserted that this practice could reduce the need for raw materials thereby contributing to other practices aimed at reducing resource consumption.

Reduce building resource consumption includes minimising the consumption of building energy resources and water use. Thus, the primary findings of the questionnaire survey data related to reducing building resource consumption (see section 4.3.1), revealed that the mean value of responses to these statements was high. Nevertheless, based on the Kendall's coefficient test, the level of participants' use was at the highest level. In fact, the findings showed that this practice was ranked first as the most used in Libya by the respondents.

This finding was confirmed by the analysis of interviews (see section 4.4.3.1) which reiterated that reducing building resource consumption such as energy was essential for all governments, businesses and individuals and other actors in the Libyan construction industry.

However, the above mentioned key findings resonated with those of earlier studies (see section 2.4.6) for example, the findings of Santoli and Matteo (2003), who asserted that the energy performance of a sustainable building should be calculated using standards that indicated the insulation of the buildings and the characteristics of technical systems and installed equipment all of which were designed for greater energy efficiency.

It is widely recognised that Building Indoor Quality Environment refers to the quality of a building's environment in relation to the health and wellbeing of those who occupy space within it.

The key findings of the questionnaire survey data (see section 4.3.1) revealed that the reuse of building resources in Libya was ranked first in Kendall's coefficient of concordances test.

The analysis of the interviewees' responses related to the Building Indoor Quality Environment process (see section 4.4.3.6) showed that indoor quality environment was well discussed due to its importance for protecting the health and wellbeing of building occupants. These findings support findings of earlier research (see section 2.4.6). For example, the findings of Xiong et al. (2015) who drew attention to the risk posed by poor quality indoor environments to people who spent a long time indoors.

### **5.3 Research objective three: Benefits of using sustainable construction practices in Libya**

This section discusses the findings related to the benefits that can be derived from the implementation of sustainable construction practices in Libya.

The review of these benefits of using Sustainable construction practices in Libya was carried out using the test for the level of agreement and ranking. This was done by using Kendall's coefficient of concordance in chapter four (see section 4.3.3). The perspectives of the review were based on most used agreement. This process of developing a strategy for implementing sustainable construction practices in Libya started with the evaluation of focal literature review findings of sustainable construction benefits around the world. This listed nine main benefits in the construction industry explained and reviewed in chapter two of the literature review (see section 2.8). These nine benefits were used in order to review their use by the Libyan construction organisation.

Kendall's coefficient of concordances test was used to rank the nine benefits and also to evaluate the level of agreement between the participants. 'Reduce building resources' was ranked in first place, followed by 'Increase production of renewable resources' while 'Enhance building occupant health and comfort' was ranked in last place.

In many studies, decreasing the cost of building resources consumption was seen as a company's highest priority. The finding of the primary data analysis from the questionnaire survey (see section 4.3.3) indicated that the use of sustainable construction practices in Libya was aimed at reducing building resources consumption costs which was ranked first by the Kendall's coefficient test based on the level of agreement between the participants.

This view was corroborated by the findings of the interview where the participants commented on the benefits which they perceived as an outcome of using sustainable construction practices (see section 4.4.4.4). Participants expressed the view that addressing the building resources consumptions enabled greater sustainability which in turn meant that the reduction in costs due to greater resource efficiency. This was mainly due to sustainable design and construction in Libya where cost of implementing sustainability was quickly recouped especially by sustainable water and energy use. These findings reflected those of earlier studies (see section 2.8.2) where the major economic benefits of sustainable construction practices were widely discussed. Earlier studies drew attention to reduced energy

and water consumption and lower operation and maintenance costs as the main benefits received by green building occupants (Ries et al., 2006; Eichholtz et al., 2013; Zhu and Lin, 2014).

The benefit of increased production of renewable resources was well discussed by the interviewees (see section 4.4.4.2), and their opinions showed that the use of renewable resources was highly regarded and that participants were increasingly promoting the use of renewable resources to save energy and to minimise pollution of the buildings in Libya.

This was concordant with the discussion in the literature (see section 2.6.1.3), where, for example, Johnston et al. (2017) clarified that sustainable construction principles helped reduce impacts on natural resources and ecosystems. Likewise, each source of renewable energy was seen as having unique benefits and costs; furthermore, many studies mentioned the benefits associated with these energy technologies used in the buildings. Moreover, sustainable construction was reported to be highly intertwined with the deliberation of energy (Wiersma, (2016).

It is widely agreed that human health is foremost when it comes to assessing the overall comfort of the built environment. If, for any reason, the built environment is leading to negative impacts on occupants' health, then it is a matter of concern and could point to some design or technical weakness in the building system. In this research, the findings of the questionnaire survey (see section 4.3.3) indicate that this benefit was ranked third based on Kendall's coefficient test based on the level of agreement between the participants.

Furthermore, from the primary findings of the interview (see section 4.4.4.7), it showed that enhanced building occupant health, comfort & safety were issues which were well considered. Participants generally felt that certain aspects of sustainability would certainly improve the indoor living conditions in Libya, in terms of the air, lighting and also the comfort of the occupants.

These findings resonated with those of earlier studies (see section 2.6.3.1), where green features of buildings were seen as enhancing indoor environmental quality, resulting in healthier and more comfortable living conditions (Issa et al., 2010; World Green Building Council, 2013). In fact, a number of studies have investigated differences in satisfaction levels between green and conventional building occupants; the health benefits of sustainable construction focused primarily on indoor environmental quality (Zhang and Altan, 2011; Ries et al., 2016).

## **5.4 Research objective four: Challenges to the implementation of sustainable construction practices in Libya**

This research objective was addressed through the survey questionnaire and semi-structured interviews. The findings of the survey was based on the result of factor analysis using Kaiser-Meyer-Olkin (KMO) measure of Sampling Adequacy to assess the adequacy of the data for 19 factors (see section 4.3.2). It was used to reduce the number of factor and also identify the main challenges. Factor analysis was performed in order to identify the key factors which were influential and to remove factors which might not have a significant influence. This approach helped to identify the key factors out of the 19 which were tested. This resulted in a reduced model based on 8 key factors (see section 4.3). These 8 were grouped into three main challenges facing the implementation of sustainable construction practices in Libya which were: Steering and knowledge challenges, Technology and Cost challenges, and finally Organisational and Technical challenges. These three were also identified in the literature review (see section 2.9) as the major challenges and these are now discussed in the following sections.

### **5.4.1 Steering and knowledge challenges**

#### **5.4.1.1 Unawareness by stakeholders about sustainability**

Experience and information about sustainability by the stakeholders such as professionals and clients can have a significant influence on the implementation of sustainable practices in the industry (Williams & Dair, 2007).

