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The Client Satisfaction of Green Building Procurement Systems

By

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A dissertation

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University of Witwatersrand

In fulfilment of the requirements for the degree of

Master of Science in Building

Supervisor: Professor David Root

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ABSTRACT

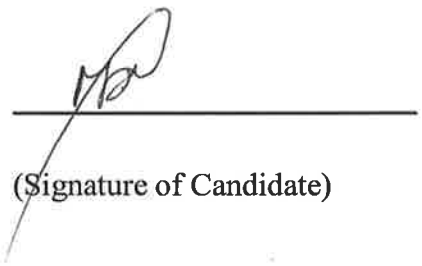
The world population continues to grow resulting in continuous demand for development. The building and construction industry is the avenue by which a vast majority of human settlements are developed. With this in mind, it is an industry that can have a far reaching effect on human and ecological well-being across the globe and South Africa is no exception.

This study posits the problem that the correct building procurement systems to enhance client satisfaction in Green Building practices are not being applied in South Africa and as a consequence the application and integration of Green Building is being curbed. The overall aim of the study was therefore to determine how to improve client satisfaction through the correct use of building procurement systems in order to increase Green Building implementation across South Africa. The relationship between building procurement systems, client satisfaction and Green Building implementation remained the focal point throughout the study. This relationship was broken down within the literature as well as through the analysis of a questionnaire submitted to South African Green Building professionals, including clients. This examination determined that the client is the key to whether a project is developed and how it is procured. Moreover, it established that the choice of procurement strategy is the defining factor in the successful outcome of a project and ultimately the outcome of client satisfaction or dissatisfaction.

The results indicated a significant correlation of the views in practice with that in theory whereby it was determined that the most appropriate procurement systems for Green Building are collaborative systems , including Design and Manage as well as Design and Build. On the contrary the findings illustrated that the Traditional System is the least appropriate for Green Building as it is a segregated building procurement system. Furthermore, the respondents confirmed the hypothesis that incorrect building procurement systems are being applied on Green Building projects in South Africa as the Traditional System was found to be the most utilised system for Green Building across South Africa even though it is the least appropriate system. This is a noteworthy finding, as environmental progress will continually be curbed on account of low levels of client satisfaction from inadequate building procurement systems. This research gives clear solutions on which building procurement systems to use and which not to use for Green Building. By applying this knowledge client satisfaction will be enhanced and so too the Green Building environment of South Africa.

DECLARATION

I declare that this Dissertation is my own unaided work. It has been submitted for the Degree of **Master of Science in Building** at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.



(Signature of Candidate)

__13th_____ Day of ____December_____ 2014_____

DEDICATION

I dedicate this Masters Dissertation to my mom, Jean Rose and grandparents, Arnold and Muriel Zonneveld. Their unwavering support and love over the many years has afforded me many opportunities and made this pinnacle achievement of completing my Masters possible.

ACKNOWLEDGEMENTS

I would like to pass my sincere acknowledgements to the following people:

Firstly to Professor David Root, my supervisor, for his helpful guidance, assistance and patience throughout the process of this dissertation, even when I was at great distance.

Secondly to Elizabeth Heron, my original supervisor, for encouraging me to pursue my masters and guiding me through the initial stages of this research.

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Chapter 1: Introduction

1.1 Background

There are approximately 7.1 billion people inhabiting the earth, consuming its finite resources needed to sustain life and generating exponential amounts of waste (McKevitt and Ryan, 2014). While the process of consumption and discharge continues to accelerate concomitantly as the human population multiplies, the state of equilibrium between demand and supply of the planet's resources is being significantly altered (Van Wyk, 2009). The modern world has now reached the point where demand outweighs supply. With this in mind the concern for the environment as a whole as well as the future of the planet has become a focal point amongst governments, industries and individuals in political debate, media coverage and day to day conversation (Glavinich, 2008). The current urbanisation rate will result in over 6.4 billion people living within cities across the planet by the year 2050 (City of Melbourne and Victorian Department of Transport, 2010). This presents a major challenge not only to provide the building capacity for these 6.4 billion inhabitants in the next forty years but to do so in a sustainable manner.

Building and construction is the avenue by which a vast majority of human settlements are developed and as such it is a sector that can have a far reaching effect on sustainability (Beyer, 2002). Green buildings have a specific focus on sustainability and are described as environmentally sustainable buildings, designed, constructed and operated to minimise the total environmental impacts (buildgreen.co.nz). Green Buildings reduce the negative effects of buildings, on the environment and global warming specifically, and have therefore become the Built Environment's major contribution to the planet on a sustainable level (Biello, 2008). Moreover, Green Building in practice involves the improvement of both natural and built environments through the reduction of energy consumption as well as resource depletion.

However, the necessity for the construction of a building only comes about when no existing building is able to meet the needs of a client, and it is therefore evident that the client is key to why a building is constructed and how it is procured (Turner, 1990).

This dissertation proposes that the lack of environmental progress within the South African built environment will continue on account of the failure to achieve client satisfaction from

inadequate building procurement systems. Therefore it is imperative to determine how to enhance client satisfaction through procurement systems in order to increase Green Building implementation in South Africa.

1.1.1 Client Satisfaction

Client satisfaction as well as the continuous improvement of project delivery are the fundamental goals of any construction processes (Adanan, 2006). However, the prevalence of client dissatisfaction within the South African and global built environment has been extensively documented in literature. Mbachu and Nkado (2005) discovered that compared with other economic industries the construction industry has invested little time and resources into investigating the actual needs of clients and therefore has a higher proportion of dissatisfied clients than that of any other industry. It is conceived this may be evident on account of the construction industry's apparent inability to fully understand the concepts and issues of client satisfaction within the procurement process due to lack of knowledge and absence of an appropriate mechanism to accurately assess satisfaction throughout the procurement process (Mbachu and Nkado, 2005).

Ideally, the principal aim of any service provider is that of satisfying the client's needs (Ogunlana, 2005). However, this cannot be achieved unless the service provider has a thorough understanding of exactly what the client wants. Furthermore, for client satisfaction to be achieved a true meeting of minds must occur between the parties involved, where the client's goals are clearly communicated to the professional team and the professional team seeks out the client's exact expectations (Ogunlana, 2005). With this in mind, the uniqueness of a Green Building becomes a problem as the client's lack of expressed interest as well as the lack of knowledge by all parties regarding this concept results in the project aims being communicated incorrectly or not at all. Therefore, a collaborative approach between the client, professional team and a Green consultant is key to achieving client satisfaction of a Green Building (Glavinich, 2008).

The general notion of customer or client satisfaction stems largely from the consumer services and production sectors, and is considered to be the fundamental reason for all companies' existence and operation (Taylor and Baker, 1994). Client satisfaction adds value to any corporation in numerous forms by way of sustainable customer loyalty to the organisation, positive word-of-mouth creation, repeat purchase, approval of further products and services

provided by the organisation and as an overall gauge of market performance (Mbachu and Nkado, 2005). In contrast, divestment from the construction industry and the Green Building sector will occur as a result of client dissatisfaction, leading to further complaints, negative word-of-mouth, declining levels of customer loyalty as well a reduction in the market share and overall profitability (Mbachu and Nkado, 2005). With this in mind, the extent to which identified client needs are satisfied within the procurement process is crucial for the current and future prospects of Green Building and the entire construction industry. The current and future prospects within the construction sector are largely dependent on the extent to which building clients are satisfied with the end results of the entire building procurement process (Nkado and Mbachu, 2002a). Consequently, the prevalence of client dissatisfaction is a significant hindrance to development of the South African construction industry as well as sustainable development and Green Building. Therefore, the need to research this is required as the application of the correct procurement system will ensure client satisfaction and subsequently the implementation of Green Buildings in South Africa.

Procurement as an activity within the construction industry has come to mean the tendering and systems required to develop and obtain a building (Turner, 1990). Within the procurement of any Green Building the selection of a suitable Contracting team is vital in the success of the project.

This study argues that without determining the most appropriate building procurement strategy within the South African built environment the implementation and integration of Green Building will not be successful on account of continued client dissatisfaction.

In order to promote a more sustainable planet, various incentives must be applied within the construction sector. Among these incentives, the deliberation over environmental consequences and issues within the procurement system is increasingly being acknowledged and emphasised (Varnas, 2008). In addition, while the focal point of sustainable procurement has been largely towards the acquisition of products, this study will centre on green procurement systems and the subsequent interrelating contracts of sustainable procurement. Furthermore, the environmental ramifications within the procurement of products can be easily evaluated through tools such as life cycle assessments, whereas assessing the suppliers' or professional teams' environmental capabilities when construction contracts are procured is vastly more challenging, as the contract and system to be procured has not yet been executed. However, one must notice that there are clearly more opportunities to steer the development

of a project towards environmentally sustainable alternatives before the project has even begun. The role of the client is crucial in the success of implementing environmental requirements and therefore satisfying clients' needs is of vital importance for implementing Green Building throughout South Africa.

1.1.2 The Urban Revolution and Green Cities

To foresee the success, need and path being ploughed for Green Building one must look to the future to envisage what is in store for countries, cities, societies, governments and generations to come. The planet is today captured within a new revolution; The Urban Revolution (City of Melbourne and Victorian Department of Transport, 2010). Additionally, the enormous influx of people into cities is unprecedented, where cities in 1900 housed 200 million people or ten percent of the planet's population, these cities currently accommodate fifty percent of the world's population at 3.5 billion inhabitants and will, by 2050, hold 6.4 billion people at seventy percent of the world's entire population. Furthermore, the majority of cities across the planet will have to expand at over six times the growth rate they are currently achieving in order to provide for this population expansion. The rates of urbanisation within Africa are the highest in the world and by 2025 more than half of Africa's population will be urban (web.mit.edu). Furthermore, the urban population will increase by more than half a billion from 1990 levels as it grows at almost twice the rate of the general population over the next quarter century. Additionally, Sub-Saharan Africa has the highest urbanisation rate of all, where the urban population is expected to increase from 387 million inhabitants in 2010 to 705 million by 2025. South Africa is certainly no exception to this, with an urban population that has grown from approximately 10 million in 1970 to 30 million in 2010 and is calculated to continue on this path through 2050 (Turok, 2012).

In essence what has been built in the entire timeline of modern civilisation will now be built in the next forty years and therefore the world needs to get more out of the resources it currently has and sustain them(City of Melbourne and Victorian Department of Transport, 2010). Furthermore, the fact that seventy percent of greenhouse emissions today are either directly or indirectly caused by cities is evidence that the world's vast urban development is of concern. With this in mind, the major challenge is not only to provide the building capacity required, but to do so in a socially successful, economic, sustainable manner while simultaneously transforming the existing cities to a low carbon future (City of Melbourne and Victorian Department of Transport, 2010).

Albert Einstein had a clear viewpoint on problem solving, stating

> *We can't solve problems by using the same kind of thinking we used when we created them.*
>
> (Massie, 2014:77)

With this in mind the built environment cannot continually apply traditional and often outdated building methods when the needs of today require innovative structures to holistically solve the issues of modern civilisation.

The myopic application of these methods in conjunction with industrialism has had extensive effects for the environment as well as people.

Within 50 years the vast development by human beings has significantly altered the earth's intricate bio systems by consuming its resources and forcing the amount of carbon dioxide to rise exponentially (Van Wyk, 2009). This is not only detrimental to the Earth but also to the human population. The choice of systems utilised in the past has had vast detrimental effects on the Earth's environment and it is now on this generation and future generations to reverse these effects through the correct choices, actions and systems.

The Built Environment is most certainly a major contributor to global carbon emissions, the declining health of the natural environment and the overall well-being of the human population. The implementation of Green Building practices has a vast influence on the reduction of carbon emissions which are responsible for climate change and the global warming phenomenon. According to a study completed by Toci and Rakwena (2009) professionals of the Built Environment lacked substantial awareness and knowledge with regards to Green Building. As a result of this lack of knowledge inappropriate building procurement systems are being applied to Green Buildings which has resulted in widespread client dissatisfaction. This study is of vital importance as client satisfaction is extensively affected by the building procurement system utilised, and therefore the future prospective foundations of the Green Building industry will be built on these systems.

1.2 Problem Statement

The built environment is one of the highest consumers of natural resources and one of the largest contributors to greenhouse gas emissions. This is only going to increase as the migration to cities grows exponentially over the next forty years, forcing the built environment to supply to the needs of billions of people. However, the fundamental issue with this is not developing the required capacity, but to do so in a sustainably viable manner which enables building, people and the planet to co-exist. There is immense potential for the building industry to achieve this as it will certainly produce the vast majority of human settlements in the foreseeable future. However, it must turn to innovative building methods in order to realise this potential. Green Buildings reduce the negative effects of buildings, on the environment and global warming specifically, and have therefore become the Built Environment's major contribution to the planet on a sustainable level (Biello, 2008). With all this in mind it is clear that there is a very real need to build in a sustainable manner through the use of Green Buildings. However, the necessity for the construction of a building only comes about when no existing building is able to meet the needs of a client, and it is therefore evident that the client is key to why a building is constructed and how it is procured (Turner, 1990). Green Buildings are no exception to this but the implementation and adoption of green building principles in practice continues to be modest, often as a result of inadequate building procurement systems and client dissatisfaction (Hoffman and Henn, 2008). The client is the crucial factor for the development of any building and it is therefore evident that without a building system that ensures client satisfaction, innovative areas of development such as Green Building will continually be curbed.

This study posits the problem that the correct building procurement systems to enhance client satisfaction in Green Building practices are not being applied in South Africa and as a consequence the application and integration of Green Building is being curbed.

1.3 Research Question

From the problem statement the following primary research questions arise:

1. Does the procurement system applied on a Green Building have an effect on client satisfaction?

2. How does the procurement system applied and client satisfaction affect the implementation of Green building in South Africa?

1.4 Hypothesis

The procurement system applied on a Green Building has an effect on client satisfaction.

Incorrect building procurement systems have a negative effect on client satisfaction and therefore have a detrimental effect on Green Building implementation in South Africa.

1.5 Aim

The overall aim is to determine how to enhance client satisfaction through procurement systems in order to increase Green Building implementation in South Africa.

1.6 Objectives

- To determine the doctrine principles that govern procurement choice and what dynamics affect successful procurement.
- To investigate the factors that involve client satisfaction and how it is achieved within the built environment.
- To explore the factors that impact the application and implementation of Green Building
- To establish these three objective's findings within the South African context

1.7 Research methodology

The research firstly consisted of a literature review on Building Procurement Systems as well as how these systems affect Client Satisfaction and the perception of the Construction Industry. It then moved on to a literature review on Green Building presently used in the built environment, the methods of implementation and the future for sustainable development. This literature established the relationship between building procurement systems, Green Building and Client Satisfaction and was used to develop the conceptual framework.

From this framework, a questionnaire was formed in order to explore this relationship within the South African context. The questionnaires were distributed amongst clients and professionals in the South African construction industry to establish accurate specifics with regards to the current levels of client satisfaction, what particular procurement systems are being utilised, how this affects Green Building development and then compare this to the findings determined within the literature. These research findings were then analysed and presented before final conclusions and recommendations were given.

The research can be expressed as basic, objective research as it focuses towards a specific issue, the level of client satisfaction achieved from different building procurement systems regarding Green Buildings. The research is directed at determining the performance of these procurement methods with regards to client satisfaction as well as why and how it is variable. The data is obtained through archived records, existing literature and the use of questionnaires targeting client satisfaction of certain procurement systems in the Green Building industry. This is used to establish the existing level of client satisfaction in particular procurement systems as well as the optimal procurement systems for particular green buildings regarding client satisfaction.

