Evaluating the knowledge and implementation of waste management by contractors in Gauteng province

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Declaration

I hereby declare that this research report submission is my own work towards the Master of Science in Project Management in Construction (Building) and that to the best of my knowledge and understanding, it contains no material previously submitted or published by any another person or myself to any School or University, nor material which has been accepted for the award of any other degree of the University, except where due credit is made in the context.

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Abstract

While much has been written about the barriers to sustainable construction globally and particularly in South Africa, the implementation of the concept is still a challenge. The aim of this research is to investigate the awareness and understanding towards environmental aspects specifically on-site Construction Waste management (Handling of waste, use of prefabrication and reuse of waste) as sustainable practise amongst construction contractors in South Africa. These barriers have limited adaptability within the industry and hence depriving the industries of the expected benefits associated with sustainable construction practices. This research focuses on the knowledge, implementation and the impact of construction waste management and the use of prefabrication as sustainable construction practices in South African buildings projects, Gauteng. A questionnaire on construction waste management was directed to experienced professionals, on recently completed building projects and on-going building projects. Previous results shown that construction waste management by **reduction, re-use and recycle** is one of the major benefits of **using prefabrication** compared with conventional construction.

In this study it was observed that South Africa contractors, particularly in the Gauteng province, fail to adopt basics of sustainable construction practices in construction of buildings projects. Observed also was the eight (8) most common barriers to the construction of sustainable buildings are Knowledge and Implementation, Prefabrication as a substantial componentry, Waste management as a sustainable construction practice reduces cost, Precast as sustainable construction practice at design stages, Materials recycle and re-use on your projects as sustainable construction practice. Others are; the effect of cost of sustainable materials compared to normal construction, environmental management, exposure to experts in one's profession and the commitment of construction firm/ organisation. Also noticed was that some contractors mentioned government involvement or funding into the practice of sustainable construction practices.

In conclusion, the research demonstrates that much needs to be done in Gauteng province with regards to waste management and sustainable construction practise be it by the government through funding and schools including professionals working in the industry.

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1 Introduction and Background

1.1 Introduction

Emuze, Kevin and Babatunde, (2015) have argued that sustainability in the built environment has become an international vital within the Architecture, Construction, and Engineering (AEC) sector. While much has been written about the obstructions to sustainable construction in South Africa, the implementation of the concept is still a challenge. Participants highlighted that education about the principles and concepts of sustainable building is most essential in main streaming sustainable building and construction (SBC) as it requires changing behaviour, which in turn requires changing attitudes. Technical training, which follows after education, will provide a better understanding of sustainability issues to support implementations.

This paper studies the obstacles for sustainable building and construction (SBC) on the basis of literature Study and with questionnaires. On the basis of the results the paper discusses what actions are needed in order to promote SB. The need for a definition of sustainability and sustainable building in the regional context was highlighted by many stakeholders. Participants expressed about the need for more education (not only for building professionals, but for the public at large) about what sustainability is all about and why we should strive for it in buildings and in general (Shafii and Othman, 2008).

For the last two decades, sustainable development and sustainable construction have been of increasing concern throughout the world. Kibert (1994) defined sustainable construction as ‘‘the creation and responsible management of a healthy built environment based on resource efficient and ecological principles”. The construction industry is both a key contributor to socio-economic development and a major user of energy and natural resources; therefore its involvement is fundamental to achieve sustainable development in our society (Omer, 2008). However, the construction industry’s culture and resistance to change are significant challenges to effective waste minimisation (Teo and Loosemore, 2001). There is a concurrence in literature that a substantial amount of construction waste instigates as a result of poor design (Osmani, Glass, and Price, 2007). The architect therefore has a decisive role to play in helping to reduce waste in construction at all levels by focussing on designing out waste (Greenwood, 2003; Coventry *et al*., 2001). In order to maximise their influence, architects need to understand the issues, constraints and opportunities related to waste prevention, and the practical means by which improvements can be achieved. By improving waste minimisation design practices, architects could realistically and successfully accelerate the pace of change (Osmani *et al*., 2007).

The 'three Rs' principle of waste (reduction, re-use and recycle), otherwise known as the waste hierarchy, has been widely adopted. Similarly, the impact of legislation, particularly the Landfill Tax, and its effects on the behaviour and practices of the construction industry has resulted in a number of research studies (Osmani *et al*., 2007). Additionally, tools, models and techniques have been developed to help handle and better manage on-site waste generation. While these tools facilitate auditing, assessment and benchmarking; waste source evaluation approaches do not offer long-term benefits, because they fail to address fundamental causes of waste (Osmani *et al*., 2007).

1.1.1 Sustainable Construction

The Marrakech Task Force on Sustainable Buildings and Construction define sustainable construction as: The construction that delivers the required performance with the minimum harsh environmental impacts while stimulating **economic, social and cultural improvement** at national and international level (Simpson, Gössling, Scott, Hall and Gladin, 2010).

Sustainable construction is a way for the building industry to move towards achieving sustainable development, taking into account environmental, socio-economic and cultural issues. Buildings, infrastructure and the environment are inextricably linked. Energy, materials, water and land are all used in the construction and operation of building and infrastructure. These built structures are also part of our living environment, affecting our living conditions, social well-being and health. It is therefore important to explore environmentally and economically sound design and development techniques to ensure that buildings and infrastructure are sustainable, healthy and affordable (Majdalani, Ajam, and Mezher, 2006). Sustainability is "Sustainable development is progress that meets the needs of the present without compromising the ability of future generation to meet their own needs'' as defined by Khalfan, Ali Noor, Maqsood, Alshanbri, and Sagoo (2015).

According to Bossel, (1999) sustainable development is all about guaranteeing a better quality of life for today's generation and accounting for generation to come.

According to the main principles sustainable construction are the following:

- maximisation of resource reuse;
- minimisation of resource consumption;
- use of renewable and recyclable resources;
- protection of the natural environment;
- creation of a healthy and non-toxic environment; and
- creation of quality in built environments.

Sustainable construction embraces three main dimensions namely social, economic and environmental in contrast with the traditional perspective, where the main concerns were economy, utility, and durability. The social dimension addresses issues pertaining to the enhancement of people's quality of life. The economic dimension addresses economics issues such as employment creation.

The environmental dimension deals with the design, construction, operation/maintenance and deconstruction approaches that minimize the adverse impacts on the environment such as air emissions, waste discharges, use of water resources, land use, and others (Baloi, 2003).

1.1.2 Sustainable Construction practices

1.1.2.1 Socio-Economic

The construction industry has often explored the economic dimension, which explains why most of the time projects are awarded to the contractor with the lowest tender. In the past, tenders used to be based solely on economic factors, which measure short-term returns at the detriment of social and environmental issues which consider long-term benefits of an asset. The built environment inherently affects and contributes to the way in which we live our lives, including health, safety, and quality of the surrounding environment. The building industry is a primary driver of many economies and has significant contribution towards creation of employment. Globally building in a responsible manner is the need of the hour with consideration to the social, economic and environmental implications is therefore critical to the progress of mankind and the preservation of our planet. While environmental consciousness was the original driver behind movement towards sustainable design and construction, the concept of sustainability has been expanded to include environmental, social and economic aspects. This concept is known as the 'Three Pillars of Sustainability' or the 'Triple Bottom Line' (Khalfan, *et al*., 2015).

1.1.2.2 Environmental factors and Waste management

There are obvious benefits to the community from implementing environmental management in construction activities, such as reducing the production of wastes, and reducing the use of materials and techniques that could have harmful effects on the environment. The benefits to contractors can be in a number of ways, for example, cost savings due to the reduction of fines associated with convictions as a result of complying with environmental legislation. Existing publications have identified a number of beneficial factors (BF) in implementing environmental management in construction. The promotion of environmental management and the mission of sustainable development have resulted in pressure demanding the adoption of proper methods to improve environmental performance across all industries including construction. Construction is not by nature an environmentally friendly activity. Existing research suggests that construction activity is a major contributor to environmental pollution according to Zeng, Tam, Deng, and Tam (2003).

1.1.2.3 Building materials

According to Ortiz, Castells and Sonnemann, (2009) Almost 130 different building parts and fifty different building material groups were identified in the inventory phase. The operation phase of the building was divided into operating electricity, operation heat and other services (water use, waste water generation, courtyard care). Those life cycle assessment (LCA) studies presented are not fully comparable; there are differences in the final product and also most studies neglect cost except those works which show the application of shadow prices. However, the most recent methodologies which incorporate information regarding environmental impacts and embodied energy in building materials are necessary for sustainable development.

Environmentally sustainable development is a major concern, and symbolises both environmental protection and management. The concept of sustainable development is broad. Generally, sustainable development concerns attitudes and judgment to help insure long-term ecological, social and economic growth in society. Functional to project development, it involves the efficient allocation of resources, minimum energy consumption (**reduce**), low embodied energy intensity in building materials, **reuse and recycling**, and other mechanisms to achieve effective and efficient short- and long-term use of natural resources. Current environment assessment methods do not adequately and readily consider environmental effects in a single tool and therefore do not assist in the overall assessment of sustainable development. Construction is one of the largest end users of environmental resources and one of the largest polluters of man-made and natural environments. The improvement in the performance of buildings with regard to the environment will indeed encourage greater environmental responsibility and place greater value on the welfare of future generations (Ding, 2007).

1.1.2.4 Green Building

As environmental awareness has gained momentum, sustainable building practices have experienced significant growth. The green building trend is projected to continue during the next 10 years, as indicated by the dramatic increase in projects seeking LEED certification. Surveys of industry professionals indicate the single largest consideration for green building is the cost premium over conventional practices. Although the increased cost of green construction can be minimized or eliminated, doing so requires an enhanced level of communication across the project team, an inclusive design charrette process for project stakeholders and careful project planning early in the project life cycle (PLC). As is evident from these discussions, the importance of environmental issues has gained momentum. As a consequence, research in the design and execution of construction projects has focused on how sustainable practices can reverse the impacts of global warming. According to the United Nations Environment Programme (UNEP) (2007) also (Robichaud and Anantatmula, 2011).

South African government has made progress in establishing policy in favour of sustainable development through regulations guiding the built environment. At present, there are two South African National Standards which promote environmental sustainability and energy savings. These include SANS 204:2011 (SABS SANS 204 2011) which regulate energy usage in new buildings and SANS 10400-XA (SABS SANS 10400-XA 2011) which has two parts: i. Part X which concerns environmental sustainability, and ii. Part XA considers energy usage in buildings (Emuze, Kevin and Babatunde, 2015).

1.1.2.5 Prefabrication

A study conducted by Chen, Okudan and Riley (2010) stated that it is more urgent to address prefabrication issues in concrete buildings while achieving sustainable construction in the United States, with heightened awareness of environmental pollution, natural resource depletion and accompanying social problems, sustainable development and sustainable construction have become a growing concern throughout the world.

Shena, Tamb and Li (2009) further stated that the minimization of construction waste has therefore become a pressing issue in pursuing the practice of sustainable construction. This paper shows the betterment of replacing in situ concreting with precast slabs for temporary works to improve sustainable construction performance. Construction waste from the obsolete concrete constitutes a large part of the construction solid waste in a typical building project. The reduction on the obsolescence by using precast slabs can significantly contribute to improving sustainable construction performance.

1.2 Problem Statement

It is never in doubt, the need for physical infrastructure and large-scale development in the built environment in developing countries (Du Plessis, 2007; Bangdome-Dery & Kootin-Sanwu, 2013). While much has been written about the barriers to waste management globally and particularly in South Africa, the implementation of the concept is still a challenge. These barriers have limited adaptability within the industry and hence depriving the industries of the expected benefits associated with waste management as part of sustainable construction practices.

1.3 Primary Research Question

From the problem statement, the following research question is framed:

What are the difficulties encountered by the Gauteng contractors in projects and what measures can be used to improve the implementation of sustainable construction practices?

1.4 Secondary Research Questions

- How the current identified challenges of sustainable construction practices concepts influence build projects?

- What are the needs of contractors created on the implementation of environmental issues specifically on-site Construction Waste Management effect in build projects?
- How the key issues identified on-site Construction Waste Management effect in build projects?
- What are major barriers to practising sustainable construction practises and factor in building projects?
- How do professionals exchange of learning on sustainable construction practices within the Gauteng construction industry?
- Can construction waste be used for recycled, reduce or re-used in Building projects?
- What challenges are being faced in recycling wastages (foot print)?

1.5 Research Aim

The aim of this research is to investigate the awareness and understanding towards environmental aspects specifically on-site Construction Waste management (Handling of waste, use of prefabrication and reuse of waste) as sustainable practise amongst construction contractors in South Africa. Sustainability is still a relatively new concept for the construction industry in the developing countries and has not yet received sufficient attention. However, generally, there is an increase in awareness on SBC in the region however not across the whole spectrum of the building and construction sector (Shafii and Othman, 2008).

1.6 Research Objectives

The main objectives are:

- To identify the challenges of sustainable concepts in build projects and the needs of contractors based on the implementation of environmental issues specifically on-site Construction Waste Management.
- To identify key issues; as well as the major barriers to practising sustainable construction practises.
- To encourage debate and the exchange of learning on sustainable construction practices within the South Africa construction industry.

1.7 Research Proposition

A wider use of prefabrication can reduce construction waste generation in South African and alleviate the burdens associated with its management.

1.8 Research Methodology

The survey questionnaire is a logical technique of data collection based on a sample (Tan, 2011). It has been extensively used to pursue professional opinions in green building research (Wong *et al.*, 2016; Shen *et al*., 2016). In this study, to investigate the criticality of various barriers to sustainable construction practices adoption, a survey questionnaire was carried out. Thus, the research reported in this paper is a quantitative research (Creswell, 2014), the results will be statistically analysed and interpreted to produce a set of ranked critical factors for sustainable construction practices within a Gauteng construction environment. In summary on the study approach is thus a strategy of inquiry in which current practices are explored in depth in the context of the Gauteng Province.

Quantitative researchers try to recognize and isolate specific variables contained within the study framework, seek correlation, relationships and causality, and attempt to control the environment in which the data is collected to avoid the risk of variables, other than the one being studied, accounting for the relationships identified (Gay and Peter, 2003 and Black, 1999). Wang, Li and Tam (2014), who did a similar study within a Chinese context, made use of a similar research design methodology to derive and rank critical factors that will minimise construction waste at the design stage of Chinese construction projects. This research methodology has complementary strengths as the second part of the research will aid in exploring the applicability and the significance of the initial conceptual framework identified in the literature review.

1.9 Significance of the study

This study will investigate the importance of on-site Construction Waste Management used in previous projects which identified the implementation of sustainable construction practises and Waste Management. This literature searches and discusses current barriers in terms of implementing the identified factors in building projects, waste management factors will be listed globally. The objective of this paper is to study the current knowledge with regards to current practices global and South Africa in the Gauteng province also look at the advantages of these practices should they be implemented. It will hopefully serve as reasoning to the final adaptation and give more information in the education of the concept.

1.10 Limitations of the study

Limitations to this research is that the participants are not a representative of the entire country, as there are suggestively high magnitudes of construction projects that are not as forming part of waste management as a sustainable construction practices. This study provides vital understandings and point out some concerns related to the implementation of waste management practices on construction sites in the Gauteng province. The individuals interviewed are also linked to the building industry; they had been involved in the construction of buildings for a substantial period of time. Their experience gave them the ability to partake on current state of the building construction industry and its sustainable construction practices associated with waste management. Results from this study are within the sample frame or population which is Gauteng. Research implication and predictions are therefore made within this fixed area, and not to the wider population of South African contractors.

1.11 Structure of the Research Report

This research report consists of multiple section or chapters, which include a page for Declaration, Acknowledgement and Abstract in order to clarify the research report. This section also contains a list of figures, a list of tables with graphs that, which are all listed on conjunction with corresponding page numbers for ease of reference.

Chapter 1 consists mainly of the Introduction and in it the practical validation of the research problem, included in this chapter also is the research problem statement, primary research question, Secondary research questions, the consequences of the problem (economic, social & environmental), research proposition as well as the aim and objectives of the study. This chapter also briefly states the proposed research methodology, but that is discussed in depth in Chapter 3.

In **Chapter 2** a comprehensive literature review can be found in which previous studies of sustainable construction practices in building project were surveyed in terms of the topic and discussions, the three R's (Reduce, Re-use & Recycle), Implementation of sustainable construction, maximisation of resources re-use for sustainability, minimisation of resource consumption (Reduce), use of renewable and recyclable materials, protection of the natural environment from construction waste, a healthy and non-toxic sustainability in construction projects, prefabrication as sustainable built environment, social factors on sustainability and barriers to sustainable construction implementation globally. The chapter concludes with a discussion on the barriers identified in terms of implementing sustainable construction practices.

Chapter 3 of this report discusses research approach, research methodology and research design of the report. This includes justification of the research methodology as well as discussions with regards to the questionnaires sampling methods used, data collection and analysis in combined with ethical considerations. Furthermore this chapter discusses validity, restrictions & reliability of the research as well as how gathered data will be analysed.

Chapter 4 discusses the research results and findings; firstly a small introduction is made then analyses of the response rate of the questionnaires of the study. This is followed by a profile of respondents; the remainder of the chapter discusses the processed data obtained through the questionnaires. This mainly is around the ranked significant critical factors that will improve sustainable construction practices as well as the implementation of these factors in building projects. The relationship between the implication of the factors as well as the implementation of these factors. Moreover this chapter discusses the techniques to analyse the data, test of assumption due to this technique that lead to have non-parametric correlations therefor the normality, Kruskal Wallis - H test, Mann Whitney - U test and correlations are done and discussed.

Chapter 5 is from the findings in Chapter 4, which contains the research conclusions and recommendations. It also states unanswered questions beyond the scope of the study and proposes areas for future studies but it is introduced by an introduction into topic and finding at hand.

This research report is then concluded with a list of references used throughout the report which is finally followed by appendixes which contain additional and supporting information towards the research. The appendixes include; the full list of references from chapter 4 under item 4.5 with the copy of survey questionnaire.

2 Literature Review

2.1 Introduction

This literature review will investigate various research methods used in previous studies which identified the implementation of sustainable construction practises and on-site Construction Waste Management. The primary objective of this literature review is to study the current body of knowledge with regards to current practices global & local also why these practices should be implemented. This literature review also searches and discusses current barriers in terms of implementing the identified factors in building projects. Sustainable construction practises factors will be listed together with its relevant context globally. It will later serve as reasoning to final choosing the research design and research methodology discussed in Chapter 3.

After a thorough review of these studies, 22 potential barriers to sustainable construction practices were adopted and identified in this study, as listed in the Questionnaire. This is a list of factors that are well detailed in previous research and therefore are more applicable. For example, cost of materials, lack of information, materials waste the three R's (Reduce, Reuse & Recycle), prefabrication and lack of awareness just name a few, are commonly acknowledged in the literature as crucial hurdles to the adoption and practices. Thus, the identification of the set of 22 potential barriers focused mainly on factors that have received considerable attention in previous studies conducted in different countries and contexts.

2.2 Sustainable Construction Practices the three R's (Reduce, Reuse & Recycle)

At first glance, the widespread advocacy of sustainable development is astonishing, given its revolutionary implications for daily life (Campbell, 1996). It is getting hard to refrain from sustainable development; arguments against it are inevitably attached to the strawman image of a greedy, myopic industrialist (Campbell, 1996).

'Construction' and 'sustainable' are both highly complex, and as a result there is an ongoing debate about their scope and meaning. Placing these two terms together to form a third further magnifies the interpretative dilemma. It is not possible simply to define 'sustainable construction' as 'construction that is sustainable' without first asking: sustainable for whom and sustainable in what way? Construction itself also has narrow and broad interpretations. As there are no agreed common definitions yet, this section of the paper sets out to explain the specific interpretations of these concepts that informed the A21 SCDC (Du Plessis, 2007).

Construction can be interpreted at four levels: as site activity, as the comprehensive project cycle, as everything related to the business of construction, and as the broader process of human settlement creation (Irurah, 2001). The most common interpretation is as the site activities that lead to the realisation of a specific building or other construction project (e.g. road, bridge, building or dam). At this simplest level construction is viewed as a specific stage in the project cycle. However, intervention at this level is limited to those aspects under the direct control of the contractor. Broader concerns need to be addressed at stages earlier or later in the project cycle, leading to the second interpretation of construction as the comprehensive cycle of a construction project, covering key stages such as feasibility, design, building/construction, operation, decommissioning, demolition and disposal.

While interventions in the construction life cycle as outlined above can considerably reduce the impact of the construction product, it still does not cover the full scope of activity allied to construction. Construction by itself is a large sector of the economy, responsible for millions of jobs and a significant proportion of GDP in most countries (Du Plessis, 2007). Du Plessis et al. (2002: 4) proposed the following definition as the fourth level: Construction is 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.

Most countries in South-East Asia are faced with the growing environmental problems that have been the natural consequence of economic development. Malaysia is one of the few countries in the world that has actively attempted to balance environmental conservation with economic development. In general, the process of driving sustainability in construction in the region is slow.

Sustainable objectives often emphasize environmental burdens. However, environmental issues often cannot be tackled if the problem of poverty remains unsolved (Huovila and Koskela, 1998). While traditional design and construction focuses on cost, performance and quality objectives, sustainable design and construction adds to these criteria minimization of resource depletion, minimization of environmental degradation, and creating a healthy built environment (Kibert 1994). The shift to sustainability can be seen as a new paradigm (Vanegas, DuBose, and Pearce, 1996) where sustainable objectives are within the building design and construction industry considered for decision making at all stages of the life cycle of the facility.

The economic development planner sees the city as a location where production, consumption, distribution, and innovation take place (Campbell, 1996). The city is in competition with other cities for markets and for new industries. Space is the economic space of highways, market areas, and commuter zones (Campbell, 1996). The environmental planner sees the city as a consumer of resources and a producer of waste. The city is in competition with nature for scarce resources and land, and always poses a threat to nature. Campbell, (1996) also said Space is the ecological space of greenways, river basins, ecological niches. The equity planner sees the city as a location of conflict over the distribution of resources, of services, and of opportunities. The competition is within the city itself, among different social groups. Space is the social space of communities, neighbourhood organizations, labour unions: the space of access and segregation (Campbell, 1996). More importantly, it emphasizes the point that a one-dimensional "man versus environment" spectrum misses the social conflicts in contemporary environmental disputes, such as loggers versus the Sierra Club, farmers versus suburban developers, or fishermen versus barge operators (Campbell, 1996).

2.3 Implementation of Sustainable Construction

The notion of sustainable development, which was introduced at a meeting of the UN Environment Program in 1982 in response to widespread environmental problems, was crystallized by ‘Agenda 21’ and the Rio Declaration on Environment and Development promulgated by the 1992 UN Conference on Environment and Development (WCED, 1987; International Council for Building (CIB) and United Nations Environment Programme – International Environmental Technology Centre (UNEP-IETC), 2002; Gambatese and Rajendran, 2005 and Shelbourn, Bouchlaghem, Anumba, Carillo, Khalfan and Glass, 2006).

Current sustainable construction practices are widely different depending on how the concept of sustainable construction is developed in various countries (Bourdeau et al. 1998). Huovila and Koskela, (1998) observed that the difference between the market economies, transition economies and developing economies influences its implementation priorities. The mature economies pay attention to a sustainable building stock either by new construction or by refurbishment. In the transition economies the emphasis is on new developments reducing the housing shortage and improving their transportation networks. In the developing economies the social agenda (e.g., job creation) is much higher on the agenda than environmental concerns.

If the owner and the contractor have different sustainability priorities, that both differentiate from the environmental priorities, it may in the short-term lead to non-optimal trade-offs from the environmental point of view. In the longer term, however, the sustainability objectives will tie and the industry's responses to environmental problems may, in fact, be a leading indicator of its overall competitiveness. Successful environmentalists and companies will reject old trade-offs and build on the underlying economic logic that links the environment, resource productivity, innovation, and competitiveness (Porter, and Van der Linde, 1995 and Huovila and Koskela, 1998).

According to CIB (1999), the paradigm for assessing the feasibility of construction projects is extended from the traditional feasibility study approach, which focuses mainly on cost, time and quality, to integrating resource consumption and environmental impacts within a global contour. In a further search for ways to improve the contribution of construction projects to sustainable development, Shen et al. (2002) developed a model for assessing the sustainable performance of a construction project. By using this model, the sustainable development value (SDV) and sustainable development ability (SDA) in implementing a construction project in its life cycle can be quantified. In addition, there are some other studies presenting various methods for promoting environmental management and enabling better sustainability in implementing construction projects across their life cycle (Brochner et al., 1999; Heerwagen, 2000; Tam et al., 2002; Wyatt, 1994 and Shen, Wu, Chan, and Hao, 2005).

Sustainable construction is a new concept that requires considering the sustainability objectives for all decision making during the life cycle of the built facility. The concept of sustainable development has different priorities in different economies, but good examples of its implementation can be listed the globe over.

Contribution from the Principles of Lean Construction to Meet the Challenges of Sustainable Development Proceedings IGLC '98 construction is already offering the conceptual basis, and potential for novel methods and tools for sustainable construction. Joint efforts from the industry and the community are called to spur further development to improve our quality of life through sustainability (Huovila and Koskela, 1998).

Soil, water and air quality are affected by the production and transport of construction materials, energy is used in significant quantities, noise is generated and various pollutants, such as deadly construction wastes and dust, are discharged into the environment (Arizona Department of Environmental Quality, 1996; Rohracher, 2001; DTI, 2006; Sev, 2009). Moreover, the degree of damage that occurs during the construction phase of a project affects environmental conditions during the operations and maintenance phases as well (Chen and Chambers, 1999; Drilling, 2003). The need to mitigate and prevent the negative effects of construction activity calls for the implementation of sustainable construction practices and the exercise of sound management principles (Pulaski and Horman, 2005).

A fair amount of progress has already been made on this front. Recently, 40% of US construction projects have been carried to completion in the design–build mode (Solomon, 2005), which shows that the role of constructors is being expanded. In other words, the efficiency of sustainable construction practices can be improved by bringing critical construction knowledge into design (Rohracher, 2001; Dahl et al., 2005; Riley et al., 2005). However, perhaps the most important factors in bringing about sustainability are awareness of the impact of non-sustainable construction on the environment and knowledge of how to deliver sustainability – during the construction phase as well as in building maintenance and operation – on the part of all the stakeholders in the life cycle of a building (Khalfan et al., 2003; Yue and Au, 2003; Myers, 2005; Shen et al., 2005). Without a solid understanding of sustainability concepts, constructors cannot deliver sustainability during the construction phase (Yue and Au, 2003; Myers, 2005; Shen et al., 2005).

