



UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

Faculty of Engineering and the Built Environment Department of Construction
Economics and Management

CON 5023Z

Supervisor: Karen Le Jeune

PERCEPTION OF QUANTITY SURVEYORS ADVISING ON BUILDING
SPECIFICATIONS TO SUPPORT SUSTAINABLE BUILDING DEVELOPMENTS

By Stephen Koigi KGXSTE001

A research report for a minor dissertation presented to the Department of Construction Economics
and Management In partial fulfilment of the requirements for the Masters of Science degree in Project
Management

October 2017

The copyright of this thesis vests in the author. No quotation from it or information derived from it is to be published without full acknowledgement of the source. The thesis is to be used for private study or non-commercial research purposes only.

Published by the University of Cape Town (UCT) in terms of the non-exclusive license granted to UCT by the author.

Plagiarism Declaration

I know the meaning of plagiarism and declare that all the work in the document, save for that which is properly acknowledged, is my own. This thesis/dissertation has been submitted to the Turnitin module (or equivalent similarity and originality checking software) and I confirm that my supervisor has seen my report and any concerns revealed by such have been resolved with my supervisor.

Date: 18-10-2017

Signature.....

Signed

Acknowledgements

I would like to thank my supervisor, Mrs Karen Le Jeune, for the constant support through this long journey of completing this dissertation.

My parents for the continued motivation and giving me the opportunity to further my studies.

I would also like to give my appreciation to my family especially Karen Koigi and Jane Koigi for their guidance, insight and support throughout to achieve completion of this dissertation.

Emily, Jesse, Thomas and Judy for their individual support during this master's degree.

Over all, I thank God for giving me the strength to finish this programme

Table of contents

Plagiarism Declaration	ii
Acknowledgements	iii
List of Figures.....	vii
List of tables	viii
Abstract.....	ix
1 Chapter One: Background and Purpose of Study.....	1
1.1 Introduction.....	1
1.2 Background	1
1.3 The role of quantity surveyors on building projects	3
1.4 The role of quantity surveyors and sustainability: The problem area.....	3
1.5 Research Problem	6
1.6 Research Question.....	6
1.7 Research assumptions	6
1.8 Research aim and objectives.....	7
1.9 Proposed research design and methodology.....	7
1.10 Limitations	8
1.11 Research justification.....	8
1.12 Structure of the report.....	9
2 Chapter Two: Literature Review.....	10
2.1 Introduction.....	10
2.2 Sustainability in the built environment.....	10
2.2.1 Principles of sustainability	11
2.2.2 Evolution of Sustainability in the construction industry.....	13
2.2.3 Sustainability certification systems.....	14
2.3 Tools used to evaluate sustainability in the built environment.....	15
2.3.1 Rating systems	15
2.3.2 Life Cycle Sustainability Assessment (LCSA)	20
2.3.3 Value management.....	23
2.4 Challenges to attaining sustainability	24
2.4.1 Knowledge and awareness	24
2.4.2 Finance	25
2.4.3 Lack of awareness/interest towards sustainable buildings	26
2.4.4 Lack of green building products	26
2.4.5 Lack of government support.....	28
2.4.6 Insufficient time	28

2.5	Drivers for sustainability in the construction industry.....	28
2.5.1	Tenant demand.....	29
2.5.2	Professional team	30
2.5.3	Enhanced operational efficiency	30
2.5.4	Information dissemination on sustainability.....	30
2.5.5	Opportunities in developing nations	30
2.5.6	Regulatory compliance	31
2.5.7	Technological Advancement.....	32
2.5.8	Buy-in to green rating systems.....	32
2.6	Collaboration towards sustainable growth in the South African construction industry	32
2.7	Sustainability and the construction professionals.....	35
2.8	Sustainability and the role of the quantity surveyor	36
2.9	Chapter Summary.....	38
3	Chapter Three: Methodology.....	40
3.1	Introduction.....	40
3.2	Research methods.....	40
3.2.1	Quantitative research approach (positivism)	40
3.2.2	Qualitative research approach (anti- positivist)	41
3.2.3	Triangulation (Mixed Methodology).....	41
3.3	The Main Research Question	42
3.4	Approach adopted and justification.....	42
3.4.1	Use of Interviews	43
3.4.2	Use of Questionnaires	44
3.4.3	Administering the questionnaire: online survey	44
3.5	Justification of mixing interviews and Surveys	47
3.6	Research population and sample.....	47
3.6.1	Research population and sample for online survey.....	47
3.6.2	Research population and sample for interviews.....	48
3.7	Research instrument.....	49
3.8	The Study Proposition	51
3.8.1	The Unit of Analysis.....	51
3.9	Criteria for interpreting the data	51
3.10	Access to data sources.....	52
3.11	Ethical concerns during research.....	52
3.12	Delimitation of the research	53
3.13	Chapter summary	53
4	Chapter Four: Data presentation and analysis	54
4.1	Introduction.....	54
4.2	Data analysis background.....	54
4.3	Survey findings and analysis	55

4.3.1	Career growth in green buildings	55
4.3.2	Education in Green Building Professionals	56
4.3.3	Developments most ideal for sustainable development	58
4.3.4	Contribution towards green building developments.....	59
4.3.5	Decision makers of green developments	60
4.3.6	Cost implications of green developments.....	61
4.3.7	Quantity surveyor contribution to sustainability	61
4.3.8	Effect of green experience towards sustainability contribution	62
4.3.9	Role of quantity surveyors in green developments.....	63
4.3.10	Sustainability barriers.....	65
4.3.11	Sustainability drivers	68
4.3.12	Challenges faced by quantity surveyors in green developments.....	70
4.4	Chapter summary	71
5	Chapter Five: Conclusions and Recommendations	74
5.1	Introduction	74
5.2	Evaluation of research objectives	74
5.3	Research aim.....	75
5.4	Research question.....	76
5.5	Research subsidiary/secondary questions.....	76
5.6	Limitations of the study	76
5.7	Conclusions	77
5.8	Recommendations.....	77
5.9	Areas of further research	78
	References	79
	Appendix A: Interview Questionnaire.....	92
	Section 1 – General information.....	92
	Section 2 – Interview Questions.....	92
	Appendix B: Online survey	94
	Appendix C: Interview transcripts	99

List of Figures

Figure 2.2-1 Figure 2.2 1 States of sustainability (Source: Edum-Fotwe and Price, 2009)	12
Figure 2.6-1 Sustainability in Construction (Source: Pearce, 2003).....	13
Figure 2.5-1 A Strategy for enabling sustainable construction (Source: Edum-Fotwe and Price, 2009)	29
Figure 3.4-1 Attributes of Online Surveys (Source: Evans and Mathur, 2005).....	45
Figure 4.3-1 Percentage of Green Star SA Accredited Quantity Surveyors.....	56
Figure 4.3-2 Histogram on retail and commercial developments benefitting from sustainable designs	59

List of tables

Table 2.3-1 BREEAM Assessment Criteria	16
Table 2.3-2 LEED Assessment Criteria	17
Table 2.3-3 Green Star List of Credits for Design and As Built Tool	18
Table 2.8-1 Advisors and decision makers at project design stage	36
Table 3.2-1 Positivism and anti-positivism approaches	40
Table 3.6-1 Membership Category Statistics as at 12 Dec 2014	48
Table 3.7-1 Literature link to posed questions in surveys	49
Table 4.2-1 Interviewed quantity surveyors with experience with green building projects.....	55
Table 4.3-1 Activities contributing to Green Building experience	57
Table 4.3-2 Green building projects worked on previously	58
Table 4.3-3 Building projects that benefit from sustainable designs	58
Table 4.3-4 Stakeholders contribution to sustainable specifications	59
Table 4.3-5 Decision makers of green developments.....	60
Table 4.3-6 Green aspects that increase building cost	61
Table 4.3-7 QS Contribution to sustainable design.....	62
Table 4.3-8 Importance of QS participation on sustainable projects at different stages.....	62
Table 4.3-9 Correlation between green building experience and QS contribution to sustainability	63
Table 4.3-10 Barriers to QS advising on green building designs	65
Table 4.3-11 Initiatives assisting to incorporate sustainable goals	68

Abstract

Purpose

This research investigates the role and perceptions of quantity surveyors experienced with sustainable building projects and how they are able contribute as well as influence designs to address sustainability issues on projects.

Design

To determine the considerations that affect quantity surveyors' perceptions towards sustainability in the construction industry, a literature review was carried out. This was followed by the development of an online survey formed of both structured and semi-structured questions that were issued out to South African quantity surveyors. This study administers online surveys distributed online to quantity surveyors on the ASAQs and the Green Building Council database consisting of 1499 registered members and 59 members respectively. Furthermore, in depth interviews were carried out with four quantity surveyors who had experience with green building projects.

Findings

South Africa is accustomed to traditional building methods and the adoption of and adaptation to alternative building techniques is challenging to implement in the industry. The main barriers to sustainable building designs were the perceived higher cost of the materials as well as the lack of training and knowledge consultants have on material choices. Quantity surveyors nevertheless regarded the early design stages of a construction project as an ideal avenue for contribution towards sustainable building designs. Based on interviews conducted, professional quantity surveyors with experience on green building projects were more likely to contribute towards sustainable building specifications due to lessons learnt and knowledge from previous projects. However, quantity surveyors believed they generally have little influence towards green building specifications as the client and architect have the final say on what is incorporated into a building.

Practical implications

The research study has provided a greater understanding of the role played by cost consultants on sustainability projects and how they can provide value to clients on such projects.

Conclusions and Recommendations

The research concludes that Quantity surveyors are aware that they play a minor role player on project teams when it comes to providing alternative building specifications. It was acknowledged that quantity surveyors have limited experience on sustainable technologies and that further training and education in this regard is essential for them to add value to projects.

It is recommended that further research be undertaken to obtain a larger sample size to get a clearer view of the perception of quantity surveyors advising on building specifications to support sustainable building developments.

1 Chapter One: Background and Purpose of Study

1.1 Introduction

This chapter introduces the background of the research importance of sustainability in the building industry, followed by a general discussion on the quantity surveyors role in building projects and their connection with sustainability aspects. This section develops the key research questions and objectives of the paper followed by identifying the methodology approach as well as the research justification for undertaking this study.

1.2 Background

At the 1992 Rio Earth Summit, Agenda 21 was articulated as the brainchild for sustainable developments and it is now globally agreed that sustainability is an integral part of the decision-making process (Du Plessis, 2002; Zainul-Abidin, 2008). This focus on sustainability has consequently led to a global shift towards buildings that are sustainable (Berardi, 2011).

Environmental issues in the construction industry are increasingly being considered, as clients and design teams become more conscious of the impacts (Ball, 2002). Eco labelling schemes have been developed to adopt values of environmental designs along with enhancing environmental standards in the economy (Galarraga, 2002; Ball, 2002). An example of Eco-labelling scheme used in the building industry in South Africa is the Green Star SA rating system which started in 2009 and continues to be implemented by the Green Building Council of South Africa (GBCSA, 2015). The Green Star SA rating system is based on the Australian Green Star rating system but has been adapted to suit local and environmental conditions (Rogerson and Sims, 2012). The availability of tools such as the Green Star SA rating system is seen to encourage the adoption of more green buildings in South Africa (Windapo, 2014).

The green building terminology leans towards the environmental impacts building have whilst sustainability takes on a wholistic approach on building developments that considers economic and social aspects of building designs (Wedding and Crawford-Brown, 2007). Like Zuo and Zhao, (2014), this paper interchangeably refers to sustainability and green building as both terms have common elements and because green buildings contributes significantly towards sustainable developments (Wedding and Crawford-Brown, 2007).

For environmental attributes to be adequately considered on projects a superior design team is essential (Elforgani and Rahmat, 2010). Samarasinghe *et al.* (2012) describes that input from the architect, mechanical and electrical engineers have the most influence on the development of green building projects. Quantity surveyor's role is to provide cost advice of designs, prepare procurement documentation and manage costs to ensure the client's cost objectives are achieved (Matipa *et al.*,

2008). The quantity surveyors' active involvement on construction projects provides them with an opportunity to influence green building designs along together with other industry stakeholders (Windapo, 2012).

As client's needs, markets, and the professionals are constantly changing in the construction industry, quantity surveyors are constantly being challenged to do more to earn their fees (Ashworth *et al.*, 2013). The professionals in the design team should therefore be challenged more and evolve with clients looking for services that are innovative and beyond the traditional services offered to be in line with the changing industry needs (Chong *et al.*, 2012). Quantity surveyors have the analytical skills from working on traditional buildings to fully understand design and construction that will facilitate them to contribute positively in the planning stages of the project (Ashworth *et al.*, 2013).

The Royal Institution of Chartered Surveyors (RICS) (2009) acknowledges that quantity surveyors' skills in measuring building works are well suited to advising project stakeholders on alternative building materials for development and pricing. Furthermore, such professionals have the capability to make positive contributions to projects that not only benefit the client by adding value but to the environment as a whole (Ashworth *et al.*, 2013). Given that sustainability issues are becoming more prominent in the future (Boswell and Walker, 2004), The choice of any alternative material specified ought to have an impact on the environment (RICS, 2009). Therefore, decisions made on the appropriate specifications of materials require a comprehensive assessment that guarantees that the environmental impacts are minimal (RICS, 2009).

Lützkendorf and Lorenz (2007) however both recognise that there exists minimal literature and consciousness within the construction sector of how building performance and sustainable design can add value to the buildings. For the industry and governments, it is no longer sustainable and cost effective in continuing to place a high focus on the initial capital cost of a building whilst disregarding the environmental impacts and cost over the life of the building (Bartlett and Howard, 2000).

Sustainable development and construction seek to improve the quality of human life (Hill and Bowen, 1997). As the importance and awareness of sustainable development is growing (Ekundayo *et al.*, 2011), it is important to consider what attributes can be managed to achieve the sustainability goals. Mora (2007) considers the management of materials as one of the main solutions to achieving sustainability. According to Treloar *et al.* (2001), the following principles are considered when specifying appropriate building materials for green buildings:

- Using materials with considerable amounts of recycled content such as bricks, timber and steel materials;
- Considering the possibility of a second use for the materials at the end of the buildings life although there is no guarantee that they will be reused;
- Making use of reused products;
- Having minimal construction waste from inception to project closeout;

- Choosing products with a long life. Selecting materials that are more durable in the long run will have a reduced environmental impact as compared to remanufacturing the same product again; and
- Applying financial life cycle costing on the selection of materials with the aim of having a minimal life cycle cost.

The above criteria is further supported by Mora (2007) who argues that in order for the built environment to comply with sustainability, projects should involve the use of renewable and recyclable materials.

1.3 The role of quantity surveyors on building projects

The professional quantity surveyor provides financial advice with initial cost as well as future costs of a project for the design team (Matipa *et al.*, 2008). Sonson and Kulatunga (2014) view the quantity surveyor's primary role in the construction industry to quantify and cost of construction works, whilst controlling and reporting of those costs to clients on a project. As value and cost of time are considered an important criterion for the client, there is an increasing need for design teams to focus on adding value to projects for the benefit of the client (Cartlidge, 2006). According to Ashworth *et al.* (2013), quantity surveyors are viewed as the cost experts in the construction industry that have an influential role in contributing their knowledge to developments and providing clients with the appropriate advice on costs and value in the industry. The knowledge areas of a quantity surveyor can extend from building projects, to specialised roles in engineering and industrial services which provide them with the opportunity to contribute and significantly influence design decisions (Ashworth *et al.*, 2013).

According to the RICS (2009), informed quantity surveyors have the opportunity to provide not only financial advice at the design stage which considers the capital costs, risks and value aspects but, factors that drive sustainability as well as the impact of the building's lifecycle costs. Working together with the client and the professional team, the quantity surveyor can effectively contribute towards the business case by providing realistic costs on alternative designs and construction that meet the overall business objectives whilst incorporating sustainable aspects (Matipa *et al.*, 2008). It is therefore important for the project stakeholders to receive a clear briefing from the client on their project requirements in order to ensure sustainability is carried out from the planning phase to procurement to construction (Matipa *et al.*, 2008). Designs and ideas developed for the client at the early stage will impact the client's decision to invest, rent or sell the potential building (RICS, 2009).

1.4 The role of quantity surveyors and sustainability: The problem area

The quest for sustainability has led governments and construction industry players to design strategies, policies, regulations, laws, initiatives that call for more adoption of sustainable buildings (Ortiz *et al.*, 2009). This quest has largely been driven by emissions which, are forecasted to keep growing at par with industrial growth rates as energy demands by the buildings continue to grow (IPCC, 2007). The

ability to reduce these levels of emission makes it worthwhile to give sustainability issues more attention in both developed and developing countries (Ortiz *et al.*, 2009). The assessment of sustainability in terms of materials and processes applied in construction is particularly useful as a starting point for the reduction of the negative environmental impacts (Van Reenen, 2014). The challenge with applying assessment tools is that the construction sector may not be conversant with these performance matrices as there is a shortage of expertise to predict the performance of alternative building materials in a buildings lifecycle (de Villiers, 2012).

Boswell and Walker (2004) acknowledged that within the building environment, there is a lack of sufficient technical training to low and middle level professionals to ensure sustainability in the industry. Although sustainability is the necessary motivation for change in the construction industry (Ashworth *et al.*, 2013), in developing countries, such as South Africa, the private sector serves a small market for sustainability developments. In the government sector in developing countries, there is also a lack of initiatives to develop the growth of sustainable projects (Alkilani and Jupp, 2013). Therefore, there is a need to introduce incentives or opportunities into the market to ensure sustainability can be applied into the construction industry (Boswell and Walker, 2004; Ofori, 2006).

Furthermore, within the built environment, sustainability principals are not generally applied due to the use of inappropriate traditional procurement systems that do not explicitly allow for sustainability consideration during the delivery projects (Rwelamila *et al.*, 2000). The client's traditional procurement systems generally employ the architect as the principal design consultant to provide significant architectural input followed by engineers, quantity surveyors and then the contractor (Ngowi, 1998). Irrespective of the multiple roles and personalities in the industry, there is limited contribution to the overall project design, resource and waste management at different stages of the project (Ngowi, 1998). Modern day developers/clients are however increasingly demanding from the architects and/or engineers to prepare solutions or final scheme designs that are well thought out for the life of the built structures (Mora, 2007). This provides the opportunity for consultants at the planning and procurement stages to offer advice on alternative material solutions that can reduce environmental impacts whilst still meeting the client's intent (RICS, 2009).

Research undertaken by Sonson and Kulatunga (2014) however showed that quantity surveyors place little importance on environmental sustainability issues in delivering their traditional services. Bartlett and Howard (2000) also argue that only specialists that understand the technologies involved in alternative building materials should be giving the advice unfortunately quantity surveyors are extremely conservative in costing such developments. Karunasena (2016), however notes that consultants may not be motivated in developing sustainable proposals for projects due to lack of rewards and incentives.

Professionals within the industry need to be at the forefront of driving for sustainability in maximising the building's serviceability and functionality (Lützkendorf and Lorenz, 2007). This can be done through contributions that are not only focused towards the environmental considerations but also to the

protection of social values, human health and wealth (Lützkendorf and Lorenz, 2007). Decisions made at the early stages of the project considering and reviewing sustainability issues will have an impact on the final outcome of a buildings (RICS, 2009). It is therefore vital to raise issues of sustainability in the initial stages of the project where feasibility of technical and economic alternatives is generated and ranked in order to construct the best possible project for the client (Essa and Fortune, 2005).

The selection of appropriate materials is viewed by Treloar *et al.* (2001) as a key issue encountered at project inception and can be utilised to drive sustainability on building projects. In considering material choices, all building professionals need to have sustainability as the key driving force in the decision-making process (Van Reenen, 2014). The decision should be one that not only provides a solution for the client, but considers the local economy as well as minimise the overall impact on environmental resources throughout the project lifecycle (RICS, 2009). For instance, the use of locally manufactured materials or aspects that make use of the local supply chain or other social aspects to further improve the sustainability of the project (Van Reenen, 2014).

Professional quantity surveyors have developed skills in keys areas relating to technology, information management, culture and economic aspects that can be expertly applied on projects at appropriate levels through training and practice (Ashworth *et al.*, 2013). They play an important part in the delivery of sustainable building developments at every stage of the project lifecycle (RICS, 2009). Their success will depend on their ability to adapt to changes and continuous development of their skills and competencies to contribute to meeting client's objectives (Chong *et al.*, 2012).

When it comes to selection and use of sustainable building materials, necessary knowledge, competence and expertise is required (Karunasena *et al.*, 2016). This means that the industry stakeholders should be able to inform the clients beforehand on the best building materials for sustainable buildings, how the end product will look like and also how it will benefit them and the environment (Meacham, 2010). The selection of appropriate materials is viewed by Treloar *et al.* (2001) as a key issue encountered in building projects. This role can be largely played by the quantity surveyor through bills of quantities which other stakeholders such as the engineer, architect and consultants will rely heavily on (Matipa *et al.*, 2008). Potts and Ankrah (2014) acknowledge that the quantity surveyor can provide value to the client by considering sustainability aspects to eliminate unnecessary functional costs, life cycle costs, opportunity costs and specification costs.

Boswell and Walker (2004) acknowledged that within the building environment, there is a lack of sufficient players who are trained to support sustainability. Zuo and Zhao, (2014) further support this by stating that education and training plays a key part in changing the behaviour of players towards considering sustainability aspects. Lewis (2004), further highlights that the traditional design processes of projects, which are once off, do not generally make provision for sustainable design strategies between team members. Due to the fragmentation in the building industry, some participants may have a limited contribution to the overall project design (Ngowi, 1998) as well as shared knowledge and

experience amongst key players (Blayse and Manley, 2004). Research undertaken by Sonson and Kulatunga (2014) shows that quantity surveyors place little importance on environmental sustainability issues. Professionals in the building industry need to drive for sustainable development (Karunasena *et al.*, 2016).

1.5 Research Problem

The research problem can be stated as follows:

Informed quantity surveyors have the opportunity to provide not only financial advice at the design stage which considers the capital costs, risks and value aspects but, factors that drive sustainability as well as the impact of the building's lifecycle costs. Quantity surveyors arguably have sufficient knowledge and skills to advice clients and consultants on sustainable issues but fail to do so.

1.6 Research Question

The research question has a primary question with four subsidiary questions:

Do quantity surveyors have sufficient knowledge in sustainable building developments to effectively engage and advise on strategies for sustainable specifications at a project planning level?

From the above primary question, four subsidiary questions need to be subsequently addressed:

- 1. How can we identify quantity surveyors who are sufficiently knowledgeable and can provide sustainability advice?*
- 2. Where do quantity surveyors attain the knowledge regarding sustainable building developments?*
- 3. What is the quantity surveyors' impression to giving advice on alternative building materials based on their knowledge of the building industry and previous experience?*
- 4. To what extent do quantity surveyors perceive themselves to be able to influence project changes at planning stages in favour of sustainability?*
- 5. What are the factors that influence quantity surveying practices to adopt a different mind-set to sustainable thinking and pricing?*

1.7 Research assumptions

To guide this study, the research assumption may be stated as:

There is a role for quantity surveyors in South Africa to engage and provide strategic advice on sustainable projects at an early stage of a project. However quantity surveyors do not perceive themselves having a major role in effectively engaging and advising sustainability aspects of projects.

1.8 Research aim and objectives

This research aims to provide insight into the perceptions of quantity surveyors on their ability advising sustainable building developments at the project planning phase in South Africa.

The following objectives of this research to:

- Determine the self-perception of quantity surveyors towards advising on alternative building specifications for sustainable buildings designs;
- To understand how to recognize quantity surveyors with the appropriate knowledge to provide insights on sustainable building;
- Establish to which degree, their willingness to give advice on sustainable building materials based on their knowledge of the building industry and previous experience;
- Gauge the ability of quantity surveyors to influence project changes at planning stages in favour of sustainability; and
- Identify factors that influence quantity surveying professionals to adopt a different mind-set to sustainable thinking and material costing.

1.9 Proposed research design and methodology

The research methodology makes use of both qualitative and quantitative approaches as discussed by Fellows and Liu (1997) and Babbie and Mouton (2005). Both approaches provide greater insight into the research problems from understanding multiple viewpoints (Creswell, 2013).

Literature from published online articles, journals, books and the internet provides background information to understand to what extent quantity surveyors are involved in advising on specifications and their understanding of sustainable building developments.

This research paper gathers the quantitative and qualitative data using online surveys and interviews. The collected data is analysed and discussed to draw conclusions.

To identify the perceptions of practitioners registered on the ASAQS database as well as distributed to practitioners in the Green Building Council South Africa (GBCSA) website. The intention of selecting the GBCSA as a part of the population is not only to identify the extent of quantity surveyors who are registered as Green Star accredited professional but to obtain clearer insight on from these practitioners on the research problem as opposed to only using practitioners registered on the ASAQS database.

Concurrently, interviews were undertaken with practitioners who as lead quantity surveyors had first-hand knowledge and experience working on green building projects. The interviews explored the roles quantity surveyors played and understand how they perceived their role to be different on green building

projects. The interviews also identified the lessons learned on green building projects to see how quantity surveyors can contribute more towards sustainable developments.

1.10 Limitations

This study did not focus on the perceptions of quantity surveyors towards sustainability aspects outside South Africa. Furthermore, the research was limited to the role quantity surveyors played in the initial pre- contract stage in projects and not during project execution.

As perceptions are subjective, the participants views may not be a true reflection of the entire industry as each have their own unique experiences. Furthermore, due to the limited literature on green buildings and sustainability in the South African construction industry, literature has been drawn from international sources. Another notable limitation the research faces is the risk that insufficient responses will be collected from the online surveys as practitioners may have busy schedules and thus unable to complete to surveys. This may impact on the validity and generalisability of the findings.

1.11 Research justification

According to, the construction industry is facing a real challenge as it tries to achieve sustainability. These challenges therefore require a global solution for improving peoples well-being without negatively impacting on other or the environment (Vanegas, 2003). According to Pearce (2003), solutions are required for challenges such excessive construction waste, resources consumption, environmental degradation, schedule delays and budget overrun among other challenges that face most construction projects.

Furthermore, the social characteristics of sustainability are generally not as adequately addressed by stakeholders compared to the environmental aspects during the development process of the project (Edum-Fotwe and Price, 2009).

The importance of the study therefore allows for professionals in project teams to think imaginatively in their recommendations on specifications for sustainable developments. Through the understanding of sustainability framework, consultants can apply practical thinking in their approach to their work and findings from this study can be used as a real world example to see the challenges, issues and solutions. This study further creates awareness on the capabilities of quantity surveyors that is not only limited to the traditional services but on value adding services that will benefit the client and the environment.

1.12 Structure of the report

The report is broken down in five sections:

Chapter 2 contains a review of already published literature on the issue which provides the framework of sustainability and the impact of material specifications. The chapter begins by looking at how the built environment can be made sustainable and then looks at green rating systems from various parts of the globe. The principals of sustainability are then assessed with a view to documenting the challenges facing the industry in the quest for sustainability. The role professional's play in delivery of sustainable specifications, quantity surveyors' role in determining costs and advising on sustainability development are also reviewed.

The primary areas therefore that are the concern of this study is covered in Chapter 2 are the following:

- (1) Sustainability in the built environment
- (2) Collaboration towards sustainability in the South African construction industry
- (3) Construction professional lifecycle costing and
- (4) The quantity surveyor's role in sustainability

Chapter 3 reviews the methodology applied to gather data in the context of the specific theoretical approach to be followed to address the research objectives.

Chapter 4 presents the findings obtained from the research using the applied methodology in chapter three. An analysis on the findings is also be carried out in this chapter comparing it with the review of existing literature in chapter two.

Chapter 5 provides conclusions and recommendations in the framework of the research objectives. Possibilities for further research are discussed in this chapter.

2 Chapter Two: Literature Review

2.1 Introduction

This chapter contains the literature review that provides the framework of sustainability and the impact of material specifications. The chapter begins by looking at sustainability in the built environment to provide an overview of the topic under study and to lay the ground work in terms of standard definitions. The role of building environment professionals in the delivery of sustainable specifications follows where each professional is analysed to enable the researcher to build the case towards collaboration as identified in some of the works later covered; this also sheds light on the critical role played by the quantity surveyors in determining costs and advising on sustainability development which is addressed in detail.

Quantity surveyors primarily provide financial as well as contract administration and procurement advice on construction projects (Nkado and Meyer, 2001; Mbachu, 2015). In new marketplaces however, the dynamic profession of the quantity surveying (Olawumi and Ayegun, 2016) is faced with growing challenges and opportunities (Dada and Jagboro, 2015). Hiew and Ng (2007) writes that there is increasing emphasis on sustainable construction in the built environment and that is a threat to quantity surveyors are viewed as lacking the skills to give strategic advice on such projects. Frei et al., (2013) also argues that this market growth for sustainable construction provides an opportunity for quantity surveying firms to develop and market their services in this sector.

2.2 Sustainability in the built environment

The Royal Institution of Chartered Surveyors (RICS) describes sustainability to be a dynamic balance of social, economic and environmental elements that can be applied at an international, national and local level of an economy (RICS, 2009). It is now a globally agreed notion that sustainability should form a part of the decision-making process (Zainul-Abidin, 2008). There is a growing focus on sustainability that has led the built industry to shift more focus towards the production of buildings that are deemed to be sustainable (Berardi, 2011).

The quest for sustainability has kept governments, other bodies and players in the industry busy designing strategies, policies, regulations, laws, initiatives to push for more adoption of sustainable buildings (Arif *et al.*, 2009). The key driving force behind this quest for sustainability has largely been emissions, which are forecasted to keep rising at par with industrial levels as energy demands by the buildings increase (IPCC, 2007). The ability of buildings to reduce these projected levels of emission to the minimal makes it credible for more attention to the building sector (IPCC, 2007). This leads to the need for sustainability rating methods to rank buildings in terms of their sustainability or greenness (Arif *et al.*, 2009).

2.2.1 Principles of sustainability

For quantity surveyors to deliver on sustainable aspects of projects, practitioners should understand the principals of sustainability (SACQSP, 2012). To gain a broad view of sustainability, the principals of sustainability are broken down into three essential characteristics that can be broken down into further issues (Hill and Bowen, 1997; Edum-Fotwe and Price, 2009) namely:

- **Economic sustainability**

Economic sustainability relates to the exchange of goods and services. Sustainable developments have the ability to generate an increasing per capita of quality of life over a period, which leads to improved real incomes, healthier well-being and education of people, enhanced value of natural and built environments. This is enhanced through any incremental profitability that results from benefits of more efficient use of resources (Pearce, 2003). To achieve the economic benefits of green buildings the environmental and social costs must be suitably priced (Eichholtz *et al.*, 2010)

- **Environmental sustainability**

Environmental sustainability relates to recognising the limits of our environment and the need to consume resources less to maintain a healthy state (Vanegas, 2003). This further entails avoiding irreversible environmental changes through optimal use of resources, waste management and protection (Pearce, 2003).