1.8 Limitations

The limitations of this study are perceived to involve the fact that literature is limited in the South African context and is predominantly from abroad; the geographical location is limited to South Africa, time restricts the extent of the study; there are only a limited number of Green Buildings to draw information from in South Africa; lastly only a relatively select number of clients have been involved in Green Buildings and therefore the amount of information available within South Africa limits the extent of this topic.

1.9 Structure of dissertation

Chapter 1 introduces the research topic and outlines the problem statement, aim, limitations and the objectives for the research including the need for the study and the hypothesis to be tested.

Chapter 2 gives a thorough literature review on Building Procurement Systems, Client Satisfaction and Green Building. Each of these concepts is broken down individually and the relationship between these three topics is then analysed and presented.

Chapter 3 presents the research methodology undertaken within this study. The various approaches to the research processes are examined and applied.

Chapter 4 illustrates the data obtained and provides an analysis of this in order to provide findings.

Chapter 5 presents the conclusions and recommendations of the study.

1.10 Definitions

1.10.1 Green Building Defined

There are a number of definitions for Green Building, one such definition states a Green Building as

> *A building that provides the specified building performance requirements while minimising disturbance to and improving the functioning of local, regional, and global ecosystems both during and after its construction and specified service life* (Glavinich, 2008:2).

On the other hand,

> *A green building is a building which is energy efficient, resource efficient and environmentally responsible- which incorporates design, construction and operational practices that significantly reduce or eliminate its negative impact on the environment and its occupants. Building green is an opportunity to use resources efficiently and address climate change while*

creating healthier and more productive environments for people to live and work in. (http://www.gbcsa.org.za/about/about.php).

1.10.2 Sustainable development

In 1987 a definition of sustainable development was opened by The World Commission on Environment and Development (WCED) stating it as:

> *Meeting the needs of the present without compromising the ability of future generations to meet their own* (Glavinich, 2008:2).

In 2003, the Organisation for Economic Co-operation and Development stated:

> *The building sector has major impacts not only on economic and social life, but also on the natural and built environment. Various building activities, such as the design, construction, use, refurbishment and demolition of buildings, directly and indirectly affect the environmental performance of the sector*.
>
> (http://buildgreen.co.nz/definition.html).

Against this background, the concept of sustainable building – reducing the detrimental effect of construction activities and buildings on the environment – has been developed.

1.10.3 Global Warming

> *Global warming is an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced. In common usage, "global warming" often refers to the warming that can occur as a result of increased emissions of greenhouse gases from human activities*
>
> (EPA, U.D.).

1.10.4 Procurement

The common definition of building procurement has been stated as

The organisational structure adopted by the client for the management of the design and construction of a building project.

(Turner, 1990:3)

Chapter 2: Literature Review

2.1 Introduction

This chapter presents a systematic analysis on the concepts of Building Procurement Systems, Client Satisfaction and Green Building as provided and established by the literature from various countries. A brief global history of ideas, constraints and facilitations in the sustainable building sector will introduce the main restraints for a change of mind in well-established habits throughout the building sector. With climate change as well as urbanisation as main and urgent threats across the planet and also in South Africa, the specific barriers with regards to the adoption of green building must be analysed in order to form a clear path to take for the future. The concept of the client as the initialising force for new buildings marks the centre of the literature review, as well as the significance of the critical relationship between the client's decision, the building procurement systems utilised and the implementation of green building.

There is little more important to the construction industry than ensuring it can actually deliver the product that the customer wants, needs and expects. Possibilities within the design and construction of buildings are continually expanding as technology advances and concurrently clients have come to expect far greater performance from their buildings (Morledge, Smith and Kashiwagi, 2006). As the scale and complexity of projects continues to escalate construction has undeniably become an act of boldness even for the simplest building (Turner, 1990).

For modern, complex buildings construction involves sophisticated design, commissioning, organisation and assembly of vast quantities of raw materials with the use of significant labour resources for extensive periods of time. However sophisticated the design of a building is, it must be matched by the procurement methods applied to procure the building in order to ensure successful project delivery (Morledge et al, 2006). It is complex and a successful outcome is frequently elusive. The construction industry has been castigated by numerous major clients in the past for its lack of project performance and successful project delivery (Masterman, 2002). Although the application of an inappropriate procurement method is not the only factor for unsatisfactory project performance and it is recognised that there is more than one procurement route to success, it is extensively acknowledged as a contributory issue within the industry's evident inability to acquire a superior level of project delivery and

overall building performance. While there is no generic best procurement route collaboration, experience, understanding and skilled judgement between the client and professional team are fundamental in deciding on the optimum route to achieve project success (Turner, 1990). This chapter covers methods of procurement that enhance client satisfaction and the successful delivery of Green Buildings in particular. The sources of literature have been concisely chosen in order to allow for a comprehensive examination of all the notions surrounding the particular topic and are deemed to be the most appropriate for the South African context.

2.2 Building Procurement Systems

This subchapter investigates what building procurement is in structure, how it has developed, the various types of systems existing and how these systems operate within the realms of construction. The client and type of project are both of particular importance in this investigation of utilising these building procurement systems.

2.2.1 Definition and history of Building Procurement

Up until the latter years of the 20th century, the term procurement was rarely used by professionals or by anyone else in the construction industry, if ever (Turner, 1990). The term was not even contained in the standard books of construction such as *Elements of quantity surveying* and *More advanced quantity surveying*. Procurement systems had not yet been conceptualised and were not an element of any building activity.

As stated in chapter one, the necessity for the construction of a building only comes about when no existing building is able to meet the needs of a client, and it is therefore evident that the client is key to why and how a building is constructed (Turner, 1990). Thus, construction professionals began to recognize and establish the building strategy to be the defining factor in a clients' needs being met or not and ultimately the successful outcome of a project (Kwakye 1991). Additionally, the term building procurement was defined by Turner (1990:3) as

The organisational structure adopted by the client for the management of the design and construction of a building project.

(Turner, 1990:3)

The historical evolution of construction procurement systems throughout worldwide construction industries has been regarded as an ongoing ad-hoc process (Morledge et al, 2006). Throughout the seventeenth and eighteenth centuries the ascendance of the architectural profession formed a gradual evolution of the standard design-led approach to building. This design-led approach produced numerous disputes as work was performed by individual tradesman on a disconnected trade by trade package basis (Morledge et al, 2006). Consequently, the development of the *traditional system* as it is known today began.

Construction projects before the Second World War (1939-1945) were almost solely produced through traditional procurement systems that had remained virtually unaltered for more than a century (Masterman, 2002). Within the Emmerson report the construction industry's non-cohesive approach to development was brought to light by declaring that:

> *In no other important industry is the responsibility for design so far removed from the responsibility for production.*
>
> (Turner, 1990 citing Emmerson, 1962)

Whilst the *traditional system* held firm for over 150 years, by the 1960s the separation between the design and construction elements became evident as a significant issue, and consequently the number of different procurement systems increased considerably (Masterman, 2002). This increase was on account of clients' desperation for innovative procurement methods because of dissatisfaction with the building industry's poor performance. The development of new building procurement methods has historically been driven by the previously applied systems' inadequacies (Morledge et al, 2006).

According to Masterman (2002) there are four historical phases across Europe in the development of procurement systems which are as follows:

1945-1972 – During this era traditional procurement systems were the method of choice and prevailed for the majority of this time.

1973-1979 – This was a period of recession with the use of non-traditional procurement systems moderately increasing.

1980-1989 – This period was characterised with post-recession recovery where new procurement methods were introduced by experienced clients and systems such as *design and build* as well as the management- oriented system significantly increased in market share. During this time it was found that although traditional methods of procurement could provide satisfactory results, the application of non-traditional systems provided much quicker progress.

1990-present time – This period is on-going and contains a slightly longer market upswing than downswing. The *partnering* process was largely defined within this time as well as the application of private finance initiatives and public private partnerships. In addition, the application of the *design and build systems* increased rapidly during

this era compared to the previous two periods, and the various management oriented structures consistently gained market share.

Over half a century is contained within these four periods, during which the continual change in the needs and attitudes of the numerous clients has done far more than any other factor in history to substantially increase the quantity and types of construction procurement systems that exist today (Masterman, 2002).

In recent years a significant change has occurred and is on-going throughout the construction industry. Professionals are noting the paramount importance of a client's needs, particularly within the realms of the implementation of a procurement process (Masterman, 2002). The importance of achieving the clients' needs as well as understanding the need to establish realistic and measurable objectives, both for the clients and contractors, formed the insurgence not only for general building procurement but for the diverse systems of procurement (Morledge et al, 2006). The aim of this study is to elucidate how the construction constituents of client, consultants and contractors fit together in collaboration and to present practical strategies for selecting a particular procurement route for a Green Building.

2.2.2 Selecting procurement systems

The procurement of construction work is remarkably incongruent to the development and purchasing of a commodity in any other sector of commercial activity. In the majority of industries a generically designed, prototyped and tested product is the outcome of a methodical manufacturing process set in a stable and controlled environment (Morledge et al, 2006). Furthermore, the product can readily be viewed and tried which allows for potential consumers to make an informed decision before the final purchase. In contrast, construction projects follow a process of procurement that has very few of these characteristics, where the final product is constantly affected by a client's individual needs and an ever changing environment. Although there is no generic best procurement route for all construction projects because of these varying factors, the clients priorities for a project will lead to certain routes being more appropriate for certain buildings (Turner, 1990).

All construction projects are set in motion by a client who will ultimately face the dilemma of how they can best procure a project to minimise risk, minimise disruptions throughout the project, achieve value for money, ensure quality and accomplish the objectives set out; in essence which system of procurement they should select (Masterman, 2002). This selection

will ultimately decide how successful project completion and client satisfaction is realised. Over the past few decades practical and theoretical experience has shown that successful completion of projects within time, cost and quality has been by no means as common as it ought to be. Additionally, in every case examined the procurement system applied has been identified as the crucial factor in client satisfaction and eventual project success or failure (Morledge et al, 2006). What is more, the current and future prospects within the construction sector are largely dependent on the extent to which building clients are satisfied with the end results of the entire building procurement process (Nkado and Mbachu, 2002a).

The construction industry embraces the sectors of construction, engineering and commerce while in constant demand to source the physical assets necessary for modern society to live and work (Morledge et al, 2006). Furthermore, it is characterised by projects of radically different complexity, size and type that produce a diverse range of outputs from the housing and infrastructure of an entire country to the water systems needed to sustain life. Groak (1994) argues that the construction industry is more an agglomeration of sectors and projects than a distinct industry. Masterman (2002) suggests that construction has an array of sub-industries, where a few are morphing into the manufacturing sector while others are curbed by socio-cultural policies. On the other hand Winch (2002) defines construction as a service industry since what is sold to the client of a construction project is not essentially a product but a capacity to produce. For this reason it is clearly evident why the client becomes so important within the construction process and further to this why it is so imperative to fulfil the client's needs and not simply produce an end-user product. In order to successfully deliver this service, the needs of the client must be met throughout the building process from initiation to delivery and even to maintenance.

Morledge et al (2006) posit that the period of time between the initiation of the project procurement process and project delivery allows for great variations in economic climate and therefore results in an inherent dysfunctional paradigm between demand and supply. Furthermore, these variations can often alter the client's initial rationale for the development of a particular building. While much remains to be done to reverse this dysfunction in order to reach the level of collaboration between supply and demand eminent in other sectors, the progress that has been made is significantly altering the management techniques and procurement systems that are needed to form greater co-operation between all members of a project team (Masterman, 2002). The need for a more cohesive and strategic approach to the

procurement process of construction has long been proposed by academics and professionals as a prerequisite for obtaining the most appropriate procurement method to achieve project success. In recent years far greater attention has been directed upon the procurement process, as the continual search for maximum value for money in construction work heightens (Morledge et al, 2006). With all this in mind it is evident that the impetus for change towards superior procurement processes is crucial in the success of all construction projects as well as the future of the built environment as a whole. To achieve this, the building procurement process must be dissected into pieces that fit together within the design and production process (Turner, 1990). Professionals must accept that they fit into the jigsaw of the procurement process not vice versa. Thus, the building procurement process is a necessity that continues to come to the forefront of the construction industry – and if successfully done it as an art that many must learn.

2.2.2.1 The role of the client

The client is the employer of a project who is generally involved in providing a design or at least a detailed specification of the work required by a specific group of contractors. Furthermore, a contractual agreement is entered into between the employer and the chosen contractor that appears to provide the highest value for money in the construction work required (Morledge et al 2006). This contractual relationship is in effect that of a supplier and customer, where the employer determines what is required to fulfil his/her needs and the contractor simply converts the design envisaged into physical reality (Glavinich, 2008). As the number of variables increase in the tendering process the more difficult it becomes to choose the most suitable tender. Additionally, failure by employers to minimise these variables and accurately represent their objectives to the tendering contractors leads to dispute, confrontation and often project failure. Avoiding confrontation and dispute leads away from the *traditional* procurement process and directly towards alternatives based upon achieving congruence between all parties and a collaborative resolution to any problems (Morledge et al 2006). Furthermore, this results in less of a supplier/customer relationship and more of a partnership between employer and contractor, placing a far greater emphasis on pursuing common goals as a collective project organisation.

The manner in which the client interacts with the project team has long been determined as a significant factor in realising project success, but more often than not the inexperienced client

has an unrealistic idea of the intricate process in achieving project goals (Green and Lenard, 1999). The role of a client is determined by their needs and objectives.

The responsibility of the client in achieving these objectives has been nonchalantly underestimated over the years and has often led to a haphazard approach to that intriguing, satisfying and often frustrating sequence of events known as the construction process (Masterman, 2002). Although the client has a key role in the successful outcome of a project it is not the sole factor. The overall management of the project must still be performed in a manner that will ensure the client's needs are met through the most effective system.

2.2.2.2 Categorising clients

According to Masterman (2002) there are certain characteristics of a client that are most likely to affect the choice of an appropriate procurement system and the overall development of a construction project. Those characteristics firstly concern the client's ownership and thus whether funding is public or private; secondly they concern the client's level of expertise, understanding and experience in the construction industry and the development of a construction projects; thirdly the client's needs with regard to the design and construction of the project must be clear, i.e. whether the building will be for occupation, sale or lease; and lastly the type of general activities performed by the client on construction projects have to be stated.

Traditionally public and private sectors have been the two major categories for construction clients and determining which category a client falls within depends on the ownership or source of finance for developing the project (Masterman, 2002). Private clients are generally less risk-averse, applying more aggressive strategies in order to maximise their investors' profits and stake in the project. Turner (1990) proposes that the most aggressive strategies will be applied in projects initiated by private clients that are funded by an external supply such as authorised financial providers rather than an internal source. These basic differences are easily distinguishable and therefore identifying a public or private client should not be particularly challenging. However, with public funding initiatives on the rise considerably more public projects are being privately financed which is likely to result in a blur between the boundaries of the two factions (Masterman, 2002).