2.4 Maximisation of resource reuse for sustainability

This practice is called "sustained yield," though timber companies and environmentalists disagree about how far the forest can be exploited and still be "sustainable’’. In the resource conflict, the industrialists must curb their profit-increasing tendency to increase timber yields, so as to ensure that enough of the forest remains to "reproduce" itself (Campbell, 1999).

To reduce the environmental footprint of buildings, new buildings need to use less energy in both their construction and operation than previous buildings of similar size and shape, while still providing a satisfactory indoor environment for their occupants. Numerous countries/regions have developed green building programs aimed at promoting more sustainable buildings. The LEED green building rating system encourages an integrated design approach, with a point scheme that allots credits for building design features deemed to improve sustainability, which includes reductions in energy use and improvements in indoor environment quality (Newsham, Mancini, and Birt, 2009).

2.5 Minimisation of resource consumption (Reduce)

In negotiation and conflict resolution (Glavovic, 1996), rather than pricing externalities, common ground is established at the negotiation table, where the conflicting economic, social, and environmental interests can be brought together. The other traditional strategy is to develop market mechanisms to link economic and environmental Green Cities, Growing Cities, and just Cities priorities. Prices are made the commonality that bridges the gap between the otherwise non-commensurable of trees and timber, open space and real estate. The market place is chosen as the arena where society balances its competing values.

Initiative of waste reduction from the Hong Kong government was the implementation of incentive schemes, the Joint Practice Notes 1& 2 (Jaillon, Poon, and Chiang, 2009), with Gross Floor Area (GFA) exemptions granted for building developments employing green and innovative building technologies and prefabrication such as balconies, sunshades, communal sky gardens and podium gardens, wider corridor/lift lobbies and non-structural prefabricated external walls. The objectives were to encourage the adoption of a holistic life cycle approach to planning, design, construction and maintenance; to maximise the use of natural renewable resources and recycled/green building materials; to minimise the consumption of energy; and to reduce construction and demolition waste, with such incentives, the benefits for developers are considerable, consisting of approval for an additional floor in most developments (Jaillon, Poon and Chiang, 2008).

2.6 Use of renewable and recyclable materials

The infrastructure such as buildings for housing and industry, and the facilities for handling water and sewage requires large amounts of construction materials. Since a large demand has been placed on the building material manufacturing industry especially in the last decade owing to the increasing population, there is a mismatch between demand and supply management of these materials. Hence to meet the continuously increasing demand, researchers are attempting to design and develop sustainable alternative solutions for the construction material. The increase in the popularity of using environmental friendly, low cost and lightweight construction materials in the building industry has brought about the need to investigate how this can be achieved by benefiting to the environment as well as maintaining the material requirements affirmed in the standards (Raut, Sedmake, Dhunde, Ralegaonkar, and Mandavgane, 2012).

A large demand has been placed on the building material manufacturing industry especially in the last decade owing to the increasing population that causes a chronic shortage of building materials. In order to meet ever increasing housing demand, there is an exponential need of production of construction materials like bricks, cement, aggregates, steel, aluminium, wood, cladding and partitioning materials (Madurwar, Ralegaonkar, and Mandavgane, 2013; Raut, Ralegaonkar, and Mandavgane, 2011)

Yet many construction materials can be recycled, including glass, aluminium, carpet, steel, brick, and gypsum. Construction and renovation waste can be reduced by salvaging, rather than landfilling, including items that have some remaining life, such as appliances, household goods, office equipment and furniture, and certain building materials (Augenbroe, Pearce, Guy and Kibert, 1998). Africa is considered a low risk area, as a result of availability of green building potentials in the zone, materials such as sun dried bricks, compressed earth blocks, lime stabilized earth blocks, laterite stones and pozzolana are sufficiently abundant but their use is so limited to have significantly increase global warming (Manu, Baiden-Amissah, Adobor, and Danquah, 2009). Lemougna, Melo, Kamseu and Tchamba, (2011), further explains the reduction of cement consumption through the use of more ecologically-friendly building materials such as earthen products (CEB, adobe or cut laterites) is thus an ideal way to protect our environment through the reduction of energy consumption and CO_2 emissions. The reduction of CO_2 is of upmost importance as this harmful gas contributes to global warming through greenhouse effect (Lemougna, Melo, Kamseu and Tchamba, 2011).

There are already many building products available today that are manufactured from recycled materials. For example, organic asphalt shingles contain recycled paper, and some shingles are made from re-manufactured wood-fibre. Cellulose insulation is manufactured from recycled newspaper. Alternative building materials can conserve resources, as well. Technologies that allow more efficient use of timber include stress-skin panels; engineered framing products, such as I-beams, glue-laminated products, and finger-jointed timber. These products allow for the use of "scrap" timber that might otherwise be landfilled, as well as the use of small-dimension wood. Timber and other products, such as windows, doors, cabinets, and appliances, can be salvaged when buildings are demolished or rehabilitated (Augenbroe, et al., 1998).

2.7 Protection of the natural environment from construction waste

According to Jaillon, Poon and Chiang (2008), Construction and demolition (C& D) material, or construction waste, is a mix of inert and non-inert materials from construction, excavation, renovation, demolition and roadwork. Construction waste is divided into two major categories: inert materials (soft and hard inert materials) and non-inert waste. In recent years, the soft materials (such as soil, earth and slurry) have accounted for about 70% of all construction waste and can only be reused as fill materials in renovation and earth filling works. The hard materials (such as rocks and broken concrete) represent about 12–15% of all construction waste and can be reused in renovation works and or recycled for construction work as coarse materials, drainage bedding layers and concrete application (Jaillon, Poon and Chiang, 2008).

Most decision-making models include a step where the various alternative solutions to a problem are evaluated and ranked according to some predetermined criteria. In environmental decision making, this step is usually covered by an environmental impact assessment (EIA). EIAs are often used to gauge the impact of construction projects or activities on the environment (Black 1981; Canter 1983; Clark 1981; Munn 1983). Disposal of waste in landfills has led to extensive amounts of air, water and soil pollution due to the production of CO_2 and methane from anaerobic degradation of the waste (Yuan et al., 2013; Lu and Tam, 2013).

Old C&D landfills are quickly being filled, and space for new ones is growing scarce. New knowledge about the toxicity of certain construction materials (such as treated timber) has caused a marked increase in C&D landfill tipping fees. Meanwhile, both the construction industry and the public are growing increasingly more concerned about raw material shortages and the impact of everyday activities on our environment (Gavilan, and Bernold, 1994).

In spite of these alarming conditions, very little detailed knowledge currently exists about the origins and distribution of construction wastes. The combination of these factors warrants that present waste-management methods in construction be re-evaluated. More important, the origins of construction wastes should be studied to determine the most effective methods for dealing with these wastes at their source. Although construction managers must by necessity always attempt to optimize resources and thus minimize waste, construction-material wastes are not considered an important variable in the cost equation (Shen, Tam, Tam, and Ji, 2010). Part of the problem stems from the long-held perception that waste "is suggestive of something which has no value and which the junkman can take away--in other words, something which a company is willing to sell if it can get anything for it, but which, if not, it is willing even to pay somebody to haul away" (Leenders et al. 1990).

2.8 Healthy and non-toxic sustainability in construction projects

In 1987 the Brundtland Report identified the construction industry as consuming natural resources at an unsustainable rate, causing environmental damage to the earth (World Commission on Environment and Development, 1987). The promotion of sustainable construction practice is to pursue a balance among economic, social, and environmental performance in implementing construction projects. Sustainable construction practice refers to various methods in the process of implementing construction projects that involve less harm to the environment (i.e. prevention of waste production) (Ruggieri, Cadena, Martínez-Blanco, Gasol, Rieradevall, Gabarrell, Gea, Sort and Sánchez, 2009), increased reuse of waste in the production of construction material (i.e. waste management) (Asokan, Osmani, and Price, 2009,and Tam, 2009), beneficial to the society, and profitable to the company (Tseng, Lin and Chiu, 2009; Turk, 2009; Tam and Tam, 2006 and Tam, Tam, Zeng and Ng, 2007).

According to Shen, Tam, Tam, and Ji, (2010), Construction activities in those developing countries and regions, such as China, have caused particular concerns such as environmental pollution, resources waste, safety problems, and effects to the public interests also Griffith, Stephenson and Bhutto, (2005); and Hill and Bowen, (1997). It has been reported that these problems present fundamental barriers to implement the principles of sustainable development in developing countries such as China (Shen, Tam, Tam, and Ji, 2010; Shen, Wu Chan and Hao, 2005; Zeng, Tam, Deng and Tam, 2002). In fact, there is a close association among these problems and the ineffectiveness of the current practice in conducting project feasibility study (Shen, Tam, Tam and Ji, 2010).

Resource conservation and waste reduction are increasingly important factors of sustainable construction. Waste minimisation is a process which avoids, eliminates or reduces waste at its source or permits reuse/recycling of the waste for benign purposes (Guthrie and Mallett, 1995). Reduction at the source for new building construction involves both design concepts and building technology/materials selection (Poon and Jaillon, 2002).

2.9 Prefabrication as sustainable construction

Prefabrication has been identified as a solution to reduce waste arising during design and construction phases (Jaillon, Poon and Chiang, 2008). Prefabrication is a manufacturing process, generally taking place at a specialised facility where various materials are joined to form a component part of the final installation (Tatum et al., 1986; CIRIA, 1999). A hybrid of research methods are employed in the study, it is found that the waste generation rate in the upstream processes of offshore prefabrication is around 2% or lower by weight. This proves the orthodox that prefabrication in a factory environment is more conducive to waste reduction than the traditional cast in-situ construction manner. However, transporting the components adds cost and simultaneously increases the risk of waste generation (Lu and Yuan, 2013). It has been commonly recognized that benefits of using construction prefabrication include reductions in cost, time, defects, health and safety risks, and a consequent increase in quality, predictability, whole-life performance and profitability (Gibb, 1999; Sparksman et al., 1999; Housing Forum, 2002; Parry et al., 2003; Venables et al., 2004).

Studies (Poon and Jaillon, 2002; Poon et al., 2004; Osmani et al., 2006) confirmed that the major causes of waste during the design stage were the last minute change due to client's requirements and design changes. A major cause of waste during the construction phase was also the off-cuts from cutting materials. Prefabrication techniques involve both early decisions in the design process and significant reduction of on-site activities. Lawton; Moore; Cox; and Clark (2002), estimated a reduction of 70% in in-situ concreting by using volumetric prefabrication, as well as a reduction of 70% in building finishing works on-site. Poon; Yu and Chiang (2004) proved that timber formwork was the major contributor to construction waste in Hong Kong accounting for 30% of all identified waste. Also, wet trades of finishing work, such as screeding, plastering and tile laying represented about 20% of all identified waste.

It has been commonly recognized that benefits of using construction prefabrication include reductions in cost, time, defects, health and safety risks, and a consequent increase in quality, predictability, whole-life performance and profitability (Gibb, 1999; Sparksman et al., 1999; Housing Forum, 2002; Parry et al., 2003; Venables et al., 2004). They also investigated the sustainable construction aspects (i.e., environmental, economic and social benefits) of using prefabrication in dense urban environment by taking Hong Kong as an example (Jaillon and Poon, 2008). Specifically, they tried to quantify the waste reduction potential of using prefabrication in building construction in Hong Kong, and found that construction waste reduction is one of the major benefits when using prefabrication compared with conventional construction; the average wastage reduction level was reported to be approximately 52% when adopting prefabrication (Jaillon et al., 2009).

2.10 Social factors on sustainability

The definition of social sustainability that guides the research reported in this paper considers this concept as a series of processes for improving the health, safety, and well-being of current and future generations (Mihelcic et al. 2003; Herd-Smith and Fewings 2008; Dillard et al. 2009). The concept of well-being is subject to various interpretations: by some it is seen as a state of mind, by others as human capability or as the satisfaction of underlying needs (see Dodds, 1997). Despite the weak agreement over what human needs and well-being are about (and how confidently we can extend them to future generations), the concepts are central in the definition of sustainability as is highlighted by the definition of sustainable development given by the WCED (1987): 'Development which meets the needs of the present generation without compromising the ability of future generations to meet their own needs'. Previous research has provided some indicators related to these considerations (Kibert 1994; Hill and Bowen 1997; Guy and Kibert 1998; Pearce 1999; Trinius and Chevalier 2005; Gilchrist and Allouche 2005; Surahyo and El-Diraby 2009).

Since the Brundtland Report in 1987, there has been an increasing awareness that the construction industry must support the sustainable development vision by including social considerations throughout the entire construction project life cycle [International Council for Building (CIB) 1999; Vanegas 2003; Trinius and Chevalier 2005; Levitt 2007; Boyle et al. 2010; WCED 1987]. Generally, researchers describe social sustainability as the engagement among employees, local communities, clients, and the supply chain to ensure meeting the needs of current and future populations and communities (Herd-Smith and Fewings 2008), a definition that more fully reflects the different perspectives of the stakeholders of a project.

Community experts indicate that although these social benefits may be intangible to developers, they are as important as financial and environmental ones (Hammond and Peterson 2007; Hammer 2009). Because the concept of social sustainability is still evolving, this is an important time to begin defining the social sustainability processes that should be integrated during the planning and design phases of construction projects. However, attempting to create a model based solely on the previous literature will be limited by the individual bias of the researchers. The understanding of social sustainability processes could be enhanced by engaging experts in developing a general framework, a critical first step in creating awareness about this topic in construction projects (Valdes-Vasquez and Klotz, 2012).

2.11 Green building

Samari, (2012) believe that the role of governments in promoting green building is unquestionable and effective, rules and regulations should be replaced with imposing new ones to backing green building development. Governments can facilitate green building development by a range of instruments. However, there is an argument about the greatest effective and efficient instruments among the specialists and academics. Some studies stated that market base intensives are both effective and efficient tools to dealing with market failure together with non-market problems to advance the situation for green buildings development (Hoffman, and Henn, 2008). Shafii et al. (2006) point out that there are many obstacles to developing sustainable development in Asia such as: Lack of awareness , Lack of training and education about sustainable design, higher cost, special materials, rules and regulation, lack of demonstration, lack of technology and lack of demand. Reductions in the costs of green building components are paralleled by a steady reduction in the cost of green buildings in their entirety. Early studies showed construction cost premiums for LEED buildings that ranged from 0.66% for a LEED certified building to 6.50% for a LEED platinum building (Hoffman, and Henn, 2008). Another study found ranges from 0.8% for certified to 11.5% for platinum (Hoffman, and Henn, 2008). Green buildings were believed to have a “higher investment or construction cost than traditional buildings, on the order of 2 percent, or $2 to $5 per square foot” (Hoffman, and Henn, 2008).

Griffin, Knowles, Theodropoulos, and Allen, (2010) reported that the operation of buildings used 39% of the primary energy spent and produced 38% of the carbon dioxide released in the USA during 2006, these numbers exclude the important environmental impact of manufacturing building materials. Subject to the climate, type of construction and energy efficiency, the embodied energy1 of a commercial building can equal 2.6 to 4.9 years of operational energy (Griffin, et al. 2010) or 8 to 15% of the primary energy used in the USA. The carbon emissions emitted in the manufacture of building materials are also significant as the worldwide production of cement accounted for 4.2% of global carbon dioxide emissions in 2006 alone (Griffin, et al. 2010). The resource use and emissions from the building sector are a significant part of human activities that have been shown to contribute to global climate change, and even slight changes in climate could have potentially disastrous consequences for physical and biological systems on which humans rely (Griffin, et al. 2010).

2.12 Barriers to sustainable construction implementation

2.12.1 Barriers of sustainable construction in South Africa

Jacobs (2011) and Wilreker (2011) examine barriers for sustainable design and construction particularly in South Africa. These studies flag cost; lack of knowledge about sustainable practices; lack of knowledge about effects of non-sustainable practices in the environment; lack of training and education; availability / lack of availability of green resources; and attitude of professionals. The absence of a legislative instrument on sustainable development and political consideration – especially in public projects - in most developing countries remain a major barrier. Jacobs (2011) argues that the right policy formulation regulating the green building practice will drive construction professionals to utilize sustainable design principles on projects. Nielson et al. (2009) assert the need for improvements in the knowledge base of both architect and client alike, for positive impact on sustainable design and construction in the industry.

2.12.2 Barriers of sustainable construction in Canada

Kibert (2008) identified financial disincentives, inadequate research and lack of awareness and preference to traditional practices as the three main barriers that affects the construction of sustainable buildings. Richardson and Lynes (2007) in a case study at the University of Waterloo considers that internal leadership, unnamed goals that aim at sustainability, lack of recognition for environmentally sustainable projects and the lack of communication between designers and top management as the four main barriers that undermines the construction of green building in the university. They therefore suggest improving teamwork among employees responsible for construction works and establishing measureable goals on sustainability (Gyesi-Mensah, 2016).

2.12.3 Barriers of sustainable construction in Brazil

A similar study conducted in Brazil suggests that challenges to the adoption of sustainable buildings in higher education institutions include the lack of incentive to minimize building maintenance cost, unavailability of indicators for evaluating sustainable buildings, high initial capital cost, lack of commitment to environmental issues by construction professionals and ineffective communication among members of the institution. Others are employee empowerment, lack of technical norm for establishing a standard construction procedure for green buildings and cultural barriers as well as resistance to change (Kasai, and Jabbour, 2014).

The barriers to sustainable building are not every different in the South East Asian countries (Gyesi-Mensah, 2016). The lack of awareness, lack of training, education and ineffective procurement systems are key barriers in the region (Shafii, Ali and Othman, 2006).

2.12.4 Barriers of sustainable construction in Nigeria

Nigerian researches has also identified the lack of training and tools, lack of relevant laws and regulation, and lack of awareness as the three major barriers to sustainable construction among Nigerian corporate organizations (Ikediashi, Ogunlana, Oladokun, and Adewuyi, 2012). In view of the situation, Ikediashi et al. (2012) recommended that the Nigerian government pass eco-friendly bills empower regulatory bodies to enforce regulation on sustainable practices and create awareness on sustainability in a bid to promote sustainability in the Nigerian Construction Industry.

2.12.5 Barriers of sustainable construction in England

Williams, and Dair, (2007), Sustainable Building in England, barrier acting unsustainably: sustainability measure was not considered by stakeholders/ Sustainability measure was not required by client (includes purchasers, tenants and end users)/ Stakeholder had no power to enforce or require sustainable measure (in some cases it was the responsibility of the client or the contractor)/ One sustainability measure was forgone in order to achieve another (traded)/ Sustainable measure was restricted, or not allowed, by regulators/ The sustainability measure cost too much (in some cases the investor would not fund) / Site conditions mitigated against the use of a sustainable measure/ Inadequate, untested or unreliable sustainable materials, products or systems (including long term management problems)/ Sustainable measure was not available/ An unsustainable measure was allowed by the regulator or statutory undertaker (so no impetus for a sustainable alternative to be used)/ Stakeholder was not included, or was included too late, in the development process to implement sustainability measure/ Stakeholder lacked information, unawareness or expertise to achieve sustainable measure.

2.12.6 Barriers of sustainable construction in Ghana

The situation is not very different from the findings of studies undertaken in Ghana. A recent study conducted in Ghana to ascertain the challenges Ghanaian architects face in the use of sustainable strategies in building design identified the overall cost of energy alternatives, the overall client control on design and the overall client awareness of sustainable strategies as the top three major challenges preventing architects from to use sustainable design strategies in Ghana (Bangdome-Dery and Kootin-Sanwu 2013).

Djokoto, Dadzie, and Ohemeng-Ababio, (2014) in another study posit that in Ghana the key barriers to sustainable construction are the lack of demand for sustainable buildings, lack of strategy to promote sustainable construction, higher initial cost, lack of public awareness and lack of Government support. The Government should therefore initiate green policies and regulations and find innovative measures of stimulating demand for sustainable construction in Ghana (Djokoto et al. 2014). Gyesi-Mensah, (2016) confirms these findings by positing that the lack of Government commitment to green building, lack of legislation, lack of professional knowledge, cultural change resistance and perceived higher initial capital are the most critical challenges in implementing sustainable strategies in Ghanaian construction industry.

Some of the associated benefits of sustainable construction, which make it worth pursuing are competitive advantage, meeting legislative framework, company reputation, client value creation, meeting client demand, overall financial incentive, and good community relation (Othman, 2011; Suresh, Bashir and Olomolaiye, 2012; and Madu and Kuei, 2012).

2.12.7 Barriers of sustainable construction in United States of America

Previous studies further suggested that although there is current drive towards sustainable design and construction, its frequency of application and the scope of sustainability tools is still poor and not all encompassing respectively (Aye, 2003 and Kang & Guerin, 2009). Sustainable design and construction practices are often adopted for ethical reasons and to promote moral beliefs, although such practices raises construction costs in most cases, investors and construction firms considered it an obligation to the community (Tzschentke, Kirk, and Lynch, 2004).

2.13 Summary of literature review and findings

In summary; literature review aims to show the research gap of Sustainable construction practises and factors affecting the implementation during the Construction phase of building projects in Gauteng province.

Table 2.1: Summary of Barriers to Sustainable Construction practices

Number	Statement
1	Flag cost and lack of knowledge about sustainable practices (Jacobs, 2011) and (Wilreker, 2011).
2	Prefabrication as a substantial componentry ((Jaillon, Poon and Chiang, 2008)
3	Waste management as a sustainable construction practice reduces cost (Yuan et al., 2013; Lu and Tam, 2013).
4	Precast as sustainable construction practice at design stages ((Jaillon, Poon and Chiang, 2008)
5	Materials re-use on your projects as sustainable construction practice ((Newsham, Mancini, and Birt, 2009).
6	Effect cost of sustainable materials compared to normal (Djokoto, Dadzie, and Ohemeng-Ababio, 2014)
7	Materials recycle on your projects sustainable construction practice ((Newsham, Mancini, and Birt, 2009).
8	Misinterpretation of project scope (Kasai, and Jabbour, 2014).
9	The lack of demand for sustainable buildings (Williams, and Dair, 2007)
10	Lack of strategy to promote sustainable construction and higher initial cost (Jacobs, 2011) and (Wilreker, 2011).
11	One sustainability measure was forgone in order to achieve another (traded) (Williams, and Dair, 2007)
12	Sustainable measure was restricted, or not allowed, by regulators (Williams, and Dair, 2007)
13	The sustainability measure cost too much ((Kasai, and Jabbour, 2014).
14	Lack of training and education; of green resources; and attitude of professionals (Jacobs, 2011) and (Wilreker, 2011).
15	lack of training and tools, relevant laws and regulation, and lack of awareness (Jacobs, 2011) and (Wilreker, 2011).

Through careful review and studying of research papers written on the topic a lot of examples of sustainable construction practices and barriers were found to give an understanding also a meaning to the topic. This was further taken into country by country to find common issues or problem for the purpose bring the literature, Results and finding together later in the study. The table above also aid as a summary of the barriers findings found in different country throughout the world, which were then taken into account when the Questionnaire was formed. With all this information put together the research methodology as chosen which had to suit the condition and area chosen for the study which was Gauteng.

3 Research Design and Methodology

3.1 Research Design

The function of a research design is to ensure that the evidence obtained enables you to effectively address the research problem logically and as unmistakably as possible (Gorard, 2013; Vogt, Gardner, and Haeffe, 2012 and De Vaus, 2001). In social sciences research, obtaining information relevant to the research problem generally involves specifying the type of evidence needed to test a theory, to evaluate a program, or to accurately describe and assess meaning related to an observable phenomenon (Gorard, 2013; Vogt, Gardner, and Haeffe, 2012 and De Vaus, 2001).

With this in mind, a common mistake made by researchers is that they begin their investigations far too early, before they have thought critically about what information is required to address the study's research questions. Without attending to these design issues beforehand, the overall research problem will not be adequately addressed and any conclusions drawn will risk being weak and unconvincing. As a consequence, the overall validity of the study will be undermined (Gorard, 2013; Vogt, Gardner, and Haeffe, 2012 and De Vaus, 2001).

3.2 Research Methodology (Method)

The method section describes the rationale for the application of specific procedures or techniques used to identify, select, and analyse information applied to understanding the research problem, thereby, allowing the reader to critically evaluate a study’s overall validity and reliability (Kallet, 2004). The methodology section of a research paper answers two main questions: How was the data collected or generated? And, how was it analysed? The writing should be direct and precise and always written in the past tense (Kallet, 2004).

3.2.1 Quantitative Design

Quantitative research focuses on gathering numerical data and generalizing it across groups of people or to explain a particular phenomenon (Anderson, 2010; Merriam, 2009 and Denzin and Yvonna, 2000). A descriptive study establishes only associations between variables; an experimental study establishes causality (Babbie, 2010). Quantitative research deals in numbers, logic, and an objective stance. Quantitative research focuses on numeric and unchanging data and detailed, convergent reasoning rather than divergent reasoning (Muijs, 2010).Quantitative methods emphasize objective measurements and the statistical, mathematical, or numerical analysis of data collected through polls, questionnaires, and surveys, or by manipulating pre-existing statistical data using computational techniques (Anderson, 2010). Quantitative research focuses on gathering numerical data and generalizing it across groups of people or to explain a particular phenomenon (Anderson, 2010; Merriam, 2009 and Denzin and Yvonna, 2000).As a consequence, the results of quantitative research may be statistically significant but are often humanly insignificant (Babbie, 2010; McNabb, 2008 and Sign, 2007).

Quantitative data is more efficient and able to test hypotheses, but may miss contextual detail, uses a static and rigid approach and so employs an inflexible process of discovery (McNabb, 2008 and Sign, 2007). The development of standard questions by researchers can lead to "structural bias" and false representation, where the data actually reflects the view of the researcher instead of the participating subject; results provide less detail on behaviour, attitudes, and motivation (McNabb, 2008 and Sign, 2007).

Identification of obstacles to sustainable construction practices adoption while traditional design and construction focuses on cost, performance and quality objectives, sustainable design and construction adds to these criteria minimization of resource depletion, minimization of environmental degradation, and creating a healthy built environment (Kibert 1994). After a thorough review of these studies, 22 potential barriers to sustainable construction practices were adopted and identified in this study, as listed in table 2.1 at the end of chapter 2. This is a list of factors that are well detailed in previous research and therefore are more applicable. For example, cost of materials, lack of information, materials waste the three R's (Reduce, Reuse & Recycle), prefabrication and lack of awareness just name a few, are commonly acknowledged in the literature as crucial hurdles to the adoption and practices. Thus, the identification of the set of 22 potential barriers focused mainly on factors that have received considerable attention in previous studies conducted in different countries and contexts. Rowlinson (1988) argued that it is more appropriate to use well-known factors for a research study, as that would allow respondents to respond easily.