- **Social sustainability**

Social sustainability looks at improvement of the quality of life and is viewed as one of the most challenging aspects to define (Hill and Bowen, 1997) as it is an ever-evolving concept (Vanegas, 2003). It has characteristics that can vary considerably from different stakeholders having diverse views that are also dependant on the lifecycle stage of the project (Valdes-Vasquez and Klotz, 2012). For instance, at the planning phase making consideration for the local community involvement on a project or considering the impact of the project on the workers involved. There are four fundamental areas which the social characteristics embrace that is, community involvement in projects, and private sector involvement in corporate social responsibility, design safety, and societal design (Venegas, 2003).

Delving into the concept of community involvement, there is a direct link to the negative environmental consequences arising because of construction projects, local communities could however be engaged on the non-technical elements of construction (Vanegas, 2003). This does not only enable locals to derive financial gain but ensures a communal buy in into the project (Valdes-Vasquez and Klotz, 2012). When approaching social aspects from a corporate social responsibility perspective, such can be seen through the eyes of game theory (Kolk, 2003; Olander and Ladin, 2005; Mathur *et al.*, 2008) where a corporate's is held accountable for their efforts towards development of projects (Valdes-Vasquez and Klotz, 2012). The safety through design characteristic on the other hand incorporates measures to

counter safety hazards during the pre-construction phase while the social design factors collaboration from the team involved in designing the project towards social sustainability (Valdes-Vasquez and Klotz, 2012).

In their research on social considerations in the preconstruction phase, Valdes-Vasquez and Klotz (2012), could come up with fifty processes which they merged into six categories that clustered social sustainability into the contexts of the: stakeholder concerns, client considerations, team composition, management concerns, impact assessment, and location contexts. While acknowledging that similar studies had appreciated the concept of social sustainability being the result of processes, their study could be classified as the first to assimilate the processes into an all-inclusive framework.

represents the core concepts of sustainability, sharing the overlapping concepts:

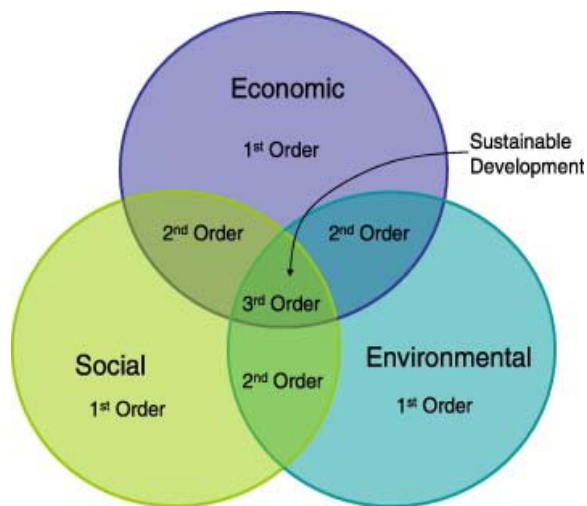


Figure 2.2-1 Figure 2.2 1 States of sustainability (Source: Edum-Fotwe and Price, 2009)

The three factors discussed are continuously changing to meet the needs of the environment and humans (Vanegas, 2003). Sustainable development is viewed to be achieved where there is optimisation of all three concepts, which are overlaid as shown in Figure 2.2-1 and referred to as the third order. The second order denotes the optimisation of two factors at the expense of the third factor, for example the environmental and economic dimension at the cost of the social aspect. Traditionally on construction projects, the focus is on the economic aspect of sustainability (Edum-Fotwe and Price, 2009).

Incorporation of the social, economic and environmental dimensions can better promote dealing with sustainable issues on construction projects (Edum-Fotwe and Price, 2009). Valdes-Vasquez and Klotz (2012) also supports the importance of the social characteristics of sustainability as it impacts on not only the project but the people affected by the project.

2.2.2 Evolution of Sustainability in the construction industry

As a large consumer of resources, the construction industry has a significant impact on the natural environment (Hill and Bowen, 1997; Boswell and Walker, 2004; Ekundayo *et al.*, 2011). The continued depletion of natural construction resources has caused the increasing need for the construction industry to start thinking about sustainability and development (Ekundayo *et al.*, 2011). Sustainability is part of the complete project lifecycle that starts well in advance of construction and continues well after the construction has been completed (Hill and Bowen, 1997; Myers, 2005). It is therefore significant to address the issues of sustainability at the beginning of project design where a range of decisions regarding the project are made (Talukhaba *et al.*, 2005, Essa and Fortune, 2008).

Figure 2.2-2 shows the three principals interlinked in the sense that they are dependent on each other to some extent. Case in point, environmental impact assessment studies normally incorporate findings based on inputs from the social principles as a cultural input (Burdge, 2004). Environmental impact assessment studies are largely commissioned by governments through government agencies to ensure that communities do not suffer from any environmental or monetary harm (Hammond and Peterson 2007; Hammer 2009).

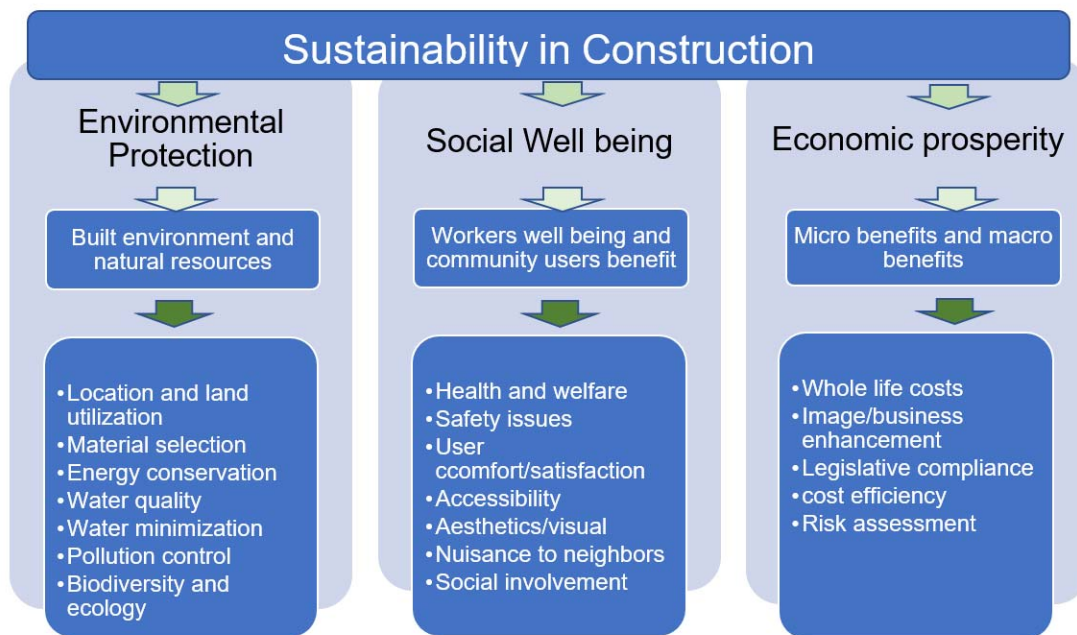


Figure 2.2-2 Sustainability in Construction (Source: Pearce, 2003)

2.2.3 Sustainability certification systems

There has been global growth of green markets that has resulted in the development of certification and labelling programmes (Kotchen, 2006; Fuerst and McAllister, 2009). Such programmes form part of policies that provide markets with guidelines to willingly participate in the enhancement of environmental performance of building developments (Kotchen, 2006; Burnett, 2007). Furthermore, through certification and labelling programmes, businesses have the facility to prove their buildings have high performance standards (Burnett, 2007), along with showing the perceived benefits such as improved productivity and lower maintenance costs, making it attractive for potential occupiers (Fuerst and McAllister, 2009). However, whilst there are several existing certification systems, they are still voluntary (Fuerst and McAllister, 2009) thus their diffusion into the construction industry has identified as low by Berardi (2012).

In order to assess the sustainability of buildings, various green rating systems such as Leadership in Energy and Environmental Design (LEED), Building Research Establishment Environmental Assessment Method (BREEAM), Comprehensive Assessment System for Building Environmental Efficiency (CASBEE), HK-BEAM as well as the Australian and South African Green Star SA rating system (Rogerson and Sims, 2012) have been developed to achieve the fusion of various techniques to rank and rate buildings as sustainable (Castro-Lacouture *et al.*, 2009). Certification and labelling programmes tools are categorised into two aspects, namely: assessment and rating. The main distinction is that assessment tools are quantitative while rating tools use the star-based classification to rate a building's performance level (Berardi, 2011).

The rating systems mentioned provide a framework for assessing the performance of several types of buildings to achieve different labels and certification (Gowri, 2004; Haapio, and Viitaniemi, 2008). The assessment tools cover several aspects such as life-cycle, energy utilization, water efficiency, indoor environmental quality and sustainability which could be based on its matter and wholesomeness of adoption of sustainability solutions (Castro-Lacouture *et al.*, 2009; USGBC, 2000). Assessment of sustainability in terms of materials used and processes used in construction is particularly useful in that it provides the starting point for reduced environmental impact (IPCC, 2007). However, energy utilization as a performance metric is observed by Berardi (2011) as the most critical aspect in measuring sustainability and by virtue of this being the hardest to attain.

The tools mentioned are used by professionals in the design team and other appropriate users in adopting a standard approach entailing the assessment, rating and labelling of buildings (Cole, 2005). It is critical to differentiate between methods that are adopted for assessment, for rating and for labelling as shown below:

- **Assessment method**

This refers to techniques adopted through a given framework to assess buildings in terms of their responsiveness to environmental needs (Larsson, 2004). Cole (2005) further adds that the techniques used in the assessment methods are generally accompanied with verification from a third party's prior to obtaining a rating or label.

- **Rating system**

Rating systems are applied within the assessment methods where scores are allocated on keys issues resulting into an overall performance matrix (Larsson, 2004).

- **Labelling system**

This borrows from the above rating system with the main difference being that the industry adopts a structured way of labelling assessing buildings and cascading this to the industry through training of assessment experts (Larsson, 2004). Labelling systems have been developed for various building types and are broadly accepted by owners, tenants and project teams that are looking to achieve sustainable buildings (Larsson, 2004). Labels issued by independent third party certification programmes such as BREEAM and LEED provide trustworthy easily recognisable labels (Cole, 2005).

2.3 Tools used to evaluate sustainability in the built environment

To contribute towards sustainable construction, the quantity surveyor needs to be fully integrated into the early design stages to be proactive as well as add value to the process (Matipa *et al.*, 2008). There are several tools are available to professional team such to evaluate sustainability in the built environment, namely:

- Rating systems
- Lifecycle sustainability assessments
- Value management

These tools have been standardised approaches for determining costs together with environmental impacts of sustainable developments (Bartlett and Howard, 2000):

2.3.1 Rating systems

This research focuses in on four rating systems, namely, BREEAM, LEED, Green Star Rating (Australia) and the Green Star SA Rating tool (South Africa) as they are known to have a significant global influence (GBCSA, 2013). These tools consider sustainability as well as design issues ranging from the use of green materials, energy use, indoor air quality, recycling amongst others (Van Reenen, 2014). The following building rating systems have been developed to quantitatively assess the environmental performance of buildings (Diamond, 2011):

2.3.1.1 British Building Research Establishment Environmental Assessment Method (BREEAM) - First Generation

BREEAM is considered as the first all-inclusive green building rating tool that was commercially available (Haapio and Viitaniemi, 2008; Berardi, 2011). BREEAM was set up in the early nineties in the UK and could well be regarded as the blue print for rating of sustainable construction in terms of how green buildings are assessed (Cole, 2005). The early head start gives BREEAM advantages in that it was used by more players since it could be regarded as a pioneer (Seo, 2002). Due to its success in the UK, an international version of BREEAM was created (Cole, 2005).

The method uses a Likert scale that rates the overall greenness score of a building on a continuum spanning from fair (pass) to excellent (Seo, 2002). BREEAM assessments are only undertaken by licensed assessors (Saunders, 2008). Table 2.3-1 below indicates the assessment criteria used for determining environmental performance with BREEAM:

Table 2.3-1 BREEAM Assessment Criteria

Criteria	Description
Management	Overall policy, commissioning and procedural issues
Energy use	Operational energy and CO2 issues
Health and well being	Indoor and external issues affecting health and well being (lighting, air quality, hazardous materials, radon, indoor noise, hot water system)
Pollution	Air (CO2, NOx, CFCx, HCFCs, Halons) and water pollution
Transport	Transport related CO2 and location related factors
Land use	Greenfield and brownfield sites
Ecology	Ecological value of the site
Materials	Environmental implication of building materials
Water	Consumption and water efficiency

(Source: Seo, 2002)

With time, BREEAM has been revised to suit emerging needs and to cover different construction projects. Since its launch in the UK, BREEAM has been adopted in other countries in different continents the most significant one being in Canada given that LEED, another system born and bred in the USA was developed.

2.3.1.2 Leadership in Energy and Environmental Design (LEED) - First Generation

LEED is another example of a green labelling system developed in the US in 1998 by the U.S. Green Building Council and covers almost any building type (Seo, 2002). It has seen its use adopted in all states in the US and in other countries including India and Spain (Larsson, 2004). It is worth noting, that this programme was heavily borrowed from its predecessor; BREEAM (Saunders, 2008). LEED however uses a checklist format that aggregates scores for different aspects resulting into an overall rating that is certified as silver, gold and platinum (Seo, 2002; Haapio and Viitaniemi, 2008). Table 2.3-2 below indicates the assessment criteria used for determining environmental performance with LEED:

Table 2.3-2 LEED Assessment Criteria

Criteria	Sub-criteria	Points*
Sustainable Sites	site selection, urban redevelopment, brownfield redevelopment, alternative transportation, reduced site disturbance, stormwater management, landscape & exterior design to reduce heat Islands, light pollution reduction	14
Water Efficiency	water efficient landscaping, innovative wastewater technologies, water use reduction	5
Energy & Atmosphere	optimise energy performance, renewable energy, additional commissioning, ozone depletion, measurement & verification, green power	17
Materials & Resources	building reuse, construction waste management, resource reuse, recycled content, local/regional materials, rapidly renewable materials, certified wood	13
Indoor Environmental Quality	carbon dioxide (CO ₂) monitoring increase ventilation effectiveness, construction IAQ management plan, low-emitting materials, indoor chemical & pollutant source control, controllability of systems, thermal comfort, daylight & views	15
Innovation & Design Process	innovation in design, LEED™ accredited professional	5

(Source: Seo, 2002)

Its rapid success in the US has seen some public institutions as well as organisations increasingly specifying LEED performance requirements in developments (Cole, 2005). This system covers over ten building classifications. With the exclusion of LEED for Neighbourhood Development commonly referred to as LEED-ND, the LEED assessment system focuses on five thematic areas which are outlined below (Retzlaff, 2008):

- Ensuring site development is sustainable at all stages;
- Efficient use of water;
- Efficient use of energy;
- Materials selection; and
- Innovation in the quality of the Indoor surroundings.

With its continued implementation, the LEED system is now being used in different continents such as Africa, America Asia and Europe (Haapio and Viitaniemi, 2008).

2.3.1.3 Green Star Rating (Australia) – Second Generation

Green Star was established in 2003 based on the BREEAM and LEED methodology but adapted to suit Australian local conditions such as the large Australian area with differing climates, as well as local building industry standards (Saunders, 2008). As it draws knowledge from the established tools and tailor made to suit the Australian environmental context it is considered a second-generation tool (Sebake, 2008). The Green Star rating system is comprehensive evaluates aspects of building design of whether new or as-built, the environmental performance of buildings as well as internal fit outs of buildings (GBCA, 2015).

Table 2.3-3 below indicates the assessment criteria used for determining environmental performance with Green Star Design and As built:

Table 2.3-3 Green Star List of Credits for Design and As Built Tool

Credit	Credit Sub- Criteria	Points available
MANAGEMENT	Green Star Accredited Professional	1
	Commissioning and Tuning	4
	Adaptation and Resilience	2
	Building Information	2
	Commitment to Performance	2
	Metering and Monitoring	1
	Construction Environmental Management	1
	Operational Waste	1
INDOOR ENVIRONMENT QUALITY	Indoor Air Quality	4
	Acoustic Comfort	3
	Lighting Comfort	3
	Visual Comfort	3
	Indoor Pollutants	2
	Thermal Comfort	2
ENERGY	Greenhouse Gas Emissions	20
	Peak Electricity Demand Reduction	2
TRANSPORT	Sustainable Transport	10
WATER	Potable Water	12
MATERIALS	Life Cycle Impacts	7
	Responsible Building Materials	3
	Sustainable Products	3
	Construction and Demolition Waste	1
LAND USE & ECOLOGY	Ecological Value	3
	Sustainable Sites	2
	Heat Island Effect	1
EMISSIONS	Stormwater	2
	Light Pollution	1
	Microbial Control	1
	Refrigerant Impacts	1
INNOVATION	Innovation	10

(Source: GBCA, 2015)

A Green Star certified rating can be undertaken by a member of the project team that is a qualified approved assessor with the Green Building Council Australia (Saunders, 2008). Green Star uses a score card approach that calculates the total points attained to determine an overall Green Star certification mark of 4, 5 or 6 Green Star (GBCA, 2015).

2.3.1.4 Green Star Rating (South Africa) – Second Generation

The Green Building Council of South Africa (GBCSA) Board was established in 2007 adopted from the Australian rating system and is also voluntary. This adoption was informed by the fact of the three main rating systems (BREEAM, LEED and GREEN Star Rating (Australia)), the GREEN Star Rating (Australia) was the closest to the South African building environment. This was then customised to the South African setting and tailored for the various sectors namely commercial, retail and/or residential. GBCSA uses several criteria to define what qualifies as a green building based on recyclability of building materials used during construction, efficient utilization of water, energy and resource efficiency and environmental focus in terms of minimizing negative impact (GBCSA, 2013).

The rating system lies on a continuum starting with four star for adoption of standard practices, five star on the other hand reflects excellence while six-star rating depicts adherence to all global standards (Media Club South Africa, 2013). This is achieved through use of the following (GBCSA, 2013):

- Management which looks at the value chain in terms of conceptualization through actualization;
- Indoor ecology management;
- Material logistics in terms of fetching it from the source to the construction site;
- Utilization of water during construction and management of the water system utilization post completion;
- Material usage to ensure minimal environmental degradation through;
- Land use and ecology;
- Minimal emissions during formation of raw materials, customization during construction and post construction usage emissions;
- Overall energy efficiency from and conceptualization through building usage;
- Innovation through modern technologies, ideas and benchmarking aimed at achieving the least environmental impact.

Since the adoption of the Green star rating SA in 2009, there has been an increased adoption leading to more green buildings and this number is expected to have grown to over 50 within five years since its adoption (GBCSA, 2015).

2.3.1.5 How rating tools impact on QS contribution to sustainability

As focus shifts to environmental degradation globally, green rating tools used to assess sustainable designs have gained traction and become more popular (Dwaikat and Ali, 2016). These tools are usually incorporated at the design stage and are increasingly being adopted as a guiding principle (Cole, 1999). While this is commendable, it would be more prudent to ensure this is factored at the concept stage preferably at impact assessment stage and ensure the inputs of collaboration are incorporated (Wu and Low, 2010). As part of the design team using green rating tools, quantity surveyors can recognise the value of design solutions developed and aptly provide for various costing scenarios (Kohler and Lützkendorf, 2002).

As quantity surveyors core competency is to determine costs, by working on green building projects, they can develop analytical costs and create benchmarks based using the green rating tools available (Rehm and Ade, 2013). As stated by Bartlett and Howard (2000), the rating and labelling tools are used by decision makers therefore it is important for quantity surveyor to understand and demonstrate the cost implications of various green costs. Quantity surveyors thus need to be knowledgeable on green building rating tools to be able to develop cost models that are adept green buildings and certification required (Seah, 2009).

2.3.2 Life Cycle Sustainability Assessment (LCSA)

LCSA studies the three dimensions of sustainability, the environmental, economic as well as the social aspects to adopt a holistic evaluation approach to determining a suitable sustainable approach to projects (Finkbeiner *et al.*, 2010). These following are useful tools used in the decision-making process that focuses on practical aspects of building developments (Gluch and Baumann, 2004):

2.3.2.1 Life Cycle Assessment (LCA) (Environmental)

The LCA method is a well-established and internationally recognised concept that is inclusive of environmental aspects of sustainability (Kloepffer, 2008; Finkbeiner *et al.*, 2010). As a systematic tool, it is a framework (Fay *et al.*, 2000) which assess a buildings impact on the environment from the manufacturing level to disposal of components in quantitative manner (Whitehead *et al.*, 2014). Challenges can arise due to lack of data to carry out the assessments as well as complexities in construction and assigning appropriate weights to impacts (Whitehead *et al.*, 2014).

The following tools are available to assess environmental impacts in a variety of countries (Whitehead *et al.*, 2014):

- The BEES (Building for Environmental and Economic Sustainability)
- Invest 2 - UK
- ENVEST Au - Australia
- Athena Impact Estimator - USA
- Eco-Quantum – Netherlands
- EcoEffect – Sweden
- SBTool - Canada
- BASF SEEBALANCE - USA
- ABB LCALight - USA
- Eco-Impact Evaluator - USA
- SBAT – South Africa

Life cycle assessments are integrated into certification systems to promote sustainability (Bribián *et al.*, 2009). The assessments evaluate and analyse some of the following aspects on building projects to develop appropriate environmental strategies (Fay *et al.*, 2000):

- Durability of building materials (Mora, 2007);
- Embodied energy (Fay *et al.*, 2000);
- Operational energy/ energy consumption (Fay *et al.*, 2000; Bribián *et al.*, 2009);
- Energy loads (Bribián *et al.*, 2009);
- Carbon dioxide emissions (Bribián *et al.*, 2009);
- Waste management (Bribián *et al.*, 2009).

2.3.2.2 Life cycle costing (LCC) approach (Economic)

LCC has been developed as alternative methodologies for assessing sustainability on projects (Aye *et al.*, 2000). LCC provides a framework to determine all real associated building costs, direct or indirect, are summarised to determine whether a sustainable development can be feasible (Kloepffer, 2008).

The following aspects are considered in LCC:

- Building operating costs
- Energy costs (including the embodied energy)
- CO₂ emission savings
- Demolition/ recycling costs

The life cycle costs of a project have a direct impact on sustainability issues that need to be carefully considered (Boswell and Walker, 2004). These costs consider features of the building such as reusability, sustainability, operating, replacement and demolition costs (Boussabaine and Kirkham, 2008). In considering whole life costs, the demonstration needs to be shown of the how lower maintenance costs can offset the initial high capital costs an alternative solution may have on the influence of the decision makers (Bartlett and Howard, 2000). However, due to the lack of availability of data to determine life cycle costs accurately, applying this technique can be challenging when it comes to costing project (Boussabaine and Kirkham, 2008).

2.3.2.3 Social Life Cycle Assessment (SLCA)

SLCA captures the assessment of the social impacts and benefits against societal values and goals, although it is difficult to quantify in a meaningful way (Finkbeiner *et al.*, 2010; Dreyer *et al.*, 2010). Although this method is still under development, there is growing attention towards the consideration of social aspects whilst carrying out the life cycle assessments on projects (Jørgensen *et al.*, 2008; Kloepffer, 2008). The following lists some of the social indicators considered with the SLCA approach (Jørgensen *et al.*, 2008; Hosseinijou *et al.*, 2014):

- Human rights
- Labour rights and practices and fair working conditions
- Society
- Product responsibility
- Legislation compliance
- Management issues
- Health and safety
- Socio-economic consequences
- Governance

In South Africa the Sustainable Building Assessment Tool (SBAT), which is a performance based tool, considers 15 areas in buildings that deal with environmental, social and economic issues (Cole, 2005; Gibberd, 2001). This tool addresses areas where basic human needs are not covered in other assessment tools and is suitable for developing countries such as South Africa (Gibberd, 2001).

Some social relationships considered with this tool include (Gibberd, 2001):

- Occupant Comfort
- Inclusive Environments
- Access to Facilities
- Participation & Control
- Education, Health & Safety Local contractors

In construction developments, the selection of appropriate building materials used in buildings has a significant impact on the environmental, economic and social aspects and should be considered within the project lifecycle evaluation for better decision making (Hosseinijou *et al.*, 2014). For example, the in choosing between steel and concrete for building structures, one can consider what is more socially favourable as a sustainable option with the following criteria (Lehmann *et al.*, 2013; Hosseinijou *et al.*, 2014):

- Communities affected by the material selection (workers and local communities) e.g. communities close to cement production sites are affected negatively by excessive amount of air and noise pollution during the mining of limestone for cement production.
- Working conditions in the sourcing and production of materials
- Community engagement
- Community dedication to sustainability matters
- Contribution to socio-economic performance
- Recovery at the end of the lifecycle

Few social aspects can be associated with the product/process (Jørgensen *et al.*, 2008) and determining the appropriate weighting for the categories identified can be difficult (Hosseinijou *et al.*, 2014). It is however vital to determine and analyse the social issues of development activities to enhance better decision-making.

2.3.2.4 Quantity surveyors and life cycle assessments

Within a construction project it is essential to consider early in the project appropriate sustainable designs to successfully integrate sustainable features into a development (Gibberd, 2001; Essa and Fortune, 2008). Life cycle costing forms the body of knowledge required by quantity surveyors (Nkado and Meyer, 2001). The SACQSP (2012) also identified one of the core activities/competency of a South African quantity surveyor is to take on whole life appraisals on projects. Quantity surveyors are well positioned in the design team to determine the real associated building costs from inception up to its anticipated life span (Seah, 2009). Aspects of environmental, economic and social issues should be linked in determining a projects sustainability impact and help in the decision-making process (Gluch and Baumann, 2004). These full costs, can used in preparing project appraisals where the whole life costs of the building are considered to determine a projects viability (Othman, 2007). Furthermore,

Green (2015) states that quantity surveyors are suitably placed to pressure the design team to consider whole life matters of future projects which can ultimately result in savings and efficiencies.

2.3.3 Value management

Value Management (VM) refers to the process of adopting a client-inspired structured approach towards achieving project objectives. VM as a tried and tested process has been in place for over five decades. While sustainability as a term is seldom used in VM, its components for instance energy efficiency, waste minimization, minimized running costs are common terms in value management (Zainul-Abidin, 2008). The ability of VM to deliver sustainability is anchored on five strengths: value management participants, knowledge dissemination, strategic timing, effective process and effective tools and techniques:

- Role of value management participants:
Each VM is composed of three types of participants namely decision makers who are the clients who decide on project specifications, facilitators who raise awareness on sustainability and team which implements what has been targeted.
- Knowledge dissemination:
The assembly of all participants provides an information transfer opportunity and a forum where sustainability can be given audience. This ensures that the process is speedier and effective (Fong, 2003).
- Strategic timing:
While sustainability is meant to form part of the fabric of the entire project lifecycle, this can only be so if these aspects are assimilated much earlier in the project (Zainul-Abidin, 2008).
- Effective process:
VM provides an opportunity to align objectives of each player in a systematic manner towards sustainable results (Zainul-Abidin, 2008).
- Effective tools and techniques:
VM offers a myriad of tools that are geared towards a better built environment. While their tools are aimed at cost efficiency, this provides a bright opportunity to showcase the fact that sustainability is not necessarily costly to implement as is usually presumed Neasbey *et al.* (1999).

Zainul-Abidin (2008) observed that VM has many qualities that can adopt to enhance sustainability in projects. This however calls for not only active participation but integration of all VM aspects in all steps of the project lifecycle especially at the introduction stage. Material costs are another aspect that is worth considering (Treloar *et al.*, 2001) as the source of materials has been found to be a subset of other factors such as transport distance, country of origin, process involved and raw materials. Treloar *et al.* (2001), therefore front practical solutions to this as higher recycle content, use of local materials,

use of long-life materials and use of materials that do not lead to an increment in life-cycle energy over a building's useful life.

The focus of value management is to create cost effective designs that address the client brief and produce better performing building projects (Aigbavboa *et al.*, 2016 ; Kulasekara *et al.*, 2013). However, in the South African construction industry value management is not fully implemented even though it is recognised as a vital element in the construction industry (Aigbavboa *et al.*, 2016). Quantity surveyors developing cost plans in the design stages are recommended to be actively involved in the value management process to eliminate unnecessary costs ensuring that solutions generated are within the clients' budgets (Potts and Ankrah, 2014). Karunasena *et al.* (2016), notes that for practitioners to lead the process they require the knowledge, skill and experience to in value management to achieve the sustainability objectives of a project.

2.4 Challenges to attaining sustainability

According to Ugwu and Haupt (2007), the construction industry is facing a real challenge as it tries to achieve sustainability. A global solution for improving peoples well-being without negatively impacting on other or the environment (Vanegas, 2003). Furthermore, the social characteristics of sustainability are not sufficiently addressed by stakeholders compared to the environmental aspects during the development process of projects (Edum-Fotwe and Price, 2009). According to Pearce,(2003), solutions are required for deal with construction challenges such excessive construction waste, resources consumption, environmental degradation, schedule delays and budget overruns among other challenges that face most construction projects.

The following barriers to sustainability have been identified as by various authors are discussed below:

2.4.1 Knowledge and awareness

The SACQSP (2012) identifies one of the core competencies of a South African quantity surveyor is to contribute towards sustainability assessments on projects.

The following factors have been considered to impact sustainability in the built environment:

- Education and attitudes of stakeholders, particularly the ones that have a significant influence on the decisions that will impact on the sustainability of the project, will have an impact on the projects ability to be sustainable all through its lifecycle (Ugwu and Haupt, 2007);
- The short term approach in making decisions as opposed to consideration of the projects lifecycle, preventing the ability to make effective and well thought out decisions (Ugwu and Haupt, 2007);

- The difficulty in assessing the performance and benefits of sustainable building designs (Lützkendorf and Lorenz, 2007). Stakeholders lack the tools that can assist in their analysis and backup of decisions to promote sustainable developments (Ugwu and Haupt, 2007); and
- Berardi (2012) states that the challenge with sustainability is that the construction sector is not conversant with these performance matrices as they are largely new concepts especially in most African countries (excluding South Africa).

The above mentioned problems can however be addressed through training of stakeholders in order to increase their knowledge on sustainable projects (Ugwu and Haupt, 2007). Stakeholders that are well-informed on sustainability issues accompanied by a supportive environment are likely to make high impact decisions on implementation of sustainability initiatives (Ngowi, 1998; Glass *et al.*, 2008).

2.4.2 Finance

There is a misunderstanding that integrating sustainable designs and technologies (van den Brand, 2004) into projects results in additional cost for projects (Lewis, 2004). This could be as results of the project's failure to articulate its vision from the word go, thus more is needed to ensure that evidence of appropriateness of sustainability aspects exists by outlining its benefits and qualities to projects (Van Bueren and Priemus, 2002; van den Brand, 2004). The perceived higher cost of sustainable designs is a significant barrier as the client may not have provision for sustainability aspects within a project (Revel and Blackburn, 2007; Eichholtz *et al.*, 2010). Studies by Dwaikat and Ali (2016) indicate that the cost premium ranges between 0.4% to 21% for the development of green buildings. Winston (2010) opines that for there to be sustainability in the industry, higher than normal standards of quality must be observed in developments. These standards include; energy efficiency, the environment in which they are built should ensure proper cleanliness and adequate security, be close to recreational areas and social amenities, also residents should easily access public transport from these houses (Winston, 2010). For such projects to be undertaken, the developers need to secure a large amount of money which can at times prove challenging.