In this research, the questionnaire results showed that the participants paid considerable attention to the level of awareness by stakeholders of sustainable construction, that can be seen from assessing of Steering and knowledge challenges (see section 4.3.2.1). It indicates that awareness by stakeholders on sustainable construction was ranked highest and seen to be highly significant (see table 4.7). The awareness seems to be of high value and reaches high agreement between stakeholders. This high level of agreement indicates that educating the public is paramount to the successful development and application of sustainability to construction industry in Libya.

Furthermore, from the finding of the interview (4.4.5.1.1), based on the findings of the analysis of the interview data, with regard to the main challenges of implementing sustainable

construction practices in Libya, the results showed that unawareness and poor knowledge of professionals was the key factor and suggested that awareness of sustainability needed to be raised among all construction organisations in Libya.

The above finding derived from both questionnaire survey and interviews was consistent with the findings of earlier studies (see section 2.9.5). According to Williams and Dair (2007) a lack of common understanding was an experience shared by many stakeholders in the construction industry, while, it has also been reported that several stakeholders have acknowledged unawareness or little knowledge of 'sustainable measures' or their alternatives.

#### **5.4.1.2 Weak government Policies, legislation**

For the success of the implementation of sustainable construction practices, strong policies are required to enforce sustainability in all aspects of government development. Therefore, the achievement of sustainable construction is highly reliant on the commitment of government and the formation of legislation (Nelms, & Russel, 2005).

Based on the findings of questionnaire survey results, the challenges related to regulations, and policies is of crucial importance for Libya, as a result of assessing steering and knowledge challenges (see section 4.3.2.1). Actually, government policies, legislation was ranked second. The mean ranks are also compared to the asymptotic significance value that was less than 0.05 for a level of significance (see table 4.2).

This was substantiated by the primary findings of semi-structured interview (see section 4.4.5.1.2). The majority of the interviewees agreed that weak polices regarding sustainability presented significant challenges to the Libyan construction industry. It was noted that government regulations to support sustainable construction were required. These should support professional developers to conduct their practice in ways that support the principles of sustainability in Libya. This challenge is linked to the lack of strong polices that support the application of sustainably aspects in the industry, due to the lack of available incentives provided by the Libyan Government to the construction industry stakeholders. Hence, there needs to be cooperation between the Government and the stakeholders. The Government's role is to regulate the building laws and codes of sustainable construction and provide incentive programmes and schemes, whereas the stakeholders provide the construction polices to the public and educate them accordingly.

Additionally, the literature in section (2.9.1) has shown that the success of sustainable construction is highly reliant on the commitment of government and the formation of legislation. Due to the many benefits associated with sustainable design and construction, governments and their agencies should lead the crusade by progressively incorporating sustainable construction practices into new construction projects so that private organizations and individuals can emulate. According to many studies, for example, Djokoto et al., (2004) suggested that the sustainable construction concept would be effective if stakeholders, particularly the Government, established legislation that would require sustainability policies and building codes and also the development of various policy documents to implement sustainability in all aspects of their development.

## **5.4.2 Technology and Cost challenges**

### **5.4.2.1 Familiarity with new technologies**

Many studies have verified that the use of new technologies posed certain challenges for several reasons as suggested by Eisenberg et al. (2002). These included lack of sufficient knowledge or technical expertise and of familiarity with the products, materials, system, or design.

This is consistent with the findings from the analysis of questionnaire survey (see section 4.3.2.2) which showed that the adoption of new technologies was a challenge which was ranked with the highest mean value and was significant.

Furthermore, the interviewees' opinions were consistent with the primary data findings from the questionnaire respondents (see section 4.4.5.2.1). In the Libyan context using new technologies in the construction industry in Libya are still at an early stage of application, where technologies are often more complicated and are totally different from conventional technologies that they use in construction industry.

This is in agreement with the literature (see section 2.9.4) where, according to Tagaza and Wilson, (2004), the main challenge was that green technologies were usually more complicated and were different from conventional technologies' Furthermore, this was confirmed by Zhang et al. (2011) who noted that a project manager had to deliver the project with the required performance specified by the client, and that lack of familiarity with the performance of green technologies might adversely affect the performance outcome.

#### **5.4.2.2 Limited availability of green materials information and specifications**

Building materials play an essential role in achieving the sustainability of the building. The usage of building materials has a substantial impact on the environment. Hence, the use of green specifications as a contractual tool to promote sustainable development should be adopted in the construction industry. In addition, specifications and information on green materials is well regarded by various actors in the construction industry in order to achieve sustainable construction principles (Godfaurd et al, 2005).

In this research, the findings of the questionnaire survey (see section 4.3.2.2) indicated that the challenge of availability of green materials information and specifications was a significant one.

Moreover, it has been found from the interviews findings (see section 4.4.5.2.4) that the selection of sustainable materials has been identified as an important strategy in the design of a building in Libya by the majority of the interviewees. The challenge of limited information and shortage of green materials specifications in the local market was seen as a significant challenge facing the stakeholders of industry. Other important challenges included the uncertainty among industry clients on the performance of these products and materials and consequently their cost effectiveness due to lack of detailed specifications.

On the other hand, it appears clearly from the literature review (see section 2.9.4) that several studies have mentioned that building materials have a considerable impact on the environment, and the availability of materials specifications is a challenge for the application of sustainable construction practices in the construction industry. Moreover, among the potential challenge identified according to Osaily (2010), he pointed out that the lack of the definition and characteristics of green materials and products specifications presented challenges to their implementation. Generally, construction stakeholders agreed that environmental considerations should be included in construction material specifications but their underlying motive may be simply for satisfying mandatory requirements (Sullivan et al., 2004).

#### **5.4.2.3 High Initial capital and investment costs**

It is widely recognised that some of the most significant and influential challenges in the implementation of sustainable construction practices are financial; one of these challenges



identify increased initial investment costs for the sustainable projects compared with traditional buildings (Häkkinen, & Belloni, 2011).

In this study, the findings of the questionnaire survey (see section 4.3.2.2) indicated that the challenge of high initial capital and investment costs was significant; the assessment of this challenge was ranked second.

Moreover, the effect of cost challenges on the implementation of sustainable construction has been well discussed by the interviewees from the interview primary data (see section 4.4.5.2.2); their opinions showed that sustainable projects usually had higher initial capital costs than any other conventional buildings, which means that there was often some hesitation about undertaking these higher investment costs by the clients and investors in Libya.

In the support of above, the primary data findings both from the questionnaire survey and interview were supported from the literature review (see section 2.9.2.); the effect of financial challenges on the implementation of sustainable construction has been well reported by several studies. According to Häkkinen, & Belloni (2011), this challenge identifies initial costs and financial resources as key components. Furthermore, many researchers have named the requirement of high financial resources as a major challenge to providing measures to improve sustainability. These increases are mainly owed to design complexity, as well as the modelling costs required, to effectively incorporate green practices into projects (Zhang et al., 2011). Furthermore, Hwang and Tan, (2010) noted that higher costs were related to green materials and the use of green construction technologies.