3.2.2 Construction of the questionnaire

The questionnaire consists of two sections: section 1 is made up of 3 questions and section 2 with 22 questions (Appendix B) and a cover letter. The questions are drawn from the literature review by careful reading and interpretation including the barriers listed on table 2.1.

- The cover letter provided the respondents with the objectives of the study and the confidentiality of their sourced information;
- Section 1 consisted of three (3) questions which cover the information of participant, experience of respondents with sustainable construction practices on projects within their organisations;
- Section 2 consisted of twenty two (22) questions which cover the effects of sustainable construction practices and the degree they pose on projects.
- An opportunity was provided to the respondents at the bottom end of the questionnaire to provide other significant factors of sustainable construction practices that they may have experienced, but are not listed in the questionnaire.

3.3 Data collection for Research

The survey questionnaires was sent to contractor either by email and some hand delivered due to none response in emailing. This sample method was developed by initially contacting the contracting organizations operating in South Africa, Gauteng province through CIDB data base. This process covered a wide range of organizational leadership and participants with direct experience and knowledge in sustainable construction. These leaders are responsible for promoting and implementing environmental, social and economic sustainability issues in their respective organizations. Even though there are variations in the job titles of the participants, all are responsible for driving forward the agenda relating to sustainable practices in construction project delivery in their organizations. To increase the response rate of the survey for this study, respondents were contacted by telephone to obtain personal emails before sending the surveys out; follow-up reminder e-mails was sent a weeks after the initial distribution. All questionnaires were held in confidentiality and recorded with participant permission was requested but refused.

Particular, stakeholders in the infrastructural development were sent a survey questionnaire in different entities like Construction contractors, Project managers, and Consultant organizations (including Engineers, BSc (QS and Architect)) with semi-structured questions which was sent to them by an e-mail.

3.3.1 Data Collection

The survey questionnaire is a logical technique of data collection based on a sample (Tan, 2011). It has been extensively used to pursue professional opinions in green building research (e.g. Wong et al., 2016; Shen et al., 2016). In this study, to investigate the criticality of various barriers to sustainable construction practices adoption, a survey questionnaire was carried out. The respondents were tasked to rate the criticalities of the 22 barriers in sustainable construction practices adoption using a four-point Likert scale (Poor, Average, Good and Excellent). To have a better understanding of the survey, a sample of the survey questionnaire was provided in Appendix K; the section on background information of respondents is excluded but they range from Project Manager, Contract Manager and Directors/ Owners as my population for the study.

Each participant was then provided with a covering letter to read and a confidentiality agreement to sign. A follow up telephone call was made for the questionnaires that were emailed to confirm that they received the survey questionnaire also are participating in the study and a follow up company visit due to lack of participation was employed in a form of semi-structured questionnaire. Each participant was asked about his/ her experience and perception of the numerous themes related to the phenomenon in the questionnaire.

Local companies that have been directly involved in the construction industry with sustainable construction practices in building projects in Gauteng province were approached from the CIDB rating grade 9-7 compared with grade 6 to identify the respondents. The initially identified respondents were asked to share information regarding other knowledgeable participants as well. Using this approach, a total of 217 Grade 9-7 GB companies was identified on the CIDB registration in Gauteng province with 13 on Grade 9; 54 on Grade 8 and 150 on Grade 7 but only 155 companies were contacted and 62 could not be reached, suspended or no response, 12 companies said they were not in the Building industry meaning 143 questionnaires were sent but only 17 respondents (individuals) returned the questionnaire filled.

Compared with a total of 211 Grade 6 GB Companies which were identified on the CIDB registration also in the Gauteng province with 142 contacted and 69 could not be reached; out of the all 142 companies: 77 was not interested plus 5 with no response / No answer including 20 company address and contact that does not exist leaving with 40 contacted and showed interest but only 26 respondents (individuals) returned the questionnaire filled. A total of 183 survey questionnaires were directed to collect responses from contractor, and developer companies.

Finally, 43 sets of questionnaires with valid responses were returned, yielding a 23% response rate. Although the sample size was relatively small, statistical analyses could still be performed because according to the commonly accepted rule, with a sample size of 30 or above, the central limit theorem holds true (Ott and Longnecker, 2010; Hwang et al., 2015). Moreover, because sustainable construction practices adoption have not been widely adopted in the construction market of South Africa specifically Gauteng province and resistance in companies also professionals, it is difficult to obtain a very large sample of experienced professionals.

Table 3.1: Respondent Profiles

Position	*Number*
Project Manager	20
Contract Manager	14
Directors/ Owners	9

The profiles of the respondents are shown in Table 3.1 above. The respondents consisted of 8 project managers, 6 contracts manager and 3 Directors or Owners compared to 12 project managers, 8 contracts manager and 6 Directors or Owners compared between companies on

CIDB Grade 9 – 7 and Grade 6 respectively. The information on Table 3.1 was obtained and established during answering of the questionnaires via emails and during the visit to companies as somewhere not responsive to emails.

3.3.2 Data Analysis Techniques

The quantitative approach technique involved a self-administered questionnaire representing construction organisations. This was to find out if these companies are sustainability conscious organisations, in that circumstance presumed to be companies with exceptional measure of integrity on matters of sustainability. In other words, the research problem is placed as central theme while concrete data (from questionnaire) was used to compare reflection and observation in order to capture a proper understanding of the research problem.

The survey questionnaire aspect of this study was conducted through a self-administered questionnaire in which it was assessing the reliability of scales in Cronbach's alpha technique as a popular method, which was sent to Construction Contractors in South Africa, Gauteng. Socio-economy and environmental concerns in South Africa have been well reported in the international media and academia. The questionnaires contain questions about companies' background, issues of sustainability in general, level of commitment and barriers to sustainable construction practice within the organisations. Defining the research questions represents one of the most important steps to be taken in any empirical study (Benbasat *et al.* 1987; Eisenhardt 1989; Mays and Pope 1995; Miles and Huberman 1994).

This study investigates the level of commitment and barriers to sustainable construction practice between Construction Contractors in South Africa. The research is supported by a review of extant literature to extract classification of variables in the relevant areas; and empirical survey using quantitative techniques. The study adopts the use of survey questionnaire in a quantitative technique setting of research to achieving overall strength. In other words, the research problem is placed as central theme while concrete data (from questionnaire) is used to compare reflection and observation in order to capture a proper understanding of the research problem. The survey questionnaire aspect of this study was conducted through a self-administered questionnaire to Construction Contractors in South Africa, Gauteng. Gauteng was chosen because it is one of the major metro cities for commercial activities in the country's sustainability in South Africa.

The questionnaires contain questions about companies' background, issues of sustainability in general, level of commitment and barriers to sustainable construction practice within the organisations. In that circumstance presumed to be companies with exceptional measure of integrity on matters of sustainability.

However, referencing to several projects does not represent the wider scenario to understand how far this concept has penetrated the industry, a survey was conducted among construction developers in South Africa focusing on their understanding on this subject matter and whether they have incorporate this knowledge within their current and past projects.

The progress in South Africa is discussed under several subheadings:

1. the level of knowledge and awareness of construction developers on the concept of sustainability and sustainable construction;
2. the application of sustainable concept; and
3. future outlook of this application in the construction industry.

To articulate the level of knowledge among project participants with regards to sustainability concept, the respondents was asked to rate their knowledge on this subject matter and what they perceived, based on their experience, the general population of project developers' level of understanding on this subject.

The purpose of this study is to contribute to the discourse on the topical issues of sustainability in the built environment by further examining the barriers hindering its full uptake by the stakeholders in infrastructural development in the South Africa. Within the construction context, the understanding of the barrier to sustainable design and construction, and the assessment of its possible enablers is of significance to sustainable development. The study further employs an interpretative paradigm to add to what is known about these issues. The collection, categorization and analysis of survey questionnaire and a review of the findings in relation to the literature, South Africa will lead to noticeable insights. The participants was be selected based on 'purposive sampling', as this is vital to the success of the survey questionnaire. Purposive sampling means that participants are selected according to a defining characteristic that makes them role players of the data needed for the study (Nieuwenhuis, 2007).

The selection of the most suitable data collection method depends largely on the intention of the research objectives and the type of data needed for the research. A questionnaire research technique was adopted to achieve the research aim.

3.4 Ethical Considerations

It is critical that ethical considerations are adhered to for the credibility of the study at every stage of the research (Cresswell, 2009), aligning the above recommendations the researcher addressed ethical issues as follows:

- Request permission and approval from the organisation being researched before the study can proceed;
- The participants will not be harmed or misled;
- The cover letter of the questionnaire will state clearly the participation in the survey is voluntary
- Participants will remain confidential and anonymous during the findings of the research.

Approval to conduct research was obtained from the construction companies and construction sites from Project Manager, Contract Manager and Directors/ Owners. The survey instrument will be developed based on research literature and questionnaires. The workers will be asked for participation, participants will be told that the objective of the research is to encourage the construction companies/organisations to implement sustainable construction practice and improve on the methods used to manage on sites, and also to build awareness.

At the commencement of the questions, each participant was reminded of the research problem and of the survey questionnaire processes. Each participant was a covering letter to read and a confidentiality agreement to sign, during this session a request to record was made to participants but was denied or smartly brushed off.

4 Results, Analysis and Findings

4.1 Introduction

In this chapter the researcher gives detail information of the data collected and how it was analysed. With the aid of tables and charts to enable good understand of the presentation and discussion. The population comprised the Building industry practitioners testing the knowledge and understanding of sustainable construction practices use in Gauteng province, South Africa. Since there was no sampling frame for this study, the sample was a nonprobability sample (Zhao et al., 2014). The nonprobability sampling technique can be utilized to acquire a representative sample (Patton, 2001).

4.2 Analysis of survey results

The aim of this study was to establish the most significant challenges facing the adoption of sustainable construction practices identified through literature and questionnaires. Respondents was tasked to rate the identified challenges from most significant to least significant factor. The statistical mean and standard deviation of the results is presented in a Table format. The absence of a legislative instrument on sustainable development and political consideration especially in public projects, in most developing countries remain a major barrier.

In summary the questions that needs to be answered in my study are those flagged in previous studies and my secondary research questions in Chapter two and below reinstated under item 4.3.1 few Research Questions and comparing these two see at which state South Africa is specifically the Gauteng province.

4.3 Data Analysis Techniques

4.3.1 Cronbach's alpha technique

One of the most popular methods for assessing the reliability of scales is Cronbach's alpha technique. Cronbach's alpha determines the average correlation or internal consistency among factors in a survey questionnaire to assess the questionnaire's reliability. The Cronbach's alpha coefficient (a) value ranges from 0 to 1 and can be used in describing the reliability of factors extracted from multipoint and/or dichotomous formatted scales or questionnaires

(Santos, 1999). The higher the value, the more reliable is the adopted scale of measurement. However, the general rule is that to conclude that the scale is reliable, the value must not be less than 0.70 (Nunnally, 1978).

Cronbach alpha is a measure of internal consistency; it is not a measure of unidimensionality and can't be used to infer unidimensionality. Danes,J.E. & Mann, O.K., 1984 Unidimensional measurement and structural equation models with latent variables. Multi-item measures, the internal consistency measure is the best reliability test, of the internal consistency measures, Cronbach's alpha is the most widely used.

Using the IBM SPSS 24 statistical software, the computed value for the 22 sustainable construction practise barriers was 0.867, indicating that the measurement using the five-point Likert scale was reliable at the 5% level of significance. Cronbach's alpha coefficient of reliability, an alpha of 0.7 is normally considered to indicate a reliable set of items (de Vaus, 2002).

The Research **Questions** are:

- How the current identified challenges of sustainable construction practices concepts influence build projects?
- What are the needs of contractors created on the implementation of environmental issues specifically on-site Construction Waste Management effect in build projects?
- How the key issues identified on-site Construction Waste Management effect in build projects?
- What are major barriers to practising sustainable construction practises and factor in building projects?
- How do professionals exchange of learning on sustainable construction practices within the South Africa construction industry?
- What is the role of learning institutes in encourage debate and exchange of learning on sustainable construction practices within the South Africa construction industry?
- What are the consequences of construction concrete wastage in the construction industry?
- Can construction waste and concrete be used for recycled, reduce or re-used in Building projects?

- What challenges are being faced in recycling wastages (foot print)?

4.4 Test of Research Questions

The tests on this research report was done to prove or test what previous studies said about the knowledge, implementation and impact of construction waste management and the use of prefabrication as sustainable construction practices in buildings projects but the focus was on South African construction industry. A questionnaire on construction waste management was directed to experienced professionals as previously stated, on recently completed building projects and on-going building projects.

4.4.1 Normality

A normality test is used to determine whether or not a sample data has been drawn from a normally dispersed population (within some tolerance). The Student's t-test and the one-way and two-way ANOVA require a normally distributed sample population as they are a sum of statistical tests. Most statistical tests depend on the idea of normality. Deviations from normality are called non-normality; makes the statistical tests inaccurate, so it is important to know if your data are normal or non-normal.

Tests that rely upon the assumption of normality are called parametric tests, this is just there is a chance that the underlying random variable of interest is distributed normally, or approximately so. Logically, the sum of a large number of independent random events may be understood as the result of normality. In statistics, normality tests are used to determine if a data set is well-modelled by a normal distribution and to compute how likely it is for a random variable underlying the data set to be normally distributed. The test rejects the hypothesis of normality when the p-value is less than or equal to 0.05. But failing the normality test allows you to state with 95% confidence that the data do not fit the normal distribution. Though passing the normality test only permits you to state no significant departure if normality was found.

Table 4.1: Tests of Normality

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
RQ1_1 Knowledge and Implementation	0.3	35	0	0.753	35	0
RQ2_1 Misinterpretation of project scope	0.193	35	0.002	0.877	35	0.001
RQ1_2 Prefabrication as a substantial componentry	0.213	35	0	0.864	35	0
RQ2_2 Exposure to experts in your profession	0.265	35	0	0.775	35	0
RQ2_3 Lack of Energy Efficient Design	0.22	35	0	0.88	35	0.001
RQ3_1 The data was not enough when the scope was defined	0.194	35	0.002	0.878	35	0.001
RQ3_2 Lack of skilled labour in sustainable construction practices	0.22	35	0	0.882	35	0.001
RQ1_3 Waste management as a sustainable construction practice reduces cost	0.211	35	0	0.87	35	0.001
RQ1_4 Precast as sustainable construction practice at design stages	0.223	35	0	0.802	35	0
RQ1_5 Materials re-use on your projects as sustainable construction practice	0.256	35	0	0.614	35	0
RQ1_6 Effect cost of sustainable materials compared to normal	0.227	35	0	0.854	35	0
RQ1_7 Materials recycle on your projects sustainable construction practice	0.218	35	0	0.869	35	0.001
RQ3_3 Pollution and Land use	0.257	35	0	0.824	35	0
RQ3_4 Commitment of construction firm/ organization	0.339	35	0	0.714	35	0
RQ2_4 Disagreements between the client and approved professional person	0.258	35	0	0.858	35	0
RQ2_5 Changes in design and specifications on-site	0.22	35	0	0.839	35	0

RQ2_6 Changes in drawings and specifications	0.272	35	0	0.781	35	0
RQ1_8 Environmental management	0.24	35	0	0.83	35	0
RQ2_7 Project procurement management	0.227	35	0	0.843	35	0
RQ3_5 Health and well-being	0.256	35	0	0.817	35	0
RQ3_6 Management of monitoring and controls process	0.239	35	0	0.799	35	0
RQ2_8 Poor budgeting process	0.19	35	0.002	0.881	35	0.001

a. Lilliefors Significance Correction

Both the Kolmogorov-Smirnov and Shapiro-Wilk are significant meaning data is not normally distributed, therefor **non-parametric test** was used hence the Mann Whitney U test and Kruskal Wallis H test which uses 0.05 for significances. Non-parametric statistics refer to a statistical system in which the data is not vital to fit a normal distribution, statistics uses data that does not rely on numbers, but rather a ranking or order of sorts. In statistics, the Mann–Whitney U test, is a non-parametric test of the insignificant hypothesis that it is equally likely that a randomly selected value from one sample will be less than or greater than a randomly selected value and they don't assume that your data follow a specific distribution. Non-parametric tests are used when your data don't meet the assumptions of the parametric test, especially the assumption about normally distributed data.

The Mann-Whitney U test is used to compare differences between two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed. In addition to the Mann-Whitney U, the Kruskal-Wallis H test used is a rank-based non-parametric test that can be used to determine if there are statistically significant differences between two or more groups of an independent variable on a continuous or ordinal dependent variable.

But find most the remaining results in the Appendix F, as l cannot be able to include all of them in the report but for more information and interest reading.

4.4.2 Reliability Test Instrument

Reliability: Cronbach's alpha coefficient of reliability, an alpha of 0.7 is normally considered to indicate a reliable set of items (de Vaus, 2002) base on item 4.3.1 Cronbach's alpha technique above. A measure is considered reliable if it would give the same result over and over again; let us explore in more detail what it means to say that a measure is reoccurring or constant. Reliability is consistency in extent that the repeatability or replicability of findings stability of measurement over time and validity is the quality or correctness of a measure; that it measures what it is supposed to measure. The reliability of a test refers to stability of measurement over time. Validity refers to the accuracy of an assessment whether or not it measures what it is supposed to measure. Even if a test is reliable, it may not provide a valid measure.

Below are the outcomes from the reliability tests conducted on all 22 questions with the Cronbach’s Alpha of 0.843 which is more than the (α) > 0.7 necessary for the test to be reliable. The Cronbach's alpha coefficient (α) value ranges from 0 to 1 and can be used in describing the reliability of factors extracted from multipoint and/or dichotomous formatted scales or questionnaires (Santos, 1999). According to Nunnally (1978), the higher the value, the more reliable is the adopted scale of measurement. However, the general rule is that to conclude that the scale is reliable; the value (α) must not be less than 0.70. But find most the remaining results are found in the Appendix E, as not all the results can be the report. The research report only reports on a few of them and there one’s with significant result and in relation with my primary and secondary question on the literature review as finding and conclusion will be drawn from these.

Table 4.2: Overall test results on all 22 Questions

Scale: OVERALL

Reliability Statistics

Cronbach's Alpha	**N of Items**
0.843	22

The Results is reliable, Cronbach's Alpha is > 0.7 (α =0.843, N = 22)

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
RQ1_1 Knowledge and Implementation	46.06	100.467	0.415	0.836
RQ2_1 Misinterpretation of project scope	45.14	99.773	0.367	0.838
RQ1_2 Prefabrication as a substantial componentry	45.54	98.667	0.500	0.833
RQ2_2 Exposure to experts in your profession	46.00	104.882	0.162	0.845
RQ2_3 Lack of Energy Efficient Design	45.11	100.869	0.339	0.839
RQ3_1 The data was not enough when the scope was defined	45.26	99.726	0.367	0.838
RQ3_2 Lack of skilled labour in sustainable construction practices	45.26	99.903	0.401	0.837
RQ1_3 Waste management as a sustainable construction practice reduces cost	45.49	98.198	0.496	0.833
RQ1_4 Precast as sustainable construction practice at design stages	45.69	102.751	0.310	0.840
RQ1_5 Materials re-use on your projects as sustainable construction practice	45.43	101.193	0.114	0.863
RQ1_6 Effect cost of sustainable materials compared to normal	45.66	99.408	0.512	0.833
RQ1_7 Materials recycle on your projects sustainable construction practice	45.34	99.173	0.384	0.837
RQ3_3 Pollution and Land use	45.57	98.605	0.453	0.834
RQ3_4 Commitment of construction firm/ organisation	46.20	101.518	0.426	0.836
RQ2_4 Disagreements between the client and approved professional person	45.37	98.829	0.530	0.832
RQ2_5 Changes in design and specifications on-site	45.66	98.526	0.518	0.832
RQ2_6 Changes in drawings and specifications	45.57	102.664	0.306	0.840
RQ1_8 Environmental management	45.83	95.970	0.645	0.827
RQ2_7 Project procurement management	45.63	96.476	0.526	0.831
RQ3_5 Health and well-being	45.74	96.197	0.536	0.831
RQ3_6 Management of monitoring and controls process	45.86	96.597	0.716	0.826
RQ2_8 Poor budgeting process	45.20	99.459	0.395	0.837

The Results is reliable, Cronbach's Alpha is > 0.7 (α =0.843, N = 22)

Table 4.3: Results Secondary Research Question (Objective #1)

Scale: RESEARCH QUESTION 1

Reliability Statistics

Cronbach's Alpha	N of Items
0.718	8

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
RQ1_1 Knowledge and Implementation	15.41	20.985	0.230	0.722
RQ1_2 Prefabrication as a substantial componentry	14.77	19.393	0.401	0.693
RQ1_3 Waste management as a sustainable construction practice reduces cost	14.85	17.818	0.616	0.652
RQ1_4 Precast as sustainable construction practice at design stages	14.97	19.341	0.519	0.677
RQ1_5 Materials re-use on your projects as sustainable construction practice	14.69	16.850	0.258	0.769
RQ1_6 Effect cost of sustainable materials compared to normal	14.90	19.884	0.382	0.697
RQ1_7 Materials recycle on your projects sustainable construction practice	14.62	17.506	0.520	0.666
RQ1_8 Environmental management	15.15	17.765	0.634	0.649

The Results is reliable, Cronbach's Alpha is > 0.7 (α =0.718, N = 8)

Table 4.4: Results Secondary Research Question (Objective #2)

Scale: RESEARCH QUESTION 2

Reliability Statistics

Cronbach's Alpha	N of Items
0.688	8

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
RQ2_1 Misinterpretation of project scope	15.93	13.404	0.357	0.664
RQ2_2 Exposure to experts in your profession	16.78	15.922	0.091	0.714
RQ2_3 Lack of Energy Efficient Design	15.88	14.676	0.219	0.695
RQ2_4 Disagreements between the client and approved professional person	16.13	13.343	0.541	0.625
RQ2_5 Changes in design and specifications on-site	16.30	12.933	0.521	0.624
RQ2_6 Changes in drawings and specifications	16.23	13.820	0.420	0.650
RQ2_7 Project procurement management	16.38	13.574	0.343	0.668
RQ2_8 Poor budgeting process	15.90	12.246	0.578	0.607

The Results is unreliable, Cronbach’s Alpha is > 0.7 (α =0.688, N = 8)

Table 4.5: Results Secondary Research Question (Objective #3)

Scale: RESEARCH QUESTION 3

Reliability Statistics

Cronbach's Alpha	N of Items
0.661	6

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
RQ3_1 The data was not enough when the scope was defined	10.29	7.362	0.502	0.573
RQ3_2 Lack of skilled labour in sustainable construction practices	10.37	8.138	0.417	0.609
RQ3_3 Pollution and Land use	10.61	7.494	0.509	0.571
RQ3_4 Commitment of construction firm/ organisation	11.37	10.238	0.098	0.697
RQ3_5 Health and well-being	10.88	8.410	0.284	0.662
RQ3_6 Management of monitoring and controls process	11.00	8.150	0.559	0.569

The Results is unreliable, Cronbach's Alpha is > 0.7 (α =0.661, N = 6)

According to Table 4.4: Results Secondary Research Question (Objective #1) the results are reliable with a Cronbach's Alpha is < 0.7 (α =0.718, N = 8), but Table 4.5 and Table 4.6: Results Secondary Research Question (Objective #2 & 3) the results are reliable with a Cronbach's Alpha is > 0.7 (α =0.688, N = 8) and (α =0.661, N = 6) respectively. This then means the based on subgrouping the questions based on the Objectives as is on the tables only certain questions pass the reliability test but as is in Table 4.3 in all 22 question grouped the test is reliable with the results of Cronbach's Alpha is > 0.7 (α =0.843, N = 22).

4.4.3 Mann Whitney U test

These are some of the results from Mann Whitney U test which gave 0.05 or more significances during the test, but here different question is used and showed much significance moreover most test groups gave a significance of more than 0.05 only two gave 0.039 and 0.027 respectively. Also on this test there is no assumption of normality or ordinal scale data with only two groups of independent sample tested as per the test. But find the remaining results are found in the Appendix H, as not all the results can be the report. The research report only reports on a few of them and there one's with significant result and in relation with my primary and secondary question on the literature review as finding and conclusion will be drawn from these.

Table 4.6: Mann Whitney U test (Results 0.495significance)

RQ1_7 Materials recycle on your projects sustainable construction practice	
Mann-Whitney U	194.500
Wilcoxon W	347.500
Z	-0.682
Asymp. Sig. (2-tailed)	
Exact Sig. [2*(1-tailed Sig.)]	

The results shows a significance of 0.495 which is more than the 0.05 this yeilds significance between two variebles or questions used in a non-parametric test.

Table 4.7: Mann Whitney U test (Results 0.109significance)

RQ1_5 Materials re-use on your projects as sustainable construction practice	
Mann-Whitney U	159.000
Wilcoxon W	312.000
Z	-1.603
Asymp. Sig. (2-tailed)	
Exact Sig. [2*(1-tailed Sig.)]	

The results shows a significance of 0.109 which is more than the 0.05 or less that yeilds non-significance between two variebles or questions used in a non-parametric test.

Table 4.8: Mann Whitney U test (Results 0.936 significance)

RQ1_4 Precast as sustainable construction practice at design stages	
Mann-Whitney U	218.000
Wilcoxon W	569.000
Z	-0.080
Asymp. Sig. (2-tailed)	
Exact Sig. [2*(1-tailed Sig.)]	

The results shows a significance of 0.936 which is more than the 0.05 this yeilds significance between two varieb les or questions used in a non-parametric test.

Table 4.9: Mann Whitney U test (Results 0.431significance)

	RQ1_2 Prefabrication as a substantial componentry
Mann-Whitney U	191.000
Wilcoxon W	542.000
Z	-0.788
Asymp. Sig. (2-tailed)	
Exact Sig. [2*(1-tailed Sig.)]	

The results shows a significance of 0.431 which is more than the 0.05 this yeilds significance between two varieb les or questions used in a non-parametric test.

Table 4.10: Mann Whitney U test (Results 0.938significance)

	RQ1_3 Waste management as a sustainable construction practice reduces cost
Mann-Whitney U	218.000
Wilcoxon W	569.000
Z	-0.078
Asymp. Sig. (2-tailed)	
Exact Sig. [2*(1-tailed Sig.)]	

The results shows a significance of 0.938 which is more than the 0.05 this yeilds significance between two varieb les or questions used in a non-parametric test.

4.4.4 Kruskal Wallis- H test

These are some of the results from Kruskal Wallis H test, which gave 0.05 or more significances during the test, but the first shows results of less than the 0.05 significance which is 0.015. Here one set of question was mostly asked but tested under different or more than two groups of independent samples. The question mostly tested on was ‘’Do you feel that sustainable construction practices is widespread in the projects of your Company / Organisation?” and “The data was not enough when the scope was defined?” but the last questions was “*In your opinion how many percent of projects are impacted/influenced by sustainable construction practices*?” and “*Health and well-being*?”