Morledge et al (2006) have determined client experience within the built environment and the procurement process of a building to be a crucial factor in a client's behaviour towards the

entire development process. It has been established that whether a client is experienced or inexperienced will directly affect the client's attitude to all aspects of building activity. The placement of the client into either one of these categories will be established through the general proficiency of the client, as well as a number of key attributes. According to Masterman (2002) experienced clients are generally perceived to portray constructive characteristics which encompass a comprehensive knowledge and understanding of the built environment and its systems, a continual and frequent participation within the built environment and often the involvement in complex high-value projects, expertise in the management of construction professionals and the overall control of projects, the employment of construction managers and construction designer, the capacity to establish a detailed project brief involving ranked time, cost, quality objectives and finally a desire to be continuously and constructively involved with the whole construction team during the life cycle of the project.

Conversely, Masterman (2002) posits that inexperienced clients are generally associated with negative characteristics, which include a lack of knowledge in the mechanisms within the built environment and the development of building projects as well as an irregular participation within the construction industry. An absence of overall expertise in the management of construction professionals and construction projects goes along with being incapable of producing a detailed project brief involving ranked time, cost, and quality objectives without the assistance from a building consultant. Finally, a dearth of understanding in the importance of producing a project brief as early as possible, being influenced on construction matters by parties other than the assigned project advisers and a haphazard approach to altering the parameters of the project throughout the design and implementation phases round off the list of inadequacies, the inexperienced client bring to the table.

Thirdly, Turner (1990) has established two sub-categories according to a client's need for a building: Primary clients whose primary activity and means of revenue originates from the development of construction projects, and secondary clients who only require a building to reside within or to perform their principal business activities. The vast majority of primary construction clients are, by their very nature experienced in the construction industry and are directly involved in the development of construction projects, while on the other hand

secondary clients generally demonstrate various levels of experience in the building industry (Masterman, 2002).

The fourth classification categorises clients by the trade that the entity is engaged in. This includes the daily business activities it conducts and the type of building in which these activities are performed (Masterman, 2002). Furthermore, the typology of the commissioned facility, for example offices, factories, warehouses, residential properties, educational facilities, directly influences the different clients of the various types of facilities approach to determining the manner in which their project is procured. A study conducted by Rowlinson and Newcombe examined forty industrial projects and established that the type of manufacture process performed within the facility had an extensive influence on the objectives adopted in implementing the projects of the various clients (Masterman, 2002). Furthermore, it has been determined that there is a firm correlation between project typology and the route a client takes in selecting what is believed to be the most suitable procurement method.

Although it has been argued that this list of identification is not as concrete as it should be, it is recognised that it does enhance the understanding of a client's organisational characteristics which is crucial in determining their expected approach and attitude toward specific project procurement routes (Masterman, 2002). Although not all construction clients are stereo-typical and no one categorisation system will be able to provide for the many variants, it is acknowledged that the majority of clients will adhere to the attributes identified. Therefore determining a client's characteristics is an essential priority in building procurement and must remain that way.

2.2.3 The Procurement Strategy

The first and most important step is to define the procurement process, as each subsequent step is likely to have a declining effect on the overall result of the project (Turner, 1990). This emphasises the fact that the choices at the start of the project, specifically the selection of procurement strategy, are the most crucial in achieving overall project success. For many years the choice of the most suitable procurement strategy has been recognised as a key determinant of project success (Morledge et al, 2006). In addition construction procurement is the framework through which construction is initiated, developed or acquired and is indeed far more than merely the creation of a contractual relationship. Cherns and Bryant (1984)

posit that the procurement method not only creates numerous social and contractual relationships but also forms a power structure within a coalition of competing or co-operating interest groups. However, before the procurement strategy is examined in detail a holistic view of the entire project process must be taken in order to discern exactly where the procurement strategy fits in the whole process. The Royal Institute of British Architects (RIBA) (2013) have established an Outline Plan of Work which systematically organises the process of designing and managing construction projects, and administering construction contracts into a number of principal work stages. Furthermore, these stages coincide with the procurement system and begin with the preparation stage of the project.

This stage includes an appraisal where the client's needs and objectives are identified together with feasibility studies which enable the client to decide whether to proceed onto the design brief which encompasses the identification of the procurement method, procedures, organisational structure and range of consultants or personnel to be engaged for the project. Once this has been completed the next step moves onto the actual design phase which includes the design concept, design development and then the technical design. Throughout the design phase the procurement route should be thoroughly surveyed.

The natural progression after the design phase is pre-construction. In this stage of the project process the production information is compiled for the contract as well as the tender documents to allow for tenders to be sent out, received back from potential contractors and then recommendations made to the client. The second to last phase in this plan of work is the construction of the project which is made possible through the various stages above. Mobilisation must occur for construction to begin, whereby the contractor is appointed, provided all the necessary information and then formally handed over the site. Through this process construction is performed to practical completion which allows for the client to use the building for its designed purpose. Post practical falls under the final stage which is the actual use of the building. This stage involves administering the final projects contracts and accounts, a final inspection which is usually performed by the architect and then continual review of the projects performance while in use. This outlined plan of work encompasses the general process from inception to construction to handover and use of a building.

Before the categories of procurement systems are examined the definition of a procurement system must be established from various perspectives. McDermott (1999) posits that this term cannot only involve the design and construction of a project. It must encompass an array of

factors which include cultural, administrative, financial, political and environmental issues that transpire from the building procurement process. Therefore, he quotes the International Commission of Building for the definition of the building procurement process: It is

> *A strategy to satisfy client's development and/or operational needs with respect to the provision of constructed facilities for a discrete life cycle*.
> (McDermott, 1999:1)

The collection of building procurement systems is now so vast that the need for objectively and systematically establishing the most effective system is vital (Masterman, 2002). However, as a result of perhaps lack of knowledge, understanding or skill, the approach from the client to this selection is often performed in a haphazard manner (Morledge et al, 2006). Furthermore, it is recognised that an insufficient number of construction professionals actually have the required knowledge to understand the differences between the numerous procurement systems, and therefore would be unable to make an educated recommendation on the most suitable system for a particular project. However, a closer look into the terms of quantifiable benefits has established that the selection of the most appropriate procurement system will reduce a project's capital outlay by an average of five percent (5%) (Morledge et al, 2006). Furthermore, in a study conducted by it was reported that of the clients surveyed, eighty nine percent (89%) stated that they had been previously dissatisfied with the procurement systems applied on their projects.

Additionally, a different study on eleven separate state financed projects found that the projects which simply applied the *traditional* procurement approach consistently failed to attain the time, cost, quality objectives of the client whereas the projects procured through the *design and build* system consistently achieved a far greater level of project success. This is not to say that the *design and build* method is generically superior to the *traditional* approach, however the *traditional system* has been seen to fail commonly as a result of it being persistently applied without analysing the actual needs of the client and his/her building. In order to assist clients in overcoming these problems it has been established that it would be valuable to categorize the major building procurement systems.

2.2.4 Categories of building procurement systems

According to Masterman (2002) there are numerous factors used to approach the categorisation of building procurement systems, which firstly includes the intrinsic degree of risk taken by each involved party. This is often referred to as the speculative risk as each construction project will vary in the risk that it holds for the participating parties. However, establishing a quantifiable degree of risk such as low, medium or high does little to provide the decision maker with knowledge on the principal differences of the various procurement options.

The second criteria to look at when categorising these systems is the available or required degree of information at commencement of the construction contract. This is always of particular importance to construction clients as the total overlap between design completion and the construction phase will directly influence how early the project can physically commence. However, this approach is often inaccurate, one-dimensional and ambiguous for the client or decision maker.

The manner in which payment is provided to the contractor is another aspect that is critical in classifying a particular building procurement system. This categorisation approach is often seen to be invalid as the majority of building procurement systems allow for payment to be provided in the same manner. Therefore it would not be viable with regards to determining individual systems.

The concluding method to categorise a building procurement system is through the manner in which the interaction between the finance, design, construction and operation of the project is managed. This is considered to be the most effective approach to classify and establish an appropriate building procurement system for a project. This method ensures that each type of procurement system is easily recognised as it enables the project's fundamental issues and elements to be identified.

As it has been determined that the fourth approach to the categorisation of building procurement systems is the most suitable, Masterman (2002) posits that the following four categories of procurement systems are available and have been adopted in the built environment.

In the *Separated Procurement Systems* the responsibility for the key elements of the project implementation process is taken by separate entities. For example the design and construction of a project will be performed by different organisations such as consultants, engineers and contractors. The client is responsible for financing each of these separate entities and ultimately the operation of the completed facility. The *traditional system* falls into this category.

In *Integrated Procurement Systems* the responsibility for the design and construction of a project is taken by only one entity which is typically the contractor. Therefore, theoretically, the client is only involved with a single organisation. The major systems within this category are *develop and construct, design and build, novated design and build*, the *package deal* approach and the *turnkey* method. The *turnkey* approach is the exception as the contractor often provides various finances for the development of the project is commonly responsible for the operation of the completed building.

The *Management-oriented Procurement Systems* define that the project is performed by an organisation collaboratively working with the designer, consultants and contractors in order to design, construct and administer the physical operations of the project. The systems involved within this category require greater collaboration between all parties and therefore the client will have far more involvement in the project compared to the systems contained in category one and two.

The *Discretionary Procurement Systems* are somewhat of a combination of the first three categories. The client outlines an overall administrative structure for the project and adopts what is perceived to be the most suitable procurement system within the other three categories. The major procurement structure contained in this category is *Partnering*.

It is worthy of note that although the use of one correct procurement category and system will ensure the realisation of a client's needs on the majority of projects, the adoption of several of these systems may often be required on larger, more complex projects (Masterman, 2002).

There is a vast array of variables to each of the commonly adopted procurement systems within the extensive range of building procurement systems available to the clients and professionals of the construction industry (Turner, 1990). Furthermore, the variables of who designs, where construction will take place, who engages with whom to construct the facility, and the boundless list of other inconsistent factors generate the many possible systems of

procurement. Despite there being such a wide variety of systems, within the categories of separated systems, integrated systems, management-oriented systems and discretionary systems, there are a number of commonly adopted fundamental procurement frameworks, each of which is examined and discussed in detail.

2.2.4.1 Separated Procurement Systems

The separation of the responsibility for the design and construction of a project is this system's fundamental and distinctive characteristic. It is often referred to as a sequential system as the project development activities from the project brief, design development, tender documentation to construction, commission and hand over, are performed sequentially one after the other (Rashid, Taib, Ahmad, Nasid, Ali and Zainordin, 2006). The category contains a single method of procurement: *the traditional system*.

The *traditional system*, also known as design-bid-build, has been used for centuries and remains by far the most used system of procurement, particularly by inexperienced or occasional construction clients (Turner, 1990). Furthermore, in this system the client appoints consultants for the design where the project then develops on a sequential basis as the client employs the design team to an advanced stage before appointing a contractor. Although it is by no means easy, if correctly implemented this system is seen to be the least risk approach as the variables of design, time and cost are relatively certain (Morledge et al, 2006). The assurance of this low risk necessitates the inherent sequential nature of this system which means that it is fairly slow prior to construction commencement. Moreover, this system is particularly attractive to clients with a strict budget as construction costs can generally be determined on a lump sum basis with reasonable certainty before construction commences. This cost, referred to as the contract sum, is derived from a bill of quantities supplied by a quantity surveyor who measures and quantifies each aspect of the project works in order to satisfy the demands of the design (scquantitysurveyors.com). In this system, payment of the client's design team or any other consultant is generally by means of a fee and expenses method, whereas the contractor is paid on a lump sum basis for completed work (Masterman, 2002). The contractor has no responsibility for the design of the project but only for the construction (scquantitysurveyors.com). Furthermore, this separation of the design and construction element has become the primary cause for the shift towards alternative methods of procurement.

There are a number of advantages and disadvantages within the traditional procurement system which will assist the client in determining whether to apply this method on a particular project or not. According to Morledge et al (2006) the main advantages of a traditional procurement strategy are competitive fairness as all contractors are tendering on the same set of project objectives. It is design-led, allowing for design quality as the client is able to have a direct influence on the professional team. There is a high level of public accountability as the system is transparent and based upon competition. There is also reasonable degree of price certainty according to the general market price. The procedures are recognised and established in the construction industry, assuring confidence in the parties involved in the development process. Changes are relatively easily made and valued in instances when a client's design needs vary, although in certain circumstances this ease may well be a disadvantage.

On the contrary Morledge at al (2006) posit that the main disadvantages of traditional procurement are that the project process is sequential and therefore the overall project duration is often longer than for other methods, it is possible to speed up the process; however this will generally result in less cost and time certainty and will subsequently cause disputes, the valued knowledge of the contractor is not utilised at all during the design and planning of the project as the contractor is only appointed after the design phase and the system is founded on price competition which can form disputes and adversarial relationships.

As tempting as the traditional system is with regards to a very predictable approach to design, time and cost, it often proves not flexible enough to respond to the changes in needs of the client and circumstances along the building.

2.2.4.2 Integrated Procurement Systems

The category of integrated procurement systems, as the name suggests, incorporates and combines the responsibilities of design and construction for the project which are taken on by one organisation, generally a contractor (Ashworth, 2006). Furthermore, this category is often referred to as a parallel or single responsibility procurement system as the client only engages with a single entity throughout the design and construction of a facility. The *design and build* system is the primary method of procurement within this category, with the remainder of the category made up by the variants of this primary system (Masterman, 2002). The design and build system and three of its variants, namely *the package deal*, *develop and construct*, and *turnkey*, are thoroughly discussed and examined.

For many years the construction industry applied the term *package deal* as a description that is all-encompassing of *design and build, develop and construct,* and *turnkey* methods of procurement (Masterman, 2002). However, this imprecise terminology formed extensive confusion and many disputes among clients and professionals of the industry, resulting in a substantial need for the term design and build to be accurately defined. According to Masterman (2002) the term *design and build* has almost been unanimously understood and defined within the built environment as:

> *An arrangement where one contracting organisation takes sole responsibility, normally on a lump sum fixed price basis, for the bespoke design and construction of a client's project.*
>
> (Masterman, 2002:67)

Three fundamental elements of this system are contained within the definition: The design and construction responsibilities lie with a single entity, payment of this entity is generally done by means of a lump sum price for a fixed duration, and the project is designed and built with only the specific needs of the client in mind (Masterman, 2002). This system of procurement is suitable for all clients which are experienced or inexperienced as well as those that require distance from the project, cost certainty and fast track projects (constructingexcellence.org.uk).

Design and build is described as a fast-track strategy for the reason that construction of the project can commence before all the detailed design is completed, however this is at the contractor's risk (Morledge et al, 2006). Furthermore, it is important that the project brief and performance specifications are unambiguous and explicitly defined before the contract is entered as changes are generally more expensive after project commencement, compared with other strategies. This project brief and the client's requirements are prepared by the client in collaboration with the professional consultants in the form of a tender document (Rashid et al, 2006). In addition, a number of contractors are invited to bid from this tender document, generating their own design and construction proposal with a detailed cost. There are a number of noticeable advantages as well as disadvantages involved in applying the design and build procurement system which Morledge et al (2006) proposes.

There is a clear advantage in the fact that the client is only required to engage with one organisation, consequently reducing the time and resources involved in contracting with

designers and contractors on a separate basis. The *design and build* method allows for an integrated contribution by the contractor in the design and initiation of the project, allowing for the client's requirements to be more effectively understood and met. This early involvement of the contractor should enhance the constructability of the facility. Further to this there is price certainty before construction commences and the system allows for interrelated and overlapping activities which reduce the total project duration.