When aspects of sustainable designs and specifications are incorporated into projects, they become a marketing point which then leads to high selling prices for the client and therefore supporting a business case for the development (Lorenz *et al.*, 2007). Hwang and Tan (2012) however state that the higher cost of green buildings for buyers leads to low market demand for sustainable developments. Buyers may feel that that buildings constructed following sustainable building policies are unaffordable and therefore will not buy them despite the benefits they may accrue to them in the long run and therefore only a few are constructed to target the high end markets (Dair and Williams, 2006; Zainul-Abidin, 2013).

Ries *et al.* (2006), noted when it comes to the final decision making, scheduling and costs are the major factors that are considered with little concern for the long-term benefits such as significant cost savings.

High building costs are thus a major barrier to industry participants implementing sustainable building and hence few sustainable building projects are available in the industry (Neal *et al*, 2000; Revel and Blackburn, 2007).

2.4.3 Lack of awareness/interest towards sustainable buildings

Sustainability aspects are among the last factors considered when a project is being commissioned (Neal *et al*, 2000). Coupled with the perceived additional cost of sustainability, those in the market to buy property lack awareness on the benefits of sustainable building and therefore do not demand it or even look for it when buying (Hakinnen and Belloni 2011). Revell and Blackburn (2007) even further states that most developers tend to focus more on short term capital costs rather than lessening the environmental effects of their buildings.

Decision making that considers the environmental, economic and social aspects in the future can be filled with uncertainty of what will occur over time (Gluch and Baumann, 2004). Where stakeholders lack information and knowledge on sustainable systems, they tend to opt for traditional methods of building (Dair and Williams, 2006). Sustainability goals can be achieved through improved knowledge management in the construction sector (Shelbourn *et al.*, 2006). Djokoto *et al.* (2014) however talks about the important roles professionals play in disseminating sustainable building principles developers/owners as well as to the project team from the inception.

The renewed drive towards sustainability has although been faced by numerous challenges regarding professional team's contribution to sustainability (Windapo, 2014). Zainul-Abidin (2008) highlights some of these challenges as blame to inertia among building professionals, lukewarm compliance and misunderstanding of what sustainability is all about. This inertia amongst the professionals has led to them not being at the forefront in promoting sustainability and waiting for such initiatives to be client-driven. Shi (2008) suggests that construction professional's do not have the sufficient experience, training or background in sustainable construction to implement green building solutions. With a minimal compliance approach, sustainability is treated as a necessary evil and makes it harder for sustainable projects to thrive (Shi, 2008). Sustainability experts are often called upon by the design team to take a lead and to incorporate sustainable value addition elements in projects (Bordass, 2000 and Vantage, 2002).

2.4.4 Lack of green building products

Construction projects have been known to be major contributors to global warming through emission of greenhouse gases (Pearce, 2003). Sustainability largely refers to the ability to maintain natural materials at certain levels by allowing time for self-renewal to stop depleting such natural materials (van Reneen, 2014). The nature of harvesting such materials should also be conducted in a manner that is friendly to the environment (van Reneen, 2014). Due to these facts, materials such as timber must be

certified as sustainable by the Forest Stewardship Council (FSC) are the only timber resource that the Green Star SA rating tool acknowledges. for it to contribute to *Timber* credit (Van Reenen, 2014).

Manufacturing or extraction of construction materials interferes with the ecosystem through release of greenhouse gases (Van Reenen, 2014). Construction also consumes energy usually in the form of fossil-fuels compounding the problem further (McCoy *et al.*, 2012). While quantification of this form of energy is not a requirement in the Green Star SA tool, reduction, reuse and recycling of such materials is recognized (Van Reenen, 2014). Sustainable building materials alternatives are however more expensive than traditional building materials (Covert *et al.*, 2016).

As large consumers of natural resources, construction projects and have been known to account for over a tenth of earth's fresh water, a quarter of the global wood and almost half of the material and energy output (Roodman and Lenssen, 1994). Finding sustainable alternatives for materials to use in the construction process such as cement is a challenge (Supino *et al.*, 2016) and often the availability of such green materials locally be insufficient amounts to satisfy the need of their current project (Neal *et al.*, 2000).

Van Reenen (2014) contends that the Green Star SA rating tool however encourages resources efficiency through dematerialization. While this is a good strategy, the Green Star SA rating tool considers alternatives such as:

- Use of 20% less steel, concrete or timber while maintaining the structural integrity of the building as well as the standard requirement;
- Using alternatives to cement (e.g. fly ash or aggregate);
- Ventilation with minimal or zero ducting;
- Use of water-free toilets;
- Dual function cladding;
- Minimizing wastage on the construction site. Waste poses a challenge in any construction project and could amount to over a third of a project cost (Forsberg and Saukkoriipi, 2007).;
- Reducing demolition waste;
- Remanufactured materials;
- Discouraged use of recycled timber;
- Virgin material usage; and
- PVC minimization.

The main challenge arises when the replacement material is equally or more hazardous as the replaced materials as this renders the efforts fruitless (Van Reenen, 2014). While the Green Star SA rating tool considers use of replacement materials, none can really pass all the checks of the tool (Zuo *et al.*, 2014). Even though designers have a range of product choices, there is inadequate product information in the market regarding building sustainable systems, which thus requires the involvement of specialists with knowledge on the appropriate materials to select (Hwang, and Tan, 2012).

2.4.5 Lack of government support

Another notable barrier to sustainable building is government support (Samari *et al.*, 2013). Being the biggest client of the construction industry, the government needs to insist to the contractors it hire on the need for using sustainable building techniques and materials. This can be achieved by the government formulating legislation and policies on sustainable building which will create incentives and enable the built environment to develop sustainable building projects that can also be implemented by private developers (Zainul- Abidin, 2013).

2.4.6 Insufficient time

There are numerous cases in the construction industry where traditional projects exceed planned costs which is a major challenge facing the industry due to project delays (Le-Hoai *et al.*, 2008); with studies in Vietnam, Nigeria and Malaysia showing that projects are seldom completed on schedule (Le-Hoai *et al.*, 2008; Amu and Adesanya, 2011; Frimpong *et al.*, 2003). Green building projects on the other hand can take an extra year to complete compared to non-green building projects (Hakinnen and Belloni 2011). The increased construction time can be attributed to sourcing of alternative building materials which may not normally be available within the local market and thus imported (Hwang and Tan, 2012). Additional construction time not only results in increased building costs but a delay on the return on investment for which the client or developer may not be willing to undertake (Hakinnen and Belloni 2011). Ugwu and Haupt (2007) however suggest that through sustainable thinking within professional team at the early design stage, projects can address these sourcing challenges prior to detailed design and construction to ensure such projects are delivered successfully.

2.5 Drivers for sustainability in the construction industry

The construction industry, the people and the government of South Africa have seen the need and are in consensus that for the sake of the environment and the economy, alternative building materials and techniques need to be implemented (De Villiers, 2012). In addition, according to the South African constitution, living in a safe and healthy environment is every South African's right whether born or unborn and it is towards pursuing this right that construction industry stakeholders are encouraged to take up sustainable building techniques and materials (Van Reenen, 2014).

The drivers to sustainability are as diverse and sometimes related to the barriers. Du Plessis (2002) identified three categories of enablers: technological, institutional and value system enablers. This is presented in Figure 2.5-1 below:

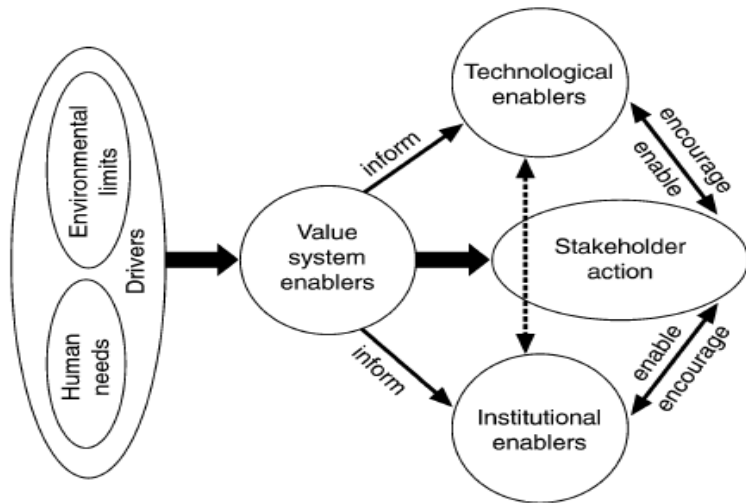


Figure 2.5-1 A Strategy for enabling sustainable construction (Source: Edum-Fotwe and Price, 2009)

These enablers are informed by both human needs and environmental limits. The value systems enablers are met to be a call to stakeholder actions and contribute significantly in shaping the agenda for the technology and institution enablers as seen in (Edum-Fotwe and Price, 2009) The technology enablers on the other hand provide a body of knowledge as well as skills while institutional enablers encourage the adoption of the other two.

2.5.1 Tenant demand

Tenant demand is the most effective driver for sustainable developments (Nelson *et al.*, 2010). With increased environmental awareness, there is growing attention towards green buildings (Eichholtz *et al.*, 2013). Tenants look to maximize occupancy and efficiency thus seek buildings with high sustainability ratings (Nelson and Frankel, 2012). Shelbourn *et al.*, (2006) encourages the participation of end users and clients during the design development of projects as they are likely to promote sustainability aspects on projects. Adopting sustainable building practices offers better economic performance for tenants, due to lower operational costs over the lifecycle of the building (Nelson *et al.*, 2010). Tenants are also more likely to go with green development to be associated with the green image it provides to its stakeholders (Cajias and Piazzolo, 2013). For owners and developers', green buildings benefit from the higher rentals and selling prices offered as compared to traditional spaces as the cost of the sustainable attributes are incorporated into the buildings (Eichholtz *et al.*, 2013; Wiley *et al.*, 2010). For commercial properties, Eichholtz *et al.*, (2010) states that investors are willing to pay a higher premium for the economic benefits provided by green buildings such as energy efficiency, improved lifecycle costing as well as cheaper risk premiums. For real estate projects, Eichholtz *et al.*, (2010) discusses that compared to commercial properties, residential buildings have inadequate evidence to influence developers to adopt green buildings apart from case studies of the financial performance benefits of such costs.

2.5.2 Professional team

Industry stakeholders' commitment is another driver to sustainable building. When the design team, contractors, engineers are in the lead to implement and advice their clients on green building the industry is built and the many challenges that face the implementation of sustainable buildings are reduced and decimated one at a time until green buildings are the norm rather than the exception (Zainul-Abidin *et al.*, 2013). Furthermore, involving professionals with capabilities, experience and understanding of green buildings and local sustainable laws can enhance the aspect of sustainability on projects (Hwang and Tan, 2012). Samari *et al.*, (2013) also acknowledges that there is a relationship between work experience and developing green buildings.

2.5.3 Enhanced operational efficiency

Green buildings require substantially lower or less water, energy and even use land efficiently due to its inherent nature to capture and recycle water, use natural light and better air quality (Windapo 2014). The metrics come to play here by itemising and highlighting the actual cost savings which can facilitate informed decision making (Arif *et al.*, 2009). Green buildings are designed to reduce operational costs over time thus adding value to the property and to the client (Cajias and Piazzolo, 2013)

2.5.4 Information dissemination on sustainability

Coupled with campaigning within the construction industry, there is a need to provide more information and understanding on the benefits of sustainable building in the industry (Cushman *et al.*, 2005). Effective and efficient marketing of sustainability leads buyers and the general economy at large to understand that sustainable construction enhances the wellbeing of the people (Abidin, 2010). As buyers become aware of the economic benefits that are apparent from the use of green practices and materials, they are more likely to adopt and get involved in sustainable developments (Hakkinen and Belloni, 2011). Resulting awareness can increase demand accompanied with supply improves affordability on sustainable developments to penetrate the entire economy rather than be a preserve of high end clients (Zainul-Abidin *et al.*, 2013).

When sustainable information is passed across effectively and understood by the stakeholders, market demand for sustainably designs and practices can be developed greater (Zainul-Abidin *et al.*, 2013). Furthermore, growing technological advances have enabled the sharing of knowledge and sustainability practices amongst the professional team and stakeholders in the construction industry (Cushman *et al.*, 2005).

2.5.5 Opportunities in developing nations

First, there are some opportunities that exist for sustainability by campaigning for the sustainability agenda among industry professionals, learning institutions, banks, national and local governments and

the client (Ugwu and Haupt, 2007). Developing countries appear to be an easier target for sustainable solutions (Du Plessis, 2002). This is because they still have remnants of memory on what environmental sustainability means given that they have only been recently exposed to the challenges of environmental degradation. They also have a higher capacity to achieve more with minimal resources and by the very fact that they are used to limited resources. This presents an opportunity for both developed and developing nations to come together as equals on one common ground (Du Plessis, 2002).

2.5.6 Regulatory compliance

Institutional enablers such as the government are a key driver of sustainable building (Shen and Yao, 2006). Government commitment to the reduction of emissions is another key driver for sustainable developments in the South African construction industry. The government has created a framework for green building which gives guidelines on sustainable building (Windapo, 2014). This has led to developers aligning themselves with the regulations leading towards to sustainable building practices (Majdalani *et al.*, 2006).

To ensure that sustainable building progressively develops and is eventually the normal way to build as opposed to the current to conventional way, there are some factors that need to be considered. These factors will not only be geared to the industry stakeholders but also to clients, tenants and buyers of houses. The government has come up with regulations and bodies that help govern the quality and availability of sustainable building materials and industry actors (de Villiers, 2012).

Government regulations on building materials in South Africa are restrictive, prescriptive and bureaucratic (de Villiers, 2012). This ensures that they are interpreted quite fast and easily applied. This also ensures that there will be no error in application (May, 2003; de Villiers, 2012). In this way, all industry participants understand what is expected of them and therefore the product will be a high quality sustainable building.

In South Africa, the creation of the Green Building Council has been a key driver to sustainable building. It does this by providing guidelines and principles to industry stakeholders on how green buildings should be built and when the provided guidelines and principles are met the building is rated Green Star SA (Windapo, 2014).

Du Plessis (2002) argues that there are two solutions to enable sustainable constructions in developing countries which are first, set up of a sector that is inclusive of sustainability and secondly ensuring support mechanisms are in place to ensure that the demands associated with sustainable developments are addressed by the sector.

2.5.7 Technological Advancement

According to the human settlement department of Kwa Zulu Natal Province, a major factor for consideration when selecting sustainable building materials is technology. Technology advancements that concentrate on sustainable building brings about a much better end product which will be affordable and therefore will lead to increased demand for sustainable construction in the industry.

2.5.8 Buy-in to green rating systems

Relevant rating and certification are other factors to consider when selecting materials for sustainable building. The South African Green Star rating is a certification created by the Green Building Council of South Africa to ensure that buildings and building techniques and materials have minimum devastating effects on the environment (Van Reenen, 2014). In sustainable building, all participants from the quantity surveyor to the client need to ensure that the materials have proper certification and rating.

Green Star rated materials are assessed and checked to ensure that they are energy efficient, resource efficient and environmentally friendly. Energy efficient materials are those materials that have been produced and that will also conserve energy throughout their useful life. It has been found that existing buildings use up to 40% of the world's consumed energy (Martin, 2011). To reduce this large energy consumption, energy efficient materials are therefore important in the construction of new buildings. Resource efficient materials usually support reuse and recycling of materials while environmentally responsible sustainable building materials are those whose use will not cause devastation to the environment or people (Van Reenen, 2014).

Kwa Zulu Natal Department of Settlement provides several certifications and ratings for the alternative building materials. One of those certifications is the Agrément certification. This certification is applied to non-standardized building materials and is recognised in 21 countries around the world. This certification together with a SABS mark is applied to products which apply and afterwards go through a rigorous testing process to receive the certification and rating (de Villiers, 2012).

2.6 Collaboration towards sustainable growth in the South African construction industry

Surveys done by Myers (2005) in Europe have shown that although the construction industry lacks the respect sustainability, there is growing acknowledgment of its importance in the industry. Glass *et al.* (2008) also recognise that those already in the industry need to be proactive when it comes to developing a sustainable society.

In the UK, there has been a move towards greater consideration of how issues regarding sustainability affect society and the economy at large. The sustainability agenda in the industry is being driven by a change in mind-set of the private sectors approach to sustainability along with support from government initiatives (Dewick and Miozzo, 2002). The priority for developed countries are the environmental concerns (Ugwu and Haupt, 2007).

The drive towards the reuse of materials and reengineering of existing buildings towards sustainability is a new trend that is being implemented in Australia (Bullen, 2007). Key to this agenda is the useful fact that this leads to building being rendered useful beyond their initial life which is a fundamental concept in sustainability. Adaptation is therefore gaining reputation as a new concept that suddenly makes existing buildings sustainable (van den Brand, 2004). One of the major challenges to this trend is that some buildings are built for obsolescence (Kendall, 1999). Another challenge is where budget implications force clients to build sub-standard buildings (Vanegas et al., 1995).

Given that adaptation is a new concept, the following definitions are offered:

- The process of retaining most of the original building and at the same time ensuring it complies with modern standards (Latham, 2000);
- Conversion through modifications (Douglas, 2002);
- Rehabilitation/renovation of existing structures for new use (Dolnick and Davidson, 1999); and
- The process of converting a neglected building into one that can be adopted for new purposes (DEH, 2004).

Bullen (2007), identifies various merits of adaptability, the key of which are reduced resource consumption, extending the useful life of buildings, cost efficiency, revitalizing past neighbourhoods, reduced land pressure, maintaining cultural heritage and increasing demand for sustainability. The UK has seen growth in the development of sustainable buildings through implementation of various government legislations that encourage developers to create strategies for proposed buildings (Manewa *et al.*, 2016).

While environmental impact is an important aspect of the three constituents of sustainable construction, attention continues to be inclined towards social economic benefits from a sustainable perspective (Magis and Shin, 2009). Affordable housing, job creation and gender equality which are largely social economic attributes continue to garner more support as issues that are perceived to be more challenging than the environmental attribute (Du Plessis, 2002). These are seen as more pressing issues especially in developing countries which are struggling with poverty (Talukhaba *et al.*, 2005, Ugwu and Haupt, 2007).

Sustainability as a building concept is however a fairly new concept in developing countries and has only been recently introduced (Du Plessis, 2002). In developing countries, the situation is similar to developed countries where sustainability at a project level is not being practiced effectively, however

this being addressed through increased government initiatives for sustainability (Ugwu and Haupt, 2007). In the South African context, legislation on the design of green buildings is limited and National Building Regulations does not clearly make provision for sustainable buildings (Windapo and Goulding, 2015)

With the prominent level of poverty and underdevelopment of economies in most developing countries, Talukhaba *et al.* (2005) states that sustainability in such countries should mainly focus on the economic and social concerns rather than the environmental issues. However, research by Ugwu and Haupt (2007) has indicated that South Africa priorities for sustainability are mainly focused on the social and environmental issues. These social aspects include the human and social capital issues such as poverty reduction, labour development as well as health and safety (Talukhaba *et al.*, 2005; Ugwu and Haupt, 2007). Nevertheless, by attending to the social issues such as encouraging labour intensive construction methods, promoting small enterprises, or using locally produced materials, it is argued that it has a multiplier effect on the local economy (Talukhaba *et al.*, 2005).

Emuze and Smallwood (2014) opine that collaboration among the various players in the construction industry is critical towards the industry's competitiveness. The industry is characterised by fragmentation effectively translating to lack of harmony amongst the various professionals involved in the end to end process (Kaatz *et al.*, 2005). According to the CIDB (2004) stagnation in the South African construction industry could be directly attributable to the splitting up of roles played by various professionals who play a part in construction projects. Emuze and Smallwood (2014) contend that efficiency in the construction sector in South Africa can only be realized if the sector leaned towards more integration. Such measures will directly result towards time efficiency which will ensure that the marginal profit per project goes up.

According to Emuze and Smallwood (2014), fragmentation of industry is not improving as characterised by an increase in the number of firms engaged in the end to end process. This seems to have a negative effect on the industry as it leads to overall project inefficiency (Kaatz *et al.*, 2005). Fragmentation within the industry can lead to the following negative effects, however collaboration is seen to present numerous merits among which the most obvious are:

- Improved relationships among industry profession's (Cain,2003);
- Smoother exchange of ideas, (Sheath *et al.*,1996; Akintoye and Main, 2007);
- Less aggressive competition, (Sheath *et al.*,1996; Akintoye and Main, 2007)
- Optimal output (Fearne and Fowler, 2006);
- Reduction in costs (Fearne and Fowler, 2006);
- Improved quality (Hill and Bowen, 1997; Myers, 2005);
- Efficient processes (CIDB, 2004; Emuze and Smallwood, 2014); and
- Happier customers (Dewick and Miozzo, 2002).

Emuze and Smallwood (2014) suggest that collaboration amongst South Africa's construction industry players is still in its infancy stages. Collaboration between key stakeholders is important in the delivery of sustainable projects (Yunus, *et al.*, 2011). Quantity surveyors as part of the design team need to integrate with stakeholders of green buildings to develop better cost data and information to provide economic value to the client (Yunus, *et al.*, 2011). Additionally, by collaborating with the project team, the QS can provide value in appraising the performance of buildings as well provide advice on cost issues during the design stage (McDougall *et al.*, 2002).

While Emuze and Smallwood (2014) advocates for immediate address of such challenges, they front the procurement process as a good starting point for collaboration. At the procurement level there are there are barriers to the development of green buildings (Elforгани and Rahmat, 2010). Quantity surveyors who are largely involved in the development of procurement and construction documentation (Matipa *et al.*, 2008) could participate proactively at initial stages to reduce uncertainty around the selection and costs of sustainable materials (Elforгани and Rahmat, 2010).

2.7 Sustainability and the construction professionals

At the start of a project, commonly known as stage 1 – Concept Stage, the client is responsible for providing the detailed brief that outlines the use of sustainability within project. The professional team such as architect, engineers and quantity surveyors are at this point responsible for interpreting the clients' requirements and providing solutions that contribute to the sustainability of the project (Dewick and Miozzo, 2002). Sebake (2008), notes that often at this stage the entire professional team may not be appointed and as such can be difficult to set sustainability targets. However, it is important to note that good decisions making at early stage of a project is critical to the success of a projects design output (Shah *et al.*, 2008). For sustainable construction to be realised, high performance standards need to be defined in advance to be monitored during construction (Boswell and Walker, 2004).

Stage 2, Outline proposal is the stage where the design concepts are developed and the viability of the project is assessed further (Sebake, 2008). At this stage the quantity surveyor prepares a cost plan from a defined brief that will act as a cost control for the design of the project (Matipa *et al.*, 2008).

Stage 3, Design development. At this stage designs are assessed against benchmarks and developed further to meet the clients' targets (Sebake, 2009). Specifications are outlined, detailed cost estimates are prepared (SACAP, 2015). At this stage the quantity surveyor prepares a cost plan from a defined brief that will act as a cost control for the design of the project (Matipa *et al.*, 2008).

Frei (2010) promotes the need for professionals in the construction industry to proactively seek out and exploit opportunities that add real value to clients. The growth of legislation on sustainability has seen companies' worldwide moving towards providing sustainability in building development services for

clients that is relevant to the market (Revell and Blackburn, 2007). Construction professionals that can offer such additional sustainability services in the building and property industry are seen to have a competitive advantage in the services they offer by creating additional value to the client (Oliver, 1997).

For the professional team to make meaningful contributions towards sustainability, the complete lifecycle of the building project needs to be considered from its design to deconstruction (Myers, 2005). To encourage key stakeholders to implement sustainable choices, professional teams therefore need to understand the whole life costs and environmental impacts of building projects at the planning stages (Talukhaba *et al.*, 2005). It is essential for all participants to provide information that validates the sustainability and whole life costs as it can be extremely useful in influencing to decision makers (Bartlett and Howard, 2000).

The design process involves many disciplines with key participants playing distinct roles at different stages of the design process to provide value to the client (Shah *et al.*, 2008). Below illustrates that quantity surveyors play a vital role in from the preliminary stages to detailed design development by providing continual advice to the team at the design stage of a project (Hughes and Murdoch, 2001).

Table 2.7-1 Advisors and decision makers at project design stage

Stage 1 - Concept		Stage 2 – Outline proposals		Stage 3 - Design development	
Adviser	Approver	Adviser	Approver	Adviser	Approver
Client's Representative	Client	Client's Representative	Client	Client's Representative	Client
Architect	Planning supervisor	Architect		Architect	Planning Officer
Quantity surveyor		Quantity surveyor		Quantity surveyor	Statutory bodies
Planning supervisor		Services Engineers		Structural Engineer	
		Planning supervisor		Services Engineers	
		Planning Officer		Specialist contractors	
		Statutory bodies		Specialist suppliers	
				Planning supervisor	

(Source: Hughes and Murdoch, 2001)

2.8 Sustainability and the role of the quantity surveyor

The quantity surveyor plays an essential role, as a project cost consultant they provide the cost advice of designs, prepare procurement documentation as well as manage costs during the construction phases to ensure that the client's demand for value for money is achieved up to completion (Matipa *et al.*, 2008; Nagalingam *et al.*, 2013). As such, their role calls for mastery of various disciplines effectively implying that the role of a quantity surveyor keeps evolving with the change in times and change in client needs (RICS, 1983 and Ozorhon *et al.*, 2010). Appropriate solutions to address the needs of the client continue to be developed at each appropriate stage of the project life cycle and integrated to achieve the outcome on the project (Boswell and Walker, 2004). For the quantity surveyor to act in the best interest and fully advise the client on the financial aspects of the project, the consultant must wholly understand the client's viewpoints and interests (Bartlett and Howard, 2000). Ofori (2006), discusses

that the role of quantity surveyors has evolved to be client oriented to meet the business strategies and add value to the client.

The traditional approach to cost management on projects has been generally based on an economic approach (Ekundayo *et al.*, 2011) that responds to market changes (Ashworth *et al.*, 2013) where an initial design is estimated followed by the procurement and construction phases (Matipa *et al.*, 2008). This economic approach has a short term view on addressing project costs as the social and environmental aspects are also significant to sustainability development (Ekundayo *et al.*, 2011).

The quantity surveyor's work begins at the conception stage of the project by estimating the price forecast of the project. Experienced quantity surveyors largely have a detailed understanding of a multitude of specifications and are well placed on a project team to contribute towards the sustainability agenda of a project at the initial stages (Kohler and Lützkendorf, 2002). However, literature has shown that the determination of the full costs such as the lifecycle costs and cost in use of sustainable designs and specifications does pose a challenge (Essa and Fortune, 2008; Boussabaine and Kirkham, 2008; Kohler and Lützkendorf, 2002). Bartlett and Howard (2000), states that engineers along with energy consultants are better equipped to develop innovative energy efficient solutions as they have a better understanding as compared to quantity surveyors who are more conservative. Quantity surveyors therefore tend to still rely on engineers for specifications and efficiencies of materials for them to provide the cost information (Ma and Luu, 2013).

Furthermore, construction clients are looking on quantity surveyors to develop their roles so as to provide value, minimise cost as well as attain sustainability on projects (Kim and Park, 2016). Hiew and Ng (2007) further stress that quantity surveyors can create value in the procurement of construction work by participating and playing a pro-active role at the early stage activities of a project such as engaging the team at the specification and design level. Some key competencies discussed by Nkado and Meyer (2001) are that the quantity surveyors in South Africa can offer advanced cost management and even play a leadership role at the pre-construction stage. The role of quantity surveyors is evolving to accommodate green building developments however there is a need for the profession to progress their skills and knowledge on sustainable technologies and products to remain relevant in the profession (Ma and Luu, 2013). Nkado and Meyer (2001) acknowledge that there is a lag in the current education and training which limits the quantity surveyors ability to provide strategic advice on sustainability. Thus through training and understanding all the knowledge areas of building from pre-construction to the post-construction stages quantity surveyors can provide quality cost advice on sustainable construction as well as add value to construction clients (Olawumi, and Ayegun, 2016).

2.9 Chapter Summary

To unravel the research problem and provide answers to the research questions the following research areas were viewed:

- **Sustainability in the built environment**

This research area was investigated to shed light on what sustainability entails and the various forms in which it was approached from. This area ensured that the research problem and research questions were clear from the beginning by providing a canvas for discussing the fundamental approach to the topic of sustainability.

- **Collaboration towards sustainability in the South African construction industry**

Players in the building industry need to drive for sustainable development. Collaboration among the various players in the construction industry is critical towards the industry's competitiveness. These players include the client, engineer, architect and the quantity surveyor among others. This area was scrutinized to shed light on the role of each party and what would be required to ensure the South African construction industry succeeds in pushing for sustainability in buildings. This linked the research problem and research questions by shedding light on what is required from each party to achieve sustainability.

- **Construction professional Lifecycle assessments**

Costing was a key hindrance to adoption of sustainable practices in the built environment in South Africa and globally. Traditionally on construction projects, the focus is on the economic aspect of sustainability. The life cycle assessment, life cycle costs and social life cycle assessments of a project has a direct impact on sustainability issues that need to be carefully considered. This linked the research problem and research questions by ensuring that use of sustainable materials perceived to be more cost effective did not lead to an increment in life-cycle energy over a building's useful life.

- **The quantity surveyor's role in sustainability**

The quantity surveyor's role, is to provide cost advice of designs, procurement documentation and manage costs during the construction phases to ensure that the client's cost objectives are achieved. Other built environments professionals such as the engineer, architect and consultants rely heavily on the bills of quantities from the quantity surveyor. To provide value addition, quantity surveyors can learn and use the various tools available such as the rating tools, life-cycle costing and value management to evaluate and cost for sustainable construction developments. In understanding these tools, they have the potential to provide professional advice at preliminary stages of the design. Although, the quantity surveyor is a well-placed medium through which sustainability cost aspects can be addressed, they still rely on engineers for information regarding sustainability of building materials due to their limited knowledge in this field.

The literature shows that quantity surveyors are aware their roles, knowledge and skills need to adapt to the growing trend of sustainable building construction. Considering a collaborative approach with other professions in the design team and external bodies cannot only help minimise fragmentation in the construction industry but help quantity surveyors adopt a holistic approach in their role as key advisors in sustainable building projects.

This links the research problem and research questions by ensuring that quantity surveyor is fully informed to be at the front row in terms of green and sustainable knowledge. Further, by establishing whether quantity surveyors were attuned to the concept of sustainability the researcher determined how interventions could be re-engineered to ensure sustainability.