The remaining results are found in the Appendix G, as not all the results can be the report. The research report only reports on a few of them and there one's with significant result and in relation with my primary and secondary question on the literature review as finding and conclusion will be drawn from these.

Table 4.11: Kruskal Wallis H test (Results 0.015 significance)

SUS_ORG Do you feel that sustainable construction practices is widespread in the projects of your Company / Organisation

		N	Mean Rank
RQ3_1 The data was not enough when the scope was defined	2 Disagree	6	7.08
	3 Neutral	20	15.43
	Total	26	

Test Statisticsa,b

	RQ3_1 The data was not enough when the scope was defined
Kruskal-Wallis H	5.967
Df	1
Asymp. Sig.	0.015

a. Kruskal Wallis Test
b. Grouping Variable: SUS_ORG Do you feel that sustainable construction practices is widespread in the projects of your Company / Organisation

The results shows a significance of 0.015 which is less than the 0.05 that yeilds non-significance between two variebles or questions used in a non-parametric test.

Table 4.12: Kruskal Wallis H test (Results 0.206 significance)

Ranks

SUS_ORG Do you feel that sustainable construction practices is widespread in the projects of your Company / Organisation

		N	Mean Rank
RQ3_1 The data was not enough when the scope was defined	2 Disagree	6	8.08
	4 Agree	14	11.54
	Total	20	

Test Statisticsa,b

	RQ3_1 The data was not enough when the scope was defined
Kruskal-Wallis H	1.597
Df	1
Asymp. Sig.	0.206

a. Kruskal Wallis Test
b. Grouping Variable: SUS_ORG Do you feel that sustainable construction practices is widespread in the projects of your Company / Organisation

The results shows a significance of 0.206 which is more than the 0.05 or less that yeilds non-significance between two variebles or questions used in a non-parametric test.

Table 4.13: Kruskal Wallis H test (Results 0.783 significance)

Ranks

SUS_ORG Do you feel that sustainable construction practices is widespread in the projects of your Company / Organisation

		N	Mean Rank
RQ3_1 The data was not enough when the scope was defined	2 Disagree	6	4.83
	5 Strongly Agree	3	5.33
	Total	9	

Test Statisticsa,b

	RQ3_1 The data was not enough when the scope was defined
Kruskal-Wallis H	0.076
Df	1
Asymp. Sig.	0.783

a. Kruskal Wallis Test
b. Grouping Variable: SUS_ORG Do you feel that sustainable construction practices is widespread in the projects of your Company / Organisation

The results shows a significance of 0.783 which is more than the 0.05 that yeilds significance between two variebles or questions used in a non-parametric test.

Table 4.14: Kruskal Wallis H test (Results 0.461 significance)

Ranks

SUS_ORG Do you feel that sustainable construction practices is widespread in the projects of your Company / Organisation

		N	Mean Rank
RQ3_1 The data was not enough when the scope was defined	4 Agree	14	9.39
	5 Strongly Agree	3	7.17
	Total	17	

Test Statisticsa,b

	RQ3_1 The data was not enough when the scope was defined
Kruskal-Wallis H	0.543
Df	1
Asymp. Sig.	0.461

a. Kruskal Wallis Test
b. Grouping Variable: SUS_ORG Do you feel that sustainable construction practices is widespread in the projects of your Company / Organisation

The results shows a significance of 0.461 which is more than the 0.05 that yeilds significance between two varieBles or questions used in a non-parametric test.

Table 4.15: Kruskal Wallis H test (Results 0.767 significance)

Ranks

PERC_PROJ In your opinion how many percent of projects are impacted/influenced by sustainable construction practices

		N	Mean Rank
RQ3_5 Health and well-being	3 50-69%	17	11.76
	4 70-89%	6	12.67
	Total	23	

Test Statisticsa,b

	RQ3_5 Health and well-being
Kruskal-Wallis H	0.088
Df	1
Asymp. Sig.	0.767

a. Kruskal Wallis Test

b. Grouping Variable: PERC_PROJ In your opinion how many percent of projects are impacted/influenced by sustainable construction practices

The results shows a significance of 0.767 which is more than the 0.05 that yeilds significance between two varieBles or questions used in a non-parametric test.

Frequency Tables and Charts

These are Tables and charts also arranged according to the three Research Objectives and are arranged to give clarity within the Primary and Secondary Research Questions. But find most the remaining results are found in the Appendix C; D and I, as not all the results can be the report. The research report only reports on a few of them and there one's with the comparing the result and in relation with my primary and secondary question on the literature review as finding and conclusion will be drawn from these.

Figure 4.3 below is a comparison in relation to responded companies between the two grades by number (Frequency) and percentages.

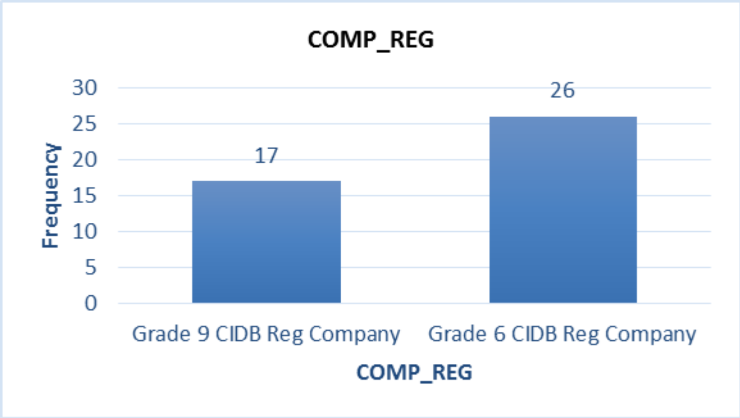

Figure 4.1: CIDB Grade 9 vs CIDB Grade 6 registered companies

The response of 17 on CIDB grade 9 with 26 on CIDB grade 6 but on the awareness its 31 on 12 that said no to the awareness.

Looking at question 2 below, 47% companies on CIDB grade 9 agreed with sustainable being widespread in their organisations with 35% remaining neutral and 20% disagreed compared with 32% agreeing but 56%remained neutral and 12% disagreed on CIDB grade 6 companies. This then means CIDB 9 companies are more aware and may be more involve of the concept of sustainable construction practises than those on CIDB 6.

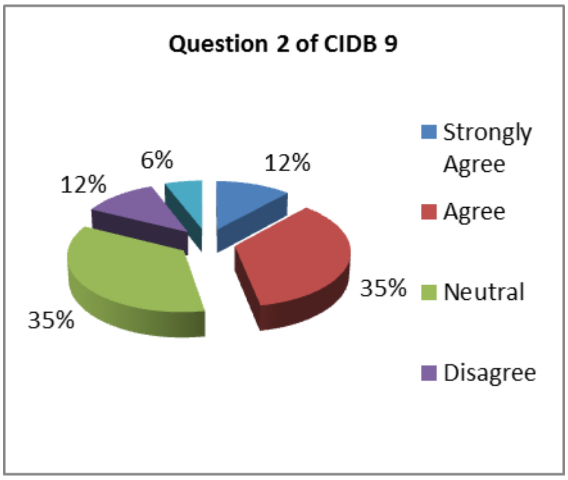

Figure 4.2: Percentages of responses based on Question 2 on CIDB 9

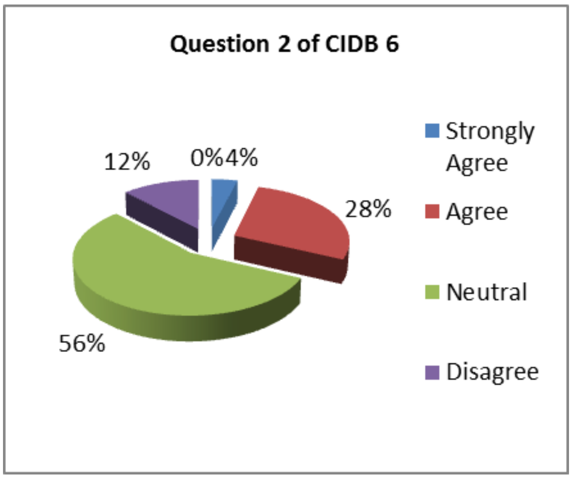

Figure 4.3: Percentages of responses based on Question 2 on CIDB 6

In questions 3 below also, the question in your own opinion ‘’how many percentage of projects are influenced by the concept’’ again 0 - 49% gave 35% with 50 – 100% well in 65% of the overall population on CIDB 9 companies compared with CIDB 6 scoring 44% on 0 – 49% influence and a 56% of 50-100% participation company involvement. This also shows that grade 9 companies are more involve and influence on the projects is considered or participants themselves are keeping up with the ever involving industry and are aware of what is happening.

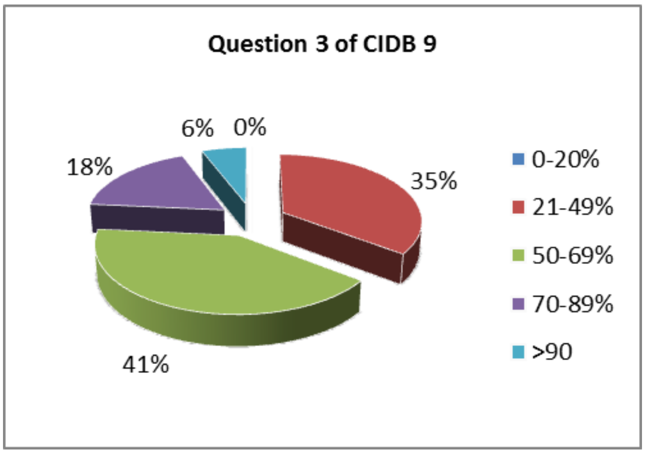

Figure 4.4: Percentages of responses based on Question 3 on CIDB 9

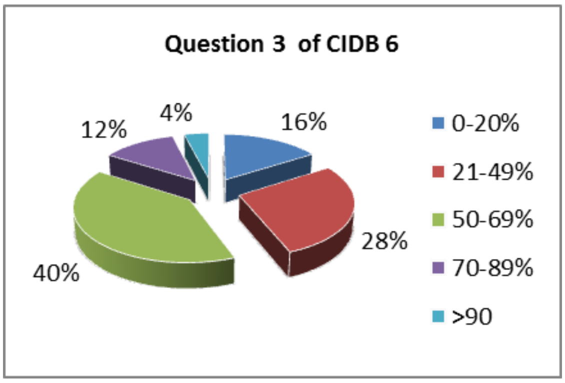

Figure 4.5: Percentages of responses based on Question 3 on CIDB 6

Chart below shows overall response based on question 1 of Section 1 in the questionnaire for all 43 despondence between CIDB 9 and 6.

Figure 4.6: Percentages of responses based on Question 1 of section 1

Chart below shows overall response based on question 2 of Section 1 in the questionnaire for all 43 despondence between CIDB 9 and 6

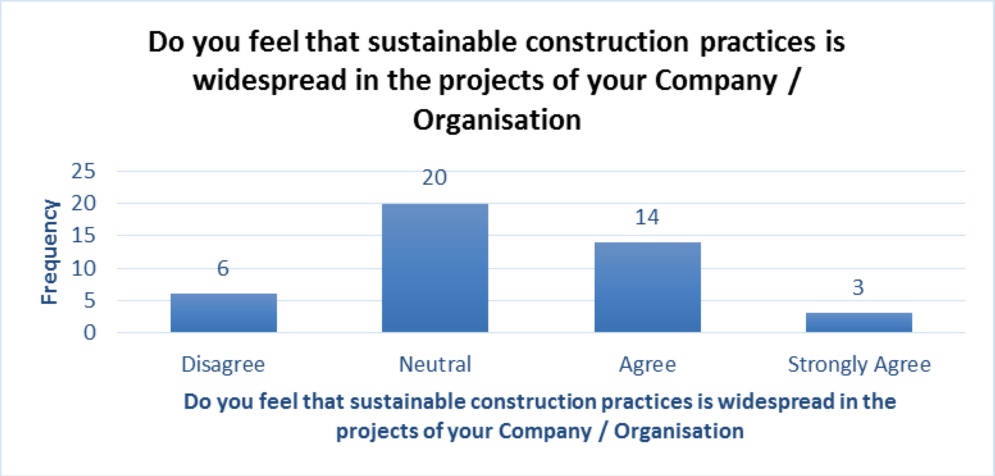

Figure 4.7: Percentages of responses based on Question 2 of section 1

Chart below shows overall response based on question 3 of Section 1 in the questionnaire for all 43 despondence between CIDB 9 and 6.

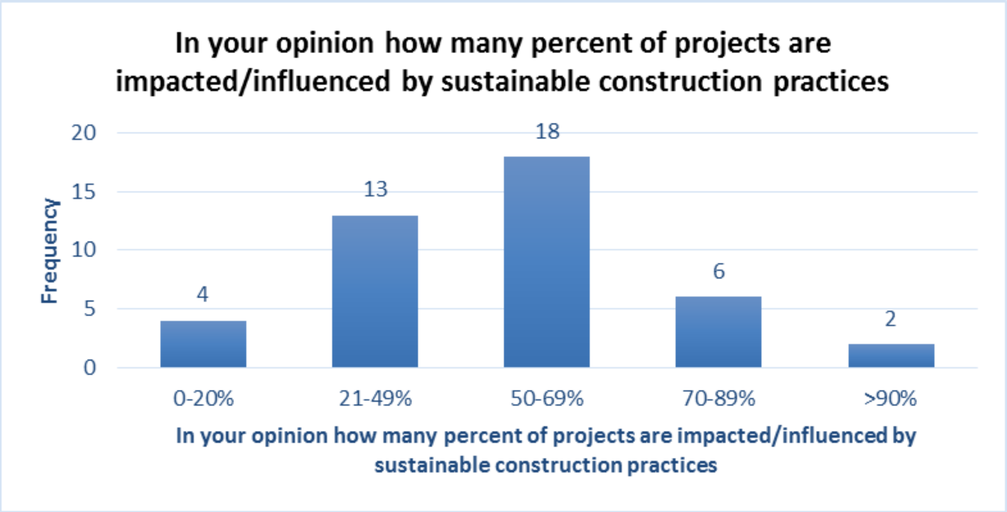

Figure 4.8: Percentages of responses based on Question 3 of section 1

Research Objective 1 - To identify the challenges of sustainable concepts in build projects and the need of contractors based on the implementation of environmental issues specifically on-site Construction Waste Management.

Chart below shows overall response based on question 1 of Section 2 in the questionnaire for all 43 despondence between CIDB 9 and 6, on these questions derived based on the objective.

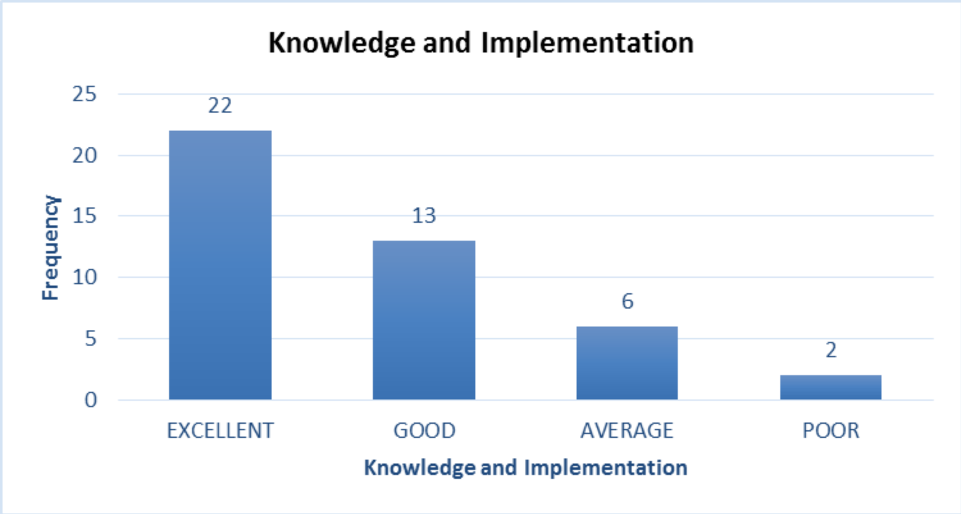

Figure 4.9: Percentages of responses based on Question 1 of section 2

Chart below shows overall response based on question 3 of Section 2 in the questionnaire for all 43 despondence between CIDB 9 and 6, on these questions derived based on the objective.

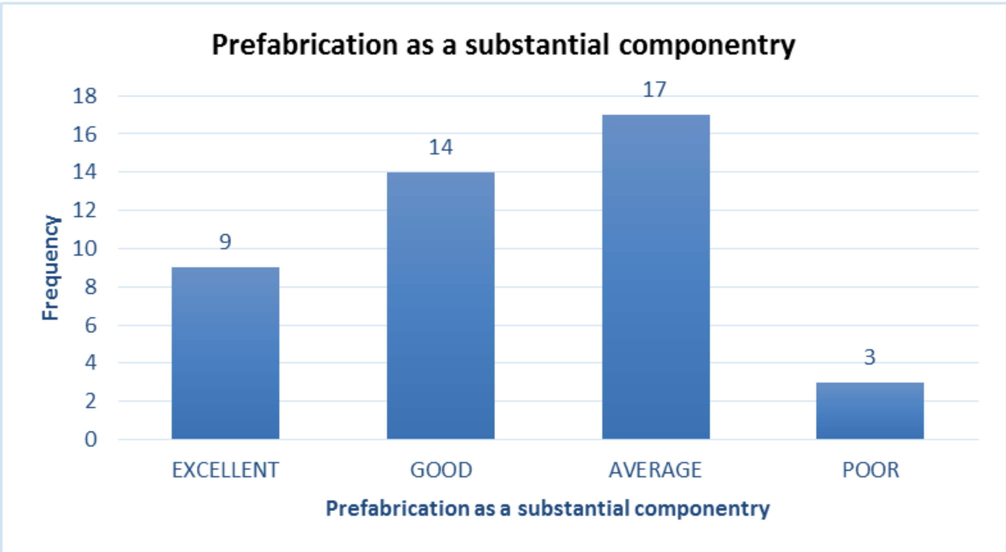

Figure 4.10: Percentages of responses based on Question 3 of section 2

Chart below shows overall response based on question 1 of Section 2 in the questionnaire for all 43 despondence between CIDB 9 and 6, on these questions derived based on the objective.

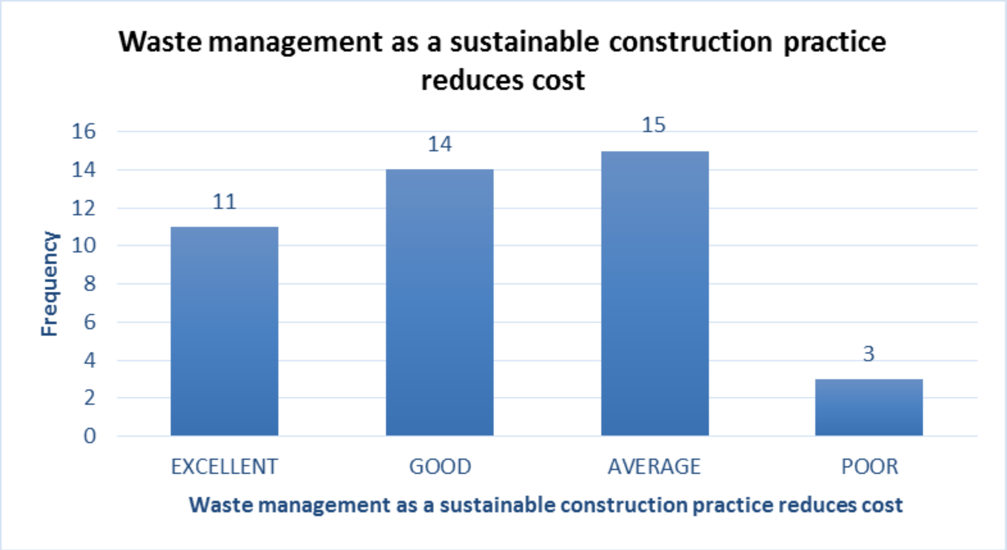

Figure 4.11: Percentages of responses based on Question 8 of section 2

Descriptive:

Chart below shows individual's response based on question selection under research objective 1 in the questionnaire for all 43 despondence between CIDB 9 and 6.

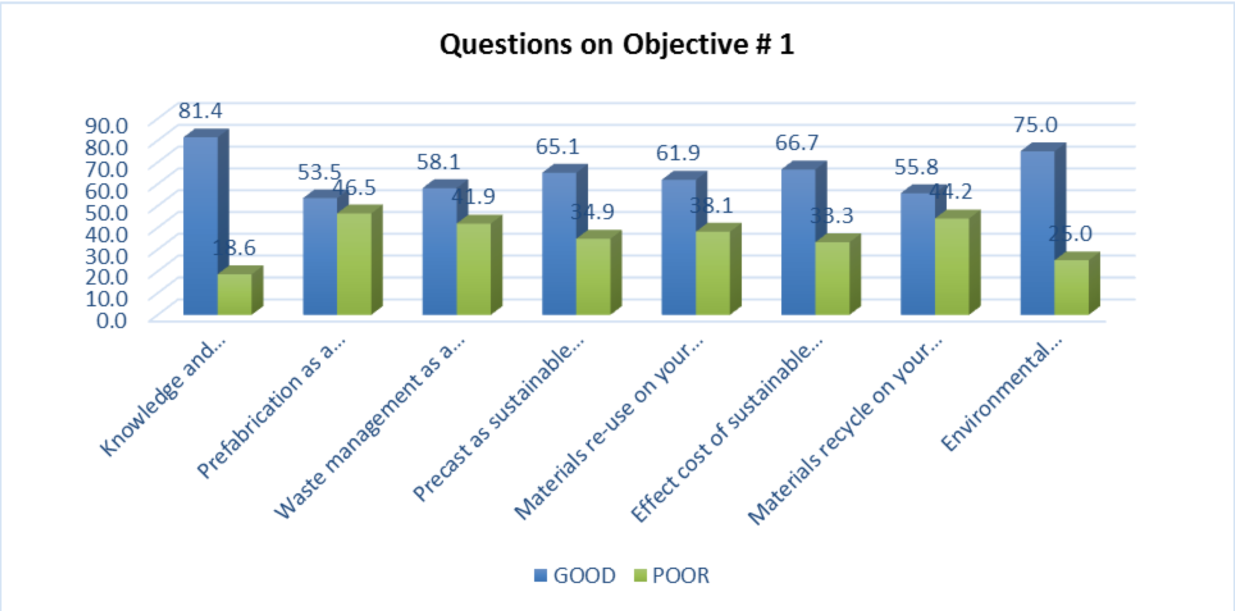

Figure 4.12: Comparison based on Objective 1

Research Objective 2 - To identify key issues; as well as the major barriers to practising sustainable construction practises.

Chart below shows individual's response based on question selection under research objective 2 in the questionnaire for all 43 despondence between CIDB 9 and 6.

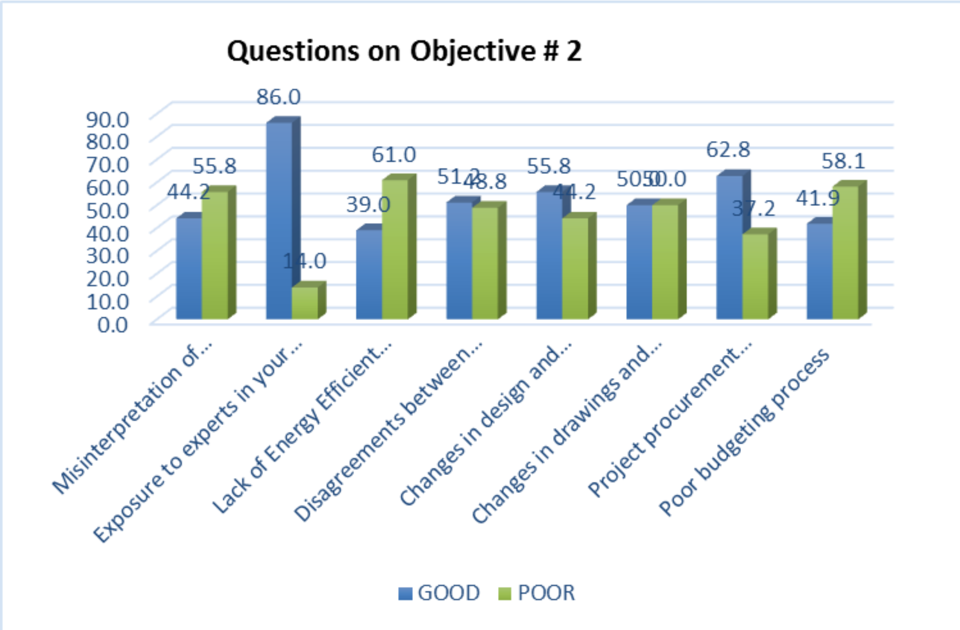

Figure 4.13: Comparison based on Objective 2

Table below shows individual's response based on question selection under research objective 2 in the questionnaire for all 43 despondence between CIDB 9 and 6.

Chart below shows overall response based on question 2 of Section 2 in the questionnaire for all 43 despondence between CIDB 9 and 6, on these questions derived based on objective 2.

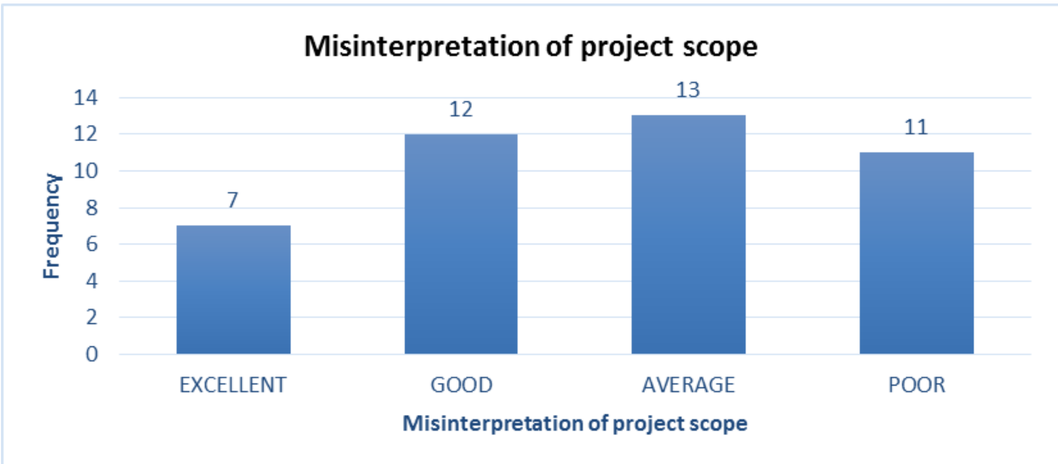

Figure 4.14: Percentages of responses based on Question 2 of section 2

Chart below shows overall response based on question 2 of Section 2 in the questionnaire for all 43 despondence between CIDB 9 and 6, on these questions derived based on objective 2.