However, in contrast to these advantages, clients can experience difficulties in developing a comprehensive project brief. This can cause problems for the various professionals involved. The client must commit on a particular design at an early stage, often before completion of a detailed design. Tenders are difficult to compare with regard to time, cost and quality as each design will differ in a number of ways. There is less competition as fewer building companies offer the design and build package. Changes to scope of the project can be costly.

The *package deal* variation on *design and build*, commonly called the *all in contract*, is a method of procurement in which the contractor has sole responsibility for all the aspects required within the design, development and delivery of the building project (Rashid et al, 2006). Contractors will often use a significant portion of a proprietary building system or simply construct a variation of a repetitive theme in order to provide an off-the-shelf building for the client (Turner, 1990). Furthermore, the major characteristic of this system is that buildings are provided to clients rather than an innovative design. Under this system, the contractor must perform all the activities involved in the project process. This specifically involves the activities from the preparation of the project brief and design to project finance, authority approval, construction, and finally to the commissioning and handover of the facility to the client (Rashid et al, 2006). The ultimate distinction between the *package deal* procurement method and *design and build* procurement method is that the latter provides a means to a bespoke project design which can fit the varying needs of each client whereas the former employs a generic method to provide a process which is unlikely to satisfy the vast assortment of client's needs. Although in theory the concept of purchasing a building as if it were a standard product or consumable is appealing to the purchaser, in practice an adaptation of a generic building product cannot meet the requirements or the needs of the majority of construction clients. Common examples of buildings developed using this system are factories, warehouses and uncomplicated offices.

The *turnkey* method of procurement is the second variation on the *design and build* system and it is markedly similar to the package deal in many aspects. This system was pioneered in the United States of America and is, as the name implies, an all in method whereby a single organisation, generally a contractor, is commissioned to undertake all the activities from the design up until completion where the client can, in essence, enter the project by simply turning the key (Masterman, 2002). When using this system the contractor must perform all the activities in the project process. This ranges from the brief, finance and construction to extended responsibilities such as furnishing, decorating, equipment installation, recruitment and training of operational staff before the facility is finally handed over for use. A number of variants on this system have been developed in order to further attract the private sector by guaranteeing investment returns through methods generally referred to as concession contracts.

Although the *turnkey system* does emulate all the characteristics of the parent *design and build* method, the forms of contract within the turnkey system are generally not drawn from the construction industry but rather from the process engineering sector. Prime examples of projects developed through the turnkey approach are oil refineries, power plants and speculative private housing (Turner, 1990).

The *develop and construct* method of procurement also falls within a section of the integrated procurement approach and is noticeably similar to its parent system *design and build*. In this case, the contractor is still responsible for design and construction. However the client's consultants design the project to a partial stage, called the scope design, where the contractor must then develop this design further to design completion (Turner, 1990). Furthermore, the amount of consultant design will vary and based on what has been developed and produced the contractor must construct the building according to the client's requirements. The application of this approach is therefore appropriate where the client still needs, or desires a single point of responsibility for design and construction but requires a detailed concept of the project before inviting tenders (Masterman, 2002). It is thus evident that the major difference between this system and its parent system is the extent to which the project design has been generated before tender invitation.

According to Masterman (2002) there are many advantages and disadvantages that are universal to all procurement options included within the category of integrated procurement systems. The advantages of the *develop and construct* system are that all aspects of the

project are dealt with by a single entity and therefore the client has the advantage of a single point of contact, generally with a contractor, which is unique to this procurement category. Integrated procurement systems allow for overlapping of project activities which should result in establishing superior communication between the client and contractor. These qualities enable overall project completion to be achieved in a shorter time and greater project management efficiency. Subsequently there is certainty of the final project price, on condition that the client has specified the project requirements accurately. In general this price is often less than when applying systems of procurement within other categories.

The disadvantages with this system are that substantial difficulties arise in evaluating tenders when the client's requirements are ambiguous and not accurately communicated to the contractor. Additionally, there is no bill of quantities which prohibits the freedom for a client to make changes at a later stage and means that the valuation of any alterations is particularly difficult. The client's control over the aesthetics of a project is less than in when applying other categories of procurement systems.

2.2.4.3 Management-Orientated Procurement Systems

Management-orientated systems have become widely recognised and applied over the last three decades although a considerable number of clients, contractors and consultants have little or no experience with the system and its attributes (Turner, 1990). The growing application of this system is largely as a result of the construction sector's image as a badly managed industry (Masterman, 2002). Clients demanded earlier commencement and completion dates, additional cost control and superior quality standards than were being achieved through previous procurement systems. Under this system, greater emphasis is given to the integration of the management for both the design and construction of projects. This integration is performed on behalf of the client by a management consultant who is generally the contractor (Rashid et al, 2006). Furthermore, this procurement approach is based on the notion that a contractor has greater expertise to manage the design and construction of a project. There are three methods within this category, namely *management contracting, construction management* and *design and manage*. These commissioned methods should enable a client's needs to be met more readily than in the application of more conventional methods, specifically with regard to earlier commencement and completion (Masterman, 2002).

According to Masterman (2002) *management contracting* is a fast track strategy to procurement with the following principal characteristics: Firstly, the main contractor is appointed as integral participant within the design team, supplying specialised construction insight. Secondly, the reimbursement for the management of the project is on a lump sum or percentage fee basis while the construction work is on a prime cost plus basis. And finally, the actual construction works of the project are carried out by various specialist or package subcontractors which are selected, employed and administered by the main contractor who acts as a management consultant on behalf of the client.

Therefore without actually performing any construction work the main contractor bears the responsibility for any of the construction carried out (Morledge et al, 2006). Furthermore, the contractor may supply standard site equipment and services such as site offices, scaffolding, cranes and security personnel unless it is a pure management contract where these are contracted out. In addition, the responsibility for the design team lies with the client through a professional basis of employment. As this procurement system applies a fast track strategy the design and construction commencement overlap in a just-in-time process in order to meet the requirements of the construction schedule (constructingexcellence.org.uk). Moreover, this strategy is consequently one with little price certainty for the client at the onset of a project before construction begins. However, it is commonly applied in circumstances where the client requires an accelerated speed of completion (Morledge et al, 2006). This system is most appropriate for projects that require a fast track strategy, complex projects and buildings with a gradually developing brief. It is less appropriate for projects requiring certainty of price before the outset of construction, inexperienced clients and clients that want to pass the project risk onto the contractor.

To a large extent the success of this approach depends on the main contractor's team (Morledge et al, 2006). Where the management construction team is not of a high standard or where the payment is insufficient, the contractor can lack motivation towards the overall project and be less pro-active. It is therefore crucial to the success of the project that the correct contractors and relevant professional teams are appointed and that the main contractor's fee is adequate, according to the market circumstances.

The *construction management system* is similarly a fast track method. However the major difference between this system and *management contracting* is that the specialist package contractors are in a direct contract with the client rather than with the construction manager

acting on behalf of the client (Rashid et al, 2006). In addition, the construction manager then deals with each of these specialist package contractors as an agent for the client. The application of the *construction management system* is beneficial in volatile market conditions as it assists in accelerating project delivery and reducing the overall cost client (constructingexcellence.org.uk).

In order to realise these benefits the construction manager must ensure seamless integration between each trade specialist as the successful completion of one operation is directly affected by and dependent on the outcome of the previous trade set. This requires constant involvement in each stage of the project process from the client so is generally only appropriate for experienced clients (Morledge et al, 2006). What is more, the client must appoint a technically and commercially astute project management team in order to maintain a firm presence, through this team, in the project. The application of this system is particularly beneficial for building projects where a high level of innovation is required and clients want a hands-on approach to the project.

According to Masterman (2002) the primary characteristics of this building procurement method are firstly that the actual construction of the project is conducted by specialist trade contractors who are appointed and employed by the client but are managed, co-ordinated and overseen by a construction manager. Secondly, the construction manager is appointed as integral participant within the design team and has equal input in the design of the project. And finally, the reimbursement for the management of the project is on a lump sum or percentage fee basis.

The *design and manage* method of building procurement combines various characteristics seen in the *design and build* system with those of management-orientated systems (Turner, 1990). After a selection process a single organisation is commissioned to both design the project and manage its construction which is carried out by specialist package contractors. According to Masterman (2002) the following primary characteristics are evident in this system: Firstly, the project's design and overall management is the responsibility of a single organisation. Secondly, this organisation is either a contracting organisation or a consultancy practice. And thirdly, the actual construction of the project is performed by specialist trade contractors who are employed by the contractor when using a contracting organisation but will be directly employed by the client in the case of the consultancy variant.

With these characteristics in mind, Morledge et al (2006) established the following advantages and disadvantages for the *design and manage* procurement method. The most beneficial advantage is that there is superior organisation and collaboration between project designers and constructors as the client is only engaged with one entity. Furthermore, the overlapping of the various processes results in relative time saving potential and the risk for the design and construction of the project lies with the contractor. In contrast to these, the first disadvantage is that the strategy relies on the experience of a client in order to select an appropriate team that is sufficiently committed to the requirements of the project. Furthermore, there is a requirement for tight information and time control and a detailed brief of a good quality must be provided by the client for this system to be successful.

The category of management orientated systems has been applied more frequently in recent times in an effort to increase the quality of overall management on building projects. The three methods covered in this category involve greater management by the contractor in the design and construction of a building than the more conventional procurement systems.

2.2.4.4 Discretionary Procurement Systems

The categories of procurement systems proposed within this chapter have been established by the way in which the interaction between the finance, design, construction and operation of a project is managed or associated. Discretionary procurement systems involve an administrative and cultural structure, into which the most appropriate procurement system or combination of systems is adopted. The client has the choice of avoiding the established approaches to procurement and forming a bespoke system with the assistance of various professionals in order to better meet the requirements of the project. The proposal for establishing a fourth procurement category emerged from a system that ignores the fundamental elements of procurement classification and does not fit into any of the other categories. This fourth system is called *partnering*. (Masterman, 2002)

A number of researchers argue that any procurement method included in this category is merely a mode by which the project environment can be controlled, rather than a true building procurement system (Masterman, 2002). However, building procurement systems have been defined in this study as a strategy to satisfy client's development and/or operational needs with respect to the provision of constructed facilities for a discrete life cycle. That means,

according to McDermott (1999) discretionary systems and in particular partnering fall completely within this definition.

The need for a more cohesive and strategic approach to the procurement process of construction has long been proposed by academics and professionals in the industry as a prerequisite for obtaining project success (Morledge et al, 2006). The conception of partnering, strategic coalitions and other collaborative approaches has induced a considerable redefinition of the building procurement process as a whole. It has led to a focus towards team cooperation, motivation, incentives, client satisfaction and performance valuation.

It is worth emphasising that the application of *partnering* does not supplant the process of the procurement system selected for developing the project, but rather operates as a structural outline within which the procurement system functions (Masterman, 2002). Additionally, the *partnering* process is a voluntary arrangement between the relevant parties, has no lawful significance and forms no contractual commitment amongst the project participants. According to Masterman (2002) the three fundamentals of the partnering approach to building procurement are: Firstly, mutual project objectives are met through the partnership of all the parties involved in the project and improving their performance. Secondly, problem resolution methods are established in collaboration by all the project participants before the project commences. And thirdly, a continuous measurable improvement is an active goal that all the relevant parties strive for with regard to the overall performance of the team.

The application of the *partnering* process can only be successful when each participating organisation is willing to trust that every member of the project team has sufficient knowledge, understanding and skill to perform the job assigned to them.

2.2.5 Summary to procurement systems

The procurement system that is most appropriate to the overall success of a specific project will arise from the objectives and priorities decided and set by the client (Turner, 1990). The decision for the objectives of a project is based on a balance, a compromise in the existing conditions between time, cost and quality. The trade-off between these constraints will most probably result in either one of the constraints pulling against another or both of the remaining two. Inevitably, to deliver a project of high quality it will cost more and may take an extended time to accomplish (Turner, 1990). Achieving the balance of time, cost and quality is the essence and challenge of building procurement. According to Turner (1990) in order to select

the most appropriate procurement route for any particular project an assessment criteria of the various priorities must be applied with regard to timing, controllable variation, complexity, quality level, price certainty, competition, responsibility and risk.

Within these criteria risk is notably the most influential factor in the balance between time, cost and quality. It is not possible to say that one procurement route has definitively more risk than another. However, the risk each party is willing to accept respectively will influence the project priorities and ultimately establish the selection of a particular procurement system (Turner, 1990). Risk allocation has been a subject of considerable debate as evidence illustrates that inappropriate risk shifting is a major cause of disputes while risk allocation through a systematic process will prevent many disputes from arising.

The selection of the most appropriate procurement system for a project is a complex process dependent upon the interaction of many variables (Masterman, 2002). Furthermore, it is a crucial strategic decision that is pivotal in achieving the client's objectives – the benchmark for realising overall client satisfaction and ultimately the success or failure of a project.

2.3 Client Satisfaction

This subchapter will determine the factors involving client satisfaction, how it is achieved and its effect within the construction industry. Particular emphasis will be put on the relationship of building procurement with client satisfaction and subsequently this relationship's influence within the Green Building environment.

The construction industry has been castigated by numerous clients in the past which has resulted in significant changes occurring throughout the built environment (Masterman, 2002). The industry has recently recognised and now understands the paramount importance of a client's needs in the success of any project. In fact according to Morledge et al (2006) the majority of all built environment participants believe that the most important indicator for the overall success of a project is client satisfaction. Client satisfaction, in the construction sense, can be defined as how effectively the client's expectations are met by the professional project team (Adanan, 2006). With this definition as the most important gauge for the level of project success it is evident that the future of the construction industry is held within the extent to which the industry's clients are satisfied.

Satisfying the needs of the client is the principal aim of any service provider and is the fundamental goal for all construction processes (Adanan, 2006). Despite this the prevalence of client dissatisfaction in the South African building industry continues and is now a significant cause for concern. Compared with other economic sectors the construction industry has invested little time and resources into investigating the actual needs of its clients and therefore has a higher proportion of dissatisfied clients than that of any other industry (Mbachu and Nkado, 2005). This may be a result of the many professionals lack of knowledge or the entire industry's apparent inability to assess the complex and often subjective phenomenon known as client satisfaction – or both. Although the definition of client satisfaction has been defined it is not always that simple in reality. Satisfaction involves an issue of dissonance between objective reality and a client's perception of that objective reality (Nkado and Mbachu, 2001). This means that the expectancy disconfirmation process used to confirm or disconfirm a client's satisfaction is often based on the client's perception of achieving objective realities such as time, cost and quality, and not purely on the actual objectives.

Client satisfaction will result in sustainable customer loyalty to the organisation, positive word-of-mouth creation, repeat purchase and approval of further products and services provided by the organisation (Mbachu and Nkado, 2005). On the contrary, divestment from the construction industry will occur as a result of client dissatisfaction, leading to further complaints, negative word-of-mouth, declining levels of customer loyalty as well a reduction in market share and overall profitability (Mbachu and Nkado, 2005). Thus, the current and future prospects within Green Building and the construction sector are crucially dependent on the extent to which building clients are satisfied with the end results of the entire building process (Nkado and Mbachu, 2002a).