#### **5.4.3.4 High cost of green materials and products**

The questionnaire results (see section 4.3.2.2) showed that Cost of green materials and products was ranked third with a mean and significant value.

Likewise, from the perspective of the respondents in the interview, see section (4.3.4.2.4), interviewees have identified design tools and method as a challenge to implementing sustainable construction practices in Libya, the findings showed that there is shortage of imported green material and equipment in the Libyan market. The materials required for use for such buildings can be difficult to find especially in urban areas where preserving the environment is not the people's first option; therefore, there is some hesitation about adopting the use of green material and equipment. The industry is facing resistance from practitioners to support the change from conventional building materials.

As mentioned in the findings of the literature review (see section 2.9.4), the use of green materials can be significantly higher than conventional construction ones. According to Zhang et al. (2011) green materials were calculated to cost between 3% and 4% more. In fact, some green materials cost significantly more, for instance “compressed wheat board costs about 10 times more than ordinary plywood” (Hwang and Tan, 2012).

### **5.4.3 Organisational and Technical challenges**

#### **5.4.3.1 Poor leadership decision making processes**

The leadership process within construction organisations has a key impact on achieving successful implementation of sustainability. Therefore, the lack of the support of top management and leadership in implementing the sustainable construction concept presents a significant challenge to its implementation.

This can be substantiated by the findings of questionnaire survey (see section 5.2.2.2), which was ranked highest and had the most significant value.

Furthermore, that was supported with the finding of semi-structured interview (see section 4.3.4.3.2). Poor management and leadership had a negative impact on the success of sustainable construction in Libya, according to the interviewees’ opinions. It indicated that the success of sustainable construction implementation in Libya lay in the commitment of managers and leaders in developing and implementing an effective plan and adequately providing the required resources and support to manage changes arising from the implementation.

The above mentioned key findings are upheld by the findings found in literature review (see section 2.9.3), that the influence of managerial concerns and decision making processes on the adoption of sustainable construction practices from the contractors’ perspective has been evidenced in this study. According to Osaily (2010) the management and leadership of the construction industry and individual organisations had a major role to play in achieving successful implementation of innovative strategies.

#### **5.4.3.2 Lack of Technical ability and IT skills**

Lack of the technical ability and chronic lack of skills by the designers had a direct impact on the success of implementation of sustainable construction values; this assumes that experts

within the industry need to be fully aware with sustainable construction principles in order to implement its practice (Hydes and Creech, 2000).

By viewing the primary findings of the questionnaire survey (see section 4.3.2.3), it appears from assessing the challenges, that lack of technical ability and IT skills challenge had the second highest mean score of 3.64 and a significance of 0.011.

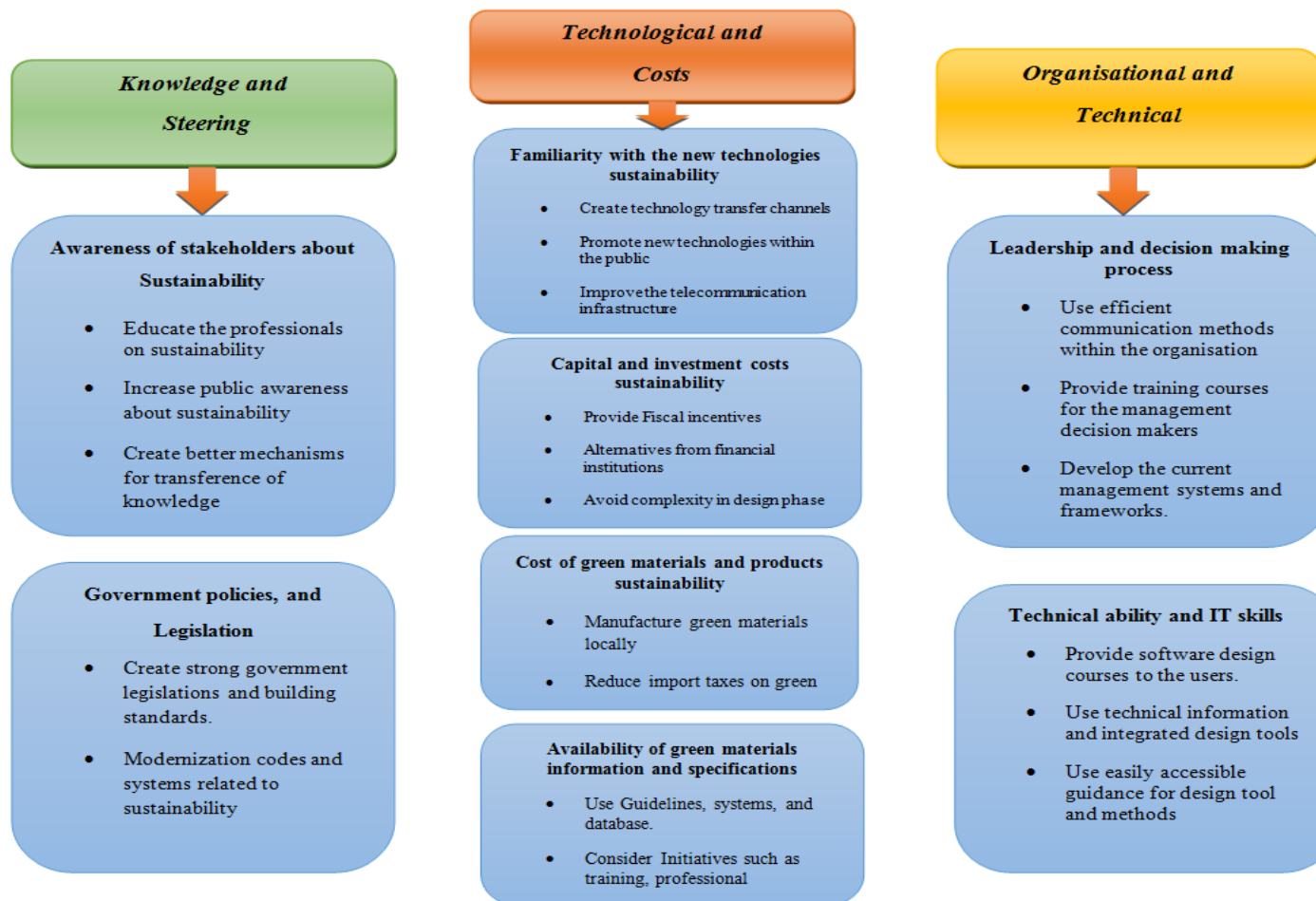
Furthermore, this was consistent with the finding of the semi-structured interviews (see section 4.4.5.3.2) where the interviewees indicated that there were some difficulties in not having exemplary projects which considered technical difficulties; also it was found that the building designers usually were not confident enough when the issues of sustainable design issues appeared.