3 Chapter Three: Methodology

3.1 Introduction

This chapter presents an overall view of the research methodology adopted within this study and the justification for using it. The chapter reviews research procedures and techniques most commonly used by authors in similar studies and what experts say about those techniques. Triangulation was utilised to addresses the research questions and objectives outlined in the literature review section. Triangulation, is broadly defined as “the combination of methodologies in the study of the same phenomenon” (Jick, 1979, p.67).

3.2 Research methods

There are two main research methodologies as discussed by Fellows and Liu (1997) and Babbie and Mouton (2005). The first methodology being qualitative research, commonly referred to as an anti-positivist approach and the second approach is the quantitative research known as a positivist approach (Welman *et al.*, 2005).

The Table 3.2-1 depicts contrasts between the positivism and anti-positivism approaches:

Table 3.2-1 Positivism and anti-positivism approaches

	Positivism	Anti-Positivist
The Observer		Is part of what is being observed
Human interests	Should be irrelevant	Are the main drivers of science
Explanations	Must demonstrate causality	Aim to increase general understanding of the situation
Research progress through	Hypothesis and deduction	Gathering rich data from ideas are induced
Concepts	Need to be designed so that they can be measured	Should incorporate stake holder perspectives
Unit of analysis	Should be reduced to the simplest terms	May include complexity of whole situations
Generalization through	Statistical probability	Theoretical abstraction
Sampling requires	Large numbers selected randomly	Small numbers of cases selected for specific reasons

(Source: Easterby-smith et al., 2008:59)

3.2.1 Quantitative research approach (positivism)

This positivist's approach conceives that the social world exists externally and involves the collection of data using experimental methods and surveys as strategies to a positivist approach (Creswell, 2013). Experimental methods use scientific techniques to acquire quantifiable data (Fellows and Lui, 1997). The survey method usually comprise of questions or structured interviews that are applied with the aim of taking a broad view from a given sample into a population (Creswell, 2013).

Quantitative research strategies apply these approaches using findings of previous literature and theories to obtain factual data from predetermined instruments, which are then analysed to produce statistical data and conclusions (Creswell, 2013; Fellows and Lui, 1997).

3.2.2 Qualitative research approach (anti- positivist)

Qualitative Research is mainly about understanding people from their own stand point and experiences (Taylor *et al.*, 2015). Mitchell (2005) views the qualitative methodology as a philosophical approach to research. Easterby-Smith *et al.* (2008) refers to this approach as a social construct which is used as a response to the positivism in social sciences. As this approach uses the subject's observations and opinions, the social constructionism is viewed as descriptive (Fellows and Lui, 1997) and appreciates the meanings people place upon their experiences (Easterby-Smith *et al.*, 2008).

There are several qualitative strategies as discussed by Creswell (2013) namely, ethnographies, grounded theory, case studies, phenomenological research and narrative research.

3.2.3 Triangulation (Mixed Methodology)

Triangulation advocates for mixing of methodologies to allow for diverse perspectives and opinions to cast light on a topic (Olsen, 2004). Denzin (1970a:13) as cited by Blaikie (1991) contended for the use of "multiple methods in the analysis of the same empirical events" as each method discovered different facets of the events studied.

Mixing methodologies employs the strengths of both quantitative and qualitative approaches (Creswell, 2013). Mixing of both quantitative and qualitative approaches is a broader form of triangulation, and although it can be costly, this methodology assists in yielding more superior utility (Abowitz and Toole, 2010). (Johnson *et al.*, 2007), state that mixed methodology is the middle of both extremes as it aims to provide an effective central solution for many research interests. Creswell (2013) appreciates that this methodology of research is growing in popularity since it provides greater insight into research problems when studying multiple viewpoints of qualitative and quantitative research approaches (Johnson *et al.*, 2007). Furthermore, Creswell (2013) implies that it is inadequate to employ a single approach to cover the complex nature of human behaviour in the social and human sciences research.

Denscombe (2008:272) as cited in Cohen *et al.* (2011) states that mixed research provides various advantages, namely:

- The increase in the accuracy of data.
- Providing a more complete picture of the subject under investigation than would be yielded by a single methodology.
- Allowing the researcher to generate an analysis and build-on original data.

Conducting a mixed method's research can however have some drawbacks for the researcher. In some cases, one method might get a higher response rate than the other (Abowitz and Toole, 2010).

3.3 The Main Research Question

The purpose of this research was to explore and understand the question “Are quantity surveyors sufficiently knowledgeable in sustainable development to efficiently engage and advice on strategies for sustainable specifications at project planning level?”

3.4 Approach adopted and justification

Various authors as referenced in the literature review either used qualitative or quantitative research (or mixed research utilising both) as their mode of data collection. These authors and their preferred approaches and methodologies are listed below:

Djokoto *et al.* (2014) carried out a study investigating consultant perspectives on the barriers to sustainable construction in the Ghanaian construction industry. They utilised the quantitative methodology, more specifically collected data through questionnaire surveys.

Windapo and Goulding (2015) carried out a study investigating the gap between green building practices and legislation in South Africa. They applied a mixed method research approach of surveys and interviews to determine the gaps and attitudes in green building practices.

Dada and Musa (2016) undertook a research to examine what factors influence the quantity surveyors' competence. The study made use of structured questionnaires that incorporated the use of the 5-point Likert scale to test appropriate factors that affect the competence of a quantity surveyor.

Hwang *et al.* (2015) carried out a study investigating the performance of green building projects using questionnaire surveys as well as face to face interviews with professionals to determine the critical factors that affect performance of green building practices.

This research adopted the mixed methods research as it utilized both qualitative and quantitative research methods. The mixed methods research was utilised in this research for the following reasons:

- The qualitative method offered an exploratory avenue that led to a better understanding of the sampled respondents (quantity surveyors), their thoughts, attitudes and perceptions towards the advising clients and various construction stakeholders on sustainable building designs.
- The qualitative “exploratory phase was vital as it provided detailed samples of the thoughts and perception (Easterby-Smith *et al.*, 2008).
- The quantitative method, which is more conclusive, assisted in measuring the extent of the exploratory findings. It helped quantify the information gathered in the exploratory phase.
- Use of both methods assisted the researcher in engaging in a deeper analysis of the data and consequently drawing richer conclusions from the data collected (Cohen *et al.*, 2011).

This research utilised interviews (qualitative research) and online questionnaires (positivism) to meet the objectives of the study.

3.4.1 Use of Interviews

The use of Interviews is the most commonly used technique when collecting qualitative data (DiCicco-Bloom and Crabtree, 2006). This technique involves oral questioning of the respondents with their answers either being recorded or written down (Bryman and Cassels, 2006). It also gives the respondent a chance to seek clarity for any questions that they may not understand (Janes, 2001). Strach and Everett (2008) accede that face to face interviews have the advantage of having direct contact with the respondent allowing for clarity during the interviewing process, probing on answers given by respondents and observing any physical reactions, if any, therefore enriching the data collected.

Interviews are categorised into three main types; structured interviews, unstructured interviews and semi-structured interviews.

- Semi – structured interviews: These interviews are normally scheduled with the respondent ahead of time and are often guided by a set of predetermined open-ended interviews (Strach and Everett, 2008). One key advantage of semi structured interviews is they allow the interviewer to ask to add on questions that may arise during the interviewing process (DiCicco-Bloom and Crabtree, 2006). These types of interviews also allow the respondent a chance to expound on their answers therefore getting more detailed data. These types of interviews can either be used in a group setting (focus groups) or with individuals (in depth interviews) (DiCicco-Bloom and Crabtree, 2006);
- Unstructured interviews: No interview can be considered purely unstructured as it would require direction and guidance from the interviewer (Easterby- Smith *et al.*, 2008). Data collected from unstructured interviews is often accompanied with observational notes from the interviewer (DiCicco- Bloom and Crabtree, 2006). This facilitates the collection of more granular data and insights. Unstructured interviews however creates the risk of the respondent veering off the main topic and this technique can also be time consuming (Easterby- Smith *et al.*, 2008);
- Structured interviews: These are mainly used to generate quantitative data (DiCicco- Bloom and Crabtree, 2006). The set of questions are predetermined and they follow the same line of questioning with little to no wiggle room for probing to avoid biases (Strach and Everett, 2008).

This research made use of both the structured and semi-structured interviews. The Semi structured interviews provided a list of questions as a guide for the discussion – but not as strict as structured interviews. The use of semi-structured interviews allows respondents to expound on areas of discussion while also allowing the interviewer to guide them back if they have veered off topic (Easterby-Smith *et al.*, 2008). The use of semi structured interviews was critical for this research as it enabled the investigation of the respondent's beliefs, attitudes and perceptions of quantity surveyors with regards to sustainable building designs. The use of structured interviews was also important for this research as it provided the same line of questioning for all respondents and this eliminated any bias. Moreover,

the data collected from the structured interviews is more numerical and conclusive (Strach and Everett, 2008).

Unstructured interviews would not have been appropriate for this research as this technique is time consuming with the added risk of the respondents veering off topic. Furthermore, data collected from unstructured interviews is difficult to analyse as it informally expressed and it is also challenging to evaluate what is “off the record” and what can be used in the research (Stokes and Bergin, 2006).

3.4.2 Use of Questionnaires

Although the term “questionnaire” is often used in research, it is not easily defined in one sentence (Dornyei, 2014). Questionnaires are often referred to in different terms such as surveys, tests, checklists or profiles; making them a misnomer to some individuals (Aiken, 1997, stated in Dornyei, 2014). According to Jankowicz (2005), questionnaires encourage respondents to respond to the questions without fear and the accurately gives a deeper understanding of issues being investigated to bring out the phenomena of interest to the study.

Questionnaires are advantageous in the following ways;

- Firstly, they can be filled at the convenience of the respondents (Trochim and Donnelly, 2001);
- Secondly, they are relatively easy to create and enable the collection of data in a brief period, especially in this age of technology advancement (Dornyei, 2014); and
- Thirdly, questionnaires can also be sent out to respondents via email and post thus enabling a wider geographical coverage (Barnes, 2001).

Questionnaires however, can be disadvantageous in that they do not allow for clarity in case the respondent is confused and as questionnaires do not allow for probing therefore making it difficult to collect in depth and detailed data (Dornyei, 2014).

3.4.3 Administering the questionnaire: online survey

This research administered the questionnaires via an online survey. “*In the last 25 years, technology has revolutionised the way in which surveys are administered – with the advent of the first email survey in the 1980’s and the initial web based surveys in the 1990’s*” (Evans and Mathur, 2005, pg. 2). The internet is increasingly used as the tool by which researchers opt to conduct their surveys (Van Selm and Jankowski, 2006). Evans and Mathur (2005) depict the attributes of online surveys in Figure 3.4-1, below which divides the attributes according to major strengths and major potential weakness:



Figure 3.4-1 Attributes of Online Surveys (Source: Evans and Mathur, 2005)

This research chose to administer the questionnaire through an online survey because of the following factors:

- **Wider Reach:** Using the internet, the researcher could access respondents living in various parts of the country and the African continent at a low cost (Van Selm and Jankowski, 2006);
- **Convenience:** Online surveys allow respondents to fill in the questionnaire at a time convenient for them; moreover, some surveys allow the respondents to start then come back and finish later (Van Selm and Jankowski, 2006);
- **Low administration costs:** Except time spent by the researcher to formulate the questionnaire, the surveys are low cost, self-administered by the respondents online, therefore no postage or interviewers are required (Evans and Mathur, 2005);
- **Speed and Timeliness:** As the survey is available online, this ensured a faster turnaround time in acquiring the data as the survey could be filled and delivered instantaneously (Sue and Ritter, 2012). Traditional survey methods such as post mail require the survey to be hand delivered then posted back and this is time consuming process (Sue and Ritter, 2012);
- **Technology Innovations:** The time-consuming task of creating online surveys is a thing of the past as the technology of online surveys continues to evolve due to its growing popularity. Online survey services, such as Survey Monkey which was utilised in this research, make online research surveys easier and faster to create (Wright, 2005);
- **Ease of data entry and analysis:** It is relatively easy for respondents to complete the survey and for their responses to be tabulated and analysed (Evans and Mathur, 2005). The online platform chosen provides instant summarised data in excel format, which can be later converted to statistical software's to allow for an in-depth statistical analysis (Howard, *et al.*, 2006);
- **Large sample easy to obtain:** According to Sue and Ritter (2012), researchers aiming for a large sample size that is geographically distributed, utilise online surveys as it is cost effective and efficient thus saving on time and monetary resources;
- **Controlled Sampling:** According to Sue and Ritter (2012), for researchers to obtain a controlled sample of the study, emails can be sent out to pre-notify respondents about the survey and encourage participation.

For this research, the researcher experienced problems such as a lower hit rate than expected despite reminders being issued via the ASAQS website. Some drawbacks to utilizing online surveys which possibly affected the hit rate of this research included:

- **Perception as junk mail:** The emails sent out to the respondents could have been perceived as junk mail as many respondents may have been unable to differentiate between a legitimate survey and a spam (unsolicited junk mail), especially if the email is delivered from an unknown source.
- **Impersonal:** Generally, there is minimal to no human interaction during these surveys. This takes away from the researcher the ability to probe and delve deeper into understanding the responses provided by the respondents (Couper, 2000).
- **Questions about sample selection:** The sample selection method is criticised especially if there is blanket emailing. This limits exactly who participates in the research, their years of experience, qualifications etc. (Evans and Mathur, 2005).

3.5 Justification of mixing interviews and Surveys

As discussed above, this research utilised both Interviews and questionnaires (survey) as techniques of data collection. Mixing methodologies, especially surveys with interviews is the more insightful approach of triangulation (Olsen, 2004). More so, it is widespread practice in construction studies to allot surveys to large samples via post, e-mail or a website to assist in gathering statistical data, which is then supplemented with interviews (Abowitz and Toole, 2010). Should the data collected from using both interviews and surveys support the hypothesis of the study, this then creates greater confidence in the data collected. However, should the data from both techniques differ, this is also a great finding as it would push the researcher to reassess their theoretical assumptions (Abowitz and Toole, 2010).

3.6 Research population and sample

The population of a study incorporates all the elements within a group that a researcher is interested in (Burns and Grove, 2003). Quantity surveyors in South Africa were the population of interest in this study while Green Star Accredited professionals were the targeted population.

Kombo and Tromp (2006) describe a sample as a collection of units chosen from the universe to represent it. Sampling is the selection of a subset of individuals from within a population to yield some knowledge about the whole population, especially for the purposes of making predictions based on and allowing for statistical inference regarding the behaviour of the variables that are specifically being studied within the universe (Scott and Wild, 1986; Knight and Ruddock, 2009).

3.6.1 Research population and sample for online survey

In this study, the respondents were categorised into: Registered professionals and GBCSA Accredited Professionals who are the quantity surveyors assumed to have adequate industry knowledge on green buildings. These experienced quantity surveyors understand a sustainable construction environment, client's needs and knowledge of other professionals involved in a project, this therefore enables them to offer conclusive and correct insights into the study.

Table 3.6-1 shows the total number of registered quantity surveyors in South Africa on the ASAQS database and their status. Professional Member Quantity Surveyors (PMAQS) is the population sample targeted for this paper and has a total number of 1499 registered members as at 12th December 2014.

Table 3.6-1 Membership Category Statistics as at 12 Dec 2014

REGION	PMAQS	MAQS	AAQS	SAQS	SENIOR	RETIRED	LIFE	HONORARY	PRACTISE	TOTAL
Eastern Cape	60	68	17	236	15		1		39	397
Border	58	27	9	55					51	149
Free State	64	33	0	430	9			1	45	537
Gauteng North	298	235	96	297	51	3	3	1	107	984
Gauteng South	351	254	77	214	56	2	3	2	125	969
KwaZulu-Natal	199	149	69	265	43				149	725
Limpopo Province	33	29	25	70	4				36	161
Mpumalanga	36	22	14	52	5				29	129
North West Province	28	12	3	51	2				26	96
Northern Cape	14	12	2	40	2				10	70
Rest of Africa	43	51	18	65	3				8	170
Overseas	44	32	14	9	5	1		4	1	109
Western Cape	271	166	35	423	47	4		1	125	947
Category /No Address		0	0	197						197
Total as at 12/12/2014	1499	1090	379	2394	242	10	7	9	751	5630

(Source: ASAQS, 2015)

At the time of the study, there are only 59 quantity surveyors registered as Green Star SA accredited professionals representing 3.9% of the ASAQS database. It is important to note that quantity surveyors registered as Green Star SA accredited professionals are also members ASAQS.

As the study aims to determine the perceptions of quantity surveyors on sustainable aspects of building, the population of the study is incorporating both professionals on the ASAQS database and targets the Green Star SA accredited professionals who should have the relevant knowledge and training in green buildings.

3.6.2 Research population and sample for interviews

In finding interviewees for the research purposive sampling also referred to as judgement sampling was used for this study (Mbachu and Nkado, 2007). Purposive sampling is described by Bernard (2011) as a non-probability sampling method where the researcher thoughtfully sets the number of informants and determines the reasons they want the people to oblige. This sampling method aims is to produce the most information from a small number of cases (Teddlie and Yu, 2007) by searching for knowledgeable and experienced participants who are willing and able to offer information on the topic (Tongco, 2007). Although the accuracy is limited by the small population size, it is a commonly used sampling method in construction research (Abowitz and Toole, 2010).

It is acknowledging that although this method of sampling is not free from bias however it can provide dependable and reliable performance for data (Abowitz and Toole, 2010; Tongco, 2007). Information of value can be obtained through the selection informants that are not only qualified but experienced in the field of interest (Teddlie and Yu, 2007)

To identify the quantity surveyor informants, the following criteria was considered:

1. Professional quantity surveyor
2. Must be in consultancy practice
3. Lead quantity surveyor on green building project
4. Experience working on green building projects
5. Located in Cape Town, South Africa

To ensure that there is validity and reliability in the results the research considered empirical indicators that were vital to the perceptions of professional quantity surveyors (Abowitz and Toole, 2010). For instance, considering the experience level and knowledge of quantity surveyors and their role on sustainability could be used as indicators to ensure that only qualified participants provide information for the study.

3.7 Research instrument

As supported earlier, this research has adopted a mixed method approach using semi-structured interviews and structured interviews (via online questionnaire) as formal methods of data collection. Barnes (2001) highlights several ways of recording data collected from semi structured interviews namely recording on tape or video as well as comprehensive note taking. The researcher made use of tape recordings and detailed notes to ensure that the relevant information was captured from the interviews.

Primary data was collected through structured questionnaires with both open and closed ended questions which were administered through an online questionnaire (survey). Semi-structured interviews were conducted on a one on one in-depth interview basis. The in-depth interviews are combined with the online surveys for this study to develop greater insight where some areas of the online surveys may lack deepness.

Table 3.7-1 illustrates how the questions posed in the online surveys and interviews are linked back to findings of the literature review:

Table 3.7-1 Literature link to posed questions in surveys

Questions	Literature source
Are you a Green Star SA Accredited Professional	Being registered shows that the quantity surveyor has knowledge of the Green Star rating tools that consider sustainability during the design stage (GBCSA, 2013).
How many projects have you worked on that have applied for Green Star rating	The Green Star SA rating tool encourages resources efficiency through dematerialization Van Reenen (2014). Participants who have worked on green star rated projects should to give advice on such projects.

Rate your experience level with regards to green buildings	It was acknowledged that having a project team with experience on green buildings was valuable in achieving sustainability goals (Hwang and Tan, 2012).
What activities have contributed to your green experience	Education has a noteworthy influence on the decisions that will impact on the sustainability of the project, (Ugwu and Haupt, 2007). It is important to identify the other activities that are considered to promote sustainable developments
Do you agree that green or sustainable practices are associated with increased costs?	There is a perception that the higher cost of sustainable designs is a significant barrier for sustainable buildings (Revel and Blackburn, 2007; Eichholtz <i>et al.</i> , 2010).
Do you agree that green or sustainable designs are more complicated to design than traditional building?	Stakeholders lack information and knowledge on sustainable systems, they tend to opt for traditional methods of building (Dair and Williams, 2006).
Which stakeholders' decision power (directly/indirectly) has the greatest influence on specifications for prospective green/sustainable development	Literature by Bartlett and Howard (2000) has shown that there are various stakeholders and decision makers in the supply chain that affect the sustainability aspects of projects.
How often do these professions or entities contribute to green/sustainable specifications on projects	
How would you rate the importance of QS participation in green/sustainable specification development at the following project stages?	The quantity surveyor plays an essential role, as a project cost consultant (Matipa <i>et al.</i> , 2008). the as the role of quantity surveyors is evolving (Ofori, 2006), it is important to determine their perception on how important their participation on sustainable projects.
At what stage in the project life cycle is QS contribution to sustainability crucial for your projects?	Furthermore, at what stage of the project is the quantity surveyor most appropriately suited to contribute toward sustainability aspects of the project (Boswell and Walker, 2004).
Please rank the following barriers to advising on sustainable building specifications on prospective green/sustainable developments	The drivers to sustainability are as diverse and sometimes related to the barriers. Du Plessis (2002). Chapter 2.4 looks at the barriers to sustainability which were used in the online survey.

What initiatives will assist to incorporate sustainable goals into projects?	Du Plessis (2002) identified three categories of enablers of sustainability: technological, institutional and value system enablers. Chapter 2.5 addresses at the drivers to sustainability which were used in the online survey.
------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

3.8 The Study Proposition

A proposition is the researcher’s premise when answering the study question. Rowley (2004) states the researcher should prepare a premise/hypothesis that the data collected can either support or refute. The proposition for this study is:

- Quantity surveyor are not sufficiently knowledgeable in sustainable development to sufficiently engage and advice on strategies for sustainable specifications at project planning level

The study proposition was instrumental in deciding the research proposition. The triangulation (mixed methodologies) would allow for different methods to be used to either refute or support the hypothesis.

3.8.1 The Unit of Analysis

The unit of analysis is the “who” or “what” that the research analyses (The Pell Institute, 2016). The unit of analysis for this study were quantity surveyors in South Africa. The research centred on these professionals and their perceptions towards sustainable projects. Physical interviews were carried out with four (4) professional quantity surveyors that have worked on green building projects. The online survey was administered via the ASAQS website as well as emails sent to quantity surveyors registered on the GBCSA website.

3.9 Criteria for interpreting the data

As was earlier indicated, this research employed both structured and semi-structured interviews. The responses collected from the semi-structured in-depth interviews were transcribed on a computer with the main points being used for the analysis. These interviews were analysed using thematic topics, content analysis and pattern matching. These qualitative techniques which involve the analysis of data for similarities, patterns and content. Rubin and Babbie (2010) considers content analysis appropriate when analysing recorded communications as it provides a good method for analysing reviewed findings. Content analysis also allows the researcher to perceive and judge the collected information according to how relevant it was to the study (Jankowicz, 2005).

On the online survey, research questions 1-14 employed structured quantitative questions, specifically correlation and factor analysis. Research Questions 15-16 are open ended questions which will enable respondents give in depth information on their subjective experiences with sustainable building.

The quantitative data collected was inspected for errors and gaps. After Inspection, the data was coded and keyed into SPSS for data analysis. Analysis of data was done using statistical measures of means, standard deviations, minimums, maximums, frequency distribution and medians.

The profile of the quantity surveyors studied was measured in several ways, i.e. the surveyors Green Star SA Accredited Professional, their length of experience with green or sustainable practices and their practical experience (if any) in working on green building rated projects.

3.10 Access to data sources

Patton and Applebaum, (2003, pg. 68) define access to the data sources as “*the ability to get close to the object of the study to find out what is truly happening*”. Access to quantity surveyors was required to obtain the necessary information and a clearer understanding on the research. Some respondents may be reluctant to provide researchers with access as it may have some sensitive information that they may not want to be revealed (Rowley, 2004).

To distribute the online surveys to quantity surveyors, the researcher requested the ASAQS to post the link survey on their ASAQS website. The ASAQS also agreed to supplement the link to the survey by including a clear description and the purpose of the survey on their regular newsletters which are sent out via email addressed to members. To find Green Star Accredited professionals, the researcher obtained the list of registered quantity surveyors from the website Green Building Council where the names are publicly available. Direct e-mails were distributed to these accredited members with a cover letter and assurance of confidentiality and anonymity together with the link to the online survey for their action.

To obtain access to the quantity surveyors to interview, a request for an appointment was issued via email followed up with a telephone call explaining the research study. Following the explanation of the study and approval to undertake the interview, the questionnaire was emailed as an attachment to the quantity surveyor to review and prepare prior to meeting with the researcher. There were no inconsistencies in questionnaires issued out to all quantity surveyors in the survey.

3.11 Ethical concerns during research

In carrying out research in an ethical manner, Rowley (2004) states that the researcher is required to be transparent about the intentions of the data collected including being respectful of privacy and confidentiality. The research ensured that participants aware of the purpose and nature of the study prior to undertaking the surveys.

Given that the research approach used within this paper was likely to collect project related information of a sensitive nature, participants were explicitly made aware of the confidentiality and anonymity when it came to the publication of the data (Bernard, 2011). For instance costing information provided by the informants is considered a guarded secret by organisations and a leak could lead to firms experiencing financial harm if divulged (Frei, 2010). Therefore, from the onset, to provide a sense of security,

participants were informed that their participation was voluntary and that their identities and identifiable any data and project information would be coded and remain confidential for the purposes of the study (Bernard, 2011).

The following ethical considerations were adhered to:

1. Written consent from all targeted respondents;
2. Assurance by means of a cover letter stating that all information divulged to the researcher during the study would be kept under strict confidentiality and would only be used for academic purposes;
3. Respondents were not required to divulge personal identifiable information;
4. Use of technology to ensure anonymity (survey monkey online survey tool);
5. Assurance that no identifying information would be used during analysis and all responses would be aggregated by type of development (commercial, retail, residential) and green star rating.

The online surveys also provided for true anonymity in that respondents were only identified as numbers as generated by Survey Monkey to encourage people to participate. Furthermore, no identifiable information of the participants was collected on the surveys to allow respondents to feel free to provide their perceptions on the topic.

3.12 Delimitation of the research

The sample for the online survey is limited geographically to South Africa based ASAQS database and listed quantity surveyors on the GBCSA website. The sample for the face to face interviews is limited to quantity surveyors in the Cape Town, South Africa that have experience on green building developments. Furthermore, during the data collection process, some respondents took time to respond to the request to complete the online survey, this was attributed to some emails reflecting on the respondents' junk mail therefore making it difficult for them to differentiate between a legitimate survey and a spam (unsolicited junk mail), as the email was delivered from an unknown source.

3.13 Chapter summary

This chapter provided a review of the research design, target population, data collection tools, data collection procedures and data analysis used to answer the research questions. The chapter describes the research methodology and statistical analysis process adopted for measuring various attributes under study based on the quantitative and qualitative output. At the end of the chapter, the ethical and practical issues are addressed.

4 Chapter Four: Data presentation and analysis

4.1 Introduction

This chapter is shaped from the theories discussed in the literature review and the methodology chapter. The research findings from web surveys and responses from interviews are presented and compared in this chapter. The chapter aims to combine and evaluate the quantitative and qualitative aspects of the web survey and interviews to determine the key findings based on the information provided by the quantity surveyors. The research findings are then analysed in conjunction with the research objectives and problem statement.

4.2 Data analysis background

This Chapter aims to answer the primary question that states, “Are quantity surveyors sufficiently knowledgeable in sustainable development to effectively engage and advise on strategies for sustainable specifications at a project planning level?” The findings were derived from research instrument, that is, an online survey and semi-structured interviews. The analysis techniques used to determine the research findings for the semi- structured in-depth interviews were content analysis and pattern matching. While statistical data analysis (i.e. means, standard deviations, minimums, maximums, frequency distribution and medians), correlation and factor analysis were applied from the online survey results.

The online survey was sent to members of the ASAQs and the Green Building Council that comprises of 1499 registered members and 59 members respectively. From both organisations 28 members completed the survey.

In addition, the four face to face in-depth interviews were undertaken with professional quantity surveyors aims to strengthen the research findings as well as further support answers to the research primary and subsidiary questions detailed in Chapter One. Semi-structured questions were sent out to the participants prior to the interview discussions to allow them to be better prepared.

The four participants interviewed had previous experience working on at least one green building project from inception to completion stages. Table 4.2-1 depicts the respondents experience with green building projects:

Table 4.2-1 Interviewed quantity surveyors with experience with green building projects

Experience	No. of respondents
Attended various green building courses provided by GBCSA	3
Registered as a green star accredited professional	1

Respondents are coded as follows:

QS|S(n) = QS from survey, coded as respondent 1 (n)

QS|P(n) = QS from interview, coded as interviewee 1 (n)

4.3 Survey findings and analysis

4.3.1 Career growth in green buildings

As per the online survey conducted, only 14% of the ASAQS quantity surveyors are Green Star Accredited Professionals as shown in the diagram Figure 4.3-1 below. Findings from the In-depth interviews showed that some quantity surveyors perceive green star accreditation as voluntary rather than a must have. One respondent indicated “A QS doesn’t need to be accredited to work on green buildings” while another stated “Green Star accreditation has no additional value to us as quantity surveyors”. This suggests that some quantity surveyors do not place an elevated level of importance in the Green Star accreditation process although they have been involved in green building projects

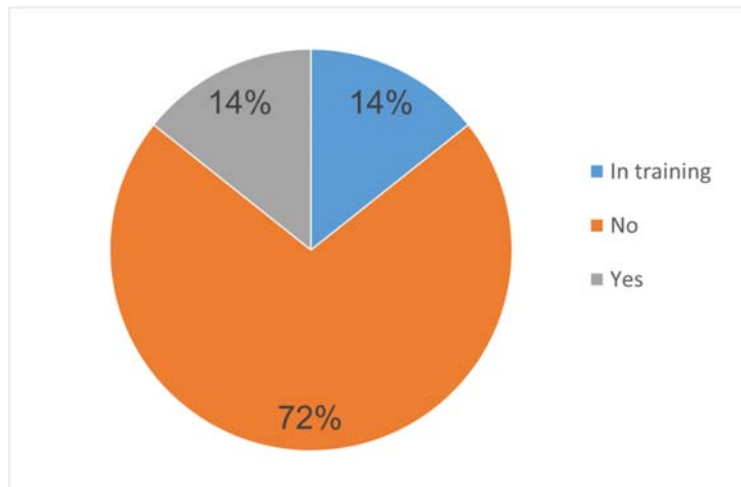


Figure 4.3-1 Percentage of Green Star SA Accredited Quantity Surveyors

Although Green Star Accreditation began in 2010, growth of the current number of Green Star Accredited Professionals appears to be slow notwithstanding 39% of the respondents stated to have been involved in Green Star projects. 57% of the respondents indicated that they had not been involved in any Green Star related projects implying that the concept of green buildings or sustainable developments movement is still at its infancy stages since its inception in South Africa. According to literature reviewed, Boswell and Walker (2004), mention that the building industry lacks sufficient players who are trained to support sustainability which is in line with the findings.