2.3.1 Defining client satisfaction

The definition of client satisfaction has been extensively debated within the built environment as people realise the significant importance of achieving client satisfaction and accurately measuring it. According to Adanan (2006) the term client satisfaction is commonly defined throughout the construction industry as how effectively the selected project team assembles the client's objectives and expectations into physical reality. Although this is an apt definition the debate amongst professionals and academics continues. Client satisfaction is a multifaceted process which can be experienced in a number of different situations, connected to goods and services (Centre for the study of social policy, 2007). It is significantly affected by client expectations and is therefore a personal and often subjective appraisal (Mbachu and Nkado, 2005). According to the CSSP (2007) satisfaction is not simply based on the outcome of the client's personal objectives but also on the interaction with the organisation as a whole. Thus, satisfaction may be reached by a client with a particular good or service, an experience, a purchase decision, a contractor, a sales agent, a service provider, or a number of these attributes. Client satisfaction is a post-purchase evaluation of all these attributes and is a cognitive decision as well as an emotional response (Abdallat and Emam, U.D). In addition, satisfaction follows an expectancy disconfirmation paradigm, whereby satisfaction/ dissatisfaction is confirmed or disconfirmed by the customer's pre-purchase expectations and post purchase assessment. Within this paradigm clients have two sets of needs, firstly, latent needs which are often not determined through conventional measurement instruments, and secondly stated needs which are clients' stated prerequisites or perceived solutions for fulfilling the latent needs (Nkado and Mbachu, 2001).

Client satisfaction is thus a behavioural process as well as an economic one which is negatively influenced by discrepancies in demand and supply (Abdallat and Emam, U.D). Generating client satisfaction is a defensive business strategy which is used to minimise client/customer turnover through customer loyalty. In order to retain customers there are two basic criteria which must be met, a switching barrier and customer satisfaction. A switching barrier makes it costly for a customer to switch to a competitor while customer satisfaction ensures that it is difficult for a competitor to win over another organisation's customer. According to Abdallat and Emam (U.D) customer satisfaction is far more effective than a switching barrier as it drastically minimises the price competition factor and considerably increases customer loyalty. Without customer loyalty or repeat business the potential future income stream as well as the future existence of the business is at threat (Hanson, 2006).

According to Uzaslan (2008) there are more advantages of client satisfaction for organisations involved in any sector of business, for example gaining a competitive advantage in the market over competitors, increasing share in the market, enhancing profits, increasing repeat purchase, reducing price sensitivity, creating positive word-of-mouth recommendations, preventing negative statements and service provider switching.

On the other hand, Uzaslan (2008) posits that client dissatisfaction can result in client complaints, negative word-of-mouth, redress seeking, diminishment of customer loyalty, decline in market share, reduction in profits, service provider switching and a potential divestment from the industry as a whole. With this in mind it is apparent how essential client satisfaction is within a business and an entire industry for that matter.

2.3.2 The necessity for Client Satisfaction

Organisations focus on client satisfaction in order to establish a strategy to increase their cash flow, profits, client base, loyalty and overall share in the market needed to continue existing (CSSP, 2007). Exemplary businesses are centred on the client's experience as this is the primary driver for the profit and survival of a business. Today investors have an array of opportunities other than construction development (Hanson, 2006). This means it is essential for service providers in the South African built environment to focus on client satisfaction if they wish to remain competitive and attract future clients. Without the support of existing clients and the inflow of prospective clients a business cannot succeed. It is therefore imperative for organisations to place a premium on client satisfaction as a strategy to enhance

performance and survive the ever-increasing competition in the marketplace engendered by globalisation (Adanan, 2006).

2.3.3 Attaining client satisfaction

According to Hanson (2006) client satisfaction can only be achieved when the needs, wants and expectations of a client are met or even exceeded. However, this cannot be achieved unless the service provider has a thorough understanding of exactly what the client wants, the client's goals are clearly communicated to the professional team and the professional team seeks out the client's exact expectations (Ogunlana, 2005).

With this in mind, the uniqueness of a green building becomes a cause for concern as the client's lack of expressed interest as well as the lack of knowledge by all parties regarding this concept often results in the project aims being communicated incorrectly or not at all. Therefore, a collaborative approach between the client, professional team and a Green consultant is key to achieving client satisfaction of a green building (Glavinich, 2008).

Within this collaboration one of the most important members is the contractor. The contractor is a pivotal factor in ensuring client satisfaction and overall project success as the contractor's principal function in the project delivery process is to convert the design envisaged by the client into physical reality (Glavinich, 2008). Moreover, the contractor has sole control of the construction means, methods, techniques, sequences, procedures and procurement system for effective project delivery. Hanson (2006) argues that in order to achieve superior levels of client satisfaction in the construction sector contractors must be involved in the very early stages of the building development process because they have a wealth of valuable knowledge and expertise regarding the building strategies and constructability of projects.

To enable client satisfaction to be achieved it must be ensured that the client and contractor are aiming at the same goals, expectations and perceptions (Adanan, 2006). Additionally, there must be a paradigm shift from focusing only on objective criteria such as time cost and quality to an awareness of the client's perceptions and priorities. The approach aims to create a better understanding of the client's objectives and primary issues. This contributes to establishing satisfaction over and above assessing it solely against completion of the project within the measurable boundaries of time, cost and quality. Most important for the contractor is the realisation that the client's expectations are not constant, but must be treated as a target

in motion (Adanan, 2006). Therefore, there is a need for a system to be put in place that adjusts to these continuous changes by gauging, recognising and enhancing the physical and abstract products or services required.

A mutually beneficial relationship between the numerous parties must be established, grown and maintained in order to successfully develop a project strategy that meets the needs and desires of the client. In this relationship, the client assesses the contractor's project performance against three comparisons, all of which affect the final outcome of client satisfaction: Firstly, the quality of the end product, which is the building, must be compared with the client's perception of the end product and the adapted objectives for the end product. Secondly, the perceptions or expectations that the client has for the project are analysed against the actual experiences that are then had (Adanan, 2006). And thirdly, the quality of the building procurement process must be compared to the experiences which have come about within this process. The last comparison involves the building procurement process which is particularly influential in achieving client satisfaction and therefore must be discussed further in some detail.

2.3.4 Habitual routine as a factor in client satisfaction

Clients and professionals, through repetitive behaviour, have established routines that are familiar, safe, comfortable and predictably reliable, thus resulting in the *traditional* procurement strategy being applied in a vast majority of cases in practice (Turner, 1990). This illustrates a fear of the unknown and a reluctance to tread unfamiliar ground which often results in individuals that are insistent on using the *traditional* method even in circumstances where this approach cannot guarantee project success. According to Hanson (2006) the *traditional* approach can often be typified with fragmentation and conflict between the various members of a project. This fragmentation has been cited as a potential catalyst for clients' dissatisfaction with the built environment. Mbachu and Nkado (2006) posit that *traditional* procurement lacks flexibility and forms claims-conscious behaviour which results in a cost certainty fallacy and diminished control for the client.

Furthermore, Hanson (2006) argues that the *traditional* method stifles the client, consultant, contractor relationship and therefore there is frequent dissatisfaction with traditional approaches. This dissatisfaction has led to the increased application of procurement systems that allow for greater flexibility and communication, such as *design and build*. The major

benefit of the *design and build* approach with regards to client satisfaction is the early involvement of the contractor, which is enabled by the close relationship between the design and construction teams (Hanson, 2006). In addition, it has been determined that when applying the *design and build* system there is greater synergy between project participants which is crucial in project success and client satisfaction.

2.3.5 Causes of Client Dissatisfaction in South Africa

According to Mbachu and Nkado (2006), the prevalence of client dissatisfaction in the South African built environment is a direct result of not reaching the overall project objectives. Within their study a number of causes of client dissatisfaction in the South African built environment were determined. The majority of the causes for client dissatisfaction were identified as occurring in the very early stages of the procurement process, where the client's needs and objectives are established. Additionally, the dissatisfaction within this early phase could prohibit client satisfaction being achieved in any other stages of project development and constrain further investment. Therefore, a methodical approach to accurately assess and extract the client's real needs must be applied in order to curb the occurrence of client dissatisfaction (Hanson, 2006).

2.3.6 Summary to client satisfaction

The construction industry's fundamental responsibility and duty is to ensure that it satisfies and creates value for its clients (Hanson, 2006). Furthermore, by ensuring clients are continually satisfied numerous advantages arise for an organisation as well as the entire construction industry. On the contrary, disadvantages such as divestment from the construction industry will occur as a result of client dissatisfaction (Mbachu and Nkado, 2005).

Kometa et al (1994) suggest that in order to successfully finish a building and thus achieve client satisfaction, the three most important elements are the client, the contractor, and the procurement system utilised. If these three elements do not collaboratively fit into a particular project, client dissatisfaction is likely to occur. Consequently, the extent to which building clients are satisfied with the end results of building projects is crucial for the current and future prospects of the built environment and sustainable development in South Africa. With

all this in mind the prevalence of client dissatisfaction is a significant hindrance to the development of the South African construction industry (Nkado and Mbachu, 2002b).

2.4 Green Building

2.4.1 Background

To foresee the success, need and path being ploughed for green building the built environment must look to the future to envisage what is in store for countries, cities, societies, governments and generations to come.

McKevitt and Ryan (2014) affirm that there are approximately 7.1 billion people inhabiting the earth, consuming its finite resources needed to sustain life and generating exponential amounts of waste. What is more, while the process of consumption and discharge continues to accelerate concomitantly as the human population multiplies, the state of equilibrium between demand and supply of the planet's resources is being significantly altered (Van Wyk, 2009). The modern world has now reached the point where demand outweighs supply. Prior to the industrial revolution the level of human interference in the natural environment was completely dependent on the balanced availability of resources, meaning that any construction development was built on the foundations of a sustainable vernacular (Van Wyk, 2009). Furthermore, where early civilisation lived off the interest of the earth, modern man is now consuming the earth's capital at an unprecedented rate, as well as depleting the remaining capital balance through waste generation. When looking back on building history it is easily noticeable that the world's rapid advances are detrimental to the human population too. Building designs and construction processes are wasteful and disconnected from the natural environment.

Although the industrial revolution instigated the consumption of vast amounts of natural resources, the planet is today captured within in a new revolution that is equally devastating: The Urban Revolution (City of Melbourne and Victorian Department of Transport, 2010). This term was given to the enormous and unprecedented influx of rural based societies into cities across the globe. There is only a thin layer of the earth in which life can exist, and it is within this womb-like layer that 7.1 billion people, as well as all other living species, draw their resources from (Van Wyk, 2009). This huge human population has managed to drastically alter the earth's delicate bio systems in a notably short period of time. What's more, the rapid onset of the urban revolution threatens to further alter these systems as ever increasing cities demand more of the planet's precious natural resources. Where cities in 1900 housed 200 million people or ten percent of the planet's population, these cities currently

accommodate fifty percent of the world's population at 3.5 billion inhabitants and will, by 2050, hold a staggering 6.4 billion people at seventy percent of the world's entire population (City of Melbourne and Victorian Department of Transport, 2010). This presents a major challenge not only to provide the building capacity for these 6.4 billion inhabitants in the next forty years but to do so in sustainable manner.

The rates of urbanisation within Africa are the highest in the world and by 2025 more than half of Africa's population will be urban (web.mit.edu). That means the urban population will increase by more than half a billion from 1990 levels as it grows at almost twice the rate of the general population over the next quarter century. Within this context, Sub-Saharan Africa has the highest urbanisation rate of all, where the urban population is expected to increase from 387 million inhabitants in 2010 to 705 million by 2025. That makes it no surprise that the concern for the environment as a whole as well as the future of the planet has become a focal point amongst governments, industries and individuals in political debate, media coverage and day to day conversation (Glavinich, 2008).

One considerable issue that has been identified is global warming (Van Wyk, 2009). The term is defined as a sustained average increase in the atmospheric temperature of the earth. This warming of the earth is attributed to an increase in greenhouse gas emissions, largely due to human activities which results in changing global climate patterns (EPA, U.D.).

Van Wyk (2009) states that some impacts of global warming are already being experienced, such as a greater frequency of heat waves with an increase in heart-related illnesses and deaths, more severe and frequent flooding, more widespread and prolonged droughts in certain regions or deteriorations of coastal and low-lying regions on account of rising sea levels.

Global warming is a natural occurrence in the earth's ever changing cycle. However, human activity is drastically accelerating this phenomenon, causing a rate of change that is without precedent in the history of the planet. One of the samples that support this acceleration theory is the measuring of Carbon Dioxide (CO_2), which is the primary greenhouse gas entering the atmosphere (EPA, U.D.). The global warming debate has always focused its attention on transport and industry as the main culprits. However evidence through recent studies confirms that buildings, under construction as well as in use, contribute equally to the role in global

warming (Van Wyk, 2009). Thus, there is a strong connection between construction and urbanisation.

It is a fact that seventy percent of the world's greenhouse emissions today are either directly or indirectly caused by cities, it is evident that this exponential urban migration could in fact be even more threatening to the planet than the hasty onset of industrialism. This presents the built environment with many challenges beyond merely providing sufficient shelter.

The building industry has become the largest single consumer and polluter of the planet's limited natural resources (Van Wyk, 2009). Commercial, residential and industrial buildings are accountable for forty eight percent (48%) of all greenhouse gas emissions produced and additionally consume forty percent (40%) of the planet's energy supply, forty percent (40%) of the world's material resources, and twelve percent (12%) of its water supply (Biello, 2008). In addition, it is expected that both the amount of energy used in buildings as well its percentage of overall annual resource consumption will increase if the current systems are continually applied.

This industry therefore holds considerable importance to all human activities, as well as ecological and environmental wellbeing. The built environment has the potential to either reverse its detrimental effects or curb the very existence of the natural environment. The International Council for Building stresses the paramount importance of the construction industry in today's times, stating

> *The pursuit of sustainable development brings the built environment and the construction industry into sharp relief. This sector of society is of such vital innate importance that most other industrial activities in the world simply fade in comparison*. (CIB, 1999:17)

There is an explicit responsibility for the built environment to place an emphasis on developing structures that create well-being for the world's growing population while simultaneously conserving the planet's resources (Van Wyk, 2009). This is placing new demands on designers to develop their knowledge in order to understand the issues surrounding sustainable development and ensure they are sufficiently competent to develop all structures in a sustainable manner. In order to provide this, professionals must realise that

building in environmentally friendly ways requires a far more sophisticated understanding of both the built and natural environment than that of traditional development.

The shortcomings of traditional systems in sustainability are witnessed on a daily basis. In order to prevent this, responsive actions should be determined on more than purely the evidence of global warming, greenhouse emissions, resource consumption and human well-being (Beyer, 2002). Furthermore, although many valuable changes will occur from focusing on these factors, applying a full life-cycle approach through more sustainable and far-sighted actions will bring far greater holistic gains. Within this holistic life-cycle approach there is an ever increasing concern on capacity: the capacity for the world's cities to endure the challenges and demands of the future, particularly population expansion, urbanisation, climate change and inadequate systems of operation (City of Melbourne and Victorian Department of Transport, 2010). When developing these cities there are obvious component stages in the construction process such as materials, tendering, design, procurement, construction, use and demolition. However, there are also less obvious elements of building development which affect people as well as overall sustainability. These factors are community, sense of belonging, heritage and intrinsic value of the natural environment. How a population's built environment is designed, planned, operated and occupied will significantly influence their quality of life. Moreover, a well designed and arranged built environment will be developed to coincide with the natural environment and emphasise its intrinsic importance to human health (City of Melbourne and Victorian Department of Transport, 2010).