Moreover, the effect of technical ability on the success of sustainable construction practices has been addressed in the literature review (see section 2.9.3); this challenge was indeed identified as a lack of technical ability and IT skills in several studies. According to Rydin et al. (2006) asserted that designers in the construction industry were not confident when the issues of sustainable construction design arose. This presupposes that professionals within the built environment needed to be fully acquainted with sustainable construction principles in order to implement its practice.

## **5.5 The Conceptual Strategy based on the findings**

The conceptual strategy was initially established based on the initial understanding of the knowledge of the field. The strategy was further developed with the new knowledge gained through the practical findings based on the results obtained from analysis of both questionnaire and the semi-structured interviews (see section 4.3 and 4.4).

Accordingly, the conceptual strategy can be divided into three main categories which are the main challenges facing the implementation of sustainable construction in Libya that can be illustrated by one figure (see figure 5.1). Each category has different components which are the sub-challenges facing the implementation of sustainable construction in Libya. Also below each component, it contains a set of further actions that can be taken towards confronting the challenges related to each main category.



**Fig. 14.1 Conceptual Strategy for the Implementation Sustainable Construction Practices**

## 5.6 Validation of the findings related to the conceptual strategy

Based on the empirical findings obtained from the semi-structured interviews and questionnaire survey analyses and comparison with the literature review, the researcher developed a conceptual strategy. This strategy aimed at implementing sustainable construction practices in Libya. With the intention of verifying and validating the strategy, the researcher prepared to interview four professionals who were intimately involved in the construction industry in Libya. These participants were asked to contribute to the validation process by semi-structured telephone interviews and each of them agreed to participate (See Appendix C).

Table (5.1) shows the characteristics of the participants. Three of them were at top management level and one was a practitioner who was the company director. These interviews were conducted through the medium of Arabic and their responses were first translated into English followed by writing up transcriptions.

**Table 21.1 The characteristics of the participants for validation**

Type of organisation	Position	Participated in the research data collection
Construction company	Seiner Project Manager	Yes
Construction company	Seiner Project Engineer	Yes
Construction company	Assistant Construction Manager	No
Construction company	Director	No

Each of the participants was contacted to obtain their consent to participate in the validation process and to provide them with a brief summary of the research aim and objectives, the

research methods used and the key findings. They were then given details of the conceptual strategy which was intended to implement sustainable construction practices within the Libyan construction industry. Their candid remarks about the strategy and their evaluation of its usefulness were requested. The experts were selected on the basis of their work experience and knowledge of the construction industry with the concept of sustainable construction in addition to some practical experience of its implementation in organisations.

Prior to the interviews, a preparatory session by telephone was held with most of the participants in order that any questions or issues could be clarified. The semi-structured interviews then took place by telephone at a pre-arranged time convenient for the participants. Each interview was around half an hour in duration and the responses were written in note format.

The following questions were asked of each participant and they were encouraged to give as much detail as they wished in their responses:

1. How clear do you think the strategy is presented? Is it easy to understand? Can you suggest any improvements to its presentation?
2. What do you think about the format and layout of the strategy? Why?
3. How beneficial do you think the strategy will be in its present format for implementing sustainable construction practices in the Libyan construction industry? Could it be improved in any way?
4. What do you think about the entire relationships between the strategy components? And the way the strategy is integrated?
5. Do you have any further suggestions?

In the following section, the purpose of each question is considered along with a summary of the responses to them.

### **5.6.1 Validation of the conceptual strategy**

The first question was designed to elicit from the expert participants their views of how easy it was to understand the strategy and whether they thought any aspect of it could be improved in terms of presentation.

Three of the participants expressed some concerns about the presentation of the strategy. The first stated that *“Although I like the way of presenting the strategy and the way it linked between challenges and their titles. However, with respect to the language used I do believe*

*that it is necessary to translate the strategy into Arabic language as the Arabic version will enhance its clarity to the practitioners*". Likewise, another participant stated that an Arabic version of the strategy was required since it would be used in the Libyan context where Arabic is the official language. Additionally, he added, with regards to the title of the strategy: *"I think it is better to address the name of the strategy to match with the aim of this study; thus the name would be the final version of sustainability in construction strategy required to implement sustainable construction practices in Libya"*.

The second question asked about what the participants thought about the format and layout of the strategy. This question aimed at finding out what the participants thought about the overall structure of the strategy, particularly the use of colour for showing the various differences between its various components. Two of the participants expressed that the use of colours and shapes was appropriate for presenting a clear picture of how various components were interlinked.

One of them stated that *"With regard to main challenges to sustainable construction in Libya, the components of the sustainable construction strategy related to main challenges should be modified to be clearer to avoid similarity and ambiguity"*.

Similarly, another participant pointed out *"I think using different layout for each main challenge with its recommendations combined would be better to enhance distinguishing them among all challenges"*. He added: *"I suggest the shapes of figures for the components should be modified to clearly distinguish between the three main categories. Therefore, he suggested that each of the whole three main categories should be in different colours."*

The third question aimed at eliciting the participants' evaluation of the effectiveness of the strategy implementation in Libya.

Different views were expressed by the respondents. Two of them thought that they were satisfied with the current design of the strategy while the other two stated that the strategy needed some modifications to enhance its implementation.

One of them commented that *"Management should establish appropriate models and indicators to regularly extend the company's performance regarding to sustainable construction applications and communicate the outcomes to its staff"*.

In contrast, the second interviewee stated that *“the strategy needs to consider the practical aspects and the responsibility of the company towards its clients and the environment issues”*.

The fourth question asked the participants what they thought about the entire links within the strategy. This concerned the relationships between the sub-challenges and the further actions to take.

All the interviewees were fully agreed that both components and the actions were well linked and made sense in terms of its importance on the formulation of the conceptual strategy of sustainable construction implementation. Thus, modification has been suggested by the interviewees.

With regards to the last question which is “do you have any further suggestions” the following remarks were elicited from the participants:

Three of the respondents agreed that the strategy provided a positive opportunity for the company to implement sustainable construction aspects within their organisation. Additionally, another interviewee added that *“since this study is devoted to the Libyan construction industry, hence it is very significant to clarify the role of the top management, and government authorities in leading and encouraging the construction organisations to employ sustainability aspects in their current and future construction projects”*.