4.3.2 Education in Green Building Professionals

When asked what activities could or have contributed to their green building experience, respondents indicate that all activities listed in the questionnaire play a role in their green building knowledge e.g. from Online research to further education. Online research/self-education is deemed the most useful resource with a mean of 2.33 (SD=0.78) in their attainment of green building knowledge. This is followed by the direct involvement of participants in sustainable developments with a mean of 2.04 (SD=1.06). Attending courses offered by GBCSA with a mean of 1.96 (SD=1.22) is also considered useful by the respondents. Table 4.3-1 illustrates the results from the questionnaire. It is important to note that respondents do not find non-governmental organizations' involvement activities such as professional bodies or trade associations useful to their green building experience.

The responses in Table 4.3-1 are coded as follows: 0. Not useful at all (very weak); 1. Not useful (weak); 2. Somewhat useful (indifferent); 3. Useful (strong); 4. Very useful (very strong).

Table 4.3-1 Activities contributing to Green Building experience

Activities	N	Mean	Median	Std. Deviation	Minimum	Maximum
Online reading/research	27	2.33	2	0.78	0	3
Direct involvement in sustainable developments	25	2.04	2	1.06	0	3
Attending Courses offered by GBCSA	26	1.96	3	1.22	0	3
Indirect involvement in sustainable developments	25	1.92	2	0.81	0	3
Further education	24	1.92	2	1.14	0	3
Attending Courses offered by other institutions	24	1.88	2	1.08	0	3
CPD events	26	1.81	2	1.20	0	3
Non-Governmental organizations' involvement	23	1.65	2	1.07	0	3

Being involved in more green activities, as listed in Table 4.3-1 above, allows the quantity surveyor to have the technical knowledge and a platform to determine the material specifications available to professionals and end users. This goes a long way in ensuring that alternative building materials are considered on projects. However, some quantity surveyors perceive that their limited knowledge of these green products inhibits their ability to recommend them in projects. QS|S(4) remarks that limited *“knowledge of these products somewhat hinder the use of the products. Clients and industry professionals prefer using products they are used to”*.

Although quantity surveyors interviewed have a reasonable understanding of sustainability, their primary focus is on capital cost of buildings. QS|P(1) and QS|P(3) discuss sustainability as the concept of approaching building that is responsible as well as considerate of the future generation. QS|P(1) further states that *“sustainability should be a standard approach; it is not onerous at all if the designs are done right”*. To achieve sustainability QS|P(3) states that specifications should *“use resources of a sustainable nature to ensure that the building...has longevity”*, This includes not exploiting resources and having a long-term view when handling projects. QS|P(2) views sustainability as *“implementing the principles of good building practice i.e. responsible building practice, reducing [the] carbon footprint [and], less damage to the environment”*. From a quantity surveying perspective, QS|P(4) states that *“sustainability is about limiting maintenance cost and making the maintenance regime easy and cost effective”*.

The literature review confirms that information on sustainability has an influence amongst participants' ability to work on sustainable projects (Ugwu and Haupt ,2007). For sustainability to be implemented role players need to understand aspects of sustainability and its impact on projects (Cushman et al., 2015). Choi (2009), states that there is however a significant gap in knowledge and education of green buildings, thus through further research and communication the knowledge barrier can be limited.

Häkkinen and Belloni (2011) thus suggest professional education in the field of sustainable buildings needs to be incorporated at all levels of education systems to promote the knowledge growth.

4.3.3 Developments most ideal for sustainable development

When asked which type of green developments they have worked on, very few respondents indicate having undertaken green building development in office (7%), retail (4%) and retrofitting (4%) projects. Most respondents' state they have never undertaken any type of green building projects as can be seen in the modes within Table 4.3-2.

The responses in Table 4.3-2 are coded as follows: 0. Never; 1. Very Rarely; 2. Rarely
3. Occasionally; 4. Frequently.

Table 4.3-2 Green building projects worked on previously

Green building projects worked on	Valid	Mean	Median	Mode	Std.		
					Deviation	Minimum	Maximum
Office/Commercial	26	1.38	2	0	1.33	0	4
Residential	24	0.96	0	0	1.27	0	4
Retail	24	0.75	0	0	1.11	0	4
Governmental	23	0.61	0	0	1.08	0	3
Retrofitting	21	0.57	0	0	1.12	0	4
Industrial	21	0.33	0	0	0.58	0	2

Despite their limited experience, we asked respondents on their views as to which developments benefit the most from sustainable designs. The frequency Table 4.3-3 shows the results.

The responses in Table 4.3-3 are coded as follows: 0. Not Important; 1. Slightly Important; 2. Moderately Important; 3. important; 4. Very Important.

Table 4.3-3 Building projects that benefit from sustainable designs

Type of development	Valid	Mean	Median	Mode	Std.		
					Deviation	Minimum	Maximum
Commercial	26	2.27	2	2	0.72	1	3
Retail	26	2.15	2	3	0.83	1	3
Residential	26	1.88	2	2	0.82	0	3
Governmental	28	1.86	2	2	0.76	0	3
Industrial	25	1.72	2	1	0.84	0	3

Respondents view commercial buildings with a mean of 2.27 (SD=0.72) as the most important type of development to benefit from green building designs. Retail type of developments follows with a mean of 2.15 (SD=0.83) as beneficiaries of sustainable development. Although there is growing demand for residential developments from end users for sustainable buildings (Häkkinen and Belloni, 2011), Residential and Governmental were not as important whilst industrial developments were considered

he least important to benefit from sustainable designs with a Mode of 1 (SD=0.84). Figure 4.3-2 below is a graphical representation of the 2 highest numerically categories.

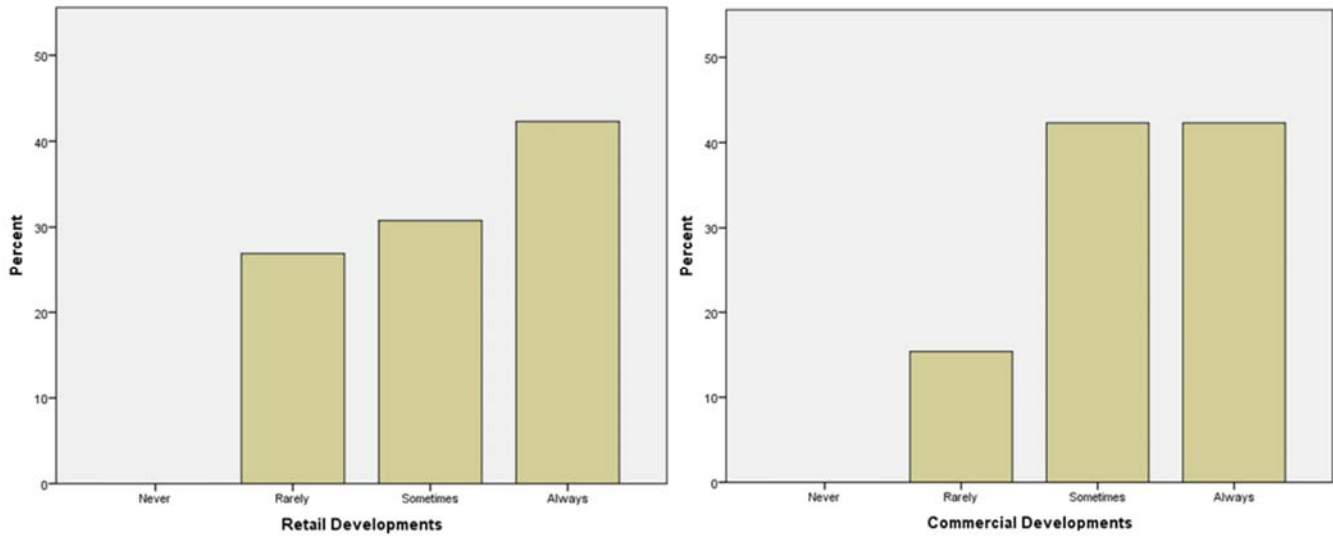


Figure 4.3-2 Histogram on retail and commercial developments benefitting from sustainable designs

4.3.4 Contribution towards green building developments

Respondents were asked to rank which stakeholders frequently contribute to sustainable specifications on projects. Table 4.3-4 shows the results:

The responses in Table 4.3-4 are coded as follows: 0. Never; 1. Very Rarely; 2. Rarely
3. Occasionally; 4. Frequently.

Table 4.3-4 Stakeholders contribution to sustainable specifications

Stakeholder	Mean	Std. Deviation	Median	N	Minimum	Maximum
Architect	2.96	0.82	3	26	1	4
Engineer	2.80	1.04	3	25	0	4
Education Units (Universities)	2.68	0.99	3	25	0	4
Quantity Surveyor	2.41	1.15	2	27	1	4
Government	2.40	0.96	2	25	1	4
Client	2.37	0.97	2	27	1	4
Non-Governmental Organisations (professional or trade associates)	2.27	0.96	2	15	1	4
End User / Tenant	1.96	0.98	2	25	0	3

Architects are viewed to have the greatest contribution to sustainable building specifications with a Mean of 2.96 (SD=0.37), followed by engineers with a mean of 2.80 (SD=1.04). The quantity surveyor has a role in contributing towards sustainable specifications with a mean of 2.41 (SD=1.15). It can be inferred from the participants' responses that quantity surveyors have a positive role to play at the design stage in terms of contributing towards sustainable specifications after architects and engineers' inputs. Bartlett and Howard (2000), supports that the quantity surveyor who understands not only the

financial aspects but the whole project, can make contributions to address client’s sustainability needs. Despite this, quantity surveyors place little importance on environmental sustainability issues (Sonson and Kulatunga, 2014).

Although the end user / tenant was ranked low by the participants, QS|S6) views that “*Green building is mostly for building owners not investors who build and sell the property*”. Revell and Blackburn (2007) highlight that as architects are usually at the top of professional team and are in an appropriate position to push the sustainability agenda on construction projects. The finding from the survey differs with literature from Shelbourn *et al.*, (2006) who states that, the end user / tenant does plays vital role in promoting sustainability aspects on projects and should be more involved in the design process.

4.3.5 Decision makers of green developments

The decision to adopt sustainable building methods is perceived to be highest with the client with a mean of 2.84 (SD=0.37) and followed by the architect with a mean of 2.46 (SD=0.58), as shown in Table 4.3-5. QS|P(4) states that “*sustainability is very much client driven*” with QS|P(4) pointing out that it is “*client decision to have it in or out.*” Nevertheless, all project stakeholders listed tend to contribute to sustainable design where necessary. Respondents also viewed that quantity surveyors have the smallest role with a mean of 1.62 (SD=0.90) in the decision-making process of sustainable building projects. The responses in Table 4.3-5 are coded as follows: 0. Not Important; 1. Slightly Important; 2. Moderately Important; 3. Important; 4. Very Important.

Table 4.3-5 Decision makers of green developments

Decision Maker	Std.		N	Minimum	Maximum
	Mean	Deviation			
Client	2.85	0.37	26	2	3
Architect	2.46	0.58	26	1	3
Government	2.36	0.86	25	0	3
Sustainability Professionals	2.19	0.69	26	1	3
Education Units	2.00	0.89	26	0	3
Engineer	1.85	0.73	26	1	3
Non-Governmental Organisations	1.84	0.55	25	0	2
Quantity Surveyor	1.62	0.90	26	0	3

It is critical to get complete buy-in from the professionals in the industry as they ultimately guide the client and other project stakeholders on the benefits of green developments. QS|P(3) states that “*the architect is the biggest influence in sustainable developments, since he can lead the whole team with his design and get the client to come on board*”.

Mora, (2007) states that as part of the design team the architects and engineers play a key role in preparing specifications on project. It is however the clients who is the key decision makers in

construction projects and can improve sustainability aspects (Blayse and Manley, 2004). as supported by the findings in the table.

4.3.6 Cost implications of green developments

While all future developments should be designed to be sustainable, the respondents stated that there is an additional cost assigned to green designs on certain elements. Majority of the respondents in Table 4.3-6 perceive that durability, availability of local materials as well as the use of energy and water efficient resources as the greatest elements that impact on the cost of sustainable design.

Table 4.3-6 Green aspects that increase building cost

Green aspect	Mean	Std. Deviation	N	Median	Mode
Durability of the product	2.46	0.81	26	3.00	3.00
Make use of energy efficient fixtures	2.37	0.88	27	3.00	3.00
Availability of materials locally	2.30	0.99	27	3.00	3.00
Make use of water efficient fixtures	2.19	0.98	26	2.50	3.00
Make use of sustainably harvested materials	1.93	0.73	27	2.00	2.00
Make use of recycled products	1.74	1.02	27	2.00	2.00
Make use of reusable products	1.70	0.99	27	2.00	2.00

Implementing the use of alternative building materials is good. However, quality, durability and cost are top of mind for project decision makers. QS|P(2) states that *“As long as the material is durable and cost effective and meets the intended use the country must use that alternative!”*.

In terms of the literature reviewed, one reason people are not committed to green building is the perception that green aspects result in higher building costs than traditional buildings from design to commissioning (Revel and Blackburn, 2007; Choi, 2009). The green aspects listed in Table 4.3-6 decrease the environmental impacts buildings generate, Mora, (2007) however highlights that with improving durability aspects of materials significantly enhances environmental performance of a building.

4.3.7 Quantity surveyor contribution to sustainability

Although the QS has minimal say in the decision-making process from what was observed Table 4.3-5, they do play a role in contributing knowledge and ideas into sustainable building projects. Table 4.3-7 below depicts that the QS has the highest contribution at the project planning phases, where design development has the highest mean of 3.38 (SD=3.38) followed by the documentation and procurement stage with a mean of 3.23 (SD=.0.91). Some respondents believe that the QS may have some insight at the construction stage however, this is considered below average with a mean of 2.42 (SD=1.03).

Table 4.3-7 QS Contribution to sustainable design

Project Stage	Mean	Std.	N	Minimum	Maximum
		Deviation			
Design development	3.38	.75	26	1	4
Documentation and procurement	3.23	.91	26	2	4
Concept and viability stage	3.08	.84	26	0	4
Construction Stage	2.42	1.03	26	1	4
Completion and Operation Stage	1.46	1.30	26	0	4

The quantity surveyors' role on projects is primarily to offer cost advice at all stages of a development to ensure the client achieves value for money (Matipa *et al.*, 2008). Kohler and Lützkendorf (2002), show that the quantity surveyor is well placed at the preliminary stages of a project to work with other consultants to provide cost advice and solutions to client problems.

Furthermore, Table 4.3-8, highlights the project phases in which the respondents view the QS to have the greatest opportunity to participate in sustainable designs which is the design development with a mean of 3 (SD=1.20), concept and viability stage with a mean of 2.96 (SD=1.09) and the documentation and procurement stage with a mean of 2.85 (SD 0.92). QS|S(5) notes that *"The need for sustainable development must come from an economic and environmental perspective at early stages of a projects"*. Table 4.3-7 above in conjunction with Table 4.3-8 below suggests that despite QS's having low decision power, they do play a role in contributing at the planning phase of sustainably designed projects.

Table 4.3-8 Importance of QS participation on sustainable projects at different stages

Project Stage	Mean	Std.	N	Minimum	Maximum
		Deviation			
Design development	3.00	1.20	26	0	4
Concept and viability stage	2.96	1.09	27	0	4
Documentation and procurement	2.85	0.92	26	1	4
Construction Stage	2.31	1.41	26	0	4

The quantity surveyor plays a key role in the focus of management of capital costs. QS|P(4) suggests that a quantity surveyors input in determining lifecycle costs can positively contribute towards the assessment of sustainability in projects. Furthermore, the quantity surveyor has the understanding and knowledge into what goes into pricing and budgeting for sustainable projects as they can interrogate other consultants' budgets as well as defend their assumptions on estimates done.

4.3.8 Effect of green experience towards sustainability contribution

To determine whether a quantity surveyor's green experience has any impact on their ability to make contribution to sustainable designs, a Spearman's Rho correlation analysis was carried out to ascertain the relationship. The survey questions used to measure this correlation looked at the quantity surveyors

level of experience with regards to green buildings and their extent of contribution toward sustainable specifications on projects. As per Table 4.3-9, the analysis produced a positive correlation between the two variables where $r=0.41$ indicates there is not a strong relationship and a p-value of 0.04 which is less than the 0.05 significance level. This suggests that at 5% interval that there is a 95% confidence that quantity surveyors with more green building experience are more likely to contribute but the relationship is weak.

Table 4.3-9 Correlation between green building experience and QS contribution to sustainability

Sustainable Contribution - Quantity Surveyor					
			Correlation Coefficient	Sig. (2-tailed)	N
Spearman's rho	Green Experience	Building	.41	.04	25

The views held by Matipa *et al.* (2008), Gibberd (2001) and Essa and Fortune (2008) consider the early design stage to be the most ideal period to consider sustainability issues. However, in terms of the literature reviewed, Bartlett and Howard (2000), reflect that the quantity surveyor’s approach towards sustainable developments is more conservative as they are not specialists in the sustainability field. Sonson and Kulatunga (2014) also believe that quantity surveyors do not usually consider environmental issues whilst carrying out their role on projects. Ashworth *et al.* (2013), however support the findings as they view the quantity surveyor’s knowledge and skills developed in the building industry to be useful on projects.

4.3.9 Role of quantity surveyors in green developments

QS|P(2) discusses that “consultants are getting more involved in [sustainable] projects”. However, to facilitate sustainable designs, most green building projects undertaken appoint sustainability or environmental consultants. However, quantity surveyors, as part of the professional team, still have an opportunity to contribute to sustainable designs aspects and add value to the client. QS|P(1) mentions that they were involved in “a number of workshops held with the team and the green star consultant in the early stages of the project.” to brainstorm on sustainability ideas. From a quantity surveying point of view QS|P(3) reveals that quantity surveyors “do not look at sustainability realistically” rather they consider “the cost point of view of how can we make the building more efficient and cheaper.” This is achieved by providing cost advice on the various sustainable options provided by the project team for the client to make an informed decision. QS|P(4) notes that “a good quantity surveyor asks the right questions at an early stage [and] make necessary provisions” in their cost estimates for example having “a line item for a green building consultant to trigger a discussion” with the client at the early cost planning stages.

QS|P(4) further suggests that the suitable approach to dealing with sustainability would be considering alternative building specifications “like the electrical and mechanical engineers [and] do a lifecycle

costing". QS|P(1) applied lifecycle costing on their project as an approach to show the client value on various alternatives as *"it is in doing the lifecycle costing on various alternatives that [consultants] starts showing regard for value"* on behalf of the client. QS|P(1) states that it is important to *"try encourage clients and show them the value but it is ultimately the decision of the client to whether they should pursue a sustainable building or not"*. Though, as QS|P(4) noted, the lifecycle costing may not always be of interest for the client, particularly for *"traditional developers [that] are looking for shorter term returns"* such as a two to three-year outlook with the aim of selling off the development not long after completion. It was therefore important to understand the impact sustainability has on buildings and costs so that consultants can advise the client appropriately.

Working closely with architects and service engineers is vital in the development of sustainable design proposals. QS|P(3) and QS|P(4) talk about understanding what goes into estimates provided by mechanical, electrical (M&E) and sustainable engineers as they are the leaders in generating ideas for sustainable designs. QS|P(3) further mentions that to give the appropriate cost advice, cost consultants need to understand the various changes that go into buildings to achieve the required green star ratings. QS|P(1) highlights the role they played in interrogating costs and solutions on projects provided by proposals given by the *"Green star consultant [and] engineers ... to achieve the required rating"*. QS|P(3) suggests that even though the M&E consultants have a good understanding of what is required to achieve the required green ratings, they may not have a full understanding of the cost aspects. QS|P(3) speaks to how the green building consultants involved on the project pointed out where the most significant cost items would sit in terms of getting the necessary points for the required green star accreditation. The QS's role was to cost these options provided by various disciplines in the team and prepare lifecycle costs with to justify to the additional expenditure and benefits.

Although this study focuses on the pre-contract stage, the quantity surveyors interviewed made note that quantity surveyors still play a significant role in managing and controlling project costs during the construction stage. In terms of green building developments, respondents indicate that their role is to work closely with architects and engineers on design issues to maintain the green rating required by the client. QS|P(4) mentions that their project, which was set out to be a 4-star green rated building at design stage, *"was not special"* for the client by the time construction on site began. Given that the client was committed to sustainability, the team was challenged to make the appropriate design changes to achieve a 5-star green rating as required by the client. This change in rating had a cost implication to consultant fees as well as the contractor terms and conditions. QS|P(4) however argued that at the time their project was undertaken, the market for construction developments was very competitive, which resulted in reasonable tender prices being submitted that made it easier to adopt green initiatives on the project. Although the scope for most of the projects undertaken was clear, there were opportunities during the project variations that added to the green star rating of the buildings.

4.3.10 Sustainability barriers

Even though the above results recognise the significant role the QS has in advising on green buildings, the researcher needed to determine what limits them to providing such services to the project team. The following Table 4.3-10 lists the major barriers quantity surveyors face to advising on sustainable building designs.

Table 4.3-10 Barriers to QS advising on green building designs

Type of barrier	Valid	Std.				
		Mean	Deviation	Median	Minimum	Maximum
The higher cost of sustainable building materials	26	3.50	0.71	4.00	2	4
No provision in fee structures	26	2.92	1.02	3.00	1	4
Limited resources to engage in sustainability	26	2.88	1.11	3.00	0	4
Clients are not interested with sustainability initiatives	26	2.85	1.22	3.00	1	4
The lack of training and knowledge on sustainability material choices	26	2.85	1.29	3.00	0	4
The lack of technical understanding on the part of project team	26	2.85	1.19	3.00	0	4
The lack of expressed importance from clients	26	2.77	1.27	3.00	0	4
Insufficient data and information to implement sustainability initiatives	26	2.62	1.27	2.00	0	4
The lack of interest on the part of project team	26	2.50	1.21	2.00	0	4
The lack of "green" products suppliers in the area	26	2.46	1.17	2.00	0	4
Difficulty in attaining financing from banks for sustainable developments	26	2.31	1.26	2.00	0	4

- **Higher costs**

The biggest barrier identified by the QS's is the associated inflated cost of sustainable building materials with a mean 3.5 (SD=0.71). This is supported by the interviews, where all the QS's view green building features as quite expensive. However, QS|P(4) highlights that although cost may be a barrier, *"most the times the cost is typically overstated"*. QS|P(4) nevertheless suggests that decisions can be made around redesigning building elements to improve costs to make provision for more sustainable design options. Furthermore, QS|S(1) points out that although the sustainable designs costs may be considered high, *"the operational costs, improved productivity, quality environment for staff"* associated with sustainable designs makes a strong case for the adoption of such approaches". Nonetheless, QS|S(1) emphasises that *"there is an ongoing search for alternative cost effective building materials with the emphasis on cost effective"*.

Perceived higher cost of green is a major barrier to adopting sustainability aspects into projects as tenants may not be willing to pay the additional costs despite the long term benefits they offer (Lewis, 2004; Hakkinen and Beloni, 2011). Clients are afraid the additional costs of implementing green aspects affects their competitiveness in the marketplace (Revell and Blackburn, 2007)

Hakkinen and Beloni (2011), also states that insufficient technologies and tools used to assess green buildings is not a barrier to the development of sustainable building designs.

Häkkinen and Belloni (2011) validates that the lack of a competent design team in sustainable buildings is a barrier to its incorporation.

- **Lack of incentives for QS consultants**

Another barrier that was highly rated with a mean of 2.92 (SD=1.02) was the lack of incentive for the quantity surveyors within their fee pricing structure to advise on sustainable designs. The QS's interviewed indicate that on all their projects, a sustainability or green building consultant is utilized to advise the professional team on sustainability aspects of the project. On the green hotel project undertaken by QS|P(1) a "*Green star consultant put a proposal of points the team should target and we went through options that were given*". Their role as a QS was purely providing cost advice to the professional team on the project. QS|P(2), QS|P(3) and QS|P(4) also have similar comments where they provide the traditional QS role on advising on costs and updating estimates.

- **Limited resources**

QS's also view highly that they have limited resources to sufficiently engage in sustainability designs, Mean = 2.88 (SD=1.11). Similarly, the lack of training and knowledge on sustainability material choices with a Mean of 2.85 (SD=1.29), as well as the lack of technical understanding on the part of project team with a Mean of 2.85 (SD=1.19) are considerable barriers. QS|P(3) however mentions that attending the green star accredited courses, has broadened his horizons on sustainability and green buildings aspects when it comes to providing cost advice regarding sustainable designs. QS|P(1) states that during their project they were engaged in several workshops for the project with the professional team to develop sustainable proposals with the QS preparing cost comparisons of the options for client approval. To prepare cost information on new technologies proposed, QS|P(1) indicates that "*manufacturers data is available*" which is used to generate lifecycle costing on the project. QS|P(3) points out that there is a growing number of manufacturers and suppliers dealing with buildings as there is an upsurge in the market for such projects. It is therefore easier to compare prices and specifications from suppliers to provide competitive prices for the benefit of the client.

Stakeholders may not necessarily have the resources within their structure to successfully adopt innovative sustainable practices (Blayse and Manley, 2004). Ugwu and Haupt, (2007) further recognize that professionals on construction projects are not sufficiently knowledgeable on the use of sustainable tools to motivate sustainable building designs. In the South African construction industry, there is a high level of inexperience on existing green building legislation and their requirements (Windapo, 2015).

- **Lack of interest from client**

Client interests towards sustainability is also viewed as a significant barrier with a mean of 2.85 (SD=1.22). Likewise, the lack of expressed importance from clients with a mean of 2.77 (SD=1.27) acts as a barrier to the development of sustainable designs.

In the facilitation of sustainable designs on projects, there was consensus among the respondents that although sustainability should be a standard approach, the decision to implement is greatly influenced by client. QS|P(3) views the focus on sustainability being “*very client driven*”. However, QS|P(2) believes that there is “*growing demand from clients for green star rated projects*”. QS|P(2) highlights that an environmentally aware client is more likely to encourage sustainable designs in their brief to the design team. QS|P(4) further notes that the client outlook on the project has an impact on how the client values sustainability on the project, and states “*Short term view for immediate profit or long term view for asset growth*”. As QS|P(4) stated, a developer looking to sell a development in the shortest period of time to withdraw from the project on completion are primarily “*traditional developers are looking for shorter term returns*”. Developers that look for immediate returns with tight profit margins look to spend as little as possible. In the case where a developer may have a long-term project view, to hold and operate the property for a longer period of five or more years, this developer places greater emphasis on sustainable development and building design to better manage their maintenance regime and operational costs effectively.

As profit margins are always a key determinant on the undertaking of a project, QS|P(3) points out that “*We were faced with the critical mass of the building and the cost of the green building measures [do] not always make sense.*”. For instance, on a single-story development, rainwater can be utilized to water the garden, but may not go as far as recycling the grey water. Building a grey water storage tank and introducing pumps is costly in relation to the size of the development.

As mentioned in the literature review, clients are the ultimate decision makers on projects (Zainul-Abidin, 2008). Provision for sustainability aspects may not be considered within the client’s own budget (Revell and Blackburn, 2007), as it will result in additional costs for the project that may make the building unaffordable for prospective buyers (Hwang and Tan, 2012). Priority for the sustainability agenda must come from the top key players such as clients and architects to promote green practices (Revell and Blackburn, 2007)

- **Availability of alternative green building materials**

South African professionals and end users are familiar with conventional building methods. QS|S(9) take on materials is that “*The growth and appreciation of alternative materials has been slow due to power marketing and promotion of it*”. QS|S (9) further notes that some sustainable “*building techniques are not supported by NHBRC [National Home Builders Registration Council] and by bank willing to funds them despite the sustainable and life cycle benefits*”.

Treloar et al. (2001) highlight that the selection of appropriate materials is a key issue encountered in building projects. If stakeholders are educated and informed on the ample options, availability quality,

and the benefits of alternative building products, the initial high upfront costs can be offset with cost savings on long term operational expenses and the demand for alternative materials accordingly. Van Reenen, (2014) however acknowledges that challenges do arise in finding alternative sustainable building materials that have been sufficient comparable data and that the building industry has adopted.

4.3.11 Sustainability drivers

Table 4.3-11 Initiatives assisting to incorporate sustainable goals

Driving Initiatives	Valid	Mean	Std.			
			Deviation	Median	Minimum	Maximum
Economic incentives	26	3.62	0.57	4	2	4
Government policy	26	3.58	0.64	4	2	4
Building codes	26	3.42	0.70	4	2	4
Lower lifecycle costs	25	3.28	0.74	3	2	4
Greater availability of green materials	25	3.08	0.86	3	2	4
Collaborative efforts	26	3.08	0.80	3	2	4
Increased awareness of benefits	26	3.08	0.80	3	2	4
Industry rating systems	21	2.90	0.77	3	2	4
Voluntary guidelines and standards	24	2.88	0.95	3	2	4
Educational programs	26	2.85	0.73	3	2	4

- **Economic incentives**

As per Table 4.3-11, the highest rated incentive for sustainability includes economic incentives (mean 3.62 (SD=0.57)). QS|P4 indicates that to attain sustainability the professional team needs to prove its commercial viability as “*margins are tight for any developer*”. QS|P(4) further views the government and local authority as being the bodies with the ability to come in and provide “*rebates to developers that are going into green buildings*” thus promoting sustainable designs on projects. QS|P(2) however notes that although legislation is developed, it is the responsibility of the professional team to produce the specifications for sustainable designs. QS|P(1) and QS|P(4) state that, the current buildings codes in South Africa provide for an adequate 4-star green star rating, but limited designs to these building codes is considered by QS|P(4) as “*stick approach rather than an incentive*”. Furthermore, it was noted that through lower lifecycle costs, followed by increased awareness of the sustainability benefits and increased collaborative efforts between stakeholders, sustainable goals can be equally as affected on projects.

While the concept of using sustainable building materials is ideal, cost remains a significant challenge in achieving their use on projects. QS|S(6) opines that “*More economic incentives must be proved to the client especially when the client's aim is financial (i.e. commercial/retail building). Client can't wait for 10-20 years to generate a proper return, they want to see the viability of the project upfront.*” The belief that green buildings are for building owners only and not for investors needs to be addressed

from a financial perspective as investors will only undertake green developments if there are proven immediate economic incentives.

Traditional approach on construction projects focuses on the economic aspect of sustainability (Edum-Fotwe and Price, 2009). Alkilani and Jupp (2013), agree that there is a lack of initiatives in developing economies to develop sustainable projects in the industry.

- **Government policies and building codes**

Development of government policy with mean 3.58 (SD 0.64) and building codes with a mean of 3.42 (SD=0.70), as depicted in Table 4.3-11, are also highly rated by respondents. Quantity surveyors' views on the industry continue to remain reluctant to the use of alternative building materials. However, if stricter building codes can be enforced, then clients and professionals will be forced to adhere accordingly. As QS|S(9) states *“Legislation to rubber stamp all alternative building materials and building methods”* is a factor outside quantity surveying that can have a positive impact on sustainable designs.