Figure 4.15: Percentages of responses based on Question 4 of section 2

Chart below shows overall response based on question 5 of Section 2 in the questionnaire for all 43 despondence between CIDB 9 and 6, on these questions derived based on objective 2.

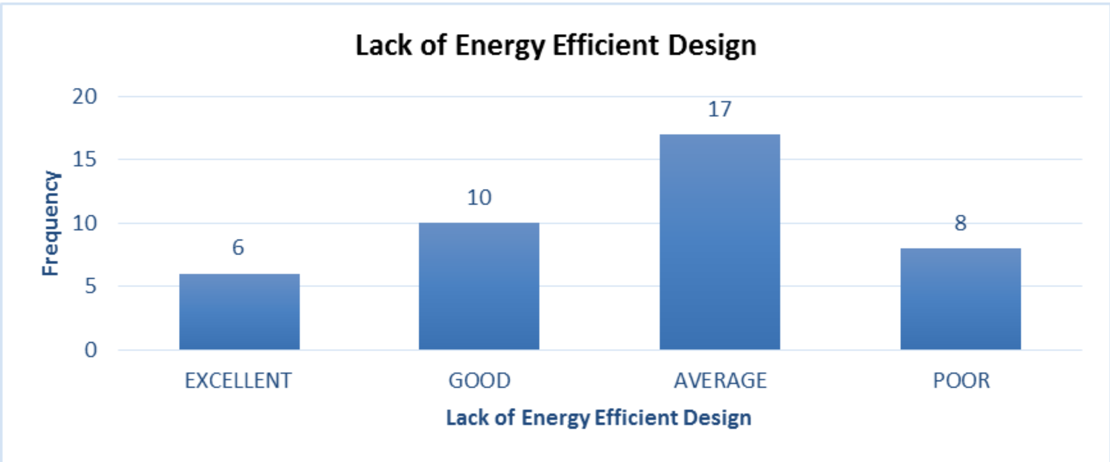

Figure 4.16: Percentages of responses based on Question 7 of section 2

Research Objective 3 - To **encourage debate** and the **exchange of learning** on sustainable construction practices within the South Africa construction industry.

Chart below shows overall response based on question 6 of Section 2 in the questionnaire for all 43 despondence between CIDB 9 and 6, on these questions derived based on objective 3

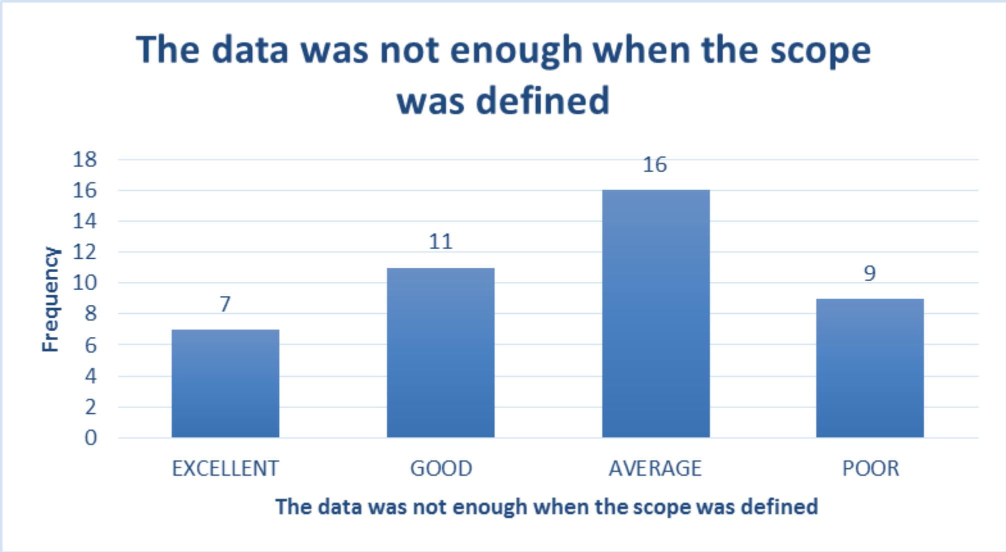

Figure 4.17: Percentages of responses based on Question 6 of section 2

Chart below shows overall response based on question 14 of Section 2 in the questionnaire for all 43 despondence between CIDB 9 and 6, on these questions derived based on objective 3.

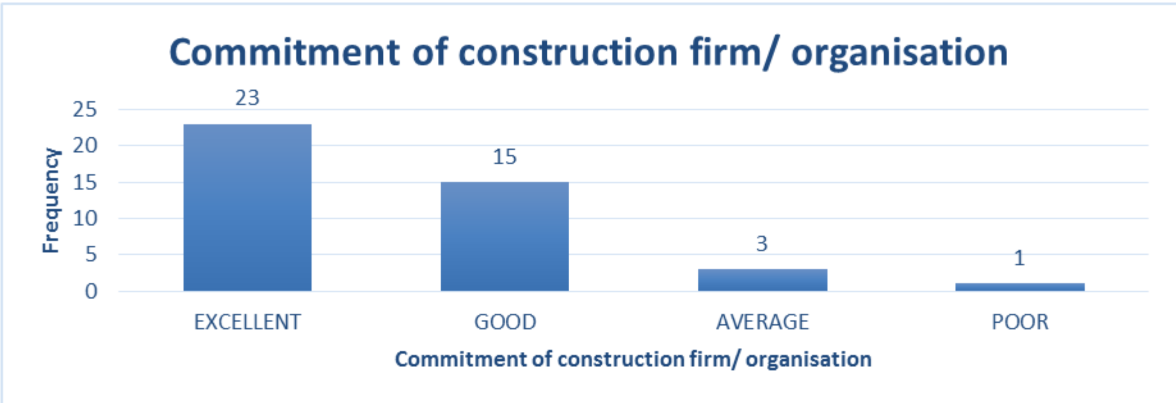

Figure 4.18: Percentages of responses based on Question 14 of section 2

Descriptive:

Chart below shows individual's response based on question selection under research objective 3 in the questionnaire for all 43 despondence between CIDB 9 and 6.

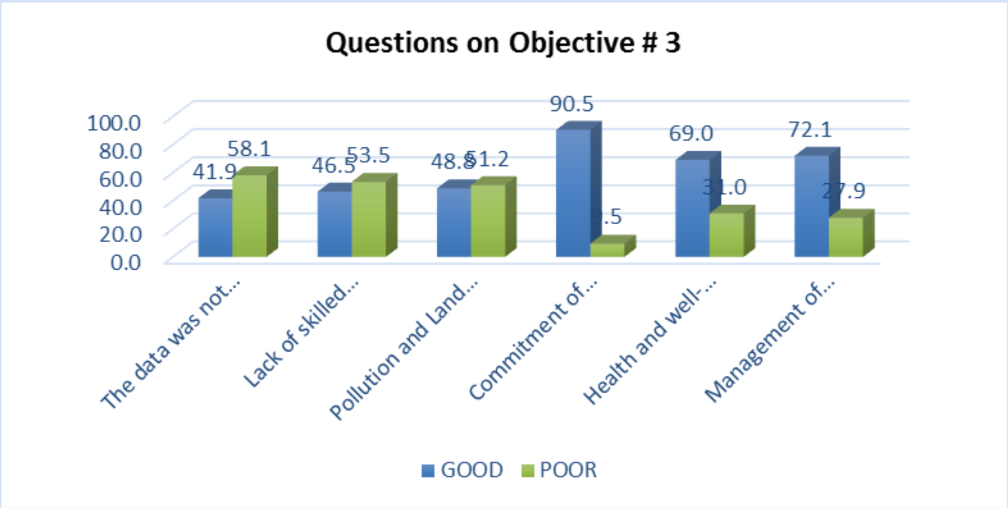

Figure 4.19: Comparison based on Objective 3

The results from the test done on this study shows a lot of similarities starting at Table 4.2: Tests of Normality with both the Kolmogorov-Smirnov and Shapiro-Wilk are significant meaning data is not normally distributed, therefor **non-parametric test** was used hence the Mann Whitney U test and Kruskal Wallis H test which uses 0.05 for significances. The outcomes from the reliability tests conducted on all 22 questions with the Cronbach's Alpha of 0.843 which is more than the (α) > 0.7 necessary for the test to be reliable thus rendering the results reliable. The Cronbach's alpha coefficient (α) value ranges from 0 to 1 and can be used in describing the reliability of factors extracted from multipoint and/or dichotomous formatted scales or questionnaires (Santos, 1999). Furthermore according to Table 4.4: Results Secondary Research Question (Objective #1) the instrument is reliable with a Cronbach's Alpha is < 0.7 (α =0.718, N = 8) based on these questions: Knowledge and Implementation; Prefabrication as a substantial componentry; Waste management as a sustainable construction practice reduces cost; Precast as sustainable construction practice at design stages; Materials re-use on your projects as sustainable construction practice; Effect cost of sustainable materials compared to normal; Materials recycle on your projects sustainable construction practice; Environmental management, but Table 4.5 and Table 4.6: Results Secondary Research Question (Objective #2 & 3) the instrument is reliable with a Cronbach's Alpha is > 0.7 (α =0.688, N = 8) and (α =0.661, N = 6) respectively.

These are some of the questions asked in previous studies which were also found to be part of the major barriers in the implementation of sustainable construction practices moreover these specific questions: Prefabrication as a substantial componentry; Waste management as a sustainable construction practice reduces cost; Precast as sustainable construction practice at design stages; Materials re-use on your projects as sustainable construction practice; Effect cost of sustainable materials compared to normal; Materials recycle on your projects sustainable construction practice are found again to be part thereof challenges.

4.5 Discussion of Findings

To achieve the objectives of the study, the survey questionnaires was sent to contractor either by email and some hand delivered due to none response in emailing. This sampling method was developed by initially contacting the contracting organizations also operating in South Africa, Gauteng province. These are the findings from the study observed also was that the main eight (8) barriers to the construction of sustainable buildings are Knowledge and Implementation, Prefabrication as a substantial componentry, Waste management as a reduces cost, Precast as sustainable construction practice at design stages, Materials recycle and re-use waste on your projects as sustainable construction practice. Others are Effect of cost of sustainable materials compared to normal construction, Environmental management, Exposure to experts in your profession and Commitment of construction firm/ organisation. Also noticed was that some contractors mentioned government involvement or funding into the practice of sustainable construction practices and Waste management; project feasibility, objectives of the project, Time; Quality & Cost for the project, Stakeholders involvement, knowledge to stand alone form implementation of Waste management, skilled labourer development, budget as a role player in decision making, integrated planning & management and post project implementation & efficient analysis.

5 Conclusions and Recommendations

5.1 Introduction

This research aimed to gain a better understanding of the challenges in the waste management process in Building projects by South African contractors particularly in Gauteng Province. Survey questionnaires was issued to employees of each participating contractor and documentary analysis, a series of findings has been generated to develop a better understanding of the challenges in waste management process in Building projects Gauteng province. This study was carried out with the aim of promoting the concept of constructing of sustainable building projects in the Gauteng Province, South African by contractors. The objectives were to assess the construction of sustainable buildings in particular Waste management, identify challenges faced by contractors in constructing sustainable buildings and suggest ways of promoting, debating and exchange of experience in sustainable construction practices in the buildings industry by South African contractors particularly in Gauteng Province. This chapter presents the conclusion and recommendations of the study.

5.2 Achievement of Research Objectives

The three objectives are tested and subjected into grouped questions to further explore by finding more option to achieve the objective. These are the test done Normality Test, Mann Whitney U, Kruskal-Wallis H, Reliability Test including charts and graphs and based on putting all questions in the Normality test they yield a positive results of $\alpha = 0.843$ with N = 22.

- To identify the challenges of sustainable concepts in build projects and the needs of contractors based on the implementation of environmental issues specifically on-site Construction Waste Management.

Based on the response from the participants and analysis of the responses this objective is fairly achieved also looking at Table 4.3 on page 43.

- To identify key issues; as well as the major barriers to practising sustainable construction practises.

Based on the response from the participants and analysis of the responses this objective is achieved also looking at Table 4.4 on page 44, these barriers are also recorded under Discussion of Funding on page 61.

- To encourage debate and the exchange of learning on sustainable construction practices within the South Africa construction industry.

Based on the response from the participants and analysis of the responses this objective is achieved also looking at Table 4.5 on page 45 including charts and tables.

5.3 General Conclusions

The following findings were established by the study from the Research Questions and from the conclusions will be drawn :

Secondary Research Questions

- What are the needs of contractors created on the implementation of environmental issues specifically on-site Construction Waste Management effect in build projects?

An attempt to answer this question was 51% of respondents said excellent with 30% good compared to 14% average and 5% that marked poor, this indicates most the 43 participants have the knowledge and implementation on the projects.

- How the key issues identified on-site Construction Waste Management effect in build projects?

This question indicates a low or negative response with most staying average 35% followed by 33% saying good with 26% excellent and 6% poor responses, here participants want to stay neutral.

- What are major barriers to precast as a component and factor in building projects?

This also question indicates a low or negative response with most staying average 40% followed by 33% saying good with 21% excellent and 6% poor responses, here participants want to stay neutral.

- How do professionals exchange of learning on sustainable construction practices within the Gauteng construction industry?

Answering this question gave 44% of respondents said excellent with 42% good compared to 9% average and 5% that marked poor, this also indicates most of the 43 participants have access to professionals and exchange learning about the concept in projects.

- Can construction waste be used for re-used in Building projects?

In answering this question gave an indication of 30% of despondence said excellent with 30% good compared to 28% average and 12% that marked poor, this indicates most the 43 participants do not receive well the use of re-using material or waste as material on the projects.

- What challenges are being faced in recycling wastages (foot print)?

This also question indicates a low response with most saying good 33% followed by 23% saying average compared with 23% excellent and 21% poor responses, here participants want to stay neutral with most answers around 20% in responses.

The following conclusions were established from the finding as mentioned in the above statement:

South Africa contractors particularly in the Gauteng province fail to adopt basics of sustainable construction practices in construction of buildings projects. Some of the responses received revealed that contractors and clients do not ensure sustainable construction is practices on site in their projects.
Also some the participants claimed that the buildings constructed are not energy efficient and do not provide suitable indoor green quality either uses environmentally friendly materials and resources.
The common eight (8) barriers to the construction of sustainable buildings are Knowledge and Implementation, Prefabrication as a substantial componentry, Waste management as a sustainable construction practice reduces cost, Precast as sustainable construction practice at design stages, Materials recycle and re-use on your projects as sustainable construction practice. Others are Effect of cost of sustainable materials compared to normal construction, Environmental management, Exposure to experts in your profession and Commitment of

construction firm/ organisation. Also noticed was that some contractors mentioned government involvement or funding into the practice of sustainable construction practices. This problem can be mitigated by engaging with all stakeholders involve increase dialogue thus creating awareness of such problem and practice as whole.

During the process of data collection the problems or barriers that l experience for grade 9 where quite different from those of grade 6. Grade 9 companies or participants were not easily willing to take part in the study especially on the phone more than any other barrier or reason like company not existing, not interested or in the construction business. On the other hand CIDB grade 6, l had to visit the companies from the beginning because some of the companies information was not available being contact details. Use of google or google earth with some companies registration address being in the residential area than being in the industrial as usual; meaning visiting the individuals at their homes being converted into businesses. The most challenging was not to find the house or the business moved with no forwarding address.

CIDB can do more to make sure that these companies are easy to find especially for Research purposes and put in place some mitigation processes for companies to up-date their contact information on the data base.

The paper concludes that the best way of encouraging sustainable construction practices is to introduce financial allowances for accomplishment of these practices by the government, review conditions of contract and contract specifications to make providing for sustainable requirements and educate staffs to create awareness of the need and benefit of sustainable construction practices in building projects.

5.4 Recommendations

Based on the conclusions of the study, the following recommendations are given;

1. Government should introduce a financial incentive program that will provide grants and support the initiative. Periodic assessment of the construction works of the industry is required to determine the extent to which sustainability is adopted thus proper waste management programmes.
2. South African contractors with good waste management systems and Waste management as a sustainable construction practice reduces cost, Precast as sustainable

construction practice at design stages, Materials recycle and re-use on your projects as sustainable construction practice can be reward within grants. One can believe that these contractors will be motivated to adopt sustainable construction practices if they are to benefit.

3. The standard conditions of contract and contract specification for building projects should be reviewed to include waste management plan components. The introduction of sustainable conditions of contract it binds contract parties to enforce sustainability.
4. Government of South Africa should organize sustainable construction practices training and workshops for professionals in the Building industry including all staff especially procurement departments as well as social-economic structures. Key to unlock and overcome the range of unawareness and misunderstanding of sustainability concept is Education including practicing professionals and places of higher learning.

Sustainability in the whole world today is a necessity that cannot be overstressed. There is the need for all stakeholders of the environment to be made aware of the threatening exhaustion of the world‘s limited resources. The government, state owned organizations, non-governmental organizations, private corporate bodies and every individual must evaluate the impact of their activities on the environment and government to formulate, proper regulate policies and agenda as well as a change of attitude to ensure a sustainable environment in the world.

5.5 Area of Further Studies

- How do professionals exchange of learning on sustainable construction practices within the South Africa construction industry?
- What is the role of learning institutes in encourage debate and exchange of learning
- What are the consequences of construction concrete wastage in the construction industry?
- Can construction waste and concrete be used for recycled, reduce or re-used in Building projects?

- What can government, state owned organizations, non-governmental organizations, private corporate bodies, religious bodies and every individual do to evaluate the impact of their activities on the environment and government to formulate policies and agenda as well as a change of attitude to ensure a sustainable environment in the world.

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APPENDICES

APPENDIX A: Skewness and Kurtosis

	Median	Skewness	Kurtosis
COMP_REG	2.00	-0.444	-1.893
PERC_PROJ In your opinion how many percent of projects are impacted/influenced by sustainable construction practices	3.00	0.228	0.007
SUS_PRACT_5YRS Have you experienced any sustainable construction practices in the projects you have worked on in the last 5 years	1.00	1.021	-1.006
SUS_ORG Do you feel that sustainable construction practices is widespread in the projects of your Company / Organisation	3.00	0.176	-0.317

	Median	Skewness	Kurtosis
RQ1_1 Knowledge and Implementation	1.00	1.030	0.229
RQ1_2 Prefabrication as a substantial componentry	2.00	-0.075	-0.842
RQ1_3 Waste management as a sustainable construction practice reduces cost	2.00	0.082	-0.946
RQ1_4 Precast as sustainable construction practice at design stages	2.00	-0.202	-1.221
RQ1_5 Materials re-use on your projects as sustainable construction practice	2.00	3.416	16.986
RQ1_6 Effect cost of sustainable materials compared to normal	2.00	0.224	-0.471
RQ1_7 Materials recycle on your projects sustainable construction practice	2.00	0.161	-1.198
RQ1_8 Environmental management	2.00	0.686	-0.487

	Median	Skewness	Kurtosis
RQ2_1 Misinterpretation of project scope	3.00	-0.160	-1.127
RQ2_2 Exposure to experts in your profession	2.00	1.061	0.899
RQ2_3 Lack of Energy Efficient Design	3.00	-0.300	-0.776
RQ2_4 Disagreements between the client and approved professional person	2.00	-0.130	-0.499
RQ2_5 Changes in design and specifications on-site	2.00	-0.071	-1.054
RQ2_6 Changes in drawings and specifications	2.50	-0.394	-1.012
RQ2_7 Project procurement management	2.00	0.380	-1.060
RQ2_8 Poor budgeting process	3.00	-0.210	-1.021

	Median	Skewness	Kurtosis
RQ3_1 The data was not enough when the scope was defined	3.00	-0.221	-0.950
RQ3_2 Lack of skilled labour in sustainable construction practices	3.00	-0.127	-0.792

RQ3_3 Pollution and Land use	3.00	-0.130	-1.283
RQ3_4 Commitment of construction firm/ organisation	1.00	1.276	1.569
RQ3_5 Health and well-being	2.00	0.594	-0.807
RQ3_6 Management of monitoring and controls process	2.00	0.083	-1.352

APPENDIX B: Frequency Tables

COMP_REG

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Grade 9 CIDB Reg Company	17	39.5	39.5	39.5
	2 Grade 6 CIDB Reg Company	26	60.5	60.5	100.0
	Total	43	100.0	100.0	

SUS_PRACT_5YRS Have you experienced any sustainable construction practices in the projects you have worked on in the last 5 years

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	31	72.1	72.1	72.1
	2 No	12	27.9	27.9	100.0
	Total	43	100.0	100.0	

SUS_ORG Do you feel that sustainable construction practices is widespread in the projects of your Company / Organisation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2 Disagree	6	14.0	14.0	14.0
	3 Neutral	20	46.5	46.5	60.5
	4 Agree	14	32.6	32.6	93.0
	5 Strongly Agree	3	7.0	7.0	100.0
	Total	43	100.0	100.0	

PERC_PROJ In your opinion how many percent of projects are impacted/influenced by sustainable construction practices

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 0-20%	4	9.3	9.3	9.3
	2 21-49%	13	30.2	30.2	39.5
	3 50-69%	18	41.9	41.9	81.4
	4 70-89%	6	14.0	14.0	95.3
	5 >90%	2	4.7	4.7	100.0
	Total	43	100.0	100.0	

RQ1_1 Knowledge and Implementation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	22	51.2	51.2	51.2
	2 GOOD	13	30.2	30.2	81.4
	3 AVERAGE	6	14.0	14.0	95.3
	4 POOR	2	4.7	4.7	100.0
	Total	43	100.0	100.0	

RQ2_1 Misinterpretation of project scope

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	7	16.3	16.3	16.3
	2 GOOD	12	27.9	27.9	44.2
	3 AVERAGE	13	30.2	30.2	74.4
	4 POOR	11	25.6	25.6	100.0
	Total	43	100.0	100.0	

RQ1_2 Prefabrication as a substantial componentry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	9	20.9	20.9	20.9
	2 GOOD	14	32.6	32.6	53.5
	3 AVERAGE	17	39.5	39.5	93.0
	4 POOR	3	7.0	7.0	100.0
	Total	43	100.0	100.0	

RQ2_2 Exposure to experts in your profession

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	19	44.2	44.2	44.2
	2 GOOD	18	41.9	41.9	86.0
	3 AVERAGE	4	9.3	9.3	95.3
	4 POOR	2	4.7	4.7	100.0
	Total	43	100.0	100.0	

RQ2_3 Lack of Energy Efficient Design

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	6	14.0	14.6	14.6
	2 GOOD	10	23.3	24.4	39.0
	3 AVERAGE	17	39.5	41.5	80.5
	4 POOR	8	18.6	19.5	100.0
	Total	41	95.3	100.0	
Missing	System	2	4.7		
Total		43	100.0		

RQ3_1 The data was not enough when the scope was defined

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	7	16.3	16.3	16.3
	2 GOOD	11	25.6	25.6	41.9
	3 AVERAGE	16	37.2	37.2	79.1
	4 POOR	9	20.9	20.9	100.0
	Total	43	100.0	100.0	

RQ3_2 Lack of skilled labour in sustainable construction practices

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	7	16.3	16.3	16.3
	2 GOOD	13	30.2	30.2	46.5
	3 AVERAGE	17	39.5	39.5	86.0
	4 POOR	6	14.0	14.0	100.0
	Total	43	100.0	100.0	

RQ1_3 Waste management as a sustainable construction practice reduces cost

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	11	25.6	25.6	25.6
	2 GOOD	14	32.6	32.6	58.1
	3 AVERAGE	15	34.9	34.9	93.0
	4 POOR	3	7.0	7.0	100.0
	Total	43	100.0	100.0	

RQ1_4 Precast as sustainable construction practice at design stages

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	10	23.3	23.3	23.3
	2 GOOD	18	41.9	41.9	65.1
	3 AVERAGE	15	34.9	34.9	100.0
	Total	43	100.0	100.0	

RQ1_5 Materials re-use on your projects as sustainable construction practice

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	13	30.2	30.2	30.2
	2 GOOD	13	30.2	30.2	60.5
	3 AVERAGE	12	27.9	27.9	88.4
	4 POOR	4	9.3	9.3	97.7

		Frequency	Percent	Valid Percent	Cumulative Percent
	11	1	2.3	2.3	100.0
	Total	43	100.0	100.0	

RQ1_6 Effect cost of sustainable materials compared to normal

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	9	20.9	21.4	21.4
	2 GOOD	19	44.2	45.2	66.7
	3 AVERAGE	12	27.9	28.6	95.2
	4 POOR	2	4.7	4.8	100.0
	Total	42	97.7	100.0	
Missing	System	1	2.3		
Total		43	100.0		

RQ1_7 Materials recycle on your projects sustainable construction practice

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	10	23.3	23.3	23.3
	2 GOOD	14	32.6	32.6	55.8
	3 AVERAGE	10	23.3	23.3	79.1
	4 POOR	9	20.9	20.9	100.0
	Total	43	100.0	100.0	

RQ3_3 Pollution and Land use

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	13	30.2	30.2	30.2
	2 GOOD	8	18.6	18.6	48.8
	3 AVERAGE	19	44.2	44.2	93.0
	4 POOR	3	7.0	7.0	100.0
	Total	43	100.0	100.0	

RQ3_4 Commitment of construction firm/ organisation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	23	53.5	54.8	54.8
	2 GOOD	15	34.9	35.7	90.5
	3 AVERAGE	3	7.0	7.1	97.6
	4 POOR	1	2.3	2.4	100.0
	Total	42	97.7	100.0	
Missing	System	1	2.3		
Total		43	100.0		

RQ2_4 Disagreements between the client and approved professional person

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	6	14.0	14.0	14.0
	2 GOOD	16	37.2	37.2	51.2
	3 AVERAGE	18	41.9	41.9	93.0
	4 POOR	3	7.0	7.0	100.0
	Total	43	100.0	100.0	

RQ2_5 Changes in design and specifications on-site

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	11	25.6	25.6	25.6
	2 GOOD	13	30.2	30.2	55.8
	3 AVERAGE	17	39.5	39.5	95.3
	4 POOR	2	4.7	4.7	100.0
	Total	43	100.0	100.0	

RQ2_6 Changes in drawings and specifications

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	9	20.9	21.4	21.4
	2 GOOD	12	27.9	28.6	50.0
	3 AVERAGE	20	46.5	47.6	97.6
	4 POOR	1	2.3	2.4	100.0
	Total	42	97.7	100.0	
Missing	System	1	2.3		
Total		43	100.0		