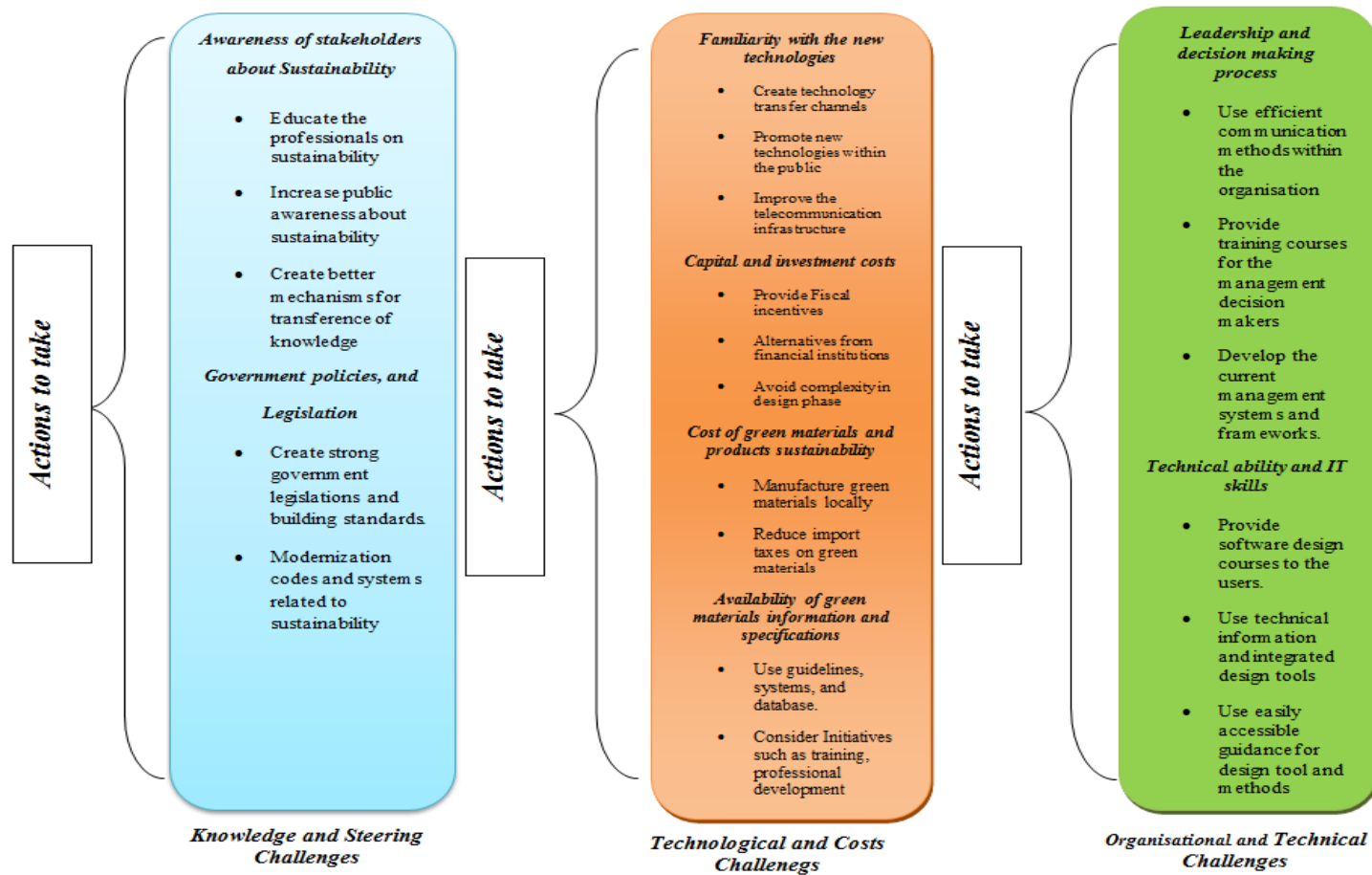
With respect to the suggestions and comments provided by the respondents to refine the strategy, the following points represent the suggestions that will be adopted for amendments of the conceptual strategy.

1. Addressing the title of the strategy
2. Translate the strategy into Arabic (See Appendixes D)
3. Modifying the layout and change the colour of the shapes that show the different between the three main categories and of the strategy structure
4. Modifying the colours and the layouts of the strategy components and actions to take

After meeting the above mentioned suggestions and comments, figure 5.2 below shows the final version of the sustainable construction strategy in Libya.



**STRATEGY FOR THE IMPELENMATION OF SUSTAINABLE CONSTRUCTION IN THE LIBYAN CONSTRUCTION INDUSTRY**



**Fig. 15.2 Final strategy for the Implementation of Sustainable Construction in Libya**

## **5.7 Summary**

In this chapter it was also explained how sustainable practices could improve the quality of the building compared to traditional building design methods, and that quality is also accompanied by enhancing the indoor quality environment of projects.

On the other hand, the benefits of using sustainable construction practices in Libya over traditional methods were discussed. In line with the previously provided benefits related to the impact of sustainable construction practices, the participants referred to the fact that sustainable construction reduced the construction's use of energy. Such benefits were also accompanied by aspects such as the reuse of resources and increasing renewable energies. However, implementing sustainable construction practices faced main challenges and sub-challenges were also mentioned in the semi-structured interviews along with the recommendations associated with implementing sustainable construction practices in Libya. It was indicated that the major challenges resided in sustainable construction, weakness of policies and legislation related to sustainability in construction in Libya were the main challenges to implementing sustainable construction practices. The high cost of sustainable construction and design were also stated as challenges. Furthermore, such as a lack of awareness and education were seen as major obstacles to the use of sustainable construction in Libya, along with ineffective leadership management within the organisation. Likewise, several technological aspects were also reported as factors hindering the adoption of technical abilities.

# **CHAPTER (6): CONCLUSIONS AND RECOMMENDATION**

## **6.1 Introduction**

Chapter five presented a discussion of the research findings based on the results obtained through data analysis with reference to the existing literature review. Additionally, it included the validation process of the research strategy to produce the final version of a strategy to implement sustainable construction practices in Libya. This chapter summarises the key findings of the research in terms of achieving its objectives and related outcomes. The implications of these findings are considered leading to recommendations. The structure of this chapter is set out below:

- Achieving the research objectives.
- Contribution to knowledge and practice.
- Limitations of the study.
- Research recommendations.
- Further research.
- Final Note.

## **6.2 Achieving the Research Objectives**

As stated at the opening chapter, the present study aimed at developing a strategy to implement sustainable construction practices in Libya. The aim was examined through five research objectives.

The first objective was to critically review the main aspects relating to sustainability in construction. This was achieved by way of a comprehensive literature review.

The second objective was to evaluate the level and the extent of sustainable construction practices awareness within Libyan construction organisations. This was achieved by way of a comprehensive literature review and supported by both questionnaire and semi-structured interviews.

The third objective was to review the benefits of using sustainable construction practices within the Libyan construction originations. This was accomplished by the questionnaire survey and semi-structured interviews, the analyses of the data from both methods and the evaluation of the key findings with reference to the comprehensive literature review.