As noted in the literature review, local authorities play a significant role as they can create policies that limit the development of non-sustainable projects in the industry (Hakkinen and Beloni, 2011). Revell and Blackburn (2007) discuss that such regulations make sustainability reforms clear to clients thus driving them to incorporate such aspects in their projects. Within South Africa, there are green building frameworks that have been developed that can guide professional teams to be comply, thus acting as a driving initiative (Windapo, 2014). Blayse and Manley (2004), recommends developing these regulations requires input from key players in the building industry for green practices to succeed.

- **Industry rating systems**

The use of green building rating tools on projects offers a valuable tool for the professional team, as QS|P(3) states, *“we need to understand the changes that need to go into buildings to achieve the specific green star ratings and put a cost to it and give advice”*. The rating tools offer guidance and emphasis on energy and water consumption aspects and considers ways to minimize their usage to the benefit of the client as well as the environment. QS|P(4) however implies that *“rather than chasing ratings or trying to get certificates saying that we have a Green Star rating”*, we should strive to be truly sustainable as the clients may not be interested in a rating for the building.

As per the interviews conducted, respondents agree that sustainable building projects have a different approach as compared to dealing with normal/traditional types of projects. QS|P(1) says *“as quantity surveyor, we are looking for value as opposed to only producing a cost effective solution”*. As sustainable projects tend to have a longer-term outlook, as stated by QS|P(1) quantity surveyors can use available tools to prove that sustainability is *“cheaper in the long run”*.

Windapo (2014) agrees that the growing accessibility to industry rating tools is a driver for the development of green buildings. Darko *et al.*, 2014 argues that legislation should be considered a top driver as it positively influences and pressures stakeholders to adopt sustainable designs in their projects.

- **Environmentally aware clients**

From QS|P(4) involvement with end user's tenants/ client who have a large property portfolio as well as "*greater depth of knowledge of buildings and a greater emphasis on facilities management*" usually require their new developments to incorporate sustainability in their designs.

Furthermore, it is observed that, environmentally aware developers are more inclined to develop green buildings and as stated by QS|P(2), "*the client who is environmentally aware [usually] wants a green building*". For instance, on the project undertaken by QS|P(2), the client was the main driver as they made it explicitly clear from the onset that they wanted the greenest hotel in Africa at the time. The client felt that people are more likely to live in green hotels as opposed to traditional hotels due to the greater benefits offered by green buildings. For green building developments QS|P(3) mentions that the client "*can sell this as a green space at a relatively high rental*" as tenants' benefit from reduced electrical and air conditioning consumption.

With QS|P(4), their multi-story office development had two major tenants driving the green agenda on the project. Both these tenants were involved in the initial stages of the project and were adamant that their building would be a 5-star green rated building as per the Green Star rating system. Both the tenants on the project had knowledge of managing building assets and they placed a great emphasis on facilities management. Specific requirements were highlighted at the preliminary stages and were based on sustainable initiatives provided by both tenants. As an example, during design meetings with the consultants, it was noted that one of the tenants would strip the entire floor every two years, performing a refresh to the layout and moving tenants around. If one were to install fixed partitioning on this floor, after two years it would be broken down and disposed of, so it made sense to spend more money on demountable partitions that can be taken down, moved and arranged to suit a new tenancy. As QS|P(4) highlights the development "*probably [does not] get credit for that in the rating tool but that is a great example of a sustainable measure*" applied on a project.

From the literature review, industry stakeholders should be able to inform the clients beforehand of the sustainable approaches to create sustainable developments that will benefit the environment, economy and social aspects (Meacham, 2010). Sebake (2008) mentions that the architect plays a crucial role at the planning and design stage in promoting sustainability on construction projects.

4.3.12 Challenges faced by quantity surveyors in green developments

QS|P(4) states that, in terms of sustainability, the challenge arises in trying to "*justify spending a premium when others might not*". On the project done by QS|P(3), their role was to identify and interrogate the cost components as the entire team of "*consultants were challenged to make sure that*

the budgets that they gave for all those specific points were achievable". Although there may be sustainable building materials available in the market, QS|P(1) suggests that consultants do not entirely understand what is involved in the development of green building designs. For instance, when it came to QS|P(3) interrogating the budgets provided by the mechanical, electrical and green consultants, there were cases of *"double accounting"* amongst their estimates. As QS|P(3) highlights for quantity surveyors the *"challenge is to make sure that the budget is not inflated by information from other consultants"* as it would lead to the project being rendered unfeasible. Therefore, clear communication amongst consultants plays a significant role to ensure provision for related items are not included under different budgets.

Professional quantity surveyors have developed skills in key areas relating to technology, information management, culture and economic aspects that can be expertly applied on projects at appropriate levels through training and practice (Ashworth *et al.*, 2013). Bartlett and Howard, (2000), discuss that quantity surveyors tend to be conservative and may find it difficult to assess and cost energy efficiency measures which should rather be dealt with by experienced engineers.

4.4 Chapter summary

In conclusion, during the life of a construction project, the client remains the biggest influencer followed by the architect then the engineer. The quantity surveyor has the potential to play a positive role in implementing sustainable building specifications during the design stage of any given project. However, quantity surveyors need to start placing more importance on environmental sustainability issues in conjunction with project costs; as this will greatly benefit end users or tenants in the entire life cycle of a development.

From the survey and in-depth interviews undertaken the research findings can be summarised as follows:

- Majority of the quantity surveyors perceived Green Star accreditation as voluntary rather than a must have. This further supports the main reason why the number of quantity surveyor sign-ups have been slow over the last six years as well as the lack of a sufficient trained professions that can drive and implement various sustainability techniques within the built environment.
- Majority of the interviewed quantity surveyors indicated they had limited knowledge of the green products available in the market, therefore making them unable to impact the use of the products during any given project. To contest this challenge, respondents indicated that online research, self-education, direct involvement of participants in sustainable developments and attending courses offered by GBCSA would be the best way to improve the current quantity surveyors limited technical knowledge in alternative building materials.
- Quantity surveyors primary focus lies in cost preservation and not sustainability of a construction

project. Therefore, it is imperative for all quantity surveyors to begin asking the right questions at the initial stages of any project. For example, adding green building materials and consultants to line items in the costing schedule to trigger a project team discussion with the client present.

- Whilst constructing sustainable developments is client driven, the architect continues to remain the greatest influencer in providing the benefits of constructing sustainable developments to the client and the professional team. Nevertheless, quantity surveyors with green building experience are more likely to significantly contribute and influence the client and project team during the design and planning phase of any sustainably designed projects.

Interviewed quantity surveyors indicated that undertaking a lifecycle costing from the electrical and mechanical engineers and other project consultants could positively impact the sustainability of construction projects. Unfortunately, this can only apply to clients/developers seeking longer term returns on a development as opposed to shorter term returns.

- Quantity surveyors indicated that sustainability should be a mandatory standard approach and a good building practice in reducing the carbon footprint and damage to the environment in the long term. The likely incentive for this to take place is through ensuring the green rating system and its incentives are well understood by the project team and client.
- Quantity surveyors' key sustainability barriers remain; inflated costs associated with procuring sustainable building materials; lack of incentive in fees when advising on sustainable designs; limited resources when engaging in sustainable designs and; lack of adequate training and knowledge on sustainable material choices.
- Key drivers that quantity surveyors stated could improve the implementation of sustainability techniques in construction projects include: a critical analysis of the sustainable design costs against the operational costs and productivity of the completed project; increased workshops and accredited green star courses to broaden the quantity surveyors' perspective and knowledge in sustainable and green building developments and; improved government policy and building codes with association support (i.e. National Home Builders Registration Council (NHBC) to increase the public awareness and benefits of constructing sustainable developments.
- Currently quantity surveyors within various organizations view alternative building materials in sustainable designs in their projects as costly and not practical. While the quantity surveyors have the avenue and ability to advice on alternative building materials, their limited knowledge or historical background has left the role of advising the client on the ideal specification to use for any green development.to the Architect and Engineer.

Overall, at the time of the survey, quantity surveyors in South Africa had limited knowledgeable in sustainable developments to effectively engage and advice on strategies for sustainable specifications at a project planning level. However, if the professional institutions and governmental policies can

eventually be put in place then, quantity surveyors will have no choice but to undertake the necessary training to become Green Star Accredited Professionals.

5 Chapter Five: Conclusions and Recommendations

5.1 Introduction

This chapter reflects on how the research aims and objectives were achieved, revisits the research assumptions and concludes the research with recommendations for future research. The research has discussed the role quantity surveyors play on sustainable building projects and their perceptions towards advising on sustainability aspects.

5.2 Evaluation of research objectives

The study set out to investigate whether quantity surveyors in South Africa are sufficiently knowledgeable in sustainable developments to effectively engage and advise on strategies for sustainable specifications at a project planning level identified into four sub sections:

- a) Determine how quantity surveyors view alternative building specifications

From the literature review, it was observed that at the design stage ideas regarding sustainability aspects commonly come from the design consultants within the project team i.e. the architect, mechanical and electrical engineers. Although findings from the Interviews also showed that green building consultants are usually appointed when the client requires a development to achieve a certain green star rating. Quantity surveyor tends to be low on the list of people that contribute to alternative building specifications, as they rather focus on cost aspects of specifications provided.

- b) Establish to which degree quantity surveyors have experience advising on alternative building materials on projects and to provide advice on alternative specifications.

Quantity surveyors have limited experience on advising on alternative specifications. The research shows that a very few percentage quantity surveyors had worked on green or sustainable building projects and are therefore were not able to provide input at the design stage. However, it is evident that those quantity surveyors with experience on green building projects, are more likely to contribute towards the sustainable design aspects like material choices on projects based on lessons learnt on previous projects. Furthermore, many quantity surveyors that have not been exposed to green building projects are more likely to adopt a traditional approach in terms of providing their professional services to clients i.e. providing only cost advice to clients based on the designs and solutions provided by other professions in the design team. This research study has also shown that even though the quantity surveyor is knowledgeable on many aspects of building construction they contribute little towards sustainable designs at the pre-contract stage of a project and they are usually not expected to give such advice on sustainability as it is not part of their scope.

- c) Gauge the ability, at a project planning level, the quantity surveyor can contribute to project changes through justification that sustainability aspects can be accommodate within the project costs.

The Literature review shows that the quantity surveyor has an influence on decisions on all design development stages of a project. The surveys and interviews also support the literature in that the quantity surveyor has reasonable opportunity to contribute at the early project stages whilst the client is looking to add value to the project. In this regard, research concluded that the quantity surveyor has an influence but primarily through making appropriate budgetary provisions for sustainability at initial stages of a project. As professionals, asking the right questions at the right time is critical for any project being undertaken and it is vital for the quantity surveyor through a well-defined brief, know the expectations and outlook of the client to make the necessary allowances within the budget for their requirements on the project.

- d) Identify factors that quantity surveyors need training and exposure on green building projects to appreciate sustainability aspects, specifications and pricing.

The research also sought to determine whether improved exposure or knowledge would influence quantity surveyors to engage in sustainable designs. The research shows that improved knowledge in the field of green/sustainable building practices can advance their ability to contribute positively towards such developments. Furthermore, as government legislation on sustainable building practices develops, there will be greater knowledge and information for which the professions will need to be acquainted with for new building developments. Thus, it is important for quantity surveyors to become aware of developments on legislation with this regard to stay relevant and practical in the building industry.

5.3 Research aim

The aim of this research was to investigate how quantity surveyors in the South African context view alternative building materials and establish to what degree they were willing to make contributions to sustainable projects at early design stages. Furthermore, the study aimed to determine the quantity surveyors influence on project changes at the design and determine what factors would influence them to think in a more sustainable way.

The research showed that quantity surveyors have a role to play in working on sustainable building projects. They should not be limited to only providing cost advise but through knowledge of various tools such green start rating tools as well as other eco labelling tools, provide insight within the professional team to provide greater value to the client. Quantity surveyors are sufficiently knowledgeable there only that there are not enough of practicing green cost management.

5.4 Research question

The research question at the beginning of this study questioned whether Quantity surveyors in South Africa are sufficiently knowledgeable in sustainable developments to effectively engage and advise on strategies for sustainable specifications at a project planning level. This study however showed that the quantity surveyors with their extensive knowledge in the building industry are sufficiently knowledgeable and that they can contribute towards sustainable aspects at the project planning level, however they need more green star related training and educational knowledge in sustainable development. As building professionals, quantity surveyors have a significant role to play in considering the economic aspects of sustainability as well as minor roles on the environmental and social aspects as their primary role is to provide cost advise on projects. This research has also shown that the quantity surveyors can play a proactive role by collaborating with members of the design team at the project planning stages to guide sustainability aspects to meet the clients.

5.5 Research subsidiary/secondary questions

The research also sought to determine answers to subsidiary questions that aimed to determine what limits quantity surveyors in contributing to sustainable developments during the planning stages. It was determined that the perceived higher cost of implementing sustainable designs is a limitation as well as the lack of reward in terms of additional fees when it comes to contributing their ideas to sustainable developments. Furthermore, the quantity surveyor views sustainable development as a client driven decision, thus they may not see any value in pushing a sustainability agenda that a client may not be interested in. However, the study research shows that quantity surveyors need more training and knowledge in this field to effectively contribute practically to the sustainable design process as currently majority of the professionals in the industry are aware but have not had significant exposure to such developments.

5.6 Limitations of the study

The study was limited to quantity surveyors in South Africa and the sample size was restricted to quantity surveyors ASAQS national members and members of the Green Building Council South Africa. The individual interviews undertaken were limited to registered ASAQS members who have been involved in green rated building projects in South Africa. This limited the number of respondents for the study.

Furthermore, there was limited time to get feedback from the respondents, this had an impact on the total number of responses received from the online surveys which limited the analysis and feedback.

5.7 Conclusions

In conclusion, based on the evaluation of the research question, aims and objectives the following was deduced;

- The construction of sustainable developments is most effective at design stage when all the project stakeholders are involved.
- Quantity surveyors in the current market are the least likely to effect alternative building specifications as they remain traditionally driven to cost preservation and remain inexperienced in sustainable development. The findings do however prove that quantity surveyors have a key role to play and that sustainability trained quantity surveyors can effectively engage and advise on strategies for sustainable specifications at a project planning level while still practicing green cost management.

5.8 Recommendations

The following recommendations were drawn from the findings:

1. Quantity surveyors need to have a better understanding of green rating tools available in the market as well as do research on green trends to be better informed on sustainability issues in the industry. As professionals, they should invest in further training related to sustainability or green building developments so that they can play a proactive part in the design process.
2. The research found that engagement and effective communication with other professionals in the team is vital to achieving project outcomes. Quantity surveyors need to ensure that they understand what other design consultants are putting forward in terms of sustainability changes and their impact to the building in terms of value as well as overall cost implications.
3. Although demand is growing towards sustainable developments. The study has shown that a small number of quantity surveyors has been involved in green projects. Governments should promote legislation that requires the adoption of sustainable building practices so that there is significant growth in the sector, thus providing opportunities for quantity surveyors to get involved in.
4. The quantity surveyor can show value of sustainability for long term gain to the client despite the added cost. Buy in from the clients will eventually lead to more demand of sustainable building practices and this will in turn compel quantity surveyors to get green ratings/accredited.
5. Provisions should be made within the quantity surveyors professional fee structure to provide them the opportunity to give advice on alternative building specifications and other sustainability aspects. Quantity surveyors should be able to show value to clients and thus be rewarded within their fees offered.

6. The misconceptions of significant inflated costs of sustainable building materials should be addressed by carrying out appropriate life cycle assessments on alternatives. Quantity surveyors working closely with key participants on projects can develop proposals to prove the viability of alternatives in the long term which will be beneficial to the client.

5.9 Areas of further research

This research is limited to the pre-contract stage of projects where it offers the greatest opportunities to contribute to design changes and specifications. However, there are other areas in which further research related to this topic can be undertaken. These include the following:

- There is a need to consider the role quantity surveyors manage the post contract stage of projects to maintain the green building ratings a project requires. As cost professionals, they continuously provide advice to the client and team and there are opportunities for them to provide value to clients as well as the design team regarding sustainability matters during construction.
- Consideration of how quantity surveyors encourage key stakeholders such as the client to promote sustainability on their projects.
- Further research is needed to see how institutions such as the Green Building Council of South Africa can promote green building practices in the industry to make the building standards that are sustainable a norm in the country.

Another area for further research can be testing life cycle assessments in case studies in a South African context to determine the value projects can get if carried out correctly. In seeing how these assessments are undertaken, the profession can learn and develop the green building industry.

References

- ASAQS (Association of South African Quantity Surveyors). 2015. Unpublished Presidential Chapter Tour 2014 Presentation in South Africa.
- Abidin, N.Z., 2010. Investigating the awareness and application of sustainable construction concept by Malaysian developers. *Habitat International*, 34(4), pp.421-426.
- Abowitz, D.A. and Toole, T.M., 2010. Mixed methods research: Fundamental issues of design. *Validity, and Reliability in Construction Research*, ASCE.
- Aigbavboa, C., Oke, A. and Mojele, S., 2016. Contribution of value management to construction projects in South Africa.
- Akintoye, A. and Main, J., 2007. Collaborative relationships in construction: the UK contractors' perception. *Engineering, Construction and Architectural Management*, 14(6), pp.597-617.
- Alkilani, S. and Jupp, J., 2013, February. Paving the road for sustainable construction in developing countries: a study of the Jordanian construction industry. In *Australasian Journal of Construction Economics and Building-Conference Series* (Vol. 1, No. 1, pp. 84-93).Amu, O.O. and Adesanya, D.A., 2011. Mathematical Expressions for Explaining Project Delays in South western Nigeria. *Singapore Journal of Scientific Research*, 1(1), pp.59-67.
- Arif, M., Egbu, C., Haleem, A., Kulonda, D. and Khalfan, M., 2009. State of green construction in India: drivers and challenges. *Journal of Engineering, Design and Technology*, 7(2), pp.223-234.
- Ashworth, A., Hogg, K. and Higgs, C., 2013. *Willis's practice and procedure for the quantity surveyor*. John Wiley & Sons.
- Aye, L., Bamford, N., Charters, B. and Robinson, J., 2000. Environmentally sustainable development: a life-cycle costing approach for a commercial office building in Melbourne, Australia. *Construction Management & Economics*, 18(8), pp.927-934.
- Babbie, E. and Mouton, J., 2005. Qualitative studies. *The practice of social research*, pp.269-311.
- Ball, J., 2002. Can ISO 14000 and eco-labelling turn the construction industry green?. *Building and environment*, 37(4), pp.421-428.
- Bartlett, E. and Howard, N., 2000. Informing the decision makers on the cost and value of green building. *Building Research & Information*, 28(5-6), pp.315-324.
- Barnes, D., 2001. Research methods for the empirical investigation of the process of formation of operations strategy. *International Journal of Operations & Production Management*, 21(8), pp.1076-1095.
- Berardi, U., 2011. Beyond sustainability assessment systems: Upgrading topics by enlarging the scale of assessment. *International Journal of Sustainable Building Technology and Urban Development*, 2(4), pp.276-282.
- Berardi, U., 2012. Sustainability assessment in the construction sector: rating systems and rated buildings. *Sustainable Development*, 20(6), pp.411-424.
- Bernard, H.R., 2011. *Research methods in anthropology: Qualitative and quantitative approaches*. Rowman Altamira.
- Blaikie, N.W., 1991. A critique of the use of triangulation in social research. *Quality & quantity*, 25(2), pp.115-136.

- Blayse, A.M. and Manley, K., 2004. Key influences on construction innovation. *Construction innovation*, 4(3), pp.143-154.
- Bordass, B., 2000. Cost and value: fact and fiction. *Building Research & Information*, 28(5-6), pp.338-352.
- Boswell, P. and Walker, L., 2004. Procurement and process design. *FIDIC and Lorna Walker Consulting Ltd, Geneva, London*.
- Boussabaine, A. and Kirkham, R., 2008. *Whole life-cycle costing: risk and risk responses*. John Wiley & Sons.
- Bribián, I.Z., Usón, A.A. and Scarpellini, S., 2009. Life cycle assessment in buildings: State-of-the-art and simplified LCA methodology as a complement for building certification. *Building and Environment*, 44(12), pp.2510-2520.
- Bryman, A & Cassell, C. 2006. The Researcher Interview: A Reflexive perspective. *Qualitative Research in Organizations and Management: An International Journal*. Vol 1. No.1
- Bullen, P.A., 2007. Adaptive reuse and sustainability of commercial buildings. *Facilities*, 25(1/2), pp.20-31.
- Burdge, R.J., 2004. The concepts, process and methods of social impact assessment.
- Burnett, J., 2007. City buildings—Eco-labels and shades of green!. *Landscape and Urban planning*, 83(1), pp.29-38.
- Burns, R. and Grove, S., 2003. Research design and methodology.
- Cain, M., 2003. The two cultures? Librarians and technologists. *The Journal of Academic Librarianship*, 29(3), pp.177-181.
- Cajias, M. and Piazolo, D., 2013. Green performs better: energy efficiency and financial return on buildings. *Journal of Corporate Real Estate*, 15(1), pp.53-72.
- Castro-Lacouture, D., Sefair, J.A., Flórez, L. and Medaglia, A.L., 2009. Optimization model for the selection of materials using a LEED-based green building rating system in Colombia. *Building and Environment*, 44(6), pp.1162-1170.
- Cartlidge, D., 2006. *New aspects of quantity surveying practice*. Routledge.
- Cohen, L., Manion, L. & Morrison, K. 2011. *Research Methods in Education – Seventh Edition*. By Routledge
- Cole, R.J., 1999. Building environmental assessment methods: clarifying intentions. *Building Research & Information*, 27(4-5), pp.230-246.
- Cole, R.J., 2005. Building environmental assessment methods: redefining intentions and roles. *Building Research & Information*, 33(5), pp.455-467.
- Covert, T., Greenstone, M. and Knittel, C.R., 2016. Will We Ever Stop Using Fossil Fuels?. *The Journal of Economic Perspectives*, 30(1), pp.117-137.
- Couper, M.P. 2000. Review: Web Surveys: A Review of Issues and Approaches. *The Public Opinion Quarterly*. 64(4). PP 464-494
- Choi, C., 2009. Removing market barriers to green development: principles and action projects to promote widespread adoption of green development practices. *Journal of Sustainable Real Estate*, 1(1), pp.107-138.

- Chong, B.L., Lee, W.P. and Lim, C.C., 2012. The Roles of Graduate Quantity Surveyors in the Malaysian Construction Industry. In *2012 International Conference on Management and Education Innovation*.
- CIDB, 2004. Construction Industry Development Regulations. Available online {http://www.cidb.org.za/publications/Documents/leg_regs_regulation_amended_14nov08.pdf}
- Covert, T., Greenstone, M. and Knittel, C.R., 2016. Will We Ever Stop Using Fossil Fuels?. *The Journal of Economic Perspectives*, 30(1), pp.117-137.
- Creswell, J.W., 2013. *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.
- Cushman, M., Cornford, T. and Venters, W., 2005. Knowledge about sustainability: SSM as a method for conceptualising the UK construction industry's knowledge environment. *CIT. Journal of computing and information technology*, 13(2), pp.137-148.
- de Villiers, W.I., 2012. Regulation of alternative building materials and systems in South Africa.
- Dada, J.O. and Jagboro, G.O., 2015. Core skills requirement and competencies expected of quantity surveyors: perspectives from quantity surveyors, allied professionals and clients in Nigeria. *Construction Economics and Building*, 12(4), pp.78-90.
- Dada, J.O. and Musa, N.A., 2016. Key factors affecting the competence of quantity surveyors: evidence from construction industry stakeholders in Nigeria. *Journal of Engineering, Design and Technology*, 14(3).
- Dair, C.M. and Williams, K., 2006. Sustainable land reuse: the influence of different stakeholders in achieving sustainable brownfield developments in England. *Environment and Planning A*, 38(7), pp.1345-1366.
- Darko, A., Zhang, C. and Chan, A.P., 2017. Drivers for green building: A review of empirical studies. *Habitat International*, 60, pp.34-49.
- Dewick, P. and Miozzo, M., 2002. Sustainable technologies and the innovation–regulation paradox. *Futures*, 34(9), pp.823-840.
- Department of Environment and Heritage (DEH), 2004. Adaptive Reuse, Commonwealth of Australia. Department of Environment and Heritage. Canberra. (Google Scholar) [<http://www.emeraldinsight.com.ezproxy.uct.ac.za/doi/full/10.1108/02632770710716911>]
- Denzin, N.K. 1970. *The Research Act: A Theoretical Introduction to Sociological Methods*, Aldine, Chicago.
- Denscombe, M., 2008. Communities of practice: A research paradigm for the mixed methods approach. *Journal of mixed methods research*, 2(3), pp.270-283.
- Diamond, R., 2011. Evaluating the energy performance of the first generation of LEED-certified commercial buildings. Lawrence Berkeley National Laboratory.
- DiCicco-Bloom, B. & Crabtree, B.F. 2006. The Qualitative Research Interview [Available Online] <http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2929.2006.02418.x/full> 25-7-2016
- Djokoto, S.D., Dadzie, J. and Ohemeng-Ababio, E., 2014. Barriers to sustainable construction in the Ghanaian Construction Industry: consultants perspectives. *Journal of Sustainable Development*, 7(1), p.134.

- Dorneyi, Z. 2014. Questionnaires in Second Language Research; Construction, Administration and Processing. Routledge
- Douglas, J. 2002. Building Adaption, Butterworth-Heinemann, Woburn (Google scholar) { <http://www.emeraldinsight.com.ezproxy.uct.ac.za/doi/full/10.1108/02632770710716911> }
- Dolnick, F. and Davidson, M. 1999. A Glossary of Zoning, Development and Planning Terms. Planning and Advisory Service Reports Number 491/492. American Planning Association, Chicago,IL. (Googlescholar) [<http://www.emeraldinsight.com.ezproxy.uct.ac.za/doi/full/10.1108/02632770710716911>]
- Dreyer, L.C., Hauschild, M.Z. and Schierbeck, J., 2010. Characterisation of social impacts in LCA. *The International Journal of Life Cycle Assessment*, 15(3), pp.247-259.
- Du Plessis, C., 2002. Agenda 21 for sustainable construction in developing countries. *CSIR Report BOU E*, 204.
- Easterby-Smith, M., Thorpe, R. and Jackson, P.R., 2008. Management research. SAGE.
- Eichholtz, P., Kok, N. and Quigley, J.M., 2010. Doing well by doing good? Green office buildings. *The American Economic Review*, 100(5), pp.2492-2509.
- Edum-Fotwe, F.T. and Price, A.D., 2009. A social ontology for appraising sustainability of construction projects and developments. *International Journal of Project Management*, 27(4), pp.313-322.
- Ekundayo, D., Perera, S., Udejaja, C. and Zhou, L., 2011. Achieving economic and environmental sustainability through optimum balance of costs.
- Eichholtz, P., Kok, N. and Quigley, J.M., 2013. The economics of green building. *Review of Economics and Statistics*, 95(1), pp.50-63.
- Elforgani, M.S. and Rahmat, I., 2010. An investigation of factors influencing design team attributes in green buildings. *American Journal of Applied Sciences*, 7(7), p.976.
- Emuze, F. and Julian Smallwood, J., 2014. Collaborative working in South African construction: contractors' perspectives. *Journal of Engineering, Design and Technology*, 12(3), pp.294-306.
- Essa, R. and Fortune, C., 2005. Project price forecasting and the evaluation of housing association projects for sustainable benefit. *Proc. of Postgraduate Researchers of the Built and Natural Environment (PRoBE)(Eds) Egbu OC and Tong MKL Glasgow Caledonian University, Scotland, UK*.
- Essa, R. and Fortune, C., 2008. Pre-construction evaluation practices of sustainable housing projects in the UK. *Engineering, Construction and Architectural Management*, 15(6), pp.514-526.
- Evans, J.R. and Mathur, A., 2005. The value of online surveys. *Internet research*, 15(2), pp.195-219.
- Fay, R., Treloar, G. and Iyer-Raniga, U., 2000. Life-cycle energy analysis of buildings: a case study. *Building Research & Information*, 28(1), pp.31-41.
- Fearne, A. and Fowler, N., 2006. Efficiency versus effectiveness in construction supply chains: the dangers of "lean" thinking in isolation. *Supply chain management: An international journal*, 11(4), pp.283-287.
- Fellows, R. and Liu, A., 1997. Research Methods for Construction: Blackwell Science.
- Finkbeiner, M., Schau, E.M., Lehmann, A. and Traverso, M., 2010. Towards life cycle sustainability assessment. *Sustainability*, 2(10), pp.3309-3322.

- Flick, U., 2009. *An introduction to qualitative research*. Sage.
- Forsberg, A. and Saukkoriipi, L., 2007, July. Measurement of waste and productivity in relation to lean thinking. In Proceedings of the 15th Annual Conference of the International Group for Lean Construction, East Lansing, Mich (pp. 18-20).
- Fong, S.W. 2003, "Value Management - Going all out for knowledge creation". The Value Manager, Vol.9 No. 1. Available at: www.hkivm.com.hk/publications/03/TVM2003-1.pdf
- Frei, M., 2010. Implications of the global financial crisis for the quantity surveying profession. *International Cost Management Journal*.
- Frei, M., Mbachu, J. and Phipps, R., 2013. Critical success factors, opportunities and threats of the cost management profession: the case of Australasian quantity surveying firms. *International Journal of Project Organisation and Management* 7, 5(1-2), pp.4-24.
- Frimpong, Y., Oluwoye, J. and Crawford, L., 2003. Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study. *International Journal of project management*, 21(5), pp.321-326.
- Fuerst, F. and McAllister, P., 2009. An investigation of the effect of eco-labeling on office occupancy rates. *Journal of Sustainable Real Estate*, 1(1), pp.49-64.
- Galarraga Gallastegui, I., 2002. The use of eco-labels: a review of the literature. *European Environment*, 12(6), pp.316-331.
- Galarraga Gallastegui, I., 2002. The use of eco-labels: a review of the literature. *European Environment*, 12(6), pp.316-331.
- Gibberd, J., 2001. The sustainable building assessment tool—assessing how buildings can support sustainability in developing countries. *Continental shift*, pp.11-14.
- Glass, J., Dainty, A.R. and Gibb, A.G., 2008. New build: materials, techniques, skills and innovation. *Energy Policy*, 36(12), pp.4534-4538.
- Gluch, P. and Baumann, H., 2004. The life cycle costing (LCC) approach: a conceptual discussion of its usefulness for environmental decision-making. *Building and environment*, 39(5), pp.571-580.
- Green, A., 2015. New models for life. *Construction Journal*, p.10.
- Green Building Council of Australia (GBCA). 2015. List of credits and changelogs., viewed 1 March 2016. [Online]. Available: <https://gbca-web.s3.amazonaws.com/media/documents/00-list-of-credits-and-changlelog-v1.1-01072015.pdf>
- Green Building Council of South Africa (GBCSA). 2015. About GBCSA. 2008., viewed 1 July 2015. [Online]. Available: <https://www.gbcsa.org.za/about/>
- Green Building Council of South Africa (GBCSA). 2013. World Green Building Trends. [Online] Available : www.gbcsa.org.za/wp-content/uploads/2013/06/WGBC-Trends-Report_2013.pdf
- Gowri, K., 2004. Green building rating systems: An overview. *ASHRAE journal*, 46(11), p.56
- Häkkinen, T. and Belloni, K., 2011. Barriers and drivers for sustainable building. *Building Research & Information*, 39(3), pp.239-255.