RQ1_8 Environmental management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	17	39.5	42.5	42.5
	2 GOOD	13	30.2	32.5	75.0
	3 AVERAGE	8	18.6	20.0	95.0
	4 POOR	2	4.7	5.0	100.0
	Total	40	93.0	100.0	
Missing	System	3	7.0		
Total		43	100.0		

RQ2_7 Project procurement management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	15	34.9	34.9	34.9
	2 GOOD	12	27.9	27.9	62.8
	3 AVERAGE	11	25.6	25.6	88.4
	4 POOR	5	11.6	11.6	100.0
	Total	43	100.0	100.0	

RQ3_5 Health and well-being

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	16	37.2	38.1	38.1
	2 GOOD	13	30.2	31.0	69.0
	3 AVERAGE	8	18.6	19.0	88.1
	4 POOR	5	11.6	11.9	100.0
	Total	42	97.7	100.0	
Missing	System	1	2.3		
Total		43	100.0		

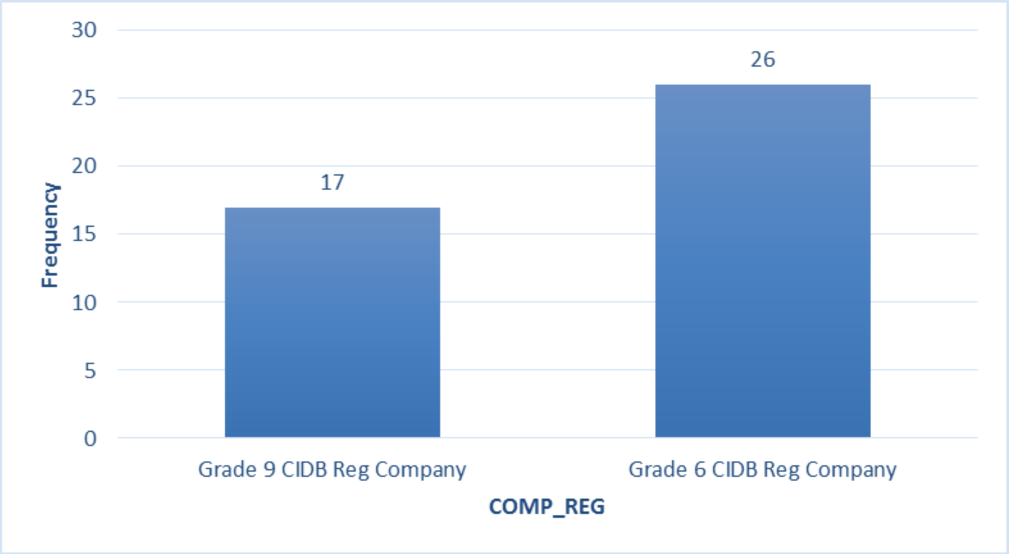
RQ3_6 Management of monitoring and controls process

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	14	32.6	32.6	32.6
	2 GOOD	17	39.5	39.5	72.1
	3 AVERAGE	12	27.9	27.9	100.0
	Total	43	100.0	100.0	

RQ2_8 Poor budgeting process

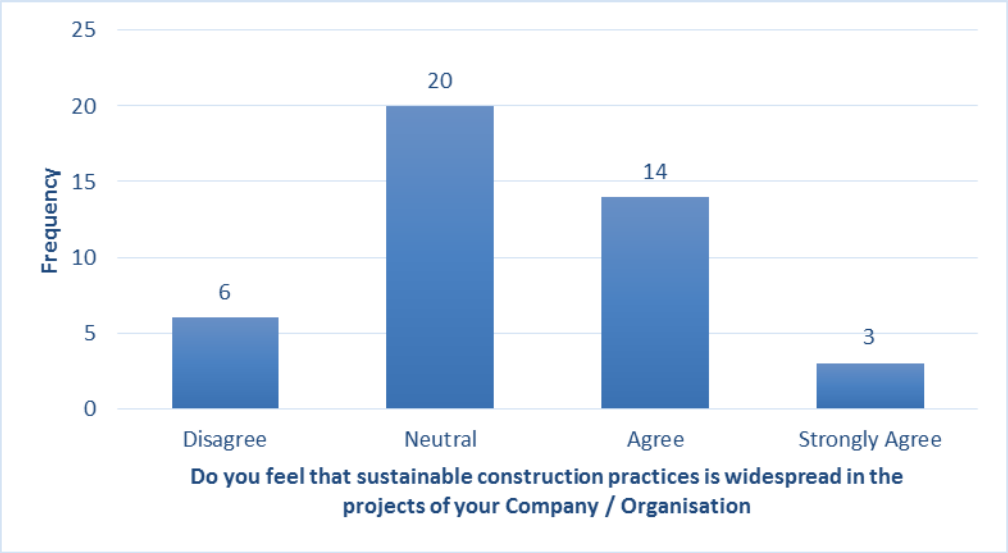
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 EXCELLENT	6	14.0	14.0	14.0
	2 GOOD	12	27.9	27.9	41.9
	3 AVERAGE	14	32.6	32.6	74.4
	4 POOR	11	25.6	25.6	100.0
	Total	43	100.0	100.0	

APPENDIX C: Charts

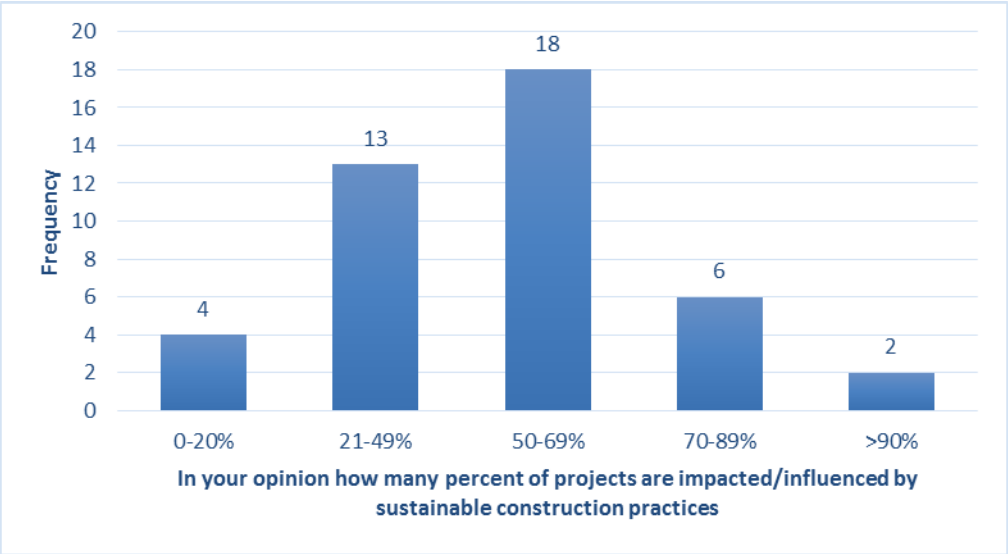


COMP REG

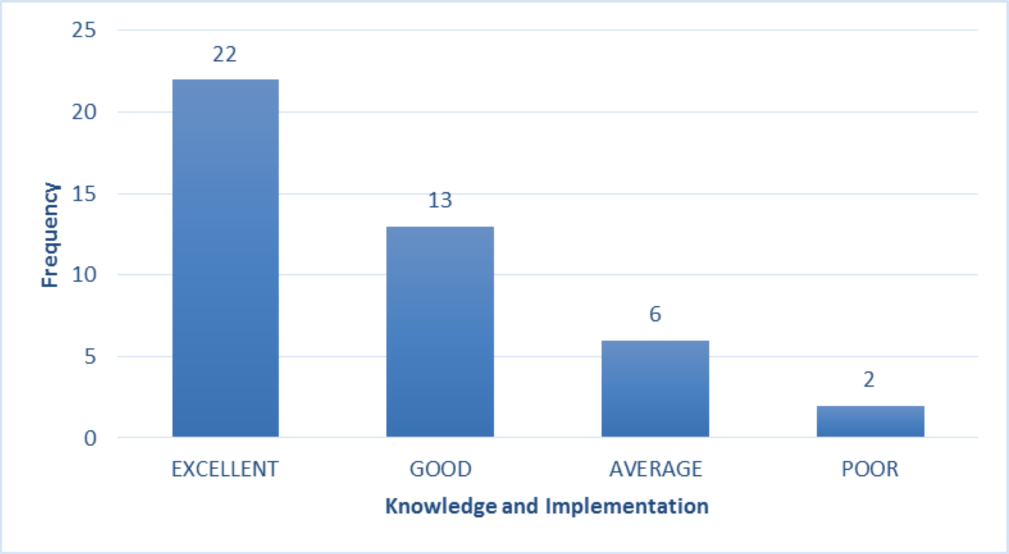
Have you experienced any sustainable construction practices in the projects you have worked on in the last 5 years



Do you feel that sustainable construction practices is widespread in the projects of your Company / Organisation

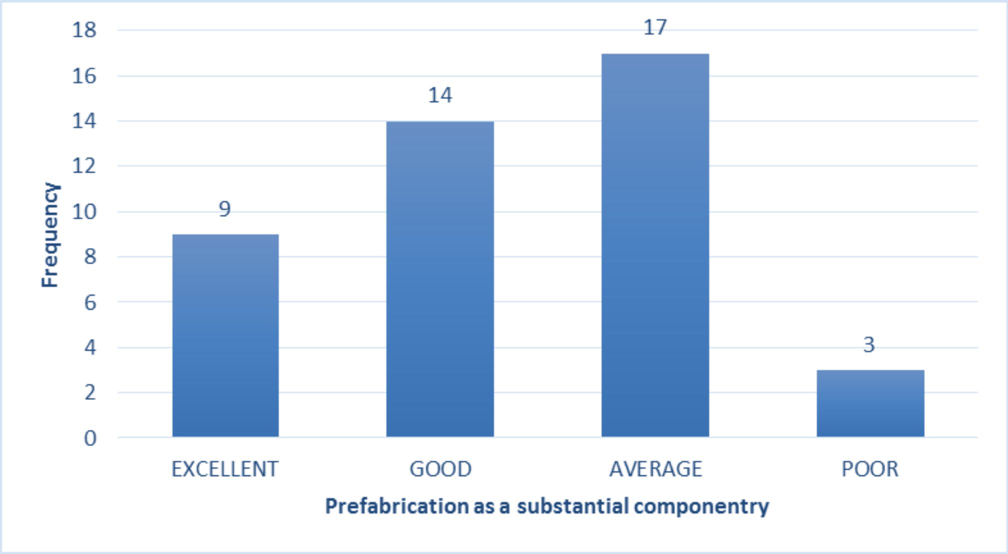


In your opinion how many percent of projects are impacted/influenced by sustainable construction practices

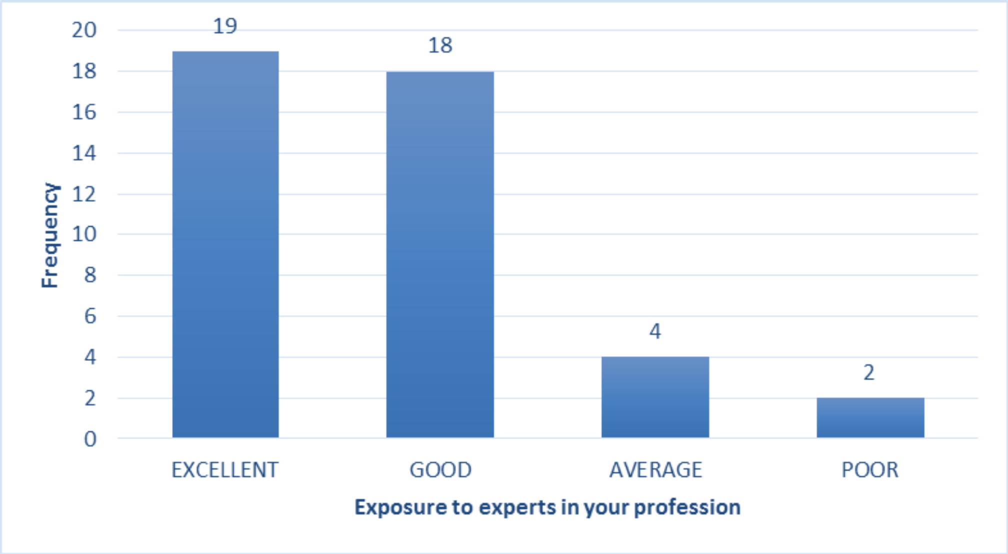


Knowledge and Implementation

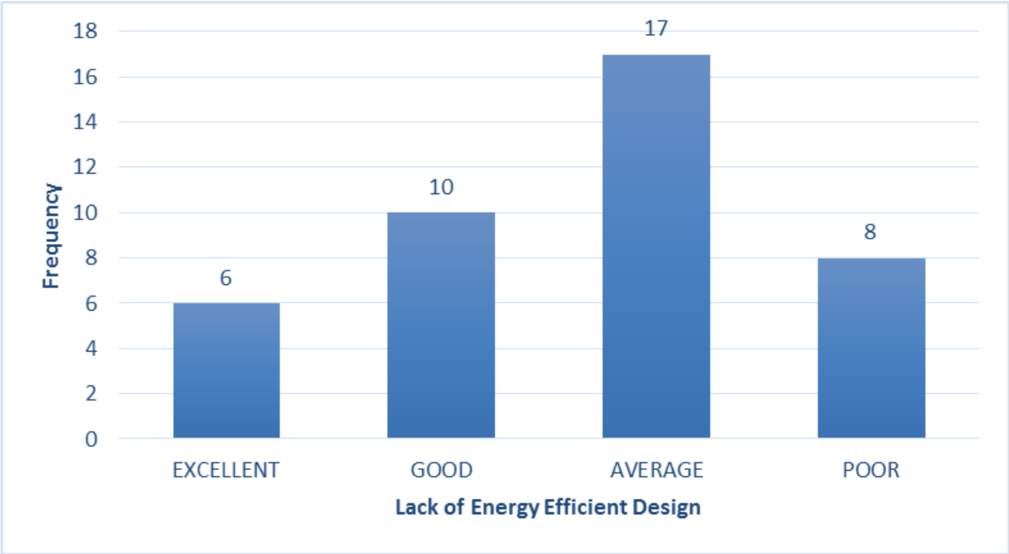
Misinterpretation of project scope



Prefabrication as a substantial componentry



Exposure to experts in your profession

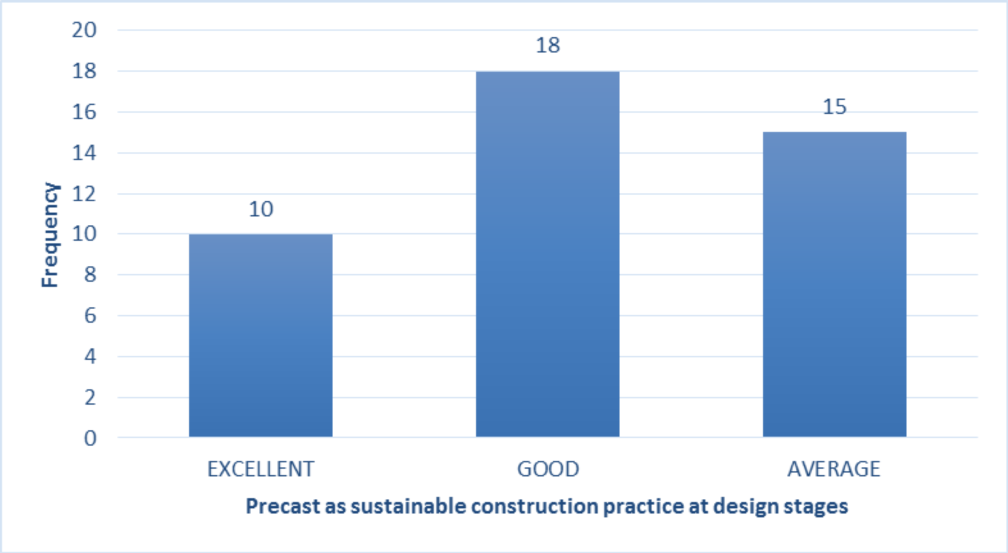


Lack of Energy Efficient Design

The data was not enough when the scope was defined

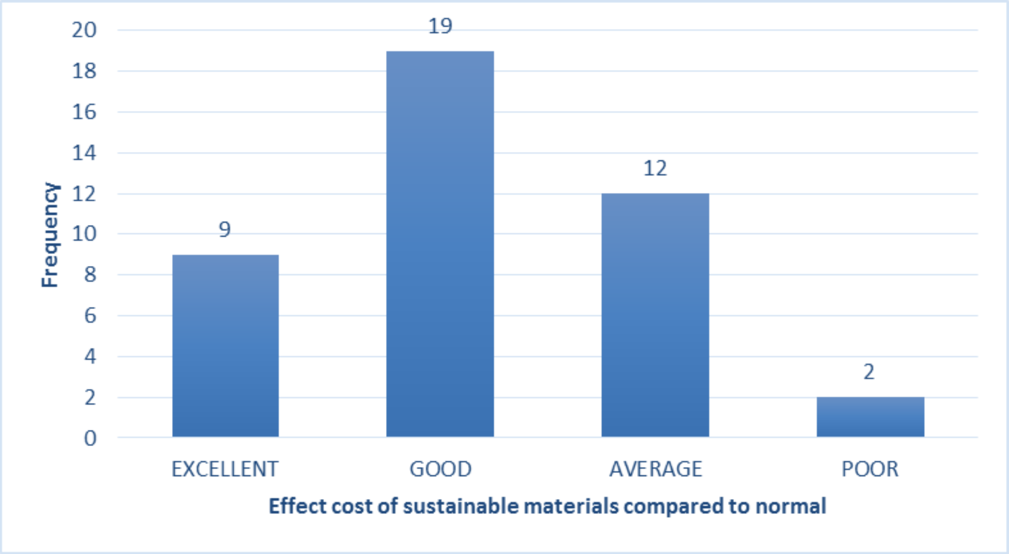
Lack of skilled labour in sustainable construction practices

Waste management as a sustainable construction practice reduces cost



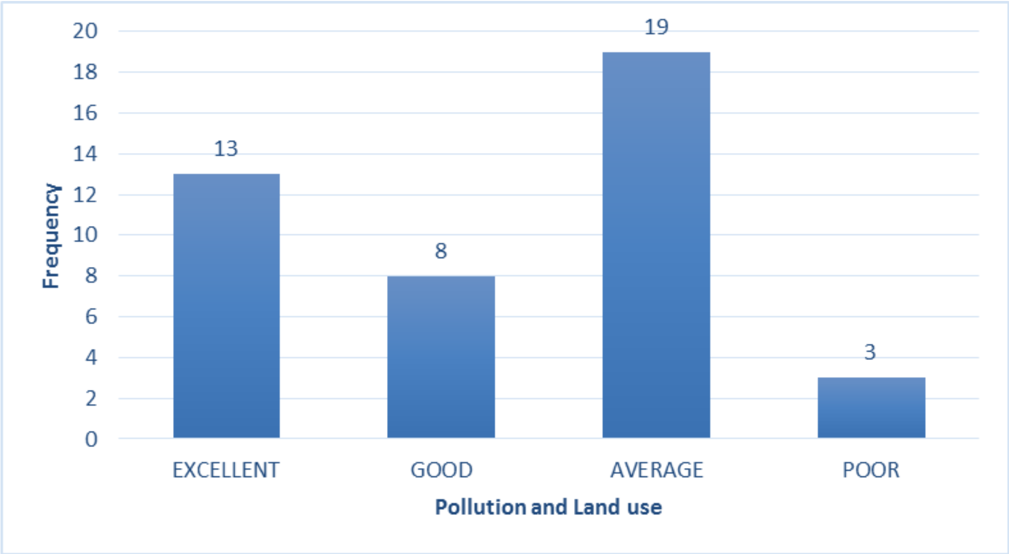
Precast as sustainable construction practice at design stages

Materials re-use on your projects as sustainable construction practice



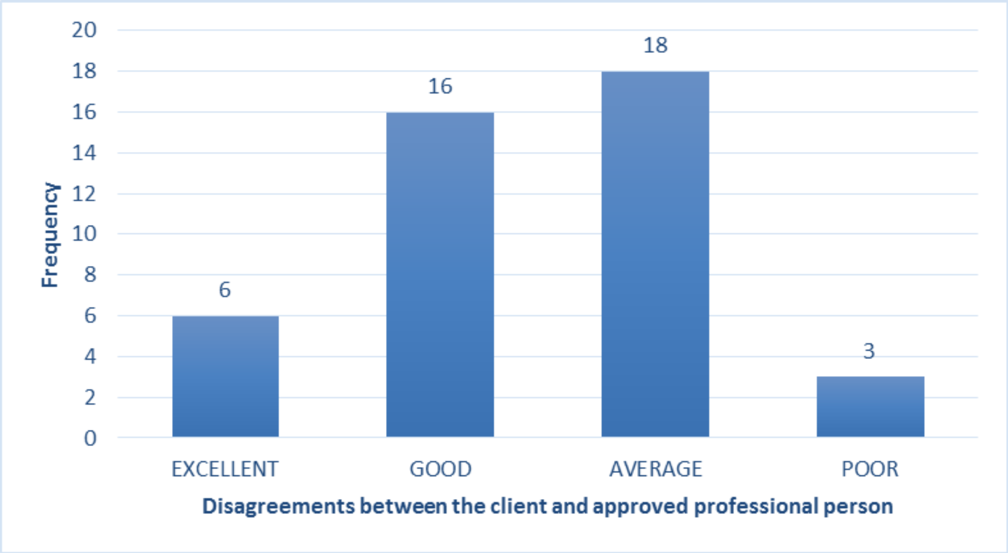
Effect cost of sustainable materials compared to normal

Materials recycle on your projects sustainable construction practice



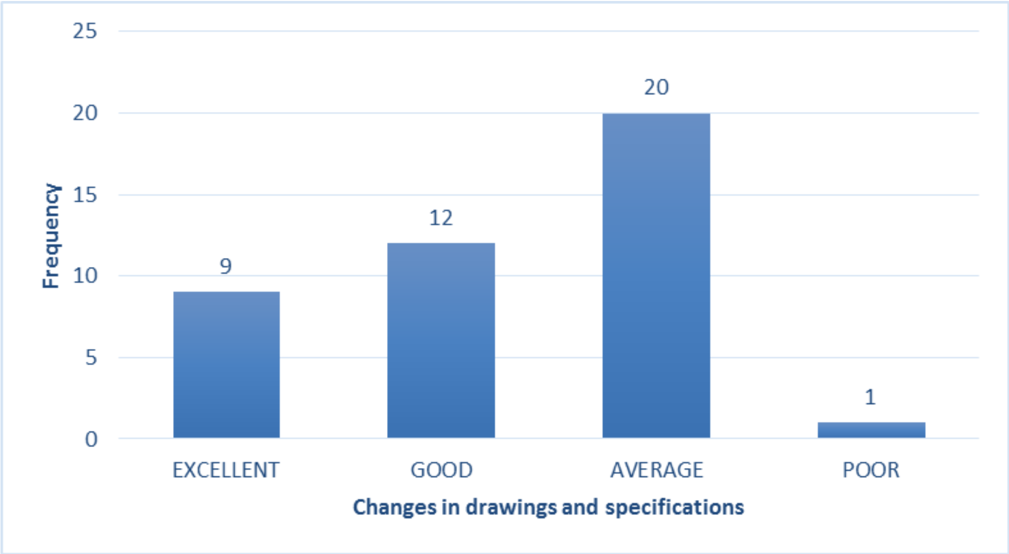
Pollution and Land use

Commitment of construction firm/ organisation

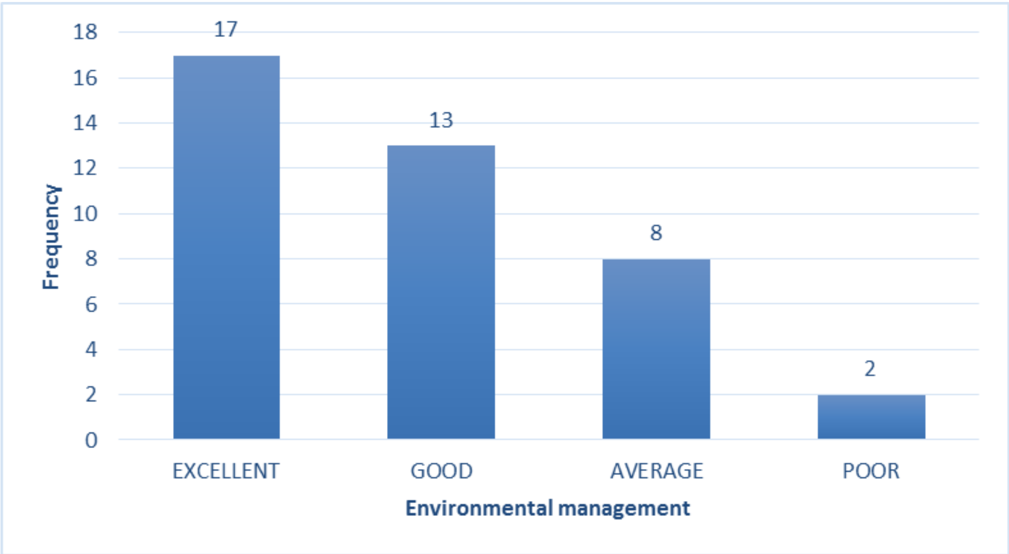


Disagreements between the client and approved professional person

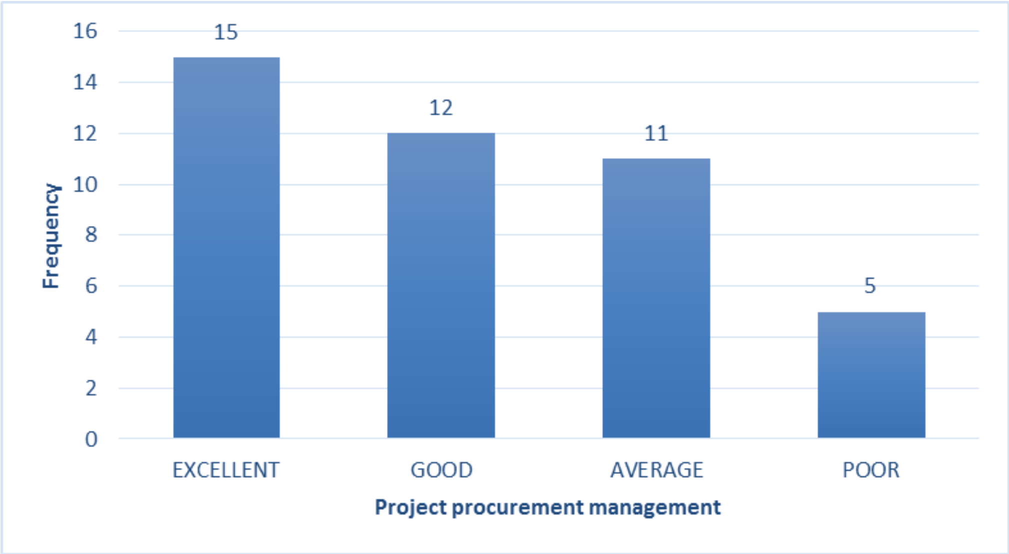
Changes in design and specifications on-site