The fourth objective was to identify the challenges confronting the implementation of sustainable construction practices in Libya. This was addressed via a questionnaire survey and semi-structured interviews which helped to identify these challenges. With the support of the literature review, it was possible to understand the nature of those challenges in a more nuanced way.

The fifth objective was to conceptualize and validate a strategy to implement sustainable construction practices in Libya, This was objectively validated using semi-structured interviews with experts. The following sections will summarise and present the key findings related to each objective.

#### **6.2.1 *Objective One:*** *To critically review existing sustainable construction practices globally.*

The study reviewed literature on the significance and analysis of sustainability in construction, and delivered a detailed account of the main explanations of sustainable construction and how the concept was functional in practice. This literature discovered the various interpretations of sustainability in construction, and recognised key elements of sustainable construction practices. Moreover, it presented literature on sustainable construction practices worldwide to obtain a better understanding of the current considerations of application in the construction industry. The literature also included the many aspects for sustainability in different contexts of the developed and developing countries to understand the best way to introduce some changes into the existing construction practices in Libya. It also showed the different perceptions and approaches for sustainable practices.

Since this research study aimed at developing a strategy to implement sustainable construction in Libya, it was, therefore, important to shed light on the most prominent and well-known sustainable construction applications globally. The outcome of this objective presented the literature on construction practices in order to gain insights into the current debates on sustainable practices and systems in the construction industry. It also provided the many studies for sustainability change in various contexts to understand how best to introduce transformation into the present construction practices. Also, the outcome showed the different perspectives and approaches for sustainable practices, thus requiring a selection of issues the researcher found useful for the fulfilment of the research aim.

**6.2.2 Objective Two:** *To evaluate the current sustainable construction practices used in Libya*

This objective was focused on exploring the current situation in Libya by evaluating the scope considered by Libyan construction organisations consider in applying sustainability measures and how these were applied in practice. Therefore, In order to achieve this objective, the research provided a wide view of construction activities of organisations by designing a questionnaire survey on sustainability in construction aspects. The questionnaire assessed and provided details of the organisations' sustainability approaches, and the extent to which environmental, economic, and social sustainability were considered and applied in organisational practices. This provided data from which the current practices and the organisation's sustainability plan could be understood. This assisted in ascertaining the current scope to gain a better knowledge about the extent to which construction organisations currently adopted sustainability aspects in construction practice. Overall, the study outcome indicated that the philosophy of sustainable construction practices was not being fully applied in Libya at the present time. In fact, sustainability philosophy seemed to be mostly confined the reuse of building resources, reducing building resource consumption and finally applying Building Indoor Quality environment.

Nevertheless, the outcomes related to the level of awareness and knowledge of the interviewees and other participants regarding sustainability in general, and sustainable construction in particular, were considered to be more than acceptable.

**6.2.3 Objective Three:** *To review benefits of using sustainable construction practices in Libya*

In order to achieve this objective, questionnaire surveys and interviews were conducted. The survey was used to identify the benefits of using sustainable construction practices in Libya through the level of agreement of participant's opinion with prepared statements. The data which was obtained helped to improve the understanding of the importance of benefits related to implementing sustainable construction in Libya. Likewise, by using the content analysis method, the interview data provided more nuanced information on their motivation of using sustainable construction and answered the question of how benefits could be gained within the Libyan context.

Overall, the outcome of this objective showed that all the nine benefits had received a high degree of support from the respondents, showing that the level of agreement for these

statements was high. The benefits were: reducing building resources, increasing production of renewable resources, and finally, enhancing building occupant health and comfort.

**6.2.4 Objective Four:** *To identify the challenges to implementing sustainable construction practices in Libya*

This objective was a focus on the challenges to implementing sustainable construction in Libya. Both the questionnaire survey and interviews were used to achieve this objective. The main issues identified were categorised into three main challenges according to the factor analysis of the survey results. These main challenges were related to knowledge and steering, technological and costs, organisational and technical, which were further divided into eight sub-challenges. The semi-structured interviews were used in order to uncover some recommendations for overcoming these challenges which were used to develop the final strategy.

Furthermore, the outcome of this objective showed that the eight challenges to implementing sustainable construction practices in Libya which emerged from both questionnaire and the interviews have revealed that there was a high degree of support from the respondents. The main challenges identified were: unawareness by stakeholders about sustainability, weak government policies, legislation, adoption of new technologies, limited availability of green materials information and specifications, high initial capital and investment costs, cost of green materials and products, poor leadership decision making processes and finally lack of technical ability and IT skills.

**6.2.5 Objective Five:** *To conceptualize and validate the strategy for the implementation of sustainable construction practices in Libya*

This objective has been achieved by choosing a number of challenges impacting on sustainable construction practices in Libya; 19 challenges were initially investigated but only items that generated over 50% or more agreement were finally selected as the most significant (8 items). All the related recommendations resulting from the interviews proved to be of crucial importance. Likewise, with a view to validating the strategy, the researcher designed semi-structured interviews with questions that concentrated on the challenges of implementing sustainable construction in Libya, including any recommendations and suggestions that could be considered in order to inform the final strategy. According to a review of various theories of the implementation of sustainable construction practices, and

based on a structured approach, an explanatory strategy was created using ideas from diverse modification theories with properties from the research data to demonstrate how a more effective change would fit across different organisations.

The strategy was, therefore, validated through semi structured interviews. The respondents were experts consisting of four professionals. These were purposively selected in order to gain insights and ideas from their considered opinions regarding structure and developments for the strategy. Moreover, the outcome of this objective discussed that this strategy could potentially assist participants in their in-depth understanding and appropriate implementation of sustainable practices in the Libyan context. The developed strategy may appear broad; however, it presents an effective method for bringing about a cultural change in Libya's construction sector. It also provides visualisation of the possibilities of change as well as a path to positive decision making towards more sustainable construction practices in Libya.

### **6.3 Research contribution to knowledge and practice**

The study has achieved its aim by demonstrating how Libyan construction organisations can improve the level at which they adopt sustainability aspects in their practices. Therefore, it introduces a number of contributions to current knowledge and practices as follows:

#### **6.3.1 Research contribution to Knowledge**

The contribution of this research to Knowledge shows that it has led to a better understanding of sustainability in construction, and clarified the main challenges facing the government, companies, educators and policy makers and which they have to take into account in order to improve the application of sustainable construction in Libya. Similarly, this research has provided a solid platform for future research that aims to expand knowledge in this field as following:

- It creates future research opportunities to estimate the impact that the strategy has had in improving the application of sustainable construction aspects within the Libyan construction industry.
- The achievement of the research aim can offer contributions in formal courses of built environment higher education, to better reflect the emergent trends in the area of practice related to developing and improving the construction industry in a sustainable manner in Libya.