- Haapio, A. and Viitaniemi, P., 2008. A critical review of building environmental assessment tools. *Environmental impact assessment review*, 28(7), pp.469-482.
- Hammer, S., 2009, June. Capacity to act: The critical determinant of local energy planning and program implementation. In *Fifth Urban Research Symposium, Cities and Climate Change: Responding to an Urgent Agenda* (pp. 28-30).
- Hammond, W.F. and Peterson, L., 2007. Developers address new challenges in the planning and implementation of very large scale developments designed as self-sustaining communities. *Journal of Green Building*, 2(4), pp.73-99.
- Hiew and Ng, 2007, 'How the quantity surveying can create values in the procurement of construction works in Hong Kong', Proceedings of TS 5G: *Affordable and Sustainable Development - Strategic Intervention of Surveying Services, FIG Working Week, Hong Kong SAR, China*, 13-17 May, 57-78
- Hosseinijou, S.A., Mansour, S. and Shirazi, M.A., 2014. Social life cycle assessment for material selection: a case study of building materials. *The International Journal of Life Cycle Assessment*, 19(3), pp.620-645.
- Howard, K.S., Lefever, J.E.B., Borkowski, J.G. and Whitman, T.L., 2006. Fathers' influence in the lives of children with adolescent mothers. *Journal of Family Psychology*, 20(3), p.468.
- Hwang, B.G. and Tan, J.S., 2012. Green building project management: obstacles and solutions for sustainable development. *Sustainable development*, 20(5), pp.335-349.
- Hwang, B.G., Zhao, X. and Tan, L.L.G., 2015. Green building projects: schedule performance, influential factors and solutions. *Engineering, Construction and Architectural Management*, 22(3), pp.327-346.
- Hill, R.C. and Bowen, P.A., 1997. Sustainable construction: principles and a framework for attainment. *Construction Management & Economics*, 15(3), pp.223-239.
- Hughes, W. and Murdoch, J.R., 2001. Roles in construction projects: analysis and terminology. Construction Industry Publications.
- IPCC (2007) Climate Change 2007: Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, eds Metz B, Davidson OR, Bosch PR, Dave R, Meyer LA (Cambridge Univ Press, Cambridge, UK).
- Janes, J., 2001. Survey research design. *Library hi tech*, 19(4), pp.419-421.
- Jankowicz, A.D., 2005. *Business research projects*. Cengage Learning EMEA.
- Jick, T.D., 1979. Mixing qualitative and quantitative methods: Triangulation in action. *Administrative science quarterly*, 24(4), pp.602-611.
- Johnson, R.B., Onwuegbuzie, A.J. and Turner, L.A., 2007. Toward a definition of mixed methods research. *Journal of mixed methods research*, 1(2), pp.112-133.
- Jørgensen, A., Le Bocq, A., Nazarkina, L. and Hauschild, M., 2008. Methodologies for social life cycle assessment. *The International Journal of Life Cycle Assessment*, 13(2), pp.96-103.
- Kaatz, E., Root, D. and Bowen, P., 2005. Broadening project participation through a modified building sustainability assessment. *Building Research & Information*, 33(5), pp.441-454.

- Karunasena, G., Rathnayake, R.M.N.U. and Senarathne, D., 2016. Integrating sustainability concepts and value planning for sustainable construction. *Built Environment Project and Asset Management*, 6(2), pp.125-138.
- Kendall, S., 1999. Open building: an approach to sustainable architecture. *Journal of Urban Technology*, 6(3), pp.1-16.
- Kim, K.P. and Park, K.S., 2016. Implication of quantity surveying practice in a BIM-enabled environment.
- Kloepffer, W., 2008. Life cycle sustainability assessment of products. *The International Journal of Life Cycle Assessment*, 13(2), pp.89-95.
- Kohler, N. and Lützkendorf, T., 2002. Integrated life-cycle analysis. *Building Research & Information*, 30(5), pp.338-348.
- Kotchen, M.J., 2006. Green markets and private provision of public goods. *Journal of Political Economy*, 114(4), pp.816-834.
- Kolk, A. 2003. Trends in sustainability reporting by the fortune Global 250. *Business Strategy and the Environment Journal*, Vol 12, pp 279 - 291
- Kombo, D.K. and Tromp, D.L., 2006. Proposal and thesis writing: An introduction. *Nairobi: Paulines Publications Africa*, pp.10-45.
- Knight, A. and Ruddock, L. eds., 2009. *Advanced research methods in the built environment*. John Wiley & Sons.
- Kulasekara, G., Jayasena, H.S. and Ranadewa, K.A.T.O., 2013, June. Comparative effectiveness of quantity surveying in a building information modelling implementation. In *The Second World Construction Symposium, Socio-Economic Sustainability in Construction* (pp. 14-15).
- Larsson, N., 2004, March. An overview of green building rating and labelling systems. In *Symposium on Green Building Labelling* (pp. 15-21).
- Latham, D. 2000. *Creative Re-Use of Buildings*, Donhead Publishing Ltd, Shaftesbury
- Le-Hoai, L., Dai Lee, Y. and Lee, J.Y., 2008. Delay and cost overruns in Vietnam large construction projects: A comparison with other selected countries. *KSCE journal of civil engineering*, 12(6), pp.367-377.
- Lehmann, A., Zschieschang, E., Traverso, M., Finkbeiner, M. and Schebek, L., 2013. Social aspects for sustainability assessment of technologies—challenges for social life cycle assessment (SLCA). *The International Journal of Life Cycle Assessment*, 18(8), pp.1581-1592.
- Lewis, M., 2004. Integrated design for sustainable buildings. *ASHRAE Journal*, 46(9), p.S22.
- Lorenz, D.P., Trück, S. and Lützkendorf, T., 2007. Exploring the relationship between the sustainability of construction and market value: Theoretical basics and initial empirical results from the residential property sector. *Property Manag*
- Lützkendorf, T. and Lorenz, D., 2007. Integrating sustainability into property risk assessments for market transformation. *Building Research & Information*, 35(6), pp.644-661.
- Dwaikat, L.N. and Ali, K.N., 2016. Green buildings cost premium: A review of empirical evidence. *Energy and Buildings*, 110, pp.396-403.
- Ma, T. and Luu, H.T., 2013. The changing role of quantity surveyors in the green building development in South Australia.

- Magis, K. and Shinn, C., 2009. Emergent principles of social sustainability. *Understanding the social dimension of sustainability*, pp.15-44.
- Manewa, A., Siriwardena, M., Ross, A. and Madanayake, U., 2016. Adaptable buildings for sustainable built environment. *Built Environment Project and Asset Management*, 6(2), pp.139-158.
- Martin, C. 2011. Establishing Energy Benchmarks for Commercial Buildings in the City of Cape Town. The University of Cape Town, South Africa, Masters Dissertation
- Matipa, W.M., Kelliher, D. and Keane, M., 2008. How a quantity surveyor can ease cost management at the design stage using a building product model. *Construction Innovation*, 8(3), pp.164-181.
- Majdalani, Z. et al, 2006. Sustainability in the construction industry: a Lebanese case study. *Construction Innovation*, 6(1), pp. 33-46, <https://doi.org/10.1108/14714170610710613>
- Mathur, V.N., Price, A.D. and Austin, S., 2008. Conceptualizing stakeholder engagement in the context of sustainability and its assessment. *Construction Management and Economics*, 26(6), pp.601-609.
- May, P.J., 2003. Performance-Based Regulation and Regulatory Regimes: The Saga of Leaky Buildings. *Law & Policy*, 25(4), pp.381-401.
- Mbachu, J., 2015. Quantity Surveyors' Role in the Delivery of Construction Projects: A Review. *Quantity Surveyors (NZIQS)*, 25.
- Mbachu, J. and Nkado, R., 2007. Factors constraining successful building project implementation in South Africa. *Construction Management and Economics*, 25(1), pp.39-54.
- McCoy, A.P., Ahn, Y.H. and Pearce, A.R., 2012. Towards establishing diffusion barriers for innovative green building products: A survey of SIPS builders. *College Publishing*, 7(2), pp.153-176.
- McDougall, G., Kelly, J.R., Hinks, J. and Bititci, U.S., 2002. A review of the leading performance measurement tools for assessing buildings. *Journal of Facilities Management*, 1(2), pp.142-153.
- Mediaclub South Africa, 2013. SA Introduces green office buildings. [online] Available at: <https://www.brandsouthafrica.com/governance/sustainable/green-220313>
- Meacham, B.J. 2010. Accommodating innovation in building regulations: lessons and challenges. *Building Research & Information*. 38 (6), pp. 686 - 698
- Mitchell, W.K. 2005. *Research Methodology*. Oxford University Press Southern Africa.
- Mora, E.P., 2007. Life cycle, sustainability and the transcendent quality of building materials. *Building and Environment*, 42(3), pp.1329-1334.
- Myers, D., 2005. A review of construction companies' attitudes to sustainability. *Construction Management and Economics*, 23(8), pp.781-785.
- Nagalingam, G., Jayasena, H.S. and Ranadewa, K.A.T.O., 2013, June. Building information modelling and future quantity surveyor's practice in Sri Lankan construction industry. In *Second World Construction Symposium* (pp. 81-92).
- Neal, A., Griffin, M.A. and Hart, P.M., 2000. The impact of organizational climate on safety climate and individual behavior. *Safety science*, 34(1), pp.99-109.
- Neasbey, M., Barton, R. and Knott, J., 1999. Value management. *Building in Value: Pre-Design Issues*, pp.232-247.

- Nelson, A.J., Rakau, O. and Dörrenberg, P., 2010. Green buildings: a niche becomes mainstream. *Deutsche Bank Research*, pp.3-22.
- Nelson, A. and Frankel, A. 2012. Building Labels vs. Environmental Performance Metrics: Measuring What's Important About Building Sustainability. Research Report, RREEF Real Estate
- Ngowi, A.B., 1998. Is construction procurement a key to sustainable development?. *Building Research & Information*, 26(6), pp.340-350.
- Nkado, R. and Meyer, T., 2001. Competencies of professional quantity surveyors: a South African perspective. *Construction Management and Economics*, 19(5), pp.481-491.
- Ofori, G., 2006, November. Attaining sustainability through construction procurement in Singapore. In CIB W092–Procurement Systems Conference.
- Olander, S. and Landin, A. 2005. Evaluation of stakeholder influence in the implementation of construction projects. *International Journal of Project Management*, 20(4), pp. 321 -
- Olawumi, T.O. and Ayegun, O.A., 2016. Are Quantity Surveyors Competent to Value for Civil Engineering Works? Evaluating QSs' Competencies and Militating Factors. *Journal of Education and Practice*, 7(16), pp.9-18.
- Oliver, C., 1997. Sustainable competitive advantage: Combining institutional and resource-based views. *Strategic management journal*, 18(9), pp.697-713.
- Olsen, W., 2004. Triangulation in social research: qualitative and quantitative methods can really be mixed. *Developments in sociology*, 20, pp.103-118.
- Ortiz, O., Castells, F. and Sonnemann, G., 2009. Sustainability in the construction industry: A review of recent developments based on LCA. *Construction and Building Materials*, 23(1), pp.28-39.
- Othman, A.A., 2007. Affordable housing: an investigation into the corporate social responsibility of South African quantity surveying firms.
- Ozorhon, B., Abbott, C., Aouad, G. and Powell, J., 2010. Innovation in construction: A project life cycle approach. *Salford Centre for Research and Innovation in the Built Environment (SCRI) Research Report*, 4.
- Patton, E. and Appelbaum, S.H., 2003. The case for case studies in management research. *Management Research News*, 26(5), pp.60-71.
- Pearce, D.W., 2003. The Social and Economic Value of Construction: The Construction Industry's Contribution to Sustainable Development, 2003. Construction Industry Research and Innovation Strategy Panel.
- Polit, D.F. and Beck, C.T., 2010. Generalization in quantitative and qualitative research: Myths and strategies. *International journal of nursing studies*, 47(11), pp.1451-1458.
- Potts, K. and Ankrah, N., 2014. *Construction cost management: learning from case studies*. Routledge.
- Rehm, M. and Ade, R., 2013. Construction costs comparison between 'green'and conventional office buildings. *Building Research & Information*, 41(2), pp.198-208.
- Retzlaff, R.C. 2008. Green Building Assessment Systems: A Framework and Comparison for Planners. *Journal of the American Planning Association*. 74(4), pp. 505-519

- Revell, A. and Blackburn, R., 2007. The business case for sustainability? An examination of small firms in the UK's construction and restaurant sectors. *Business Strategy and the Environment*, 16(6), pp.404-420.
- RICS., 1983. Marine resource management. *Ocean Engineering*, 10(6), pp.489-489
- RICS., 2009. Guidance note: Sustainability and the RICS property life cycle.
- Ries, R., Bilec, M.M., Gokhan, N.M. and Needy, K.L., 2006. The economic benefits of green buildings: a comprehensive case study. *The Engineering Economist*, 51(3), pp.259-295.
- Rogerson, J.M. and Sims, S.R., 2012, September. The greening of urban hotels in South Africa: Evidence from Gauteng. In *Urban Forum* (Vol. 23, No. 3, pp. 391-407). Springer Netherlands.
- Roodman, D.M. and Lenssen, N., 1994. Our Buildings, Ourselves. *World Watch*, 7(6), pp.21-29.
- Rowley, J., 2004. Researching people and organizations. *Library Management*, 25(4/5), pp.208-214.
- Royal Institute of Chartered Surveyors, Quantity Surveyors Division, 1983, *The Future Role of the Chartered Quantity Surveyor*
- Rubin, A., & Babbie, E. 2010. *Research Methods for Social Work*. Belmont, CA: Cengage/Brooks & Cole
- Rwelamila, P.D., Talukhaba, A.A. and Ngowi, A.B., 2000. Project procurement systems in the attainment of sustainable construction. *Sustainable Development*, 8(1), p.39.
- Samari, M., Ghodrati, N., Esmailifar, R., Olfat, P. and Shafiei, M.W.M., 2013. The investigation of the barriers in developing green building in Malaysia. *Modern Applied Science*, 7(2), p.1.
- Samarasinghe, D.A.S., Tookey, J.O.H.N., Rotimi, J.O.B. and Windapo, A.B.I.M.B.O.L.A., 2012. Clients and their professional advisers' role in construction materials purchasing functions.
- Saunders, T., 2008. A discussion document comparing international environmental assessment methods for buildings. BRE, March.
- Scott, A.J. and Wild, C.J., 1986. Fitting logistic models under case-control or choice based sampling. *Journal of the Royal Statistical Society. Series B (Methodological)*, pp.170-182.
- Seah, E., 2009. Sustainable construction and the impact on the Quantity surveyor. In *13th Pacific Association of Quantity Surveyors Congress (PAQS 2009)* (pp. 36-48).
- Sebake, T.N., 2008. Limitations of implementing sustainable construction principles in the conventional South African design approach. *The Third Built Environment Conference 2008*.
- Sebake, T.N., 2009. Overview of green building rating tools.
- Seo, S., 2002. International review of environmental assessment tools and databases.
- Shah Ali, A., Rahmat, I. and Hassan, H., 2008. Involvement of key design participants in refurbishment design process. *Facilities*, 26(9/10), pp.389-400.
- Sheath, D.M., Woolley, H., Cooper, R., Hinks, J. and Aouad, G., 1996. A process for change-the development of a generic design and construction process protocol for the UK construction industry. *INCIT 96 Proceedings: Bridging the Gap*, p.91.
- Shelbourn, M.A., Bouchlaghem, D.M., Anumba, C.J., Carillo, P.M., Khalfan, M.M. and Glass, J., 2006. Managing knowledge in the context of sustainable construction. *ITcon*, 11, pp.57-71.
- Shen, L.Y. and Yao, H. 2006. Improving environmental performance by means of empowerment of contractors. *Management of Environment Quality*. 17(3). pp 242 - 254
- Shi, Q. 2008. Strategies of Implementing a Green Building Assessment System in Mainland China

- Sonson, S. and Kulatunga, U., 2014. Quantity surveying role and environmental influence in Saint Lucia.
- South African Council for the Architectural Profession (SACAP) 2015. Framework for the professional fees guideline: Government Gazette
- South African Council of the Quantity Surveying Profession (SACQSP), 2012. Identification of Work Provisional Document. Agenda Items.
- Stokes, D. and Bergin, R., 2006. Methodology or "methodolatry"? An evaluation of focus groups and depth interviews. *Qualitative market research: An international Journal*, 9(1), pp.26-37.
- Štrach, P. and Everett, A.M., 2008. Transforming research case studies into teaching cases. *Qualitative Research in Organizations and Management: An International Journal*, 3(3), pp.199-214.
- Conducting online surveys. Sage Publishers, Los Angeles
- Supino, S., Malandrino, O., Testa, M. and Sica, D., 2016. Sustainability in the EU cement industry: the Italian and German experiences. *Journal of Cleaner Production*, 112, pp.430-442.
- Talukhaba, A., Ngowi, A.B. and Letlape, K., 2005, May. Implementation of socioeconomic sustainability in construction projects at the planning stage in developing countries. In *Proceedings, CIBW99 working commission fourth triennial conference—rethinking and revitalizing construction safety, health and quality* (pp. 17-20).
- Taylor, S.J., Bogdan, R. and DeVault, M., 2015. *Introduction to qualitative research methods: A guidebook and resource*. John Wiley & Sons.
- The Pell Institute, 2016. Defining the Unit of Analysis [Available Online]
<http://toolkit.pellinstitute.org/evaluation-guide/analyze/define-unit-of-analysis/> 26/7/2016
- Treloar, G., Fay, R., Ilozor, B. and Love, P., 2001. Building materials selection: greenhouse strategies for built facilities. *Facilities*, 19(3/4), pp.139-150.
- Trochim, William MK, and James P. Donnelly. "Research methods knowledge base." (2001).
- U.S. Green Building Council (USGBC). (2000) "Leadership in energy and environmental design." Available from http://www.civil.uwaterloo.ca/beg/ArchTech/LEED%20rating%20V2_0.pdf (accessed May 31, 2015).
- Ugwu, O.O. and Haupt, T.C., 2007. Key performance indicators and assessment methods for infrastructure sustainability—a South African construction industry perspective. *Building and Environment*, 42(2), pp.665-680.
- Valdes-Vasquez, R. and Klotz, L.E., 2012. Social sustainability considerations during planning and design: Framework of processes for construction projects. *Journal of construction engineering and management*, 139(1), pp.80-89.
- Vanegas, J.A., 2003. Road map and principles for built environment sustainability. *Environmental science & technology*, 37(23), pp.5363-5372.
- Vanegas, J.A., DuBose, J.R. and Pearce, A.R., 1995, November. Sustainable technologies for the building construction industry. In *Proceedings of the symposium on design for the global environment, Atlanta, GA* (Vol. 23).
- Van Bueren, E.M. and Priemus, H., 2002. Institutional barriers to sustainable construction. *Environment and Planning B: Planning and Design*, 29(1), pp.75-86.
- van den Brand, G.J., 2004. Analyse that!. PLEA.

- Van Reenen, C., 2014. Principles of material choice with reference to the Green Star SA rating system.
- Vantage, B., 2002. Equal Partners–Customer and Supplier Alignment in Construction. *London: Business Vantage Ltd.*
- Van Reenen, C., 2014. Principles of material choice with reference to the Green Star SA rating system.
- Van Selm, M. and Jankowski, N.W., 2006. Conducting online surveys. *Quality and Quantity*, 40(3), pp.435-456.
- Wedding, G.C. and Crawford-Brown, D., 2007. Measuring site-level success in brownfield redevelopments: A focus on sustainability and green building. *Journal of Environmental Management*, 85(2), pp.483-495.
- Welman, C., Kruger, F. and Mitchell, B., 2005. *Research methodology*. Oxford University Press.
- Whitehead, B., Andrews, D., Shah, A. and Maidment, G., 2014. Assessing the environmental impact of data centres part 2: Building environmental assessment methods and life cycle assessment. *Buildn Environ*, pp.1-11.
- Wiley, J.A., Benefield, J.D. and Johnson, K.H., 2010. Green design and the market for commercial office space. *The Journal of Real Estate Finance and Economics*, 41(2), pp.228-243.
- Windapo, A.O. and Goulding, J.S., 2015. Understanding the gap between green building practice and legislation requirements in South Africa. *Smart and Sustainable Built Environment*, 4(1), pp.67-96.
- Windapo, A.O., 2014. Examination of green building drivers in the South African construction industry: economics versus ecology. *Sustainability*, 6(9), pp.6088-6106.
- Winston, N. 2010. Regeneration for sustainable communities? Barriers to implementing sustainable housing in urban areas. *Sustainable Development*. 18(6). PP 319 – 330
- Wright, K, B. 2005. Researching Internet Based Populations: Advantages and Disadvantages of Online Survey Research, Online Questionnaire Authoring Software Packages and Web Survey Services. *Computer-Mediated Communication*. 10(3). PP00
- Wu, P. and Low, S.P., 2010. Project management and green buildings: lessons from the rating systems. *Journal of Professional Issues in Engineering Education and Practice*, 136(2), pp.64-70.
- Yin, R.K., 2003. Applications of Case Study Research. Sage. *Thousand Oaks*.
- Yunus, R., Yang, J. and Too, E.G., 2011, June. Sustainability factors in industrialised building system. In *Proceedings of the World Sustainable Building Conference, Volume 2* (pp. 1-10). Finnish Association of Civil Engineers RIL and VTT Technical Research Centre of Finland.
- Zainul Abidin, N., Yusof, N.A. and Othman, A.A., 2013. Enablers and challenges of a sustainable housing industry in Malaysia. *Construction Innovation*, 13(1), pp.10-25.
- Zainul-Abidin, N., 2008. Achieving Sustainability through Value Management: A Passing Opportunity?. *International Journal of Construction Management*, 8(2), pp.79-91.
- Zainul Abidin, N. and Pasquire, C.L., 2005. Delivering sustainability through value management: Concept and performance overview. *Engineering, Construction and Architectural Management*, 12(2), pp.168-180.
- Zuo, J. and Zhao, Z.Y., 2014. Green building research–current status and future agenda: A review. *Renewable and Sustainable Energy Reviews*, 30, pp.271-281.

Zuo, J., Xia, B., Zillante, G. and Zhao, Z., 2014. The future of sustainable building assessment tools: a case study in Australia. In *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate* (pp. 91-98). Springer Berlin Heidelberg.

Appendix A: Interview Questionnaire

Investigating the perception of quantity surveyors advising on building specifications to support sustainable building developments

Section 1 – General information

1. Are you a Green Star SA Accredited Professional?
2. When did you qualify to become a Green Star accredited professional?
3. How many projects have you worked on that have applied for Green Star rating (design or as built)?

Section 2 – Interview Questions

Section A: Attitudes towards sustainability in the built environment

4. What does 'sustainability' mean to you?
5. How would you define a sustainable project and what makes it distinguishes it to a normal project?
6. How important do you think is sustainable development?
7. How would you describe the meaning of the term 'sustainable development' in your practice?
- 8.

Section B – Attitudes towards responsibility for sustainable development

1. In your opinion, what would be the best way to facilitate the implementation of sustainable practices on projects?
2. Where do you get your ideas/strategies for sustainable designs and specifications?
3. What is in your opinion/from your experience the main advantage of advising on sustainable developments?
4. What do you think are the leading drivers for addressing sustainability issues on projects?
5. What do you think are the leading barriers for addressing sustainability issues on projects?
6. Do you have any additional remarks about the importance of sustainability in the construction industry?

Section C Project related Interview Questions

1. Could you describe one project that involved sustainability? (*Office/Commercial, Residential, Industrial, Governmental, Retail (Malls, Restaurants, Stores), Retrofitting*)
2. What was the Green Star rating for the project?
3. What were the characteristics of the project that made it sustainable?
4. What roles did people (you and the project team) take into the sustainability project process?
 - What were the actions BEFORE the project?
 - What were the actions DURING the project?
 - What were the actions AFTER the project?
5. Was the scope of the project clear from the start?
6. Did stakeholders have a short term or long term focus on the project?

7. What was the cost of the project and do you think the initial budget was sufficient?
8. Can you describe the challenges encountered when addressing sustainability issues on the project?
9. What were the most effective actions to solve these challenges?
10. What lessons learnt in the project that will be helpful for your next sustainability project?

Appendix B: Online survey

Perception of quantity surveyors advising on building specifications to support sustainable building developments

1. Are you a Green Star SA Accredited Professional?

Yes	No
-----	----

2. When did you qualify to become a Green Star accredited professional?

YEAR	CODE
2008	07
2009	06
2010	05
2011	04
2012	03
2013	02
2014	01
Accreditation program on-going	00

3. A) How many projects have you worked on that have applied for Green Star rating (design or as built)??

YEAR	CODE
None	01
1-5	02
6-10	03
11-15	04
More than 15	08

- B) Rate your experience level with regards to green buildings

No Experience				Very Experienced
1	2	3	4	5

4. What activities have contributed to your green experience - rate the contribution - very useful - not at all useful?

	Not useful at all				Very Useful
Direct involvement in sustainable developments	1	2	3	4	5
Indirect involvement in sustainable developments	1	2	3	4	5

Attending Courses offered by GBCSA	1	2	3	4	5
Attending Courses offered by other institutions	1	2	3	4	5
Non-Governmental organizations' involvement	1	2	3	4	5
Online reading/research	1	2	3	4	5
Further education	1	2	3	4	5
CPD events	1	2	3	4	5
Other (please specify):	1	2	3	4	5

5. Which type of green development have you worked on?

	Never				Frequently
Office/Commercial	1	2	3	4	5
Residential	1	2	3	4	5
Industrial	1	2	3	4	5
Governmental	1	2	3	4	5
Retail (Malls, Restaurants, Stores...)	1	2	3	4	5

6. "In your opinion, which type of developments benefit most from being designed to be sustainable?"

	Least important				Most important
Commercial	1	2	3	4	5
Residential	1	2	3	4	5
Industrial	1	2	3	4	5
Governmental	1	2	3	4	5
Retail (Malls, Restaurants, Stores...)	1	2	3	4	5

7. Do you agree that green or sustainable practices are associated with increased costs?

Strongly Disagree		Neutral		Strongly Agree	
1	2	3	4	5	

8. Do you agree that green or sustainable designs are more complicated to design than traditional building?

Strongly Disagree		Neutral		Strongly Agree	
1	2	3	4	5	

9. Do you agree that green or sustainable design and/or construction benefits the environment and society?

Strongly Disagree		Neutral		Strongly Agree	
1	2	3	4	5	

10. How often do these professions or entities contribute to green/sustainable specifications on projects?

	Never				Frequently
Client	1	2	3	4	5
End User / Tenant					
Architect	1	2	3	4	5
Engineer (Civil, structural, mechanical)	1	2	3	4	5
Quantity Surveyor	1	2	3	4	5
Government (Local & planning authorities)	1	2	3	4	5
Education Units (Universities...)	1	2	3	4	5
Non-Governmental Organisations (professional or trade associates)	1	2	3	4	5
Other (please specify)	1	2	3	4	5

11. Which of the following stakeholders' decision power (directly/indirectly) has the greatest influence on specifications for prospective green/sustainable development.

	Not at all important				Very important
Client	1	2	3	4	5
Architect	1	2	3	4	5
Engineering (Civil, mechanical...)	1	2	3	4	5
Quantity Surveyor	1	2	3	4	5
Government	1	2	3	4	5
Education Units (Universities...)	1	2	3	4	5
Sustainability professional	1	2	3	4	5
Non-Governmental Organisations	1	2	3	4	5
Other (please specify)	1	2	3	4	5

12. At what stage in the project life cycle is your contribution to sustainability crucial for your projects?

Project stage	None		Average		High
Concept and viability stage	1	2	3	4	5
Design development					
Documentation and procurement	1	2	3	4	5
Construction Stage	1	2	3	4	5
Completion and Operation Stage	1	2	3	4	5

13. How would you rate the importance of your participation in green/sustainable specification development at the following project stages?

Project stage	None		Average		High
Concept and viability stage	1	2	3	4	5
Design development	1	2	3	4	5
Documentation and procurement	1	2	3	4	5
Construction Stage	1	2	3	4	5

14. Please rank the following barriers to advising on sustainable building specifications on prospective green/sustainable developments.