Changes in drawings and specifications

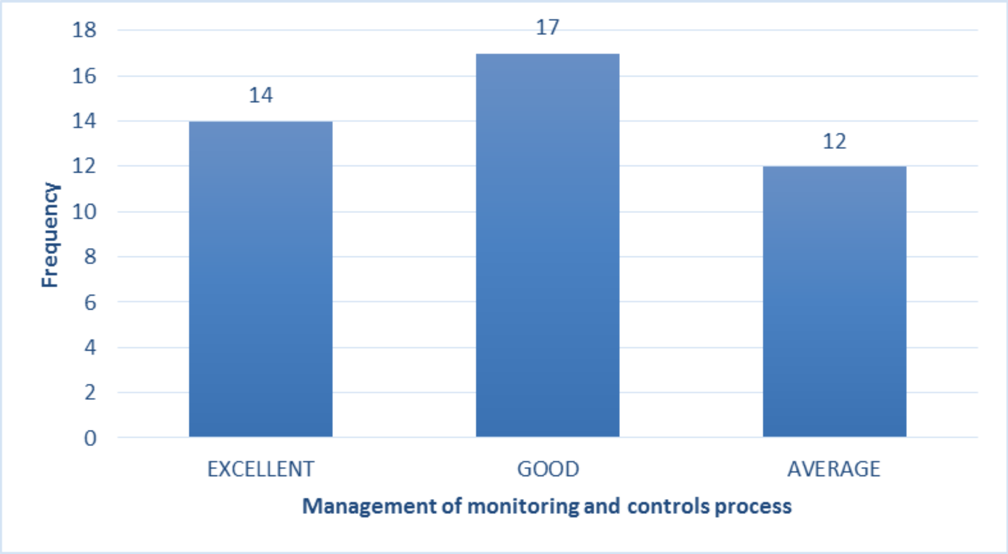


Environmental management

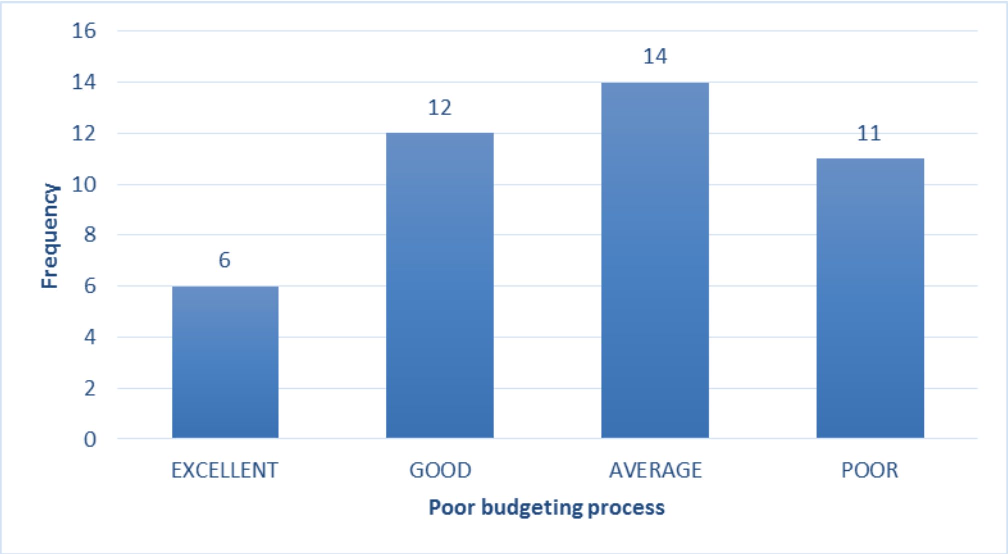


Project procurement management

Health and well-being

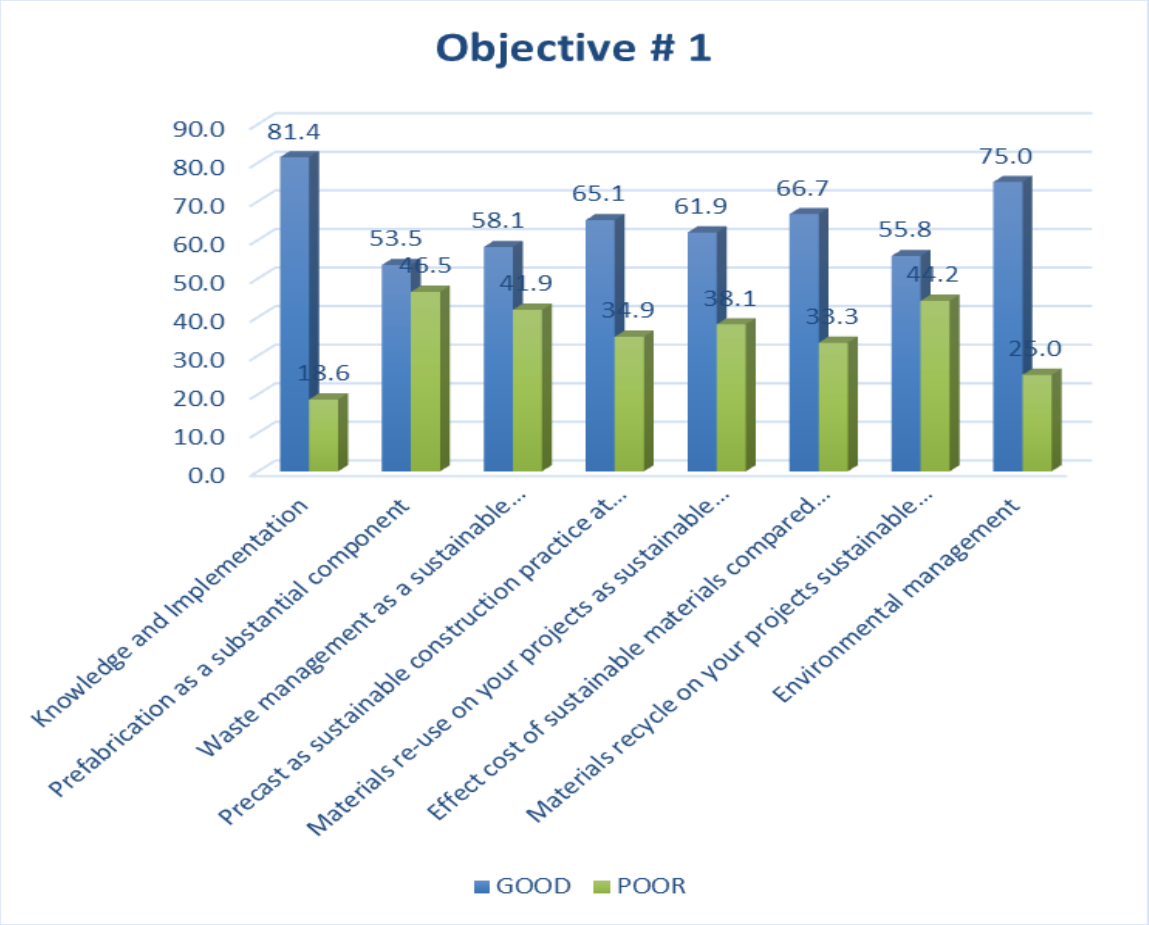


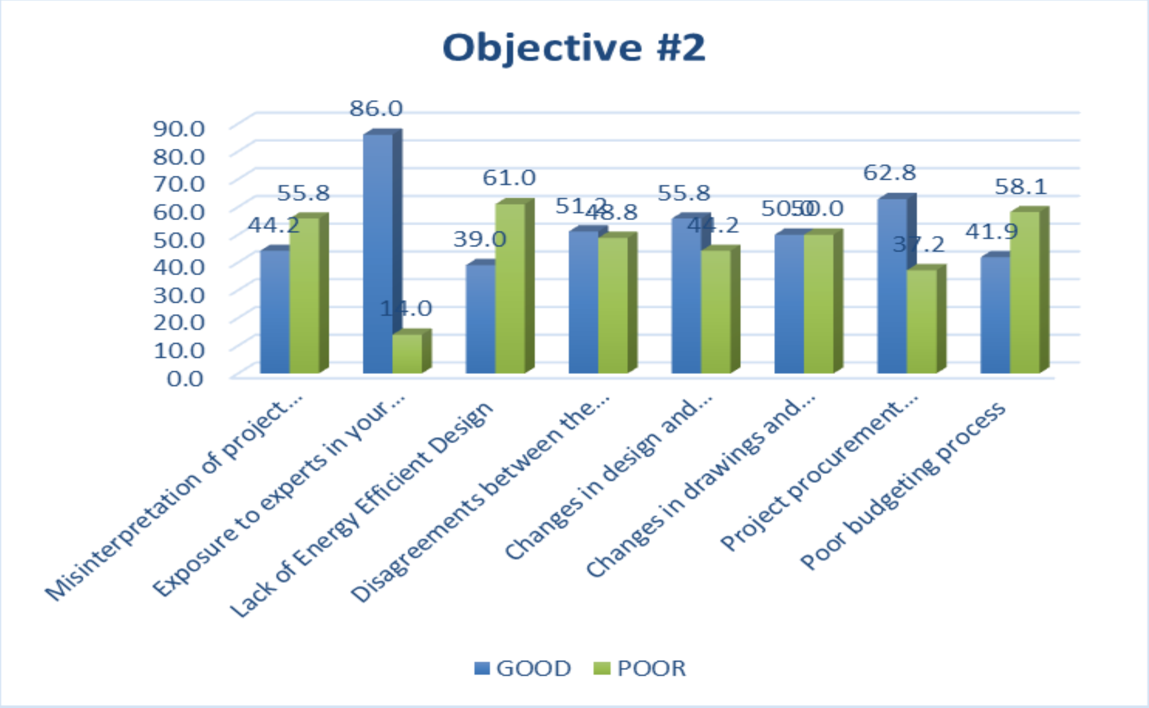
Management of monitoring and controls process

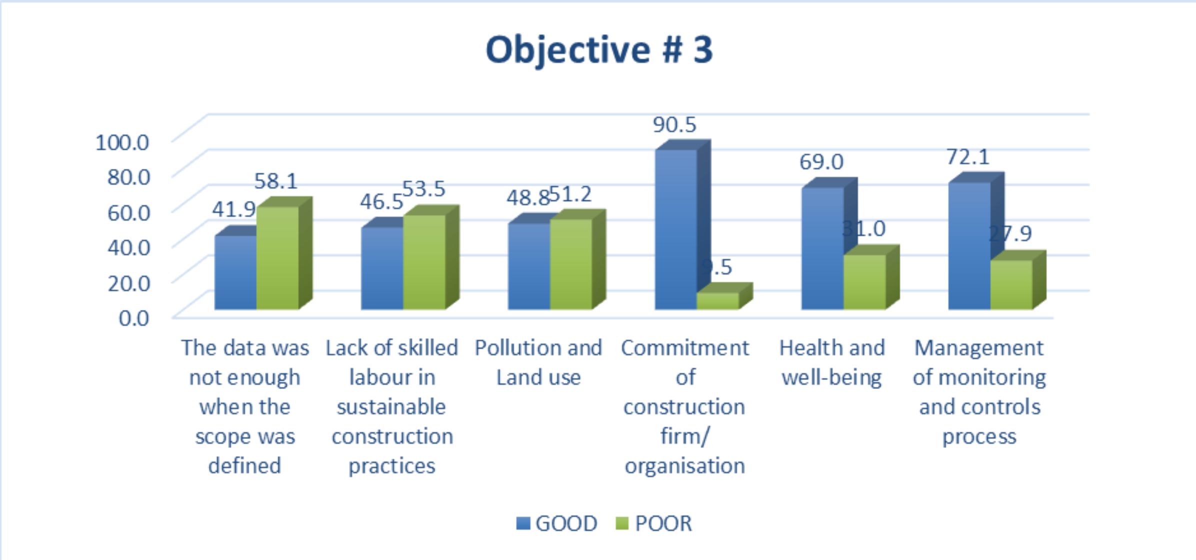


Poor budgeting process

APPENDIX D: Group Frequencies







Objective # 3
100.0
80.0
60.0
40.0
20.0
0.0
41.9
58.1
46.5
53.5
48.8
51.2
90.5
69.0
72.1
The data was not enough when the scope was defined
Lack of skilled labour in sustainable construction practices
Pollution and Land use
Commitment of construction firm/ organisation
Health and well-being
Management of monitoring and controls process
GOOD
POOR

APPENDIX E: Reliability Test

Scale: OVERALL

Reliability Statistics

Cronbach's Alpha	N of Items
0.843	22

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
RQ1_1 Knowledge and Implementation	46.06	100.467	0.415	0.836
RQ2_1 Misinterpretation of project scope	45.14	99.773	0.367	0.838
RQ1_2 Prefabrication as a substantial componentry	45.54	98.667	0.500	0.833
RQ2_2 Exposure to experts in your profession	46.00	104.882	0.162	0.845
RQ2_3 Lack of Energy Efficient Design	45.11	100.869	0.339	0.839
RQ3_1 The data was not enough when the scope was defined	45.26	99.726	0.367	0.838
RQ3_2 Lack of skilled labour in sustainable construction practices	45.26	99.903	0.401	0.837
RQ1_3 Waste management as a sustainable construction practice reduces cost	45.49	98.198	0.496	0.833
RQ1_4 Precast as sustainable construction practice at design stages	45.69	102.751	0.310	0.840
RQ1_5 Materials re-use on your projects as sustainable construction practice	45.43	101.193	0.114	0.863
RQ1_6 Effect cost of sustainable materials compared to normal	45.66	99.408	0.512	0.833
RQ1_7 Materials recycle on your projects sustainable construction practice	45.34	99.173	0.384	0.837
RQ3_3 Pollution and Land use	45.57	98.605	0.453	0.834
RQ3_4 Commitment of construction firm/ organisation	46.20	101.518	0.426	0.836
RQ2_4 Disagreements between the client and approved professional person	45.37	98.829	0.530	0.832
RQ2_5 Changes in design and specifications on-site	45.66	98.526	0.518	0.832
RQ2_6 Changes in drawings and specifications	45.57	102.664	0.306	0.840
RQ1_8 Environmental management	45.83	95.970	0.645	0.827
RQ2_7 Project procurement management	45.63	96.476	0.526	0.831
RQ3_5 Health and well-being	45.74	96.197	0.536	0.831
RQ3_6 Management of monitoring and controls process	45.86	96.597	0.716	0.826
RQ2_8 Poor budgeting process	45.20	99.459	0.395	0.837

Scale: RESEARCH QUESTION 1

Reliability Statistics

Cronbach's Alpha	N of Items
0.718	8

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
RQ1_1 Knowledge and Implementation	15.41	20.985	0.230	0.722
RQ1_2 Prefabrication as a substantial componentry	14.77	19.393	0.401	0.693
RQ1_3 Waste management as a sustainable construction practice reduces cost	14.85	17.818	0.616	0.652
RQ1_4 Precast as sustainable construction practice at design stages	14.97	19.341	0.519	0.677
RQ1_5 Materials re-use on your projects as sustainable construction practice	14.69	16.850	0.258	0.769
RQ1_6 Effect cost of sustainable materials compared to normal	14.90	19.884	0.382	0.697
RQ1_7 Materials recycle on your projects sustainable construction practice	14.62	17.506	0.520	0.666
RQ1_8 Environmental management	15.15	17.765	0.634	0.649

Scale: RESEARCH QUESTION 2

Reliability Statistics

Cronbach's Alpha	N of Items
0.688	8

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
RQ2_1 Misinterpretation of project scope	15.93	13.404	0.357	0.664
RQ2_2 Exposure to experts in your profession	16.78	15.922	0.091	0.714
RQ2_3 Lack of Energy Efficient Design	15.88	14.676	0.219	0.695
RQ2_4 Disagreements between the client and approved professional person	16.13	13.343	0.541	0.625
RQ2_5 Changes in design and specifications on-site	16.30	12.933	0.521	0.624
RQ2_6 Changes in drawings and specifications	16.23	13.820	0.420	0.650
RQ2_7 Project procurement management	16.38	13.574	0.343	0.668
RQ2_8 Poor budgeting process	15.90	12.246	0.578	0.607

Scale: RESEARCH QUESTION 3

Reliability Statistics

Cronbach's Alpha	N of Items
0.661	6

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
RQ3_1 The data was not enough when the scope was defined	10.29	7.362	0.502	0.573
RQ3_2 Lack of skilled labour in sustainable construction practices	10.37	8.138	0.417	0.609
RQ3_3 Pollution and Land use	10.61	7.494	0.509	0.571
RQ3_4 Commitment of construction firm/ organisation	11.37	10.238	0.098	0.697
RQ3_5 Health and well-being	10.88	8.410	0.284	0.662
RQ3_6 Management of monitoring and controls process	11.00	8.150	0.559	0.569

APPENDIX F: Normality Test

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
RQ1_1 Knowledge and Implementation	0.300	35	0.000	0.753	35	0.000
RQ2_1 Misinterpretation of project scope	0.193	35	0.002	0.877	35	0.001
RQ1_2 Prefabrication as a substantial componentry	0.213	35	0.000	0.864	35	0.000
RQ2_2 Exposure to experts in your profession	0.265	35	0.000	0.775	35	0.000
RQ2_3 Lack of Energy Efficient Design	0.220	35	0.000	0.880	35	0.001
RQ3_1 The data was not enough when the scope was defined	0.194	35	0.002	0.878	35	0.001
RQ3_2 Lack of skilled labour in sustainable construction practices	0.220	35	0.000	0.882	35	0.001
RQ1_3 Waste management as a sustainable construction practice reduces cost	0.211	35	0.000	0.870	35	0.001
RQ1_4 Precast as sustainable construction practice at design stages	0.223	35	0.000	0.802	35	0.000
RQ1_5 Materials re-use on your projects as sustainable construction practice	0.256	35	0.000	0.614	35	0.000
RQ1_6 Effect cost of sustainable materials compared to normal	0.227	35	0.000	0.854	35	0.000
RQ1_7 Materials recycle on your projects sustainable construction practice	0.218	35	0.000	0.869	35	0.001
RQ3_3 Pollution and Land use	0.257	35	0.000	0.824	35	0.000
RQ3_4 Commitment of construction firm/ organisation	0.339	35	0.000	0.714	35	0.000
RQ2_4 Disagreements between the client and approved professional person	0.258	35	0.000	0.858	35	0.000

RQ2_5 Changes in design and specifications on-site	0.220	35	0.000	0.839	35	0.000
RQ2_6 Changes in drawings and specifications	0.272	35	0.000	0.781	35	0.000
RQ1_8 Environmental management	0.240	35	0.000	0.830	35	0.000
RQ2_7 Project procurement management	0.227	35	0.000	0.843	35	0.000
RQ3_5 Health and well-being	0.256	35	0.000	0.817	35	0.000
RQ3_6 Management of monitoring and controls process	0.239	35	0.000	0.799	35	0.000
RQ2_8 Poor budgeting process	0.190	35	0.002	0.881	35	0.001

a. Lilliefors Significance Correction

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
COMP_REG		Statistic	df	Sig.	Statistic	df	Sig.
RQ1_1 Knowledge and Implementation	1 Grade 9 CIDB Reg Company	0.329	16	0.000	0.751	16	0.001
	2 Grade 6 CIDB Reg Company	0.272	19	0.001	0.757	19	0.000
RQ2_1 Misinterpretation of project scope	1 Grade 9 CIDB Reg Company	0.197	16	0.099	0.879	16	0.038
	2 Grade 6 CIDB Reg Company	0.192	19	0.062	0.880	19	0.022
RQ1_2 Prefabrication as a substantial componentry	1 Grade 9 CIDB Reg Company	0.229	16	0.025	0.879	16	0.037
	2 Grade 6 CIDB Reg Company	0.211	19	0.026	0.815	19	0.002
RQ2_2 Exposure to experts in your profession	1 Grade 9 CIDB Reg Company	0.368	16	0.000	0.707	16	0.000
	2 Grade 6 CIDB Reg Company	0.313	19	0.000	0.767	19	0.000
RQ2_3 Lack of Energy Efficient Design	1 Grade 9 CIDB Reg Company	0.227	16	0.027	0.886	16	0.049
	2 Grade 6 CIDB Reg Company	0.210	19	0.027	0.888	19	0.030
RQ3_1 The data was not enough when the scope was defined	1 Grade 9 CIDB Reg Company	0.255	16	0.007	0.841	16	0.010
	2 Grade 6 CIDB Reg Company	0.243	19	0.004	0.883	19	0.024

RQ3_2 Lack of skilled labour in sustainable construction practices	1 Grade 9 CIDB Reg Company	0.214	16	0.048	0.871	16	0.028
	2 Grade 6 CIDB Reg Company	0.259	19	0.002	0.871	19	0.015
RQ1_3 Waste management as a sustainable construction practice reduces cost	1 Grade 9 CIDB Reg Company	0.273	16	0.002	0.833	16	0.008
	2 Grade 6 CIDB Reg Company	0.243	19	0.004	0.883	19	0.024
RQ1_4 Precast as sustainable construction practice at design stages	1 Grade 9 CIDB Reg Company	0.239	16	0.015	0.796	16	0.002
	2 Grade 6 CIDB Reg Company	0.211	19	0.026	0.815	19	0.002
RQ1_5 Materials re-use on your projects as sustainable construction practice	1 Grade 9 CIDB Reg Company	0.236	16	0.018	0.809	16	0.004
	2 Grade 6 CIDB Reg Company	0.243	19	0.004	0.659	19	0.000
RQ1_6 Effect cost of sustainable materials compared to normal	1 Grade 9 CIDB Reg Company	0.257	16	0.006	0.814	16	0.004
	2 Grade 6 CIDB Reg Company	0.222	19	0.014	0.874	19	0.017
RQ1_7 Materials recycle on your projects sustainable construction practice	1 Grade 9 CIDB Reg Company	0.255	16	0.007	0.841	16	0.010
	2 Grade 6 CIDB Reg Company	0.189	19	0.072	0.888	19	0.030
RQ3_3 Pollution and Land use	1 Grade 9 CIDB Reg Company	0.265	16	0.004	0.822	16	0.005
	2 Grade 6 CIDB Reg Company	0.327	19	0.000	0.735	19	0.000
RQ3_4 Commitment of construction firm/ organisation	1 Grade 9 CIDB Reg Company	0.415	16	0.000	0.648	16	0.000
	2 Grade 6 CIDB Reg Company	0.272	19	0.001	0.757	19	0.000
RQ2_4 Disagreements between the client and approved professional person	1 Grade 9 CIDB Reg Company	0.207	16	0.066	0.882	16	0.041
	2 Grade 6 CIDB Reg Company	0.309	19	0.000	0.837	19	0.004
RQ2_5 Changes in design and specifications on-site	1 Grade 9 CIDB Reg Company	0.239	16	0.015	0.796	16	0.002
	2 Grade 6 CIDB Reg Company	0.226	19	0.012	0.866	19	0.012
RQ2_6 Changes in drawings and specifications	1 Grade 9 CIDB Reg Company	0.272	16	0.002	0.787	16	0.002
	2 Grade 6	0.265	19	0.001	0.788	19	0.001

	CIDB Reg Company						
RQ1_8 Environmental management	1 Grade 9 CIDB Reg Company	0.290	16	0.001	0.786	16	0.002
	2 Grade 6 CIDB Reg Company	0.207	19	0.031	0.865	19	0.012
RQ2_7 Project procurement management	1 Grade 9 CIDB Reg Company	0.313	16	0.000	0.760	16	0.001
	2 Grade 6 CIDB Reg Company	0.304	19	0.000	0.783	19	0.001
RQ3_5 Health and well-being	1 Grade 9 CIDB Reg Company	0.249	16	0.009	0.809	16	0.004
	2 Grade 6 CIDB Reg Company	0.256	19	0.002	0.829	19	0.003
RQ3_6 Management of monitoring and controls process	1 Grade 9 CIDB Reg Company	0.343	16	0.000	0.732	16	0.000
	2 Grade 6 CIDB Reg Company	0.241	19	0.005	0.814	19	0.002
RQ2_8 Poor budgeting process	1 Grade 9 CIDB Reg Company	0.239	16	0.015	0.869	16	0.026
	2 Grade 6 CIDB Reg Company	0.243	19	0.004	0.883	19	0.024

a. Lilliefors Significance Correction

Tests of Normality

SUS_PRACT_5YRS Have you experienced any sustainable construction practices in the projects you have worked on in the last 5 years		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
RQ1_1 Knowledge and Implementation	1 Yes	0.375	25	0.000	0.693	25	0.000
	2 No	0.202	10	.200*	0.878	10	0.124
RQ2_1 Misinterpretation of project scope	1 Yes	0.178	25	0.041	0.874	25	0.005
	2 No	0.224	10	0.168	0.911	10	0.287
RQ1_2 Prefabrication as a substantial componentry	1 Yes	0.227	25	0.002	0.876	25	0.006
	2 No	0.308	10	0.008	0.756	10	0.004
RQ2_2 Exposure to experts in your profession	1 Yes	0.304	25	0.000	0.727	25	0.000
	2 No	0.240	10	0.107	0.886	10	0.152
RQ2_3 Lack of Energy Efficient Design	1 Yes	0.238	25	0.001	0.874	25	0.005
	2 No	0.224	10	0.168	0.911	10	0.287
RQ3_1 The data was not enough when the scope was defined	1 Yes	0.195	25	0.015	0.852	25	0.002
	2 No	0.272	10	0.035	0.802	10	0.015
RQ3_2 Lack of skilled labour in sustainable construction practices	1 Yes	0.220	25	0.003	0.876	25	0.006
	2 No	0.245	10	0.091	0.820	10	0.025
RQ1_3 Waste management as a sustainable	1 Yes	0.198	25	0.012	0.870	25	0.004
	2 No	0.233	10	0.133	0.904	10	0.245

construction practice reduces cost							
RQ1_4 Precast as sustainable construction practice at design stages	1 Yes	0.210	25	0.006	0.803	25	0.000
	2 No	0.245	10	0.091	0.820	10	0.025
RQ1_5 Materials re-use on your projects as sustainable construction practice	1 Yes	0.323	25	0.000	0.570	25	0.000
	2 No	0.246	10	0.089	0.874	10	0.111
RQ1_6 Effect cost of sustainable materials compared to normal	1 Yes	0.220	25	0.003	0.854	25	0.002
	2 No	0.272	10	0.035	0.802	10	0.015
RQ1_7 Materials recycle on your projects sustainable construction practice	1 Yes	0.267	25	0.000	0.838	25	0.001
	2 No	0.297	10	0.013	0.868	10	0.095
RQ3_3 Pollution and Land use	1 Yes	0.233	25	0.001	0.836	25	0.001
	2 No	0.308	10	0.008	0.756	10	0.004
RQ3_4 Commitment of construction firm/ organisation	1 Yes	0.373	25	0.000	0.662	25	0.000
	2 No	0.272	10	0.035	0.802	10	0.015
RQ2_4 Disagreements between the client and approved professional person	1 Yes	0.223	25	0.002	0.880	25	0.007
	2 No	0.416	10	0.000	0.650	10	0.000
RQ2_5 Changes in design and specifications on-site	1 Yes	0.199	25	0.012	0.855	25	0.002
	2 No	0.308	10	0.008	0.756	10	0.004
RQ2_6 Changes in drawings and specifications	1 Yes	0.278	25	0.000	0.773	25	0.000
	2 No	0.245	10	0.091	0.820	10	0.025
RQ1_8 Environmental management	1 Yes	0.308	25	0.000	0.773	25	0.000
	2 No	0.324	10	0.004	0.794	10	0.012
RQ2_7 Project procurement management	1 Yes	0.257	25	0.000	0.809	25	0.000
	2 No	0.297	10	0.013	0.868	10	0.095
RQ3_5 Health and well-being	1 Yes	0.304	25	0.000	0.761	25	0.000
	2 No	0.233	10	0.133	0.904	10	0.245
RQ3_6 Management of monitoring and controls process	1 Yes	0.300	25	0.000	0.763	25	0.000
	2 No	0.324	10	0.004	0.794	10	0.012
RQ2_8 Poor budgeting process	1 Yes	0.184	25	0.028	0.863	25	0.003
	2 No	0.305	10	0.009	0.781	10	0.008