- Lastly, the current findings will be published to maximise the utility of this research (e.g. publications, public construction magazines as well as lectures and seminars). It is important that it is translated into Arabic to make it more accessible.

### **6.3.2 Research contribution to Practice**

This research presents the scope to which construction organisations consider sustainability and how it is established in construction practices in Libya. Though many studies have discovered the weakness in sustainable construction performance in developing countries, it has been noteworthy that there has been limited research into the extent to which the main three elements of sustainability (environmental, economic, and social sustainability) were considered and adopted in practice by companies in Libya's construction industry prior to the current research.

In addition, the first time this research presented the basis of the current practices through a detailed description of sustainability and construction in Libya. It also delivered an in-depth understanding of the complexities related to integrating sustainability in the Libyan construction industry. Similarly, it recognised the opportunities and challenges to adopting sustainable practices and the benefits that influence the actions of developers in the industry. The study showed that a weak understanding and awareness of sustainable construction informs the policies and practices that challenge the operations of developers in the industry. This relates to the lack of regulations and the lack of empowerment of institutions to enforce and implement regulations that support sustainable practices. Furthermore, challenges relating to awareness, knowledge and construction perception considerably influenced the commitment of the main stakeholders. The government organisations do not particularly demand sustainable practices and, with the absence or ineffective enforcement of sustainability policies and legislation, construction organisations and developers in the industry act in an apathetic manner towards sustainability in delivering their projects. In addition, the challenges of insecurity, corruption, improper coordination of construction activities, uncertainty regarding benefits of sustainability, inadequate training, skills and funding to support sustainable construction all present additional issues and difficulties.

This study, with the developed strategy, contributes to a better value of sustainable construction performance in the following context for application in practice as following:



- A guideline to aid construction decision making experts for the management of both existing and future construction activities in a sustainable manner in practice.
- It can be an appropriate approach and reference document to be used in meeting the sustainable construction challenges when adopted by practitioners, policy makers, and the government officials for the post-construction management of their projects.

## **6.4 Research Recommendations**

This research proposes a number of recommendations that could improve sustainable construction practices in the context of Libya, based on the literature review and the research findings, also perhaps leading to more widespread improvements in the construction industry. Actions towards increasing the awareness of sustainable construction aspects will positively enhance its application to a greater level, particularly when targeting the individuals and organisations involved in construction.

- It is recommended that government authorities should issue stricter legislations, codes or standards relating to sustainable construction practice specifically for Libya's construction industry for both the public and private sector to ensure appropriate and effective implementation by all parties.
- Improving the level of awareness of sustainable applications and knowledge could have a significant impact on the applications of sustainable construction concepts on the larger scale specifically for the stakeholder contributing to the construction industry. That could be achieved by presenting suitable guidelines, techniques or tools based on previous research carried out in the industry to make them more practical and operative. Similarly, by organising more seminars, discussions, training sessions, and workshops, guiding developers and both the small and medium-sized stakeholders to gain the awareness and knowledge levels, the importance of sustainability in construction can be more widely disseminated.
- Increasing the competition process between manufacturers to reduce costs related to sustainability, and more actions and strategies should be carried out to make sustainable practice become more common practice.
- Increasing awareness regarding government incentives should be considered so that people would be motivated towards more sustainable construction principles.

- Reviewing the assistance given for energy conservation measures adopted by consumers as an incentive to reduce pollution resulting from construction activities,
- Developers in the industry are in need of more support to increase the price of energy and water to ensure its efficient and economical use.
- More efforts and plans need to be put in place by the developers towards increasing the production of renewable energy resources so that these can be used as alternatives.
- Greater attention at the design stage should be paid to delivering sustainable solutions at a more appropriate and reasonable cost.
- There is a need for highly experienced managers of staff who will grow the confidence of other staff members and designers and eventually at the construction level.
- Finally, more work is required to widen the range of environmental awareness among the individuals to ensure a sustainable future. This is the role and responsibility of developers, contractors, architects and consultants, and this is influenced by the existing market situation and also by the demand from the client.

## **6.5 Research Limitations**

- There are limitations that are associated with the ability to generalize the outcome of this research. In conducting this study, the critical realist philosophical stance was chosen as a framework because this research was not just about objectively describing the present reality, neither was it about the subjective interpretation of the perceptions of different participants. Rather, it was about understanding the causes of the present situation and identifying how to improve them. In this philosophical stance, emphasis is not on generalizability of the findings; but, to understanding the contributory factors, identifying opportunities to develop a strategy to improve the present practices. By understanding the causal challenges for the action or inaction of actors in the industry and the context within which these actions occur, it was possible to identify how to improve the situation. However, the work would suggest that a similar result could be found in most developing countries.
- In general, the research has successfully achieved its aim and the objectives. Nevertheless, this research had some difficulties during the research processes. The

first was the lack of any significant Libyan specific literature. The second obstacle faced was the unwillingness of some individuals to participate in the study.

- In terms of data collection, there were some difficulties. The collection procedure was to give the questionnaires to the participants by hand and then collect them using the same method after completion to obtain a high response rate. However, some of the questionnaires were not returned or completed which caused a small sample size.

## **6.6 Future Research**

This present research identified the opportunity inherent in the sustainability concept in the industry to develop a clear strategy. The sustainable construction process in the industry could be investigated further to gain a more in-depth insight into the companies' sustainable construction practices and utilise the benefits in the industry. This will help to identify specific areas requiring change to improve social and environmental practices of construction stakeholders in the Libyan construction industry.

Findings in this present research indicate sustainability is more closely associated with economic concerns, and environmental practices have major benefits in both the long and short term views. There is a need for further research to explore the benefit of embedding environmental assessments in construction practices in Libya. This would strengthen the economic significance of socio-environmental practices and further incentivise companies towards the uptake of sustainable construction practices.

Moreover, a framework of challenges and benefits could be created from the available factors gathered from the literature by using Interpretive Structural Modelling (ISM), AHP, Fuzzy AHP, Fuzzy MICMAC like techniques to find solution for such problems, which would also help the practitioners and policy makers toward better understanding the problems relating to sustainable construction practices.

Finally, this research has given a clear vision of challenges that the individuals, companies, educators, government agencies and policy makers should take into account in order to improve sustainable construction practices in Libya. Similarly, the research has produced a solid platform for future research that targets increased knowledge in this field. The current findings will be published to maximize the utility of this research (e.g. publications, public construction magazines as well as lectures and seminars).

## **6.7 Final Note**

The main findings of the study obtained from literature and survey strategy revealed that sustainability in construction has been widely researched and adopted worldwide; however in the context of Libya, there are not many existing studies which adequately cover the sustainability in construction in general and in the Libyan construction industry in particular. Therefore, the study has addressed a knowledge gap on the level of application of sustainable construction practices in Libyan construction organizations. The study also concluded by producing a strategy in order to adopt the implementation of sustainable construction practices in Libyan construction industry. The developed strategy was grouped into three themes namely major challenges that hindered sustainable construction implementation in Libya, including a set of further actions to be taken for each challenge. It can be concluded that the developed strategy will enable the implementation of sustainable construction practices within the Libyan construction industry which will, in turn, have positive impacts on its overall performance.