The sustainability of the built environment, and peoples physical and emotional well-being are all intrinsically bound to and somewhat dependent on the natural environment's level of quality. With this in mind the construction industry must ensure that the world's built environment is one that supports social and economic prosperity, while promoting the on-going wellness of individuals, society and the natural environment. In order to successfully achieve this, change is needed and a culture of sustainability must be created and maintained. Beyer (2002) reinforces this notion, stating that an individual or a society that believes sustainability provides the framework for the world's future prospects will need no argument for change. All that is required is identifying and establishing the most suitable systems to facilitate this change. William McDonough and Dean Emeritus envisage what could be achieved in the area of sustainable development if the right mindset and the right systems are established: Imagine buildings producing more energy than they use, water cleaner when it

leaves the building than when it arrived, better indoor light and air quality, and healthier and more productive work environments. Imagine projects where physical, biological, socioeconomic, cultural and environmental needs are so complete, that the Environmental Assessment concludes: no mitigation required (Beyer, 2002).

However, if this mindset is not achieved and inadequate systems continue to be used considerable shortcomings will arise in cities across the planet. In Melbourne, Australia a number of these shortcomings were experienced as recently as February 2009. According to the City of Melbourne and Victorian Department of Transport (2010) as temperatures climbed to considerably high levels and then settled in the 40-50 degrees Celsius range, the city battled to cope and experienced many failures. The water consumption increased three fold while the overall water storage levels were at dangerously low levels of thirty three percent (33%). Rail systems failed and could only cope with half the standard load as they were designed for cooler conditions. Huge pressures on power generation resulted in considerable amounts of the city having blackouts and numerous electrical failures. Fires not only put risk to people, livestock and property but also narrowly missed destroying the major electrical distribution network, an event that would have closed down the entire city of Melbourne. And across all the major parks in Melbourne the soil moisture levels dropped below the forty percent (40%) mark, the trigger point to significant stress for the city's 60 000 trees which includes over 15 000 older than 100 years.

Similar shortcomings and failures were experienced throughout South Africa in 2008. In week three of January 2008 the electricity demand of South Africa exceeded twenty percent (20%) of country's total generating capacity (CDE, 2008). By week four a quarter of Eskom's power capacity was unavailable, and South African's became increasingly familiar with huge blackouts across the country. Additionally, major cities and economic hubs were paralysed by traffic gridlock, numerous businesses in the food sector lost entire inventories and at least one person died on a hospital's operating table as a direct result of power failure. The national power network narrowly escaped a country-wide blackout, an occurrence that would have left South Africa with no electricity for nearly a week and in an extensive energy crisis. This has repeated itself in the summer of December 2014, putting South Africa's energy supply in arguably an even more detrimental position.

Environmentally sound building is of particular importance as each green building will reduce energy consumption by 30-70% (Nisbet, 2009). In addition, sustainable building is formed on

an integrative perspective of the natural environment and the built environment which is closely responsible for the vitality of individuals, organisations and businesses. The vast pressures on energy demand from South Africa's rapidly growing population, the bulk use of coal in power generation which is slowly diminishing and the rising costs of electricity have all forced the need for alternative energy solutions that are considerably sustainable.

Green buildings reduce energy consumption and therefore have become the built environments' major contribution to the planet on sustainable level (Toci and Rakwena, 2009). However, the South African government and built environment must look beyond the present, driving not only the development of green buildings, but also sustainable infrastructure, systems and ultimately entire green cities.

When embarking on new concepts governments and industries must look to places where similar concepts have been tried, tested and implemented correctly. For South Africa, Australia has a remarkable number of similarities on numerous fronts. As a result, the Green Star Rating System that the Green Council of Australia developed in 2002 is now being applied by the South African Green Building Council as well (gbcsa.org.za(b)). The Green Star rating tools are used to provide an objective measurement of the primary concepts and systems for a green building, as well as a means to identify and reward environmental leadership in the building industry.

If South Africa's cities are to achieve this a new paradigm needs to be established, where the future demands of population and urbanisation growth are met, but not through conventional, out dated methods where farmlands on the urban fringe are exploited (City of Melbourne and Victorian Department of Transport, 2010). Moreover, the government must ensure that the development of cities is contained in the existing boundaries as far as possible, while enabling ease of access to public amenities and greater affordability. What is more, the majority of existing cities fall short, and therefore must establish strategies that cover the six key factors for a successful city: adaptability, connectivity, mixed use of function, high quality public realm, density and local character.

Of the six key factors for a successful city, the most important is arguably that of city density. Compact cities such as Vienna with high densities are able to operate at lower levels of energy consumption. They form communities of diversity and social inclusiveness, allow for easy access to essential services and most importantly these type of cities are the most robust

against the challenges created by climate change (City of Melbourne and Victorian Department of Transport, 2010).

According to the State of Cities report conducted in 2011 South Africa has one of the lowest urban densities and some of the worst cases of urban sprawl in the world (sacities.net). If socio-economic and environmental conditions are to be improved, the form of these cities must be significantly transformed to one of resilient cities. Additionally, without this change South Africa will be tied into a narrow and unsustainable growth path whereby cities will be increasingly dependent on private transport, non-renewable energy sources and low density, highway-oriented development. The concept of a resilient city involves the ability of a city to foresee, adjust to and deal with challenging conditions such as market slumps, population growth and climate change (sacities.net). What's more, low density car oriented urbanism will become unsustainable long before fossils fuels are depleted. Therefore South African cities cannot continue to regard the environment as a separate issue if they are to manage challenges such as irregular and unpredictable rainfall patterns due to climate change. The demand for fresh water will outweigh supply in the majority of cities by 2025 and the rising costs of electricity from Eskom produced through coal and nuclear energy will not be sufficient in the near future (sacities.net). Furthermore, increasing pressures from international protocol will force South Africa to calculate, penalise and decrease carbon emissions in cities. Finally, reduced land availability will drastically increase the costs of landfill waste dumping.

In order to successfully manage and reduce these challenges cities need to be correctly densified and development along public transport corridors must be maximised (City of Melbourne and Victorian Department of Transport, 2010). Urban corridors should connect to key development areas and the existing suburban regions transformed into large areas of stability acting as green lungs through increased tree growth, water catchment, agriculture and solar power generation. The success of these high density urban corridors will rely on collaborative communication between government, building professionals and all citizens as well as a proficient system of implementation.

By applying this type of form, cities will enhance their long term social inclusiveness, liveability, economic output and ecological sustainability through the use of only a small portion of the current land (City of Melbourne and Victorian Department of Transport, 2010). In addition, the implementation of urban corridors will yield specific benefits. Considerable population growth can then be accommodated in the current urban districts without depleting

green lands. This is achieved through the use of medium rise buildings along the corridors. Increased densities means that the current infrastructure will be utilised optimally and therefore the general public will have better access to services. These dense corridors would allow for the development of high quality public transport and therefore a reduction in the need for cars which not only assists the environment but also the economic pressures on residents. Thus, less need for cars is greatly beneficial to transport disadvantaged people. Finally, a safe and vibrant pedestrian environment is created.

Furthermore, environmental excellence with regards to water, energy and waste management considerably reduces the need for existing and new infrastructure upgrades (City of Melbourne and Victorian Department of Transport, 2010). With building development along these corridors a large supply of affordable housing will be available. Consequently, a substantial improvement in the quality of urban space will be attained through the application of appropriate urban design principles such as sun and weather protection techniques, a clear demarcation between private and public space, high quality public realm and active street frontages. Greater accessibility to local job opportunities, services and recreational facilities will be created by means of mixed use development. And the corridors will connect activity centres and form an experience that is somewhat urban but close to suburbia.

Many South Africans love open spaces, extensive greenery and single standing homes. This is not going to change in the short term and attempting to retro-fit these areas to become highly dense regions will probably not be a viable option as the existing service infrastructure would not cope. Therefore these areas should be transformed into high quality productive suburbs and areas of stability with superior sustainability. The interconnected relationship between these productive suburbs, urban corridors and activity centres provide numerous benefits: The existing housing supply is calculated, valued and upgraded according to future needs. Thus, houses become more self-sufficient, using less water and energy and producing less waste (City of Melbourne and Victorian Department of Transport, 2010). Through the use of solar power South Africa can become a country where the majority of houses produce their own energy and feed excess back into the main grid at peak demand times. By feeding power into the grid households will receive a feed-in income. The collection of rainwater reduces the pressures on conventional and natural water systems with regard to the supply needed and the waste created (Van Wyk, 2009). The increased planting of trees will significantly support carbon removal. It will also assist in reducing the heat island effect. That is the process of

cities becoming regions of trapped heat. It is approximated that every rand spent on planting a tree provides five and half rand in benefits to the city (City of Melbourne and Victorian Department of Transport, 2010). By integrating more trees into the city in conjunction with flora and fauna, far greater bio diversity will be achieved.

Furthermore, local business and job opportunities are enhanced through the use of incentives for environmentally sustainable products and practices (City of Melbourne and Victorian Department of Transport, 2010). Precinct-based sewer mines provide water for areas such as parks, golf estates and gardens. This reduces the capacity required from the current systems and therefore there is far less need to build new infrastructure. And finally, productive backyards are used as means to reduce hard waste. These backyards will provide long term benefits by reducing the need for travel and extensive landfill.

The key to implementing such a strategy in South Africa is that applying it rapidly enough to instil confidence in the city's residents as well as professionals of the built environment. However, not so rapidly that people cannot accept the change. There is a finite window period to successfully implement such systems. Therefore the main objectives for implementation are to establish simple practical strategies and then use completed developments as examples to clearly exhibit the efficacy of this innovative approach to sustainability. According to the City of Melbourne and Victorian Department of Transport (2010), there are a few prerequisites that are necessary to successfully implement areas of stability. Firstly, the areas of stability must be clearly demarcated and any construction within these demarcated areas must augment the character of these regions as green suburbs. These areas must then become environments of biodiversity that have high densities of trees and are safe for the inhabitants. Furthermore, sufficient time must be created for storm water to be cleaned and absorbed into the ground water table through the installation of urban water treatment facilities and all buildings must be capable of collecting their own stormwater and greywater. With that, all parks and gardens should be watered through the use of precinct sewer mines. Additionally, every property should be required to generate energy through solar and wind methods. There must be capability for this energy to be fed back into the main grid at a tariff. Finally, recycling and reuse must be considerably promoted in order to minimise waste.

In order to successfully realise all these benefits strong political leadership is a necessity. It has been determined that if a comprehensive strategy to change becomes compulsory, the society will generally come to accept and believe in this change (City of Melbourne and

Victorian Department of Transport, 2010). This comprehensive strategy and strong political leadership is particularly crucial in integrating areas of sustainability, as while corridor development is by no means a new idea, the notion of linking it to suburban areas of consolidation is.

For this entire strategy to be successful it is required that existing suburban regions must be transformed into areas of stability and protected against further building development. Large public spaces and buildings of national heritage must be preserved. Furthermore, all new building developments will present at least eighty percent (80%) active frontages along all street frontages and vehicle access to the site will be provided through back streets or side streets.

The maximum threshold for the redevelopment footprint must be comprehensively established and enforced and the appropriate height of development for the area, between four and eight storeys, must be established as the first priority. This height must be established according to the public realm and the surrounding buildings. The chosen level must become compulsory for that area. Clear strategies regarding the transformation of these areas must be set out and explained to the public. For every development built in these identified areas, a certain percentage of affordable housing must be built by the developer. Furthermore, new developments must meet stringent environmental requirements, regarding the sustainability of water, energy and waste schemes. All streets will be adapted a way that largely favours pedestrians, bicycles and public transport systems over cars.

All of these factors are required for the successful implementation of sustainable cities. However the basic notion behind all these requirements is to alter planning schemes to ensure that development moves away from areas of stability and towards key development areas.

The existing spatial development structure of South African cities is causing current problems as well as accumulating larger problems for the future (sacities.net). Municipal governments are failing to manage the country's significant urbanisation rate and its effects on the natural environment. Retrofitting designated areas through densification must be implemented into South Africa's cities in order to handle the growing population while raising environmental standards. High density development, not high rise, can be used to accommodate the influx of people into cities around South Africa, while simultaneously providing infrastructure that is crucial for a liveable and sustainable future city.

Therefore the South African government must work in conjunction with built environment professionals to establish a set of strategies and policies that will alter the existing practices and form cities that are truly resilient. South Africa needs to significantly alter the way it envisages its cities. In a country where the bulk of electricity generation is from coal which is referred to as dirty energy, environmentally sound building is of particular importance (Nisbet, 2009).

Furthermore, sustainable building is formed on an integrative perspective of the natural environment and the built environment which is closely responsible for the vitality of individuals, organisations and businesses. The government must begin to understand and quantify the monetary, social and environmental costs of continuing to build South Africa's cities in the current manner. By effectively utilising and transforming the current infrastructure South Africa can make huge savings on all these costs while only using a small portion of the existing land.

> *This is a once in a generation opportunity to transform our cities while preserving their intrinsic qualities that should not be missed*.
>
> (City of Melbourne and Victorian Department of Transport, 2010:39)

Currently the drivers of sustainable cities and liveable cities are one and the same. This has placed the built environment in an extremely fortunate position, where it now has the ability to solve cities environmental and social problems simultaneously.

2.4.2 The Green Building Movement

The Green Building Movement may be considered a relatively recent and innovative concept, but the first green homes were constructed thousands of years ago by the American Anasazi Indians who designed and developed green homes as early as 700 A.D. (DeVries, 2010). Green Building is now at a reactive standpoint regarding implementation and adoption where it should in fact become a way of life for the success of future generations throughout the world. However, the built environment only became a key focus for environmental concern in the late 20th century again.

According to Everett Haynes (2008) the environmental movement as well as the concept and progress of sustainability was driven by the hippie movement. Although not every change was seen as morally and politically correct, it did alter the paths of society in a ground breaking

manner, where the positive influences can still be seen today. Furthermore, the generation of love and peace made the use of renewable energy a standard among these people as well as a trend across the globe. The hippie movement has later transformed into the modern green movement which has produced the green building concept (Rome, 2003).

In the 1970s, a small group of forward-thinking architects, environmentalists, and ecologists inspired by the work of Victor Olgyay began to question the practicality of building in a non-sustainable manner (EPA, UD). Only three years later, the American Institute of Architects (AIA) formed an energy task force to respond to the energy crisis, which is known as the AIA Committee on Energy. According to the EPA, (UD) it took another fifteen years until the UN World Commission determined the founding definition of the term *sustainable development*, as that which *meets the needs of the present without compromising the ability of future generations to meet their own needs*. In 1992 the AIA Environmental Resource Guide, the first assessment of building products based on life cycle analysis, was established. With the beginning of the new century, an increasing number of municipalities and corporations began to demand and set internal standards for green buildings within their organizations in the US. Canada established its Green Building Council in 2002, the same year that Australia founded this council and designed the Green Star rating tool. South Africa joined in 2008 with the Green Building Council of South Africa- GBCSA (gbcsa.org.za(a)).

2.4.3 Defining Green Building

There are a number of aspects involved in the concept of Green Building as a whole which are applied in defining this term. It is not only the practice of developing strategies, techniques, and construction products that are environmentally responsible, resource and energy efficient throughout the lifecycle of the building but also ensuring that it is comfortable and of high performance for the tenant. According to the Environmental Protection Agency, (UD) the reduction of the overall impact on human health and the natural environment is achieved through green buildings by an efficient use of energy, water, and other natural resources, the protection of the occupant's health and the improvement of employee productivity, and finally, by the reduction of waste, pollution and environmental degradation.