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Tests of Normality

SUS_ORG Do you feel that sustainable construction practices is widespread in the projects of your Company / Organisation		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
RQ1_1 Knowledge and Implementation	2 Disagree	0.492	6	0.000	0.496	6	0.000
	3 Neutral	0.249	16	0.009	0.809	16	0.004
	4 Agree	0.282	11	0.015	0.786	11	0.006
	5 Strongly Agree	0.260	2				
RQ2_1 Misinterpretation of project scope	2 Disagree	0.209	6	.200*	0.907	6	0.415
	3 Neutral	0.189	16	0.132	0.887	16	0.050
	4 Agree	0.275	11	0.020	0.879	11	0.100
	5 Strongly Agree	0.260	2				
RQ1_2 Prefabrication as a substantial componentry	2 Disagree	0.254	6	.200*	0.866	6	0.212
	3 Neutral	0.220	16	0.037	0.892	16	0.061
	4 Agree	0.232	11	0.101	0.795	11	0.008
	5 Strongly Agree	0.260	2				
RQ2_2 Exposure to experts in your profession	2 Disagree	0.492	6	0.000	0.496	6	0.000
	3 Neutral	0.223	16	0.032	0.848	16	0.013
	4 Agree	0.327	11	0.002	0.742	11	0.002
	5 Strongly Agree	0.260	2				
RQ2_3 Lack of Energy Efficient Design	2 Disagree	0.183	6	.200*	0.960	6	0.820
	3 Neutral	0.251	16	0.008	0.888	16	0.051
	4 Agree	0.259	11	0.037	0.828	11	0.022
	5 Strongly Agree		2				
RQ3_1 The data was not enough when the scope was defined	2 Disagree	0.302	6	0.094	0.775	6	0.035
	3 Neutral	0.225	16	0.030	0.853	16	0.015
	4 Agree	0.255	11	0.044	0.899	11	0.181
	5 Strongly Agree	0.260	2				
RQ3_2 Lack of skilled labour in sustainable construction practices	2 Disagree	0.202	6	.200*	0.853	6	0.167
	3 Neutral	0.207	16	0.066	0.882	16	0.041
	4 Agree	0.266	11	0.029	0.887	11	0.127
	5 Strongly Agree	0.260	2				
RQ1_3 Waste management as a sustainable construction practice reduces cost	2 Disagree	0.325	6	0.047	0.827	6	0.101
	3 Neutral	0.266	16	0.004	0.856	16	0.017
	4 Agree	0.280	11	0.016	0.785	11	0.006
	5 Strongly Agree	0.260	2				
RQ1_4 Precast as sustainable construction practice at design stages	2 Disagree	0.319	6	0.056	0.683	6	0.004
	3 Neutral	0.309	16	0.000	0.757	16	0.001
	4 Agree	0.227	11	0.120	0.819	11	0.017
	5 Strongly Agree		2				

RQ1_5 Materials re-use on your projects as sustainable construction practice	2 Disagree	0.471	6	0.000	0.580	6	0.000
	3 Neutral	0.261	16	0.005	0.810	16	0.004
	4 Agree	0.448	11	0.000	0.572	11	0.000
	5 Strongly Agree	0.260	2				
RQ1_6 Effect cost of sustainable materials compared to normal	2 Disagree	0.277	6	0.168	0.773	6	0.033
	3 Neutral	0.307	16	0.000	0.768	16	0.001
	4 Agree	0.385	11	0.000	0.724	11	0.001
	5 Strongly Agree	0.260	2				
RQ1_7 Materials recycle on your projects sustainable construction practice	2 Disagree	0.293	6	0.117	0.915	6	0.473
	3 Neutral	0.255	16	0.007	0.841	16	0.010
	4 Agree	0.327	11	0.002	0.742	11	0.002
	5 Strongly Agree	0.260	2				
RQ3_3 Pollution and Land use	2 Disagree	0.302	6	0.094	0.775	6	0.035
	3 Neutral	0.260	16	0.005	0.870	16	0.027
	4 Agree	0.334	11	0.001	0.769	11	0.004
	5 Strongly Agree	0.260	2				
RQ3_4 Commitment of construction firm/ organisation	2 Disagree	0.492	6	0.000	0.496	6	0.000
	3 Neutral	0.268	16	0.003	0.796	16	0.002
	4 Agree	0.448	11	0.000	0.572	11	0.000
	5 Strongly Agree	0.260	2				
RQ2_4 Disagreements between the client and approved professional person	2 Disagree	0.223	6	.200*	0.908	6	0.421
	3 Neutral	0.324	16	0.000	0.831	16	0.007
	4 Agree	0.232	11	0.100	0.822	11	0.018
	5 Strongly Agree	0.260	2				
RQ2_5 Changes in design and specifications on-site	2 Disagree	0.492	6	0.000	0.496	6	0.000
	3 Neutral	0.266	16	0.004	0.856	16	0.017
	4 Agree	0.287	11	0.012	0.754	11	0.002
	5 Strongly Agree	0.260	2				
RQ2_6 Changes in drawings and specifications	2 Disagree	0.254	6	.200*	0.866	6	0.212
	3 Neutral	0.271	16	0.003	0.793	16	0.002
	4 Agree	0.296	11	0.008	0.708	11	0.001
	5 Strongly Agree	0.260	2				
RQ1_8 Environmental management	2 Disagree	0.407	6	0.002	0.640	6	0.001
	3 Neutral	0.220	16	0.037	0.892	16	0.061
	4 Agree	0.332	11	0.001	0.756	11	0.002
	5 Strongly Agree	0.260	2				
RQ2_7 Project procurement management	2 Disagree	0.333	6	0.036	0.827	6	0.101
	3 Neutral	0.266	16	0.004	0.816	16	0.005
	4 Agree	0.330	11	0.001	0.754	11	0.002
	5 Strongly Agree	0.260	2				

RQ3_5 Health and well-being	2 Disagree	0.285	6	0.138	0.831	6	0.110
	3 Neutral	0.238	16	0.016	0.857	16	0.017
	4 Agree	0.300	11	0.007	0.703	11	0.001
	5 Strongly Agree	0.260	2				
RQ3_6 Management of monitoring and controls process	2 Disagree	0.302	6	0.094	0.775	6	0.035
	3 Neutral	0.220	16	0.038	0.819	16	0.005
	4 Agree	0.277	11	0.018	0.799	11	0.009
	5 Strongly Agree	0.260	2				
RQ2_8 Poor budgeting process	2 Disagree	0.293	6	0.117	0.915	6	0.473
	3 Neutral	0.189	16	0.132	0.887	16	0.050
	4 Agree	0.231	11	0.104	0.876	11	0.093
	5 Strongly Agree	0.260	2				

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Tests of Normality

PERC_PROJ In your opinion how many percent of projects are impacted/influenced by sustainable construction practices		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
RQ1_1 Knowledge and Implementation	1 0-20%		3			3	
	2 21-49%	0.310	11	0.004	0.760	11	0.003
	3 50-69%	0.283	13	0.005	0.790	13	0.005
	4 70-89%	0.407	6	0.002	0.640	6	0.001
	5 >90%	0.260	2				
RQ2_1 Misinterpretation of project scope	1 0-20%	0.385	3		0.750	3	0.000
	2 21-49%	0.219	11	0.146	0.889	11	0.134
	3 50-69%	0.195	13	0.188	0.874	13	0.059
	4 70-89%	0.333	6	0.036	0.827	6	0.101
	5 >90%	0.260	2				
RQ1_2 Prefabrication as a substantial componentry	1 0-20%	0.385	3		0.750	3	0.000
	2 21-49%	0.232	11	0.100	0.822	11	0.018
	3 50-69%	0.222	13	0.080	0.901	13	0.139
	4 70-89%	0.254	6	.200*	0.866	6	0.212
	5 >90%		2				
RQ2_2 Exposure to experts in your profession	1 0-20%	0.385	3		0.750	3	0.000
	2 21-49%	0.232	11	0.100	0.822	11	0.018
	3 50-69%	0.306	13	0.002	0.753	13	0.002
	4 70-89%	0.407	6	0.002	0.640	6	0.001
	5 >90%	0.260	2				
RQ2_3 Lack of Energy Efficient Design	1 0-20%	0.385	3		0.750	3	0.000
	2 21-49%	0.330	11	0.001	0.754	11	0.002
	3 50-69%	0.214	13	0.107	0.894	13	0.110

	4 70-89%	0.277	6	0.168	0.773	6	0.033
	5 >90%	0.260	2				
RQ3_1 The data was not enough when the scope was defined	1 0-20%	0.385	3		0.750	3	0.000
	2 21-49%	0.263	11	0.033	0.829	11	0.023
	3 50-69%	0.242	13	0.035	0.799	13	0.007
	4 70-89%	0.183	6	.200*	0.960	6	0.820
	5 >90%	0.260	2				
RQ3_2 Lack of skilled labour in sustainable construction practices	1 0-20%	0.385	3		0.750	3	0.000
	2 21-49%	0.227	11	0.117	0.863	11	0.064
	3 50-69%	0.240	13	0.039	0.809	13	0.009
	4 70-89%	0.293	6	0.117	0.915	6	0.473
	5 >90%	0.260	2				
RQ1_3 Waste management as a sustainable construction practice reduces cost	1 0-20%	0.385	3		0.750	3	0.000
	2 21-49%	0.275	11	0.020	0.879	11	0.100
	3 50-69%	0.288	13	0.004	0.766	13	0.003
	4 70-89%	0.392	6	0.004	0.701	6	0.006
	5 >90%		2				
RQ1_4 Precast as sustainable construction practice at design stages	1 0-20%		3			3	
	2 21-49%	0.227	11	0.120	0.819	11	0.017
	3 50-69%	0.335	13	0.000	0.720	13	0.001
	4 70-89%	0.254	6	.200*	0.866	6	0.212
	5 >90%	0.260	2				
RQ1_5 Materials re-use on your projects as sustainable construction practice	1 0-20%	0.385	3		0.750	3	0.000
	2 21-49%	0.293	11	0.009	0.643	11	0.000
	3 50-69%	0.199	13	0.166	0.875	13	0.062
	4 70-89%	0.333	6	0.036	0.827	6	0.101
	5 >90%		2				
RQ1_6 Effect cost of sustainable materials compared to normal	1 0-20%	0.385	3		0.750	3	0.000
	2 21-49%	0.227	11	0.117	0.863	11	0.064
	3 50-69%	0.284	13	0.005	0.785	13	0.005
	4 70-89%	0.492	6	0.000	0.496	6	0.000
	5 >90%		2				
RQ1_7 Materials recycle on your projects sustainable construction practice	1 0-20%	0.385	3		0.750	3	0.000
	2 21-49%	0.234	11	0.094	0.878	11	0.097
	3 50-69%	0.195	13	0.188	0.874	13	0.059
	4 70-89%	0.223	6	.200*	0.908	6	0.421
	5 >90%	0.260	2				
RQ3_3 Pollution and Land use	1 0-20%	0.385	3		0.750	3	0.000
	2 21-49%	0.232	11	0.101	0.795	11	0.008
	3 50-69%	0.326	13	0.000	0.820	13	0.012
	4 70-89%	0.285	6	0.138	0.831	6	0.110
	5 >90%		2				
RQ3_4 Commitment of construction firm/	1 0-20%	0.385	3		0.750	3	0.000
	2 21-49%	0.300	11	0.007	0.703	11	0.001

organisation	3 50-69%	0.327	13	0.000	0.756	13	0.002
	4 70-89%	0.407	6	0.002	0.640	6	0.001
	5 >90%	0.260	2				
RQ2_4 Disagreements between the client and approved professional person	1 0-20%	0.385	3		0.750	3	0.000
	2 21-49%	0.219	11	0.146	0.889	11	0.134
	3 50-69%	0.289	13	0.004	0.772	13	0.003
	4 70-89%	0.293	6	0.117	0.822	6	0.091
	5 >90%		2				
RQ2_5 Changes in design and specifications on-site	1 0-20%	0.175	3		1.000	3	1.000
	2 21-49%	0.227	11	0.117	0.863	11	0.064
	3 50-69%	0.240	13	0.039	0.809	13	0.009
	4 70-89%	0.319	6	0.056	0.683	6	0.004
	5 >90%	0.260	2				
RQ2_6 Changes in drawings and specifications	1 0-20%	0.175	3		1.000	3	1.000
	2 21-49%	0.232	11	0.100	0.822	11	0.018
	3 50-69%	0.415	13	0.000	0.650	13	0.000
	4 70-89%	0.302	6	0.094	0.775	6	0.035
	5 >90%	0.260	2				
RQ1_8 Environmental management	1 0-20%	0.385	3		0.750	3	0.000
	2 21-49%	0.252	11	0.049	0.803	11	0.010
	3 50-69%	0.235	13	0.048	0.851	13	0.029
	4 70-89%	0.293	6	0.117	0.822	6	0.091
	5 >90%	0.260	2				
RQ2_7 Project procurement management	1 0-20%	0.253	3		0.964	3	0.637
	2 21-49%	0.263	11	0.033	0.829	11	0.023
	3 50-69%	0.199	13	0.166	0.875	13	0.062
	4 70-89%	0.202	6	.200*	0.853	6	0.167
	5 >90%	0.260	2				
RQ3_5 Health and well-being	1 0-20%	0.385	3		0.750	3	0.000
	2 21-49%	0.277	11	0.018	0.799	11	0.009
	3 50-69%	0.268	13	0.011	0.807	13	0.008
	4 70-89%	0.223	6	.200*	0.908	6	0.421
	5 >90%		2				
RQ3_6 Management of monitoring and controls process	1 0-20%	0.385	3		0.750	3	0.000
	2 21-49%	0.282	11	0.015	0.786	11	0.006
	3 50-69%	0.242	13	0.035	0.799	13	0.007
	4 70-89%	0.293	6	0.117	0.822	6	0.091
	5 >90%	0.260	2				
RQ2_8 Poor budgeting process	1 0-20%		3			3	
	2 21-49%	0.173	11	.200*	0.889	11	0.135
	3 50-69%	0.199	13	0.166	0.875	13	0.062
	4 70-89%	0.293	6	0.117	0.915	6	0.473
	5 >90%	0.260	2				

*. This is a lower bound of the true significance. a. Lilliefors Significance Correction

APPENDIX G: Kruskal Wills – H Test

Test Statistics[a,b]

	RQ1_1 Knowledge and Implementation	RQ2_1 Misinterpretation of project scope	RQ1_2 Prefabrication as a substantial componentry	RQ2_2 Exposure to experts in your profession	RQ2_3 Lack of Energy Efficient Design	RQ3_1 The data was not enough when the scope was defined	RQ3_2 Lack of skilled labour in sustainable construction practices	RQ1_3 Waste management as a sustainable construction practice reduces cost	RQ1_4 Precast as sustainable construction practice at design stages	RQ1_5 Materials re-use on your projects as sustainable construction practice	RQ1_6 Effect cost of sustainable materials compared to normal	RQ1_7 Materials recycle on your projects sustainable construction practice	RQ3_3 Pollution and Land use	RQ3_4 Commitment of construction firm/ organisation	RQ2_4 Disagreements between the client and approved professional person	RQ2_5 Changes in design and specifications on-site	RQ2_6 Changes in drawings and specifications	RQ1_8 Environmental management	RQ2_7 Project procurement management	RQ3_5 Health and well-being
Kruskal-Wallis H	3.058	0.536	0.666	4.525	4.082	9.642	3.693	1.569	5.463	2.466	5.136	2.180	1.219	3.505	4.573	3.072	1.119	4.837	3.643	3.240
df	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Asymp. Sig.	0.383	0.911	0.881	0.210	0.253	0.022	0.297	0.666	0.141	0.481	0.162	0.536	0.749	0.320	0.206	0.381	0.772	0.184	0.303	0.356

a. Kruskal Wallis Test

b. Grouping Variable: SUS_ORG Do you feel that sustainable construction practices is widespread in the projects of your Company / Organisation

Test Statistics[a,b]

	RQ1_1 Knowledge and Implementation	RQ2_1 Misinterpretation of project scope	RQ1_2 Prefabrication as a substantial componentry	RQ2_2 Exposure to experts in your profession	RQ2_3 Lack of Energy Efficient Design	RQ3_1 The data was not enough when the scope was defined	RQ3_2 Lack of skilled labour in sustainable construction practices	RQ1_3 Waste management as a sustainable construction practice reduces cost	RQ1_4 Precast as sustainable construction practice at design stages	RQ1_5 Materials re-use on your projects as sustainable construction practice	RQ1_6 Effect cost of sustainable materials compared to normal	RQ1_7 Materials recycle on your projects sustainable construction practice	RQ3_3 Pollution and Land use	RQ3_4 Commitment of construction firm/ organisation	RQ2_4 Disagreements between the client and approved professional person	RQ2_5 Changes in design and specifications on-site	RQ2_6 Changes in drawings and specifications	RQ1_8 Environmental management	RQ2_7 Project procurement management	RQ3_5 Health and well-being
Kruskal-Wallis H	5.277	2.374	8.920	2.164	7.263	4.729	4.298	4.444	3.171	3.977	5.338	5.396	6.713	2.298	6.167	1.696	9.041	2.568	1.352	10.108
df	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Asymp. Sig.	0.260	0.667	0.063	0.706	0.123	0.316	0.367	0.349	0.530	0.409	0.254	0.249	0.152	0.681	0.187	0.791	0.060	0.633	0.853	0.039

a. Kruskal Wallis Test

b. Grouping Variable: PERC_PROJ In your opinion how many percent of projects are impacted/influenced by sustainable construction practices

APPENDIX H: Mann Whitney – U Test

Test Statistics[a]

	RQ1_1 Knowledge and Implementation	RQ2_1 Misinterpretation of project scope	RQ1_2 Prefabrication as a substantial componentry	RQ2_2 Exposure to experts in your profession	RQ2_3 Lack of Energy Efficient Design	RQ3_1 The data was not enough when the scope was defined	RQ3_2 Lack of skilled labour in sustainable construction practices	RQ1_3 Waste management as a sustainable construction practice reduces cost	RQ1_4 Precast as sustainable construction practice at design stages	RQ1_5 Materials re-use on your projects as sustainable construction practice	RQ1_6 Effect cost of sustainable materials compared to normal	RQ1_7 Materials recycle on your projects sustainable construction practice	RQ3_3 Pollution and Land use	RQ3_4 Commitment of construction firm/ organisation	RQ2_4 Disagreements between the client and approved professional person	RQ2_5 Changes in design and specifications on-site	RQ2_6 Changes in drawings and specifications	RQ1_8 Environmental management	RQ2_7 Project procurement management	RQ3_5 Health and well-being
Mann-Whitney U	215.000	199.000	191.000	193.500	183.000	141.500	136.500	218.000	218.000	159.000	169.000	194.500	187.500	174.000	162.000	171.000	196.500	171.500	209.500	191.500
Wilcoxon W	368.000	352.000	542.000	346.500	319.000	294.500	289.500	569.000	569.000	312.000	322.000	347.500	340.500	327.000	315.000	324.000	349.500	324.500	362.500	344.500
Z	-0.163	-0.567	-0.788	-0.745	-0.478	-2.060	-2.208	-0.078	-0.080	-1.603	-1.192	-0.682	-0.887	-1.110	-1.569	-1.313	-0.442	-0.699	-0.298	-0.565
Asymp. Sig. (2-tailed)	0.871	0.571	0.431	0.456	0.633	0.039	0.027	0.938	0.936	0.109	0.233	0.495	0.375	0.267	0.117	0.189	0.658	0.484	0.766	0.572
Exact Sig. [2*(1-tailed Sig.)]					.663[b]													.516[b]		

a. Grouping Variable: COMP_REG

b. Not corrected for ties.

Test Statistics[a]

	RQ1_1 Knowledge and Implementation	RQ2_1 Misinterpretation of project scope	RQ1_2 Prefabrication as a substantial componentry	RQ2_2 Exposure to experts in your profession	RQ2_3 Lack of Energy Efficient Design	RQ3_1 The data was not enough when the scope was defined	RQ3_2 Lack of skilled labour in sustainable construction practices	RQ1_3 Waste management as a sustainable construction practice reduces cost	RQ1_4 Precast as sustainable construction practice at design stages	RQ1_5 Materials re-use on your projects as sustainable construction practice	RQ1_6 Effect cost of sustainable materials compared to normal	RQ1_7 Materials recycle on your projects sustainable construction practice	RQ3_3 Pollution and Land use	RQ3_4 Commitment of construction firm/ organisation	RQ2_4 Disagreements between the client and approved professional person	RQ2_5 Changes in design and specifications on-site	RQ2_6 Changes in drawings and specifications	RQ1_8 Environmental management	RQ2_7 Project procurement management	RQ3_5 Health and well-being
Mann-Whitney U	143.500	149.500	178.000	164.500	103.000	148.500	142.500	184.000	161.500	171.000	150.000	165.500	166.000	171.000	123.500	155.500	166.500	139.500	169.000	129.500
Wilcoxon W	639.500	645.500	674.000	660.500	169.000	644.500	638.500	680.000	657.500	667.000	646.000	243.500	662.000	636.000	619.500	651.500	631.500	545.500	665.000	594.500
Z	-1.259	-1.025	-0.229	-0.635	-1.919	-1.059	-1.239	-0.057	-0.710	-0.423	-0.627	-0.575	-0.577	-0.282	-1.812	-0.873	-0.405	-0.896	-0.480	-1.476
Asymp. Sig. (2-tailed)	0.208	0.305	0.819	0.525	0.055	0.289	0.215	0.955	0.477	0.672	0.531	0.565	0.564	0.778	0.070	0.382	0.685	0.370	0.631	0.140
Exact Sig. [2*(1-tailed Sig.)]	.254[b]	.328[b]	.841[b]	.565[b]	.070[b]	.314[b]	.243[b]	.968[b]	.512[b]	.698[b]	.572[b]	.584[b]	.602[b]	.815[b]	.091[b]	.414[b]	.711[b]	.405[b]	.659[b]	.162[b]

Appendix I: Questionnaire

The purpose of this survey is the Evaluation of knowledge and implementation of sustainable construction practices by South African contractors.

The information provided in this questionnaire is highly confidential and shall be used **ONLY** for research purposes. Your feedback will be highly appreciated.

This questionnaire is divided into two sections, 1 and 2

Evaluating the knowledge and implementation of sustainable construction practices by South African contractors						
<u>Section 1: Influences of knowledge and implementation of sustainable construction practices</u>						
The following information will only be used to make group comparison and the questionnaire will not be analysed on an individual basis.						
Circle your choice below. If you are completing the questionnaire electronically, please highlight your selection in RED						
Question		Answer				
1	Have you experienced any sustainable construction practices in the projects you have worked on in the last 5 years	Yes	No			
2	Do you feel that sustainable construction practices	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

	is widespread in the projects of your Company / Organisation					
3	In your opinion how many percent of projects are impacted/influenced by sustainable construction practices	0-20%	21-49%	50-69%	70-89%	>90%

Section 2: Factors of sustainable construction practices					
Please indicate to what extent you agree that the following statements **cause/contribute to sustainable construction practices in the organisation** by placing a cross (x) in one of the four columns below.					
If for example, you rate a question **poor**, it means that this variable will not influence sustainable construction practices in your opinion					
whereas if you rate a statement as **excellent**, it means that this variable would definitely influence sustainable construction practices					
		Degree of influence			
Statements		**EXCELLENT**	**GOOD**	**AVERAGE**	**POOR**
1	Knowledge and				

	Implementation				
2	Misinterpretation of project scope				
3	Prefabrication as a substantial componentry				
4	Exposure to experts in your profession				
5	Lack of Energy Efficient Design				
6	The data was not enough when the scope was defined				
7	Lack of skilled labour in sustainable construction practices				
8	Waste management as a sustainable construction practice reduces cost				
9	Precast as sustainable construction practice at design stages				
10	Materials re-use on your projects as sustainable construction practice				
11	Effect cost of sustainable materials compared to normal				

12	Materials recycle on your projects sustainable construction practice				
13	Pollution and Land use				
14	Commitment of construction firm/ organisation				
15	Disagreements between the client and approved professional person				
16	Changes in design and specifications on-site				
17	Changes in drawings and specifications				
18	Environmental management				
19	Project procurement management				
20	Health and well-being				
21	Management of monitoring and controls process				
22	Poor budgeting process				
23	Kindly add anything that you believe will have a significant influence in terms of sustainable construction practices which you feel was not included in the questionnaire.				