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# **APPENDIXES**

# Appendix (A)

## Questionnaire

This study that aims for developing a strategy for the implementation of sustainable construction practices in Libya, which will help to identify the level of knowledge and awareness and identify the challenges to the Libyan construction industry. The questionnaire is divided into the following sections:

**Sec 1:** Respondent Background

**Sec 2:** Practices of sustainable construction

**Sec 3:** Challenges to implementing sustainable construction

**Sec 4:** Benefits of implementing Sustainable construction

**Please tick [✓] to the suitable answer (s):**

Section 1: Respondent Background	
<b>Your Highest educational level:</b> <input type="checkbox"/> Below bachelor <input type="checkbox"/> Bachelor <input type="checkbox"/> Masters <input type="checkbox"/> PhD <input type="checkbox"/> Other, Specify: - .....	<b>Years of experience in construction industry:</b> <input type="checkbox"/> Less than 5 years <input type="checkbox"/> 6 – 10 years <input type="checkbox"/> 11 – 15 years <input type="checkbox"/> Over 15 years
<b>Your area of expertise:</b> <input type="checkbox"/> Engineering <input type="checkbox"/> Architecture <input type="checkbox"/> Management <input type="checkbox"/> Other, Specify: - .....	<b>Your work sector:</b> <input type="checkbox"/> Public sector <input type="checkbox"/> Private sector <input type="checkbox"/> Both
<b>Size of your organization:</b> <input type="checkbox"/> More than 100 employees <input type="checkbox"/> 60- 100 employees <input type="checkbox"/> 11- 59 employees <input type="checkbox"/> Less than 10	<b>Your area of specialization:</b> <input type="checkbox"/> Residential/ Housing buildings <input type="checkbox"/> Commercial buildings <input type="checkbox"/> Industrial <input type="checkbox"/> Infrastructure <input type="checkbox"/> Other, Specify: - .....

Please tick [✓] on the frequency of using the following practices:

<b>Section 2:</b> Practices of sustainable construction						
<i>Practice</i>	<b>Never</b>	<b>Rarely</b>	<b>Sometimes</b>	<b>Often</b>	<b>Always</b>	<b>N/A</b>
Reduce building resource consumption						
Reuse building resources						
Use recyclable building resources						
Minimize pollution and negative environmental impacts						
Site selection and planning						
Apply Building Indoor Quality Environment						

Please tick [✓] the level of importance of the key factors to the implementation of sustainable construction practices:

<b>Section 3: Challenges to sustainable construction practices</b>						
No	<i>Key challenge</i>	1	2	3	4	5
		Not at all	Low	Med	High	Very High
1	Government commitment and support					
2	Government policies and legislation					
3	Building codes and regulations on sustainability					
4	Initial capital and investment costs					
5	Additional cost in construction and services					
6	Availability of Financial resources and incentives					
7	Life-cycle cost assessment					
8	Availability of Green materials information and specifications					
9	Accessibility to green materials information, and specifications					
10	Cost of green materials and products					
11	Adoption and Familiarity with the new technologies					
12	Accessibility to integrated design tools and methods					
13	Leadership ability and decision making process					
14	Effective communication amongst project team members					
15	Technical ability and IT skills					

16	Common understanding and awareness by stakeholders in sustainability					
17	Professional capacity, knowledge & innovation in sustainability					
18	Education and training on sustainability					
19	Public awareness					

Please tick [✓] on your level of agreement with the following benefits:

<b>Section 4: Benefits of Sustainable Construction practices</b>						
No.	<i>Benefit</i>	1	2	3	4	5
		Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1	Reduced waste production and increased recycling					
2	Increase production of renewable resources					
3	Maintain integrity of environment					
4	Reduce building resources consumption costs					
5	Decreased initial costs for reused and recycled materials					
6	Reduce overall building lifecycle cost					
7	Enhanced building occupant health, comfort & Safety					
8	Improve satisfaction of occupant					
9	Better individual productivity of occupant					

## **Appendix (B)**

### **Interview Transcripts**

#### **Section 1: Level of awareness and current application of Sustainable Construction practices**

**Q1:** What is your understanding of sustainable construction?

**Q2:** How do you observe sustainability in your practice?

**Q3:** Can you indicate from the 6 practices below the most considered during your projects?

- Reduce building resource consumption
- Reuse building resources
- Use recyclable building resources
- Minimize pollution and negative environmental impacts
- Site selection and planning
- Apply Building Indoor Quality Environment

**Q4:** Are these selected practices effective within your organization?

#### **Section 2: Benefits of Sustainable Construction practices**

**Q5:** Can you indicate from the benefits 9 below that you believe are the most useful for your client and society in whole, and why?

- Reduced waste production and increased recycling
- Increase production of renewable resources
- Maintain integrity of environment
- Reduce building resources consumption costs
- Decreased initial costs for reused and recycled materials
- Reduce overall building lifecycle cost
- Enhanced building occupant health, comfort & Safety
- Improve satisfaction of occupant
- Better individual productivity of occupant

### **Section 3: Challenges to implementing Sustainable Construction practices**

Below **8** key challenges that face the implementation of SC practices in Libya.

**Q6:** In your opinion, can you explain how these challenges can affect the implementation of sustainability in construction within your organization?

**Q7:** What are the most effective actions that should be taken in order to overcome these challenges?

1. Awareness of stakeholders about sustainability
2. Government policies, legislation
3. Familiarity with the new technologies
4. Capital and investment costs
5. Cost of green materials and products
6. Availability of green materials information and specifications
7. Leadership and decision making process
8. Technical ability and IT skills



## **Appendix (C)**

### **Invitation letter for validation Interview**

Dear Sir/Madam,

My name is **AUSSAMA KHALIL**, I contacted some of you earlier 2017 to carry out an interview regarding to the application of sustainable construction practices in Libya.

For those who I have not been in contact with them, a brief background about the research is available as requested. Bearing in mind that I will have a fair conversation with you prior to the interview to make sure you are fully aware of the research.

I am contacting you now to conduct phone-structured interview to verify and validate a STRATEGY, It will be very much appreciated if you send me your availability for no more than 20 – 30 min interview in your convent time.

I would like to thank you positively for your collaboration and looking forward to hearing from you.

Please note that I attached with this email a covering letter that includes background about the strategy and the interviews' questions.

Sincerely,

## Appendix (D)

### Arabic version of the strategy

#### استراتيجية تنفيذ البناء المستدام في صناعة البناء الليبية