Thus, implemented in the correct manner Green Building is beneficial to human quality of life, overall environmental health, life cycle cost and sustainability. Moreover, green building in practice involves the improvement of both natural and built environments. This is

addressed within the construction process through correct design, procurement, site layout, energy consumption, the management of waste, and technology (Anonymous, 2006)

The following criteria have been established to define a Green Building: indoor environmental quality, indoor air quality, outdoor air quality, materials, innovations, water and energy. These factors and criteria will be introduced and discussed in further detail.

Indoor environmental quality (IEQ) refers to the quality of the air and environment within a building. IEQ is determined by pollutant concentrations and conditions that can affect the health, comfort and performance of occupants within an indoor built environment. IEQ includes artificial lighting, natural lighting and thermal comfort but generally refers to air quality (Van Wyk, 2009). The facilitation of this concept is only possible through quality design, construction, maintenance and the supply of sufficient ventilation levels of outdoor air to guarantee indoor air quality on an everyday basis (WBDG Sustainable Committee, 2009). A green building must incorporate, as part of the definition, the provision of a healthy and comfortable working environment for all occupants which consequently results in enhanced productivity. There are numerous health, comfort and productivity dynamics that constitute a green indoor environment.

Besides the indoor air quality and the thermal comfort, sufficient natural lighting and pollutant-free water will add to the individual's productivity. An acceptable noise level and a controlled noise pollution round this environment off to a productive and healthy living arrangement.

Indoor air quality (IAQ) refers to air quality within a building or structure with regards to the health and comfort of the building occupants (Van Wyk, 2009). Within this section, the mission of a green building is the improvement of IAQ which can be defined as the absence of air pollutants within a building. IAQ is negatively affected by common pollutants and contaminants such as mould or bacteria, chemicals such as carbon monoxide and radon, allergens, volatile organic compounds (VOCs), legionella and any other mass or energy stressor which are detrimental to the health of inhabitants of a building or structure (Van Wyk, 2009).

The ventilation of outdoor air throughout a building is critical for human health as well as the productivity of its occupants since outdoor air is often considered less polluted than indoor

air. Therefore the correct airflow rate and outdoor air percentage (OA %) must be accurately calculated (Dols, Persily and Nabinger, 1996).

Green Building can be classified as an innovation that involves a change in thought process or a revolutionary change in thinking to integrate a new concept within the industry. (Van Wyk, 2009). Green design innovations can be categorised into two divisions, namely architectural and non- architectural designs (latimesblogs.latimes.com). Site planning, downsizing the house, informal floor plans and landscaping for example are considered architectural innovations. While site planning means that the arrangement of rooms can substantially assist the cooling and heating of a house as well as the comfort of individuals, downsizing the house in general means that smaller houses require less energy and therefore have less impact on the environment. Furthermore, informal floor plans tend to have rooms with multiple uses. This reduces energy costs since as rooms are not dedicated to one specific use. And finally, landscaping refers to the fact that heat gain can be drastically reduced by planting and positioning tress correctly (latimesblogs.latimes.com).

Non-Architectural innovations on the other hand include hyper-efficient heating/cooling systems with ground-source heat pumps which involve systems that use the earth as a heat sink and as a heat source. Low-emissivity glass can be used in double-glazed panes with or without argon gas and pre-engineered wood structural components are most efficient for construction. Photovoltaic systems make the most use of the sun's omnipresent energy. Overall it is suggested to use more durable materials that will last longer, require less maintenance and are efficiently recyclable (latimesblogs.latimes.com)

Building Information Modelling (BIM) is arguably the most important factor within the innovation of green design. The BIM, also known as Building Product Model is employed to document a building design as well as to promote the construction and function of a new capital facility through utilising a complex computer software model (Van Wyk, 2009). This is used to analyse the design and life-cycle of a building in order to optimise energy efficiency, sustainability and overall green functioning.

Although global warming and energy consumption are extremely serious concerns for governments, industries and individuals it could be humankind's continual need for water that may ultimately prohibit the development of humanity and global economies (Kibert, 1999).

As potable water is becoming an increasingly scarce commodity, green buildings are used to reduce the consumption and pollution of this resource by enabling buildings to be self-reliant with regard to water needs. This is achieved through the use of systems such as rainwater harvesting and ecological sanitation systems in the aid of minimising the polluting of water (Van Wyk, 2009). Water conservation regarding building products involves conserving or even eliminating the use of water for their operation. In addition, these building products are evaluated against an established criterion to ensure the specified standard is met (Glavinich, 2008). Water conservation is given much higher priority in drought-stricken countries than in South Africa where water is often taken for granted. Without the change in mindset of South African built environment professionals, as well as the general public, water will be vastly depleted, becoming a far more scarce resource than it already is. A substantial amount of independent studies have confirmed that a building certified by a green building council in which ever region will consume sixty percent (60%) less potable water throughout the building as compared to a non-certified building (worldgbc.org).

Water systems within green buildings are designed as efficiently and ergonomically as possible and are characterised according to Van Wyk (2009) as self-sufficient. That means rainwater harvesting is utilised to meet almost all the water needs for a Green Building. Furthermore, Green Buildings are determined by the quality. Therefore the highest quality water is used for drinking and the poorest, such as grey water, for irrigation. Overall, the aim of a Green Building is to absorb water and to ensure that water run-off is minimised, which Van Wyk (2009) calls Onsite Retention. Finally, the Evaporation of water and transpiration from plants is used to enhance comfort levels in place of mechanical systems by cooling the air.

Finally, the energy consumption of a building is a crucial factor in determining to what degree a building is green. Energy efficiency is fundamental within any Green Building.

Products that are classified as energy efficient must be certified and must meet a specific standard pertaining to the design of these products, including building appliances as well as equipment. The energy star program, which is managed in conjunction by the U.S. Environmental Protection Agency and the U.S. Department of Energy, is one illustration of an energy-efficiency program that is administered for the design and construction of green buildings. This program as well as the Australian system adopted by the Green Building

Council of South African (GBCSA), is designed to enforce the use of energy efficient products in practice to protect the environment (Glavinich, 2008).

The GBCSA makes use of the rating tool Office V1 to evaluate these concepts and systems, which is categorised into defined sections and furthermore into sub-sections to correctly evaluate each aspect of the criteria for classification of a green building. Two different certifications are awarded through the same tool: Green Star SA - *Design* at the end of the design phase of the project and Green Star SA - *As Built*, following construction completion. The weighting of each section varies from the most points available being twenty-eight (28) within the indoor air quality category to the least amount available within the category innovation being five (5) points. The sections and sub-sections used to assess how green a building is consist of nine (9) categories which are as follows: management, indoor environmental quality, energy, transport, water, materials, emissions, land use and ecology, and Innovation (gbcsa.org.za(b)).

Once a Building has been assessed against the criteria for measuring the primary concepts and systems, a rating of zero to six is attained based on a one hundred (100) point scale which is determined and certified by the Green Building Council of South Africa (GBCSA). This certification only applies to a building that achieves a four, five or six star level (gbcsa.org.za(b)). Furthermore, the GBCSA administers the certification process which enables a project to qualify as a Green Star SA certified project through the following thresholds:

One star rated buildings achieved a score of ten points which represents a status of *minimum practice*. Two star rated buildings achieved a score of twenty points which represents a status of *average practice*. A score of thirty points represents *good practice*, forty five points *best practice*. Five stars or a score of sixty represents *South Africa excellence*. And the highest level, a six star rating and a score of seventy five represents *world leadership* (Van Wyk, 2009).

The overall energy efficiency of industrial or mining economies such as South Africa's is extremely poor as a result of the large number of stages for production and the inefficiency of each specific stage (Kibert, 1999). The most efficient and economic method to solve the energy crisis is to reduce the energy required, not to increase energy generation as it is often perceived. Great opportunity lies within designing solutions that intelligently respond to

location and climate. This can be achieved through passive energy strategies such as natural cooling and heating or, by creating the building envelope as efficient as possible, by effectively addressing unwanted heat transfer from radiation, convection or conduction within a building or structure. In addition, energy consumption of a particular building can be reduced radically if correctly designed regarding location and climate. In South Africa, that means ensuring a building is orientated correctly can save up to forty percent (40%) of the total energy consumption.

According to research done by the National Renewable Energy Lab (2006), the solar energy that reaches the earth's surface each and every day is greater than the amount of energy needed to power the needs of the planet for twenty seven years. Furthermore, solar energy is the sole source of energy income the earth receives without production. Wind, tidal, and biomass energy are all formed from solar energy and thus can be used in conjunction with energy efficient measures to reduce the cost of the remaining energy that must be supplied (Anonymous, 2006). Additionally, the use of renewable energy and solar energy through products such as photovoltaic systems can save costs of heating, cooling, and ventilation by as much as forty percent (40%).

2.4.4 Barriers and Resistance to Green Building

Each generation of people has its own personality characteristics which have been shaped by historical events such as wars, impacts from biological ageing, and historical circumstances that each generation has been brought through. Wilton (2010) classifies people into four diverse generation categories:

The Silent Generation which includes all born between 1909 and 1945; The Baby Boomers Generation – Born during the years 1945 and 1964; Generation X - Born between the years 1965 and 1980; The Millennial Generation which involves all born after 1980.

Wilton (2010) posits that the millennial generation, who possess traits of a new way of thinking, are more prone to be open to new movements as well as trust and embrace institutions as compared to Generation X and the Baby Boomers Generation at the same age in generational growth. This suggests that these latter two generations will have a natural resistance to new movements such as the Green Building concept as a result of the integral personality characteristics.

According to O'Donnell (1985) the concern and focus of the generation between ages forty and sixty moves to others, namely family, society and notably, future generations. Therefore, with this in mind, these defined older generations have a moral obligation to change their mindset that is accountable for a resistance to the Green Building movement in order ensure that the future of generations to come is not a bleak one.

Based on studies done by Hoffman and Henn (2008) in the U.S this study argues that the resistance to environmental progress by key role players of the older generation within the built environment will continue in South Africa if the significant social, psychological and economic barriers are not addressed at large. The barriers must be surveyed and addressed on an institutional, organisational and individual level.

On an institutional level it can be argued that it provides a far reaching influence on the implementation of sustainable construction. Institutions present technical, legislative and social restraints which affect individual and organisational perspectives as well as the adoption of green principles in practice. Additionally they can influence on Green Building on in terms of regulative aspects, normative aspects and cognitive aspects. Regulative Aspects can be considered legal influences in the form of regulations which organizations and individuals must comply with. Normative Aspects are aspects regarding social concepts, where organisations must comply with certain standards on a moral or ethical basis. And finally, cognitive aspects refer to beliefs and customs the individuals and organisation will adhere to without conscious thought (Hoffman and Henn, 2008).

On an individual level, there are a variety of cognitive biases that result in a resistance to the green building movement. Be it consciously or subconsciously, individuals resist because of over discounting the future, egocentrism, positive illusions, presumed associations and environmental literacy. Of these examples, two of the most crucial aspects, which are over discounting the future and environmental literacy, will be introduced shortly.

The resistance to making intelligent long-term decisions regarding energy efficiency is a result over discounting the future. That means people are using unrealistic discount rates on future energy consumption behaviour as well as the inability to calculate correctly to make an informed decision based on long- term payback periods. According to Toci and Rakwena (2009) a green building will result in a total saving of approximately two hundred and forty Rand per square meter a year in the long term, but because the initial payment for energy

efficient products is higher than that of standard products people base consumption behaviour on this without informed calculation.

The lack of environmental literacy and awareness by individuals in the built environment is a key factor in the integration of green building in South Africa. What is worse, it turns out that a large group of people are purposefully resistant to becoming aware of environmental issues, and would rather not know about these significant problems. According to Toci and Rakwena (2009) the older generation lack the most awareness and often simply do not want to know about it.

According to Hoffmann and Henn (2008), the resistance to Green Building is not only affected by individual biases but also by the organisations that these individuals work for, such as architectural firms or international institutions. Moreover, information regarding the viability and importance of green construction is filtered through the organisation resulting in decisions based on subjective organisational goals and routines. The structure of an organisation defines its boundaries, interaction regulations and individual's responsibilities which all affect objective decision making meaning that both the problems and the solutions are inevitably multifaceted.

With regards to the individual and organisational level, habitual routine seems to be one of the grounding factors that affect the adoption of Green concepts in South Africa. The older generation, through repetitive behaviour, has established routines that are familiar, safe, comfortable and predictably reliable. However, these routines are mostly inefficient concerning long-term objectives on sustainable development on account of a continued resistance. Moreover, these habitual routines mean that professionals often cannot and do not want to invest in the learning process as it will affect an already established activity that is critical to the individual's work function (Hoffman and Henn, 2008). This is also referred to as the fear of the unknown. This is highlighted in the fact that adding non- traditional technologies increases the risk an organisation must bear, resulting in management professionals naturally resisting the adoption of these technologies (Hoffman and Henn, 2008). As it has been proved by Wilton (2010) that members of the older generations have difficulty trusting in change, it is understandable that there will be a resistance to the Green Building movement by these generations.

Also Landman (1999) concludes that the most significant barrier to sustainable development is to be found on an individual level and in the lack of expressed interest from clients, owners, developers and the target market. A building project cannot be started and then concluded effectively without the full support of the developer or owner. Thus, the clients' lack of concern and indifference clearly is a crucial reason for projects not being designed and built in a green manner. Less than ten percent (10%) of all clients request to build in an environmentally sustainable manner. Furthermore, when built environment professionals presented Green designs for the construction of a building, fewer than thirty percent of the clients within the target market accepted the designs (Landman, 1999). The resistance from clients to the green building movement goes hand in hand with the inexperience, unawareness and lack of interest each individual possesses regarding the topic.

One of facts that are mostly unknown regarding a green building is the costs. It is a complex and often misunderstood subject as various factors must be taken into account. The initial expenditure for going green is almost always the leading concern for the consumer and is a formidable barrier to any form of Green construction or design. The cost of a Green Building is an integrated approach that considers economic benefits of a green project in relation to the initial overall cost. Initial costs must be evaluated against future yields on the building as well as long term operating costs. A study conveyed by the World Business Council for Sustainable Development (2007) posits that consumers have formed a barrier to Green Construction through the misconception by overestimating green costs by three hundred percent (300%). Moreover, this survey revealed that respondents estimated the additional cost of building green at seventeen percent (17%) greater than that of conventional methods which is more than three times the true cost difference of five percent (5%). That means there is an additional capital expenditure of approximately five percent (5%) when constructing a green building. But since a green building will reduce energy consumption, employee absenteeism and enhance employee productivity it will result in a significant monetary saving per square meter every year (Toci and Rakwena, 2009). However, the initial payment for energy efficient products will be one of the major barriers for consumers in the Green Building market. This is because people's consumption behaviour is based on the initial capital outlay without informed calculation of the future benefits.

Overall, the attitudes of consumers within the Green market are categorised into five divisions thus determining each target market (Burall, 1991). Sixteen percent (16%) are considered

activists. This group is categorised as relatively upmarket, aware of the green movement, optimistic that the use of technology will be beneficial and concerned about environmental well-being over growth. Thirty-four percent (34%) are thought to be realists. This division is categorised as the average market or middle class. They are concerned with issues on the environment but perceive a conflict between profit motive and going green. They are pessimistic with regards to resolution. Another twenty-eight percent (26%) are classified as upmarket. They lack knowledge and believe that the rest of society will eradicate all the problems. They are called complacent. Twenty-two percent are simply alienateds. That means they are uneducated, have a limited understanding and awareness of green building. A large amount of subsequent worry results in an overpowering sense of desolation. They can be considered the downmarket (Burall, 1991).

To market green building successfully governments, organisations and individuals must take these divisions into account. The method of marketing must also be determined according to the various generations. As each generation portrays specific characteristics the marketing technique must be adapted for every generation.

2.4.5 Green Building and Job Creation

With growing issues such as resource depletion, rapid urbanization, climate change and global warming there is a clear need to change the way people travel, produce and consume energy, heat and cool buildings, utilise water and construct buildings. Ultimately the overall behaviour of the human race must change. With all these changes as a necessity for the future of the planet, a significant number of people will be required to facilitate these changes and therefore a large amount of jobs will be created (Van Wyk, 2009).

However, for this to happen effectively there is a need for strong global leaders to establish the use of sustainable development that can stabilise climate change, use less water, preserve more land and also greatly stimulate economic growth. In 2008 Barack Obama stated at the G-20 summit that the creation of green jobs is one of the highest priorities in the US government and that one million existing homes will be retrofitted every year (Van Wyk, 2009). This will contribute to the growth of the green sector which is already rapidly expanding in the US. It is considered a billion dollar industry which includes sustainable power generation, clean energy vehicles and green buildings amongst numerous other green categories (EPA, U.D.). Moreover, such an industry protects the environment and creates

local job opportunities which cannot be outsourced from abroad, an invaluable economic and social advantage in a globalizing world. The United Nations Environmental Programme (UNEP) has determined that the market value of the green industry technology will be approximately 1.9 trillion dollars by the year 2020 (unep.org). What's more, numerous studies suggest that this is just the proverbial tip of the iceberg and the green industry should become one of the largest in the world. The worldwide investment has resulted in a substantial increase in jobs and in 2006 it was determined that approximately 2.3 million people across the planet had jobs directly resulting from the sustainable energy sector (Van Wyk, 2009). The investment in Africa's clean energy grew fivefold in 2007 to 1.3 billion dollars. Furthermore, in South Africa the forecast investment in green home improvement is R197 billion rand for the period 2008-2015, creating approximately 837 750 new jobs. It must be noted that this only accounts for the residential sector while the largest potential for sustainable building lies within the non-residential sector. It is clear that in South Africa, a country that has vast unemployment issues, the green industry will certainly hugely benefit the country economically, socially and environmentally.

2.4.6 Summary to Green Building

Although the built environment is one of the largest contributors to the emissions of greenhouses gases, little attention has been received from international protocol. For example, the Kyoto protocol has simply overlooked the building sector by focusing on industry and transport. It must be noted that the reduction of the negative effects by a nominal percentage will not eradicate or solve the world's environmental crises, but by becoming standard practice it will make a substantial contribution. Within South Africa, environmentally sound building is of particular importance as a green building will reduce energy consumption by up to seventy percent (70%) (Nisbet, 2009). In a country where millions of people still live without electricity and the bulk of the available electricity is from coal, sustainable building is the most efficient way people can live an innocuous and sustainable life where communities can effectively co-exist with each other as well as nature. Furthermore, sustainable building is formed on an integrative perspective of the natural environment and the built environment which is closely responsible for the vitality of individuals, organisations and businesses (Nisbet, 2009). By identifying social and psychological barriers to green building one can influence the change that is necessary concerning the adoption and implementation of the concept within South Africa. Through identifying these barriers and enforcing the correct

standards and rating systems it can be ensured that green building becomes mainstream in practice. This transformation cannot take place without fundamental structural changes in the built environment's organisational building systems, concurrent with adjustments to society's unconscious value system.

2.5 Conclusion

This chapter entailed a comprehensive examination on the three facets of this study individually, namely Building Procurement Systems, Client Satisfaction and Green Building. Further to this the integral relationship between these three knowledge areas was explored and revealed the extensive influence each of these facets have on each other. Within this process it was found that the choice of the building procurement system is a crucial strategic decision that is pivotal in achieving the client's objectives as well as client satisfaction and ultimately the overall success or failure of the project. As the client is key to why a building is constructed and how it is procured, it is evident that the extent to which building clients are satisfied has a far-reaching effect on the development of the built environment, including the Green Building sector.

The various categories of building procurement systems, from separated systems such as the Traditional Method all the way to integrated systems such as Design and Build were illustrated and then recommended for particular types of building projects. Within these realms integrated procurement systems were found to be the more appropriate types of systems for application on Green Building projects.

Green Buildings have become the built environment's major contribution the planet on a sustainable level and therefore are crucial in restraining the effects of climate change and urbanisation. However, the fact that the client is the crucial factor for the development of any building exemplifies that without a building system which ensures client satisfaction, innovative areas of development such as Green Building will continually be curbed.

Chapter 3: Research Methodology

3.1 Introduction

This chapter presents the processes by which research has been undertaken within this study. The various approaches to research are examined and applied. More specifically this chapter involves the methodology utilised to conduct the literature review, the questionnaires and the collection of data, as well as the analytical approaches applied in the evaluation of the gathered data. The research undertaken can be expressed as basic, objective research as it was focused on a specific issue: the level of client satisfaction achieved from different building procurement systems regarding Green Buildings. The research has been directed at determining the performance of these procurement methods with regards to client satisfaction as well as why and how it is varies. The data was obtained through the examination of existing literature and the use of questionnaires targeting client satisfaction of certain procurement systems in the Green Building industry of South Africa.

This was then used to explore several different areas. Namely; the existing level of client satisfaction in particular procurement systems; whether there is a relationship between building procurement systems and client satisfaction; if the type of building system utilised on a green building project affects the level of client satisfaction attained; how client satisfaction and dissatisfaction affects the implementation of Green Building as a whole in the South African construction industry and whether certain building procurement systems are more appropriate for Green Building projects than others. Furthermore, the literature and data analysed was used to determine the most and least appropriate procurement systems to utilise on the development of Green Buildings in South Africa.

3.2 Overview to the research

Within this study it was fundamental to determine and execute the correct method of research. By determining a suitable and effective methodology for research of the study, the most accurate results were established and formed into conclusions.

The descriptive survey method was utilised as it is recommended for research that requires a high level of observation through interviews and questionnaires. This study requires such a method in order to facilitate a means for in-depth exploration into the research objectives.

Furthermore, the research was conducted in two stages with the purpose of being able to clearly define the constructs of the research. The first stage involved a critical analysis of literature which gave clear insight into what should be incorporated in the questionnaire in stage two.

3.3 Types of research utilised within this study

In order to accurately assess any research conducted there must be a thorough understanding of the term and the correct types of research must be applied.

Two major schools of research methodology are classified and applied in this study, namely qualitative research methodologies, collecting data in the form of words and pictures, and quantitative research methodologies, collecting data in the form of numbers (Neuman, 2000). To determine whether qualitative research methodologies or quantitative research methodologies were most accurate in defining research findings and conclusions, the research question of the study was applied.

The qualitative research firstly involved focusing on events which occur in natural settings within the real world and secondly studying those events in complete depth. Qualitative research has been extremely important within this study as it allowed for greater insight into the participants knowledge and opinions. Furthermore, the questions were generally open-ended and less structured than that of quantitative research methods in order to determine a far more extensive understanding of the expertise of the sample. This also enabled deeper exploration of the relationship between building procurement systems, client satisfaction and Green Building in South Africa.

The Quantitative research within this study was founded with a problem statement and then entailed the formation of a hypothesis, a literature review, and a quantitative data analysis where the data was used as an objective approach of measuring reality. Furthermore, the research gathered was easily quantified numerically and was therefore used in a comparison of the existing theories presented within the literature chapters. These numerical values captured through the quantitative analysis have been interpreted and used to form a summary of these results.

Although qualitative and quantitative research are both effective methods of research, neither has been used exclusively for this study because it includes the analysis of numerical data as well as narrative data. Therefore, the mixed strategy approach is utilised as it integrated the quantitative and qualitative research methods of collecting accumulated data into a single research study. It effectively analysed literature, statistics and opinions on the client satisfaction of Green Building procurement systems.

3.4 Method of research presented

3.4.1 Background

A critical literature review was based on academia, journals, web information and archived records of particular building developments. This was utilised to develop the conceptual framework for the questionnaire which was distributed to members of the Green Building Council of South Africa (GBCSA). Primary research was used to establish whether there was a difference between the literature that has been published to date and the findings from the data analysis. This was particularly beneficial and noteworthy as the literature was predominantly from abroad. Therefore the data analysis was used in order accurately analyse the literature and present the findings for the South African context.

3.4.2 Research Strategy and Programme

The research throughout this dissertation involved a clear strategy, programme and process through the following:

- A literature review to determine the doctrine principles that govern procurement choice and what dynamics affect successful procurement.
- A literature review to investigate the factors that involve client satisfaction and how it is achieved within the built environment.
- A literature review to explore the factors that impact the application and implementation of Green Building.
- The Distribution of questionnaires amongst clients and professionals associated with the Green Building Council of South Africa to establish the relationship between procurement systems, client satisfaction and the implementation of Green Building within the South African context.

- Present and analyse the research findings
- Present conclusions and recommendations

Furthermore, throughout this process there are several overall stages that must take place. The first stage of the research involved clearly identifying the research question as well as defining the objectives of the study. A literature review covering these objectives was then undertaken in a systematic manner. Through the literature review sufficient knowledge on the topic was gained in order clearly form the constructs of the questionnaire. The questionnaire was utilised in order to gather quantitative and qualitative data. The data was analysed and used to form results and draw conclusions for the study.

3.4.3 Strategy for questionnaires

The questionnaire introduced the participants into the survey with an introductory block of questions and then continued by utilising two broad classes of questions, namely, open-ended and closed-ended questions. The open-ended questions were designed and phrased in a manner to allow a great deal of freedom to the respondents when presenting answers and did not constrain the respondent in any way. On the other hand closed-ended questions were utilized in order provide only categorical answers so that information could be gathered effectively and timeously. The five-point Likert scale is recommended by Nkado (1999) for measuring opinions and was therefore utilized in the questionnaires for this study for these types of questions. The questionnaires were formulated according to the steps Leedy and Ormrod (2005) present for developing any specific questionnaire. Therefore, following these guidelines the questionnaire was kept short and simple, without any ambiguous language. The questionnaire utilised simple drop down bars in Microsoft Word to make the questions easy for the respondent to answer. Moreover, the layout was attractive and professional with clear instructions from the onset of the survey. This strategy to formulating the questionnaire as well as the layout is clearly depicted graphically in Chapter 4.

3.4.4 Target Population

The target population consisted of clients and professionals in the building industry which had various levels of experience and knowledge on Green Building. This gave a thorough understanding on a wide spectrum of personnel. In order to form a definitive population useful to this study, questionnaires were targeted at members of the GBCSA, which included clients and professionals which have been and are involved in Green Building projects. This

allowed for the population to involve both individuals that have a definite interest in Green Building as well as individuals that have been directly involved in Green Building. The target population of professionals included architects, engineers, project managers, construction managers and quantity surveyors as this allows far greater understanding into the needs for successfully meeting the objectives of clients on Green Buildings.

3.5 Limitations

Within any study there are numerous limitations to what can be compiled. There were certain limitations during the course of this study which must be expressed.

The first limitation encountered within this study is that the literature available in the research area is predominantly only available from abroad. Although Green Building is a concept that is universal, the intricacy of how to apply the concept varies between countries. It was therefore a challenge to get a clear understanding of how to apply the literature within the South African context.

The next two limitations were quite generic as they involved geographical location and time. The study was limited to South Africa as it was determined that South Africa is a country that is in certain need of such a study and is the home location of the researcher. In order to complete the study there was naturally a time limit to carrying out all the necessary tasks.

As this study points out, South Africa is far behind many countries abroad with regards to Green Building development. This meant that there are only a relatively small number of Green Buildings that have been built in South Africa. Therefore there was a limited amount of information that could be drawn from Green Building projects as well as personnel that have experience on South African Green Building projects. This further meant that often individuals did not have a great deal of experience or knowledge of Green Building in practice.

These limitations not only gave the whole study a manageable framework to work within but also several clearly definable outcomes for application in the South African built environment.

3.6 Bias within the study

Within every study specific measures must be taken in order to minimise as far as possible the influence of bias. Bias is next to impossible to completely eliminate, however it must be managed closely as it may affect the integrity of the study. Clear processes must be defined and implemented to safeguard any distortion from bias within the study. There were many steps taken in order to minimize the bias in this study. The questionnaires clearly stated the topic and purpose of the study. This gave the participant an understanding of the study as well as created an interest in order to increase the response rate. The questions within the questionnaires were expressed as concisely as possible so to avoid any ambiguity which could lead to bias. Furthermore the questions were formulated in such a manner to allow for a free response from the participant that is not invoked towards a particular answer. The survey was aimed at a sample of individuals from the GBCSA from all backgrounds which meant there was no bias towards or against a particular group. Finally questionnaires were kept to a length that is designed to keep the attention of the participant in order to maximise the response rate.

3.7 Research ethics

As human subjects were involved in this study, the Wits Code for Research involving Human Subjects had to be adhered to and an ethical clearance was obtained from the department. The background and purpose to the study was clearly outlined to each and every participant within the questionnaire. Furthermore, it was explained how the data would be obtained, the importance of this and the manner in which the data would be utilised solely for the completion of a Masters dissertation. The participants were informed that all names and contact details would remain completely confidential, unless requested otherwise. The cover letter which accompanied the questionnaires invited the various individuals and companies to partake in the study, only with their consent. They had the option to withdraw at any time and also were allowed the opportunity to receive an electronic copy of the outcomes on request.

3.8 Conclusion to Research Methodology

The method of research applied is fundamental within any study. By determining a suitable and effective methodology for research of this study, the most accurate results were established and formed conclusions. As the complex nature of this study is apparent, various

strategies to research were applied which have been discussed in detail within this chapter. The mixed strategy approach to research was applied in order to utilise the benefits of quantitative and qualitative research which was accordingly necessary for this study to generate numerical and narrative data. This approach was used to effectively analyse literature, statistics and opinions on the client satisfaction of Green Building procurement systems. The analytical results from this research allowed the presentation of data by means of graphical analogies which were compared to the literature presented in this study. These graphical presentations are clearly depicted in the following chapter.

Chapter 4: Data Presentation and Analysis of Findings

This chapter presents a systematic analysis of the data captured and presents comprehensive findings and interpretations from this data. Furthermore the findings presented in this chapter demonstrate the link between the literature provided and the subject in practice.

4.1 Introduction

The analysis, through a formulated questionnaire, was submitted via email to five hundred and twenty six participants, all registered with the Green Building Council of South Africa. The questionnaire was sent directly to the email addresses of these Green Building Professionals. Every email was enabled with delivery and read receipts in order to allow for accurate quantification of the total number of questionnaires sent out and received by the individuals. The Green Building Council of South Africa was chosen as it has the most comprehensive database of personnel that have a large interest in Green Building development and are Green Building professionals.

The study period was conducted over five weeks, during which five hundred and twenty six questionnaires sent out via email. One hundred and seven individuals actually received the questionnaire via email, the remaining four hundred and nineteen bounced back immediately on account of spam blocking or invalid/outdated email addresses. Of this a total of forty six participants returned completed questionnaires, resulting in a return rate of nine percent (9%) from the entire population and a return rate of forty three percent (43%) from the individuals that actually received