	None		Average		High
Clients are not interested with sustainability initiatives	1	2	3	4	5
The lack of expressed importance from clients i.e. sustainability is set as a low priority	1	2	3	4	5
The lack of training and knowledge on sustainability material choices	1	2	3	4	5
No provision in fee structures taking into account the recovery of long term savings on projects	1	2	3	4	5
The higher cost of sustainable building materials	1	2	3	4	5
The lack of technical understanding on the part of project team e.g. technical performance	1	2	3	4	5
The lack of interest on the part of project team	1	2	3	4	5
Insufficient data and information to implement sustainability initiatives	1	2	3	4	5
Limited resources to engage in sustainability	1	2	3	4	5

Other (please specify):	1	2	3	4	5
-------------------------	---	---	---	---	---

15. What initiatives will assist to incorporate sustainable goals into projects?

	None	Average	High		
Economic incentives	1	2	3	4	5
Educational programs	1	2	3	4	5
Regulatory requirements	1	2	3	4	5
Voluntary guidelines and standards	1	2	3	4	5
Collaborative efforts (public-private partnerships for sustainable building)	1	2	3	4	5
Other (please specify)	1	2	3	4	5

16. What is your take on use of alternative building materials in South Africa?

<ul style="list-style-type: none"> ▪ ▪ ▪

17. What factors outside of quantity surveying interfere with sustainable developments?

<ul style="list-style-type: none"> ▪ ▪ ▪

Appendix C: Interview transcripts

Question	QS P(1)	QS P(2)
<p>Green star accredited professional Attended GBCSA course Worked on GreenStar rated projects What does a QS consider sustainability</p>	<p>No. Believes it adds no additional value but it is good to know what happens</p> <p>Yes</p> <p>Yes</p> <p>7 No. including residential, commercial and industrial buildings</p> <p>Having a future for the children</p>	<p>No</p> <p>No</p> <p>Yes</p> <p>Hotels and Office blocks</p> <p>Implementing the principles of good building practice i.e. responsible building practice, reducing carbon footprint, less damage to the environment. Recycling materials and looking after the planet</p>
<p>Differences from normal projects</p>	<p>There is a different approach when looking at green star rated projects as there are more factors to consider.</p> <p>For example we look at orientation of the building, specifications that are appropriate.</p> <p>It may require carrying out lifecycle costings on various alternatives.</p> <p>As a QS we are looking for value as opposed to only producing a cost effective solution.</p>	<p>Project built using those factors. Using recyclable waters, savings on energy costs and amounts consumed. There is a trend towards sustainability as a norm in the industry. There is new legislation but it is the architects role to produce the specifications</p>
<p>Importance of sustainability</p>	<p>Sustainability should be a standard approach; it is not onerous at all if the designs are done right.</p>	<p>It is gaining an importance. The size and type of project can determine whether the project is sustainable or not. E.g you might build a single storey in using rainwater to water the garden, but you may not go as far as recycling your grey water and building a grey water storage tank and introducing pumps because it becomes too expensive in relation to the size of the block. E.g for the office block we got quite a big roof and we thought about storing the rain water by means of building a storage tank underground and pump it up and irrigate the garden but we got very little planting so it was not justified. We were faced with the critical mass of the building/project and the cost of the green building measures did not always make sense. For instance putting in bicycle racks or changing low energy light bulbs, for the cost of the project we could justify using some of the green features. Being a basement 3 levels down, we discovered underground water, the subsoil water is however being collected and stored for use in irrigation</p>
<p>How do you focus on sustainability</p>	<p>Sustainability is very much client driven. We try encourage clients and show them the value but it is ultimately the decision of the client to whether they should pursue a sustainable building or not. For clients it may be very much driven by the tenants, thus if the tenants want a sustainable building the client will aim to deliver one.</p>	<p>The client who is environmentally aware and wants a green building.</p>

Question	QS P(1)	QS P(2)
How do you show client value	<p>We have a simple approach. For example show the client option A which has a higher capital outlay on day one but it repays itself in six to seven years on a 15 year lease, so the next nine years the client will be making money and the client likes making money. It is in doing the lifecycle costings on various alternatives that one starts showing regard for value.</p> <p>One needs to prove to the client that there is value as they will not undertake the project if there is no value.</p>	
Best ways to facilitate the implementation of sustainable designs in projects	<p>Show the value and sustainable practices. You must show the value, people tend to look at sustainability as expensive, it's not expensive but it's cheap and cheaper in the long run</p>	<p>Comes from 2 sources. The client who is environmentally aware and wants a green building. Often one wants a green building as it is considered good marketing. E.g, if you have an office block, tenants would like to know that they are operating in a green environment with good lighting, quality air conditions, feeling more comfortable in the space. The developer can therefore consider having sustainable approach to be a part of the green building movement or because he thinks it may be easier to let to tenants, running costs should be less, which is advantageous. The hotel developer was the driver, he wanted the greenest hotel in Africa and that was his motivation. The client felt that people will want to live in green hotels rather than normal hotels. E.g. the gym has these exercise bikes which tells you the amount of electricity generated for the hotel, even though it is not a lot, guests are also given points/rewards for energy saved. All this driven by the client because of the benefits to him. Consultants are also getting more involved on such projects.</p>
ideas for sustainable designs and specifications for sustainability	<p>There are the different technologies out there and you get exposed to them through sales people and you look at the merits on each.</p> <p>In terms of strategies, it varies from job to job, client to client, needs and all that.</p>	<p>There was an environmental consultant on the project with an engineering background. I did not contribute to ideas. My role as a qs was the traditional qs role. E.g. the concrete slab had cobiax balls which are like little plastic soccer balls which went into the slabs to reduce the amount of concrete. For the double glazing we just prepared the tender documents of what was specified by the architect, describing the windows and shopfronts. My strategic involvement was to preparing tender documents, adjudicating tenders and negotiation subcontracts.</p>
leading drivers to sustainability in projects	<p>Energy is a huge thing and building orientation and location, if done right it ticks half the boxes of sustainability issues and energy.</p> <p>Obviously there is the materials side of it, you want to use environmentally friendly materials.</p>	<ul style="list-style-type: none"> • Potential long term savings in operating costs • Encourage tenants/guests to live and work in green buildings
leading barriers to sustainability in projects	<p>Initial capital cost is the big one.</p>	<ul style="list-style-type: none"> • Initial costs, as some of these things can be quite expensive <ul style="list-style-type: none"> • Cost implications of green features.

Question	QS P(1)	QS P(2)
<p>knowledge of the client as a barrier</p> <p>Importance of sustainability</p> <p>Cost implications having green star rated buildings</p> <p>Project Specific</p>	<p>You have developers that are looking for competitive rent thus the developers are looking for the cheapest alternative solution. In doing so you can miss the opportunities that sustainability offers because it has a slightly higher capital cost.</p> <p>If you however look at the operational costs, improved productivity, quality environment for staff it makes sense to adopt such approaches.</p> <p>Nowadays clients are generally aware, so if they request for it we provide for it and vice versa. Their knowledge is not an inhibiting factor</p> <p>Sustainability is slowly becoming the norm as people want to do the right thing.</p> <p>There is growing demand from clients for green star rated projects.</p> <p>For a 4 star there are generally no cost implications. It is generally becoming the norm on standard building projects. A well designed building with a standard building budget should be able to achieve a 4 star rating.</p> <p>5 Star rated buildings have a cost implication as you start introducing more features. 23,000 m²</p> <p>6 Star rated building Office building Green star consultant involved</p> <ul style="list-style-type: none"> • Double skin façade • Sea water cooling plant, • Displacement ventilation air conditioning, where the air conditioning comes from the floor. Sea water which is collected at 12 – 13 degrees, for 3 quarters of the year the water is cool enough so it comes out from the floor rising up and cooling the room at almost the required temperature. Using 75% less energy than the traditional AC system as it is literally off most of the time as you got chilled water. • Grey water system • Metering • Controlled lighting system i.e. every light can be switched off individual • Sustainable timber, FSC Certified. This was the first building that used this type of timber. 	<p>Platinum LEED Certification, 6 Stars for green building Hotel</p> <ul style="list-style-type: none"> • On the project, we did a geothermal installation. We excavated for a parking basement, holes were then drilled over 500 approx. 70m into the ground by a mining contractor. Black pipes were placed in these holes for heating and cooling the air conditioning. In summer it acts like a cooling agent and in winter acts like a heating agent. Was a massive extra cost which a normal building would not require. So the cost depends what you do. The concept is not new. • The contractor was given a list of items to comply with such as dust, noise control measures, walk off mats. Geothermal heating. Ventilation and air-conditioning system that constantly uses constant underground temperatures to heat and cool the building. Three 17m wind turbines. . Cobiax balls to reduce concrete volume, similar to hollow blocks construction. Double glazing. Heat and light efficient glass – high performance windows. Roof construction- double layered for sound insulation. Recycled rainwater with a stainless steel tank in the basement which

Question	QS P(1)	QS P(2)
<p>QS role played in design stage</p>	<p>Goals were set and the whole team bought in.</p> <p>Green star consultant put a proposal of points the team should target and we went through options were given and we had to cost them, prepare a lifecycle to justify additional expenditure, from there technologies were chosen that would suit the building.</p> <p>A number of workshops were held with the team and the green star consultant in the early stages of the project.</p> <p>Green star consultant, Engineers provided proposal to achieve the required rating. we as the QS's reviewed the costs, queried how the solutions would work on the building and carried out lifecycle costings on the options.</p> <p>The client approved certain items and rejected others.</p>	<p>is visible to visitors that park in the basement. Grey water recycling. Photo voltaic panels on the roof. Planters on roof slabs. Mechanical and electrical engineers also made provisions for environmental aspects. Public areas with movement sensor lighting, water saving fittings. Incorporated surrounding wetlands into the building.</p> <ul style="list-style-type: none"> • Social aspects – used local products as much as possible. Using products with low voc. Walls in basement parking were painted by local community • Traditional QS role and advising on costs. • Updating estimates as more information came in and considering alternative materials and cost implications.
<p>Lifecycle costing</p>	<p>Although the technology maybe new, there is manufacturers data available which was used as a basis of the costs.</p> <p>E.g. The manufacturers have an expected lifecycle of 15 years for the project, maintenance is a costed amount per year, based on the maintenance contract. The engineers can provide you with energy saving data that the technology saves and base the cost of energy today escalated appropriately to its expected life, one can work out the cost in today's terms.</p> <p>Present it to the client saying this will pay itself off in six to seven years, over its lifecycle this is the overall cost for lifecycle A compared with lifecycle B which is the traditional showing it is cheaper over the lifecycle A. On this project lifecycle costing was done as we were trying to prove the new technologies themselves but on the following projects it has not been a requirement from lessons learnt.</p>	<p>Was not required to carry out lifecycle costing, just standard Quantity surveying role.</p>

Question	QS P(1)	QS P(2)
<p>Challenges</p> <p>During construction Was the scope of the project clear from the start? Did stakeholders have a short term or long term focus on the project? What was the cost of the project and do you think the initial budget was sufficient? Challenges</p> <p>Lessons learnt</p>	<p>Suppliers were not the challenge, people did not understand what was involved – Fear They would say green/sustainability is expensive</p>	<p>Cost control and management We all realised as consultants what we were in for from the start as the client knew what they wanted, africas first green hotel. Long term focus</p> <p>Initial budget sufficient but there were a number of changes that came along during the design stage. Money spent on things that were not anticipated for such as the geothermal heating but not all cost increases were due to green building features. Big challenge with the geothermal installation. Finalising the final account with the subcontractor. Commissioning of all the equipment was a challenge but mostly for the engineers. It was ongoing for some time after the project was completed. First real green building project I was involved in. Learnt how green buildings are dealt with i.e. what the requirements are, what things to look for, what to strategies you can implement e.g. grey water recycling, solar. Know what to allow for when dealing with new green projects.</p>

Question	QS P(3)	QS P(4)
Green star accredited professional	No.	Yes 2010
Attended GBCSA course	Yes	
Worked on GreenStar rated projects	Yes Have worked on two office projects but executed only one	Only one projects Worked on buildings that have called for green building scoring.
What does a QS consider sustainability	that is a very vast question actually it goes back into environmental or is it sustainable work creation, or is it using sustainable products? It's a very large scale thing actually. But I think that there is a responsibility that what it comes down to, there is a responsibility to each and every human being and also towards the professionals on specific projects to ensure that whatever they implement it is a sustainable product that we are putting down because it is going to be there for the next 60 to 100 years. Using sustainable materials contributes to that, but it does not always mean it is the cheapest and that is where it actually becomes tricky for you as the QS. You will much rather advise your clients of the cost benefit now than the kickback over 30 years because let's say in 30 years you will be retired and will not have to worry about it anymore. Sustainability, I think, is to build responsibly and to use the resources that you have responsibly, and also using resources of a sustainable nature to ensure that the building you are putting down has longevity, using products of a sustainable nature and you are not exploiting resources and putting nature in harm unnecessarily.	From a QS perspective, its different from how other professions see it In as much QS's focuses on capital costs of the building that's actually the most insignificant part of the cost when you look at the lifecycle cost of the building. Sustainability is about limiting maintenance cost and making the maintenance regime easy and cost effective as you find when buildings are not maintained that's when they dilapidate fastest. When buildings are built and designed with sustainability in mind and maybe spending a bit more upfront on the capex then the benefit goes to the owner and occupants of the building. But it is a bit of a contradiction for the QS as you are spending a bit more upfront. When looking at sustainability in the true sense rather than chasing ratings or trying to get certificates saying that we have a greenstar rating, it's about a building that is truly sustainable.
Differences from normal projects	I think there is a degree of sustainability being used, but there are better things they could do that especially in regards to energy and water consumption as those are biggest ones. You can see now with what eskom is doing and secondly what is going to happen when we get constrained on water usage? Electricity you can substitute by using gas but water, you can drink coke for the rest of your life, what we are going to do with water is a big aspect. So there should be responsible usage of water and electricity. And it therefore comes back to the product that you build. Firstly, the taps that you put in does it actually waste water or is it a product that limits the amount of water that one uses. Those are the two main issues to look at.	One that takes a longer term view. Take a private developer as a client, if that developer is looking for a short term return and looking to sell the property on immediately and withdraw from the project on completion or soon after they are not necessarily have a long term view in terms of sustainability. Whereas where someone is going to hold the property and is going to operate it for 10 years far more emphasis will be placed on sustainability. Its about the long term and short term view of the client. Short term immediate profit or long term asset growth. Anyone who is looking for an immediate return with tight margins is looking to spend as little as possible and that goes beyond sustainability it just good practice. There are a lot of clients or developers that cut corners to save on costs but it catches up with them in the long run.
Importance of sustainability		In our viabilities we always have a line item for a green building consultant to trigger a discussion as well as make provision for it. It is a key part of

Question	QS P(3)	QS P(4)
		<p>the clients brief. It's a question you would ask the client, do you want a sustainable building or rated, which might be different. Clients might ask for a sustainable but not interesting in the rating. It may not be a marking aspect but an internal requirement and an operational issue for the client. Where the onus comes on the QS if we don't ask the question upfront and we don't make the necessary provisions in our viabilities, when it comes to cutting costs, typically that is the item that is taken out first. Its client decision to have it in or out.</p> <p>A good QS asks the right questions at an early stage. Make necessary provisions e.g. are you going to submit to the green building council, will you employ a green building consultant. Then goes on the actual design initiatives. You can ask the mechanical engineer if you are going for an air cooled or water cooled system. If its air cooled you forget about getting a good green rating but you have a chance to get points with a water cooled system at a premium. Discussions start right on the outset in order to make the necessary provisions.</p> <p>You never get a brief in the traditional sense as taught academically. As a QS one needs to set out the brief as it comes down to money. When you set out a cost plan it sets out all the assumptions and allowances that need to be made and that formulates what the building will be.</p> <p>Should be led by engineers, if not the qs should prompt them</p>
How do you focus on sustainability	is very client driven, from a QS point of view, we don't look at sustainability realistically, we have met and dealt with certain issues on projects such as the taps and that's something you advise the client on. Looking at a specific project, we are considering the cost point of view, how can we make the building more efficient and cheaper. There are a few things like you can save on your capital expenditure now or you can spend more now and increase the lifecycle of the building. There are a few things that one can actually determine at the start of the project. What does the lifecycle of the building say, in how many years will light bulbs, floor carpets etc. need to be replaced? It might be more worthwhile to put in more expensive product now but save on the lifecycle cost of the building whilst considering the payback period. Sustainable development should be dealt with on a constant basis, however we as QS's are not really involved in	<p>Depends on the type of projects.</p> <p>Office – client will tell you or you will ask them is this a spec development i.e. you do not have a tenant in mind and in which case do you want to market it as a green building and do you think that will be a plus point to tenants. Whether or not you can charge an additional rental and typically you can't as the market can accommodate. Comparing a green and non-green building at same price tenants will go for the green building due to reduced operating costs.</p> <p>If its an office building being built for a tenant, the may dictate their requirements. E.g. if it is a blue chip company they will define their requirements and the developer must comply.</p> <p>Shopping centre – not as well advanced in the retail as the commercial sector. There is not a big push from tenants saying we will only come into your building if it is a green rated building.</p> <p>Industrial – Similarly</p>

Question	QS P(3)	QS P(4)
	<p>most of the time. We are driven by client wants, does he want a green building, and does he want to go the accreditation route?</p>	<p>Does correlate with the green rating tools from GBCSA that the office tool is most commonly used and the others are slowly developing. Parking garage how do you make it sustainable – deal with concrete mixes, led lighting, water harvesting, such things. You might not do a rating but it is good practice and it takes advantage of that opportunity. Thus dependent on the type of project and the role players. You can apply some of the tools to get points but it may not have an overall impact on the building. E.g. installing bike racks to get credits but no one uses them because the tenant or the owner is not really behind the initiative.</p> <p>We getting a better response from building owners to build sustainable buildings but not necessarily needing to do a rating which is where we should be. The rating is nice but mainly a marketing tool. If you truly committed to sustainability you should not need that.</p>
<p>How do you show client value</p>	<p>there is a new market space for a new market leader in consultancy for sustainable developments. We need to understand the impact of sustainable building so that you are able to advise your client on whether the building will cost 5%, 10%, 15%, or 20% more to build a specific green star building. The client needs to know what they are in for, we need to understand the changes that need to go into buildings to achieve the specific green star ratings and put a cost to it and give advice. We as Qs's facilitate it but there are consultants who deal with that on a constant basis. We can make mention that a type of tap is more efficient but it costs more or less, we can only speak on the cost aspect when presenting. Building orientation are the type things for architects and other consultants look at. With water and electricity, if it is a certain size of building you will need a certain amount of KVA coming in, supply cost is already fixed, the generation of that electricity is something you can look at. Are you going to put plants on the roof, are you going to use sustainable light fittings, light sensors? The mechanical and electrical consultants are experts in this area but we need to know the impact there is on cost.</p>	<p>Its all about differentiating your services. As a qs, it adds value having experience working on a green building.</p>
<p>Best ways to facilitate the implementation of sustainable designs in projects</p>		<p>Perception are costs are driven up to increase fees, take it of the table completely. We play a massive role in compiling fees to get the point of fixed fees at the beginning. We can say that the tariff is a method to agree the fee, whether the cost goes up or down lets say 15% then there can</p>

Question	QS P(3)	QS P(4)
		<p>be an adjustment due to scope change. But you want to get to a point where the sensitivity around fees is off the table because if you suggesting to the client to spend 3% more on building costs to be sustainable, that ends up being a 6 to 7% increase. I think the way to do it would like the electrical and mechanical engineers is to do a lifecycle costing. For example showing that if you spend the typical minimum i.e. cheap as possible then calculate what the operating costs are going to be. Lets say it's a house with a normal electric geyser no insulation in the roof underfloor heating in, no leds. Work out the consumption of the geyser, light fittings, heating elements. Now you say if you put insulation, solar geyser or heat pump, if you have a gas heating solution/wood fire, yes you are paying lets say 10% more upfront, but look at the payback. But if you start factoring in the uncertainties such as where the price of electricity is going and water, it only makes sense to spend the money upfront. Sometimes it can be an easier argument for a residential setting, in a commercial building it becomes harder. That being said those examples given are pretty much standard, you just would not put a new electric geyser in a new house or florescent lighting and never not put proper insulation. Already you are seing that but one needs to show the lifecycle costing. Even that sometimes is not enough for the client, particulary one that takes a 2 to 3 year outlook and wants to get out of the building and sell it. It's difficult to get a payback in under 5 years but if you are holding a building for 10 years you get back in 5 years and theres big escalation on electrical costs then it becomes exponential. Sometimes you don't even need to do that but that's the easiest way to show it from a financial point of view. You cannot just look at the capital cost of the building.</p> <p>Commercial viability showing a first year yield, if the first year yield gets sort of 8-9% then all the other financial parameters work i.e. NPV,IRR. So you don't even need to do a discounted cashflow. If you did one you would see your increase in cash flows, your operating costs and instead of escalating they are either staying straight line or they might even start reducing. Its not really our core service but as a valuer it is something you could do to differentiate yourself and go further. But I think that is where the facilities management industry in SA is very young, its not a big thing. When we design buildings you don't have a facilities management in team and they should be.</p> <p>In the project the clients FM team was involved right from the start. They said don't give me that</p>

Question	QS P(3)	QS P(4)
		lovely ceiling in the back of house areas, I want cromadek ceilings coz its easier to clean and wash it off, don't give us fancy acoustic tiles or plasteboard ceiling, don't care what it looks like, its about functionality.
ideas for sustainable designs and specifications for sustainability	I also attended the green star course that actually broadened my horizons quite a bit just to get an understanding of what it is all about. It has come from the Australian guide copied over to South African context. It was not our own initiative since most of it came from our Australian counterparts. That's basically where I got involved in it for the first time and then also we did the project where we had a green building consultant and he pointed out where the biggest costs would sit in terms of getting the necessary points to get the necessary accreditation. It gave us an idea of what it would cost to go into the sustainability side. I think that at the start of the project, the cost of sustainable building is always overstated as the costs of sustainability have come down quite dramatically. But also depends what you want to do, as you can do a five star building that will not cost you an arm and a leg.	
leading drivers to sustainability in projects	it has opened up a new market for a specific consultancy. We as QS's can help them in putting their budgets together on their sustainability items to achieve the required ratings. We are not the drivers, the M&E consultants are more drivers,, they may not have the cost aspect but they do understand what one can do to enable to reach a more suitable and viable building in terms of sustainability.	
leading barriers to sustainability in projects	I think the barrier is on the cost but most the times cost is mostly overstated. Let me give you an example. It will cost about only 3% more and it is mostly on electricity and water and materials. In terms of cost there are decisions that can be made around that that can improve your costs as well. The leading barrier is cost but there is ways to get around it. There are so many guys marketing green projects out there, so there are bringing better prices.	<p>Cost.</p> <p>Western cape is more exposed.</p> <p>In the office environment there are limited tenants, there are many offices with high vacancies. A lot of supply not enough demand. In that environment how do you justify spending a premium when others might not. It all translates down to the rental. If there is one tenant in the market who has the option to rent at R180/m² or R165/m² he is either going to select the cheapest or he is going to be swayed to R180/m² eventhough he is paying more it's a green building. But ideally you want both buildings at R165/m² then you choose the green building.</p> <p>Margins are tight for any developer.</p> <p>The most number of green buildings are ones owned by institutions in the long haul.</p> <p>Traditional developers are looking for shorter term returns.</p> <p>Govt and local authorites need to come in and offer rebates to developers that are going into</p>

Question	QS P(3)	QS P(4)
		<p>green buildings. There are opportunities for them to incentivise developers in any shape or form to develop sustainable buildings.</p> <p>Looking at current building standards one can achieve a 4 star rating which is good. But it is a stick approach rather than an incentive. Offer an opportunity to motivate developers.</p> <p>In this period of green revolution it takes time for products to be developed on mass in order for it not to come at a premium. E.g. when we put led lightings in the buildings we got innovation points for that now its pretty much standard and we talking 2, 3 years ago. You would not really put in a fluorescent lighting in an office. Market has developed to offer new technologies.</p>
knowledge of the client as a barrier		
Importance of sustainability		
Cost implications having green star rated buildings	<p>There is a recent upsurge in the market for green buildings. There are so many companies dealing with that. There are websites with all items e.g. green design initiatives which lists all the items which speak to your green star book. For instance lists paints with low VOC. Currently in the market, there is a lot of advice in the catalogues with alternative products that are approved in the green star realm. It makes it so much easier since you can compare prices right from the start even from the suppliers. I think it's a lot easier since there are a lot of suppliers and more competitive pricing.</p>	<p>There has not been a need to develop lifecycle costs to justify additional expenditure for sustainable features. Is it the responsibility of the QS to make that argument? It's a great value to have but I would expect a green building consultant to do it. Its probably more important for mechanical electrical and green consultants to do that. If we do it as QS's it is a massive value.</p>
Project Specific	<p>Commercial offices 5 Star green rated building</p>	<p>5 Star as built. Capitalized on innovation points Led lighting Car charging points in the parking</p> <p>Used local professionals Glass façade – local company Maximised use of local labour</p>
	<p>First the façade. Limiting the amount of heat into the building but because the floor plates of the building were so big it limited the impact of the façade. The bigger the building the more the less the square meters external façade you have per square meter floor thus brings down the component of the building down. What the architects achieved out of this was that they presented the big open floor spaces which helped to bring the area of the façade down which meant that they can go double glazing</p>	<p>On this project the two major tenants. Adamant it had to be a 5 star green rated building design and as built. The client has a large property portfolio and they recognise the importance. The second tenant are a banking institution with a different approach, they have a greater depth of knowledge of buildings and had a greater emphasis on facilities management. They are the facilities managers and they had specific requirements of what they had to have on the building which were based on sustainable</p>

Question	QS P(3)	QS P(4)
	<p>and fewer windows. You can therefore save on air conditioning and also on electricity consumption and size of chiller plant to be installed. There were a lot of things that had a knock on effect on the façade e.g. fewer sunscreens. The façade actually made the building.</p>	<p>initiatives. They churn floors every 2 years so they actually gutting the whole floor doing a refresh and moving tenants around. A simple example if you put a fixed partitioning after 2 years you are breaking it down and disposing it, so they spent more money on demountable partitions that can be taken down, moved and arranged to suit a new tenancy. You probably don't get a credit for that in the rating tool but that is a great example of a sustainable measure. For the client it is not a requirement that every building must be rated but that it be sustainable which is better than just chasing credits.</p>
<p>QS role played in design stage</p>	<p>Cost comparisons were carried out on the façade. Because the façade was not a cost driver, we never trimmed down on what the architects wanted. There were two products we had to look at, Hulabond for aluminum cladding on the outside and the other being a Rheinzink product. They had already decided they would go with a double glazing from the start, but that already covered the amount of light and heat that could get in but on the outside they considered rheinzink as the alternative. The product is 20% more expensive but has a longer lifespan than aluminum but looking back 20% on the final account of the aluminium would not had a big impact on the cost. The rheinzink was a proposal from the architects side stating that its scratch resistant, long life span than aluminium. But its one of those products that has not been used much so the client opted not to go for it he is not willing to pay a premium to be a dummy for the product. So we did a cost comparison of aluminium versus rheinzink but it did not impact on the glass Due to the big circumference of the building it meant that the cost per square meter of the façade came quite low.</p>	
<p>Lifecycle costing</p>	<p>In terms of sustainability, not much action was required from our side. The green consultants needed to get all the submissions in for the green star</p>	
<p>Challenges</p>	<p>Before construction, we received estimates from the sustainability engineers; they also needed to present and confirm with the client exactly what we they were going to do to reach the specific points. All the consultants were challenged to make sure that the budgets that they gave for all those specific points were achievable. The biggest cost components sit on the energy, greenhouse gas emissions, energy sub metering, etc. are the biggest cost drivers on the green star. It also works back to</p>	

Question	QS P(3)	QS P(4)
	<p>your HVAC and then to water e.g. water meters and also occupant water. So that what you get from your shower and toilets and taps is efficiently used.</p>	
<p>During construction</p>	<p>they maintained the rating and achieved the rating which is nice from the client's side because they can sell this as a green space at a relatively high rental. And it gives all these benefits since the tenants who will come in will pay less in electricity and hvac consumption. During the process, it was also necessary for the contractor to indicate local sourcing of materials, where he gets steel and concrete, how much timber has being used that was one of the constant things. Did we minimize PVC yes or no? There were some instances where the contractor at tender stage had crazy prices on sub ground HDPE pipes and we changed that back to concrete just because there was reason to spend that kind of money when there is a similar substitute being a concrete pipe, HDPE is not always the cheaper option but we used it in the plumbing pipes. The other was the timbers being used. We had to consistently monitor them on because there was a percentage we were trying to achieve on the natural and also the resale on SAP approved timbers. Outside benches and seats were made with those FSC timbers and we had to work the architects issue on design they maintained the rating and achieved the rating which is nice from the client's side because they can sell this as a green space at a relatively high rental. And it gives all these benefits since the tenants who will come in will pay less in electricity and hvac consumption. During the process, it is also necessary for the contractor to indicate local sourcing of materials, where he gets steel and concrete, how much timber has being used that was one of the constant things.</p> <p>Most of our fills, aggregates, concrete; most of the materials came locally. Timbers were local and reuse.</p> <p>the contractor has a certain number that he has to achieve and give a record back to the consultants. The whole green star specification was included in the document. Contractor was given the opportunity to price the items .The requirement for local labour formed also part of the contract document. On the green side we need to have all the documents to show what we did.</p>	<p>By the time we finished the project which was scheduled in 2013, a 4 star rating wasn't special. The client came in and said we have to make it a 5 star and if we are really committed to sustainability then it must be a 5 star as built. We therefore looked at those initiative and we had already tendered the project and we now changing the terms, so there were extra costs. That's when all the led lights came in and probably the biggest extra cost. There was a variation body sent to the client of about R10m which was not really that much in the bigger scheme. It likely brought the cost up by 1.5-2%. All the client bodies within that structure approved the additional costs and the initiatives then went ahead.</p> <p>We executed the project at a time in the market when it was very competitive so we had very good results from the main contractor and subcontracts. So we were never really under much financial pressure on the project but that being said, the clients got a big saving back at the end of the project which they chose not to spend. Costs on the projects were strictly controlled but when we presented the green building spend they approved.</p> <p>The problem is in a different time in the market that may not have been able to afford it. Timing of the market made it easy to adopt green initiatives on the project.</p>

Question	QS P(3)	QS P(4)
Was the scope of the project clear from the start?	Scope was clear. There were alternatives that were looked at from green consulting side there some things not feasible but we made some late scope changes such as atrium lighting which was one of the aspects which cost the client an additional R300, 000, which was an afterthought to get additional points to the required green star rating.	It was clear that was going to be a green building. 4 star then it changed to 5 star. Affects fee implications, contractor terms and conditions etc.
Did stakeholders have a short term or long term focus on the project?	Long term focus. I think again it sells to corporate clients these days. Corporate clients these days want to be in green spaces so that they are seen as socially responsible.	Long term focus. Institution 1 was focused on sustainability on all projects they put in the market Institution 2 given that it was going to be their headquarters for the next 20 years it made sense to have a sustainability.
What was the cost of the project and do you think the initial budget was sufficient?	Initial budget sufficient	
Challenges	<p>challenges will be in double accounting. You will get budgets from the mechanical and electrical and they will already allow for green star items in their design to a certain extent. Then you get the green star consultants who will bring in their budget, where he allows for basically the same thing the electrical and mechanical engineers are providing. They do not speak to one another. Our challenge is to make sure that the budget is not inflated by information from other consultants and also keeping the guys on their toes. In specifying, a certain product they may have implications on the project program For example the M&E and green star consultant may not have an understanding the building programme, lead times and when what is required to be procured to be able to make the set dates. The challenges will be double accounting of the budgets presented by consultants, and all of a sudden being a green star they forget that they do best practice in any case and that most of the things are already there. Secondly, between the green star consultant, M&E consultants, there is not always a conversation upfront. There is also a risk of specifying a product to achieve a certain rating but not making sure it is available locally affecting lead times and other factors e.g increasing other costs like P&G's.</p> <p>I think its clear communication from the start. Use clear budgets and also understand what is in there don't just include items without challenging it. Which we did with the mechanical and electrical engineer. We asked them what their design was going to be as their costs came in extraordinarily high at about</p>	

Question	QS P(3)	QS P(4)
	<p>R2000/m2 which was not realistic for the system the client wanted to use. Just sitting down with the other guys and making sure what they have budgeted for is sufficient. The client also has to understand what the design is as they usually don't especially when it comes to HVAC and electrical point of view. What will they see when they come in. Is there a certain blocks that will be metered separately, has flexibility been allowed for to accommodate different type of tenants? Those were some of the challenges on the client side.</p>	
Lessons learnt	<p>making sure that the green star and the services consultants understand what the client wants. Incorporate it into the budget accurately and also not having double accounting. On green star projects, consultants sometimes are unsure of costs and just allow numbers and all of a sudden you price yourself out of the market and not become viable. At the end of the day you can construct for a lot less. Second being involved in such developments, it gives you insights to use in the next one. We can add value towards the client from the start. You will understand what goes in and pricing and budgeting for the next project will be much easier. You actually know what to budget for and also not go over the top based on a certain project and you are aware of what goes into it. You will be able to defend your assumptions on new estimates from lessons learnt on such projects.</p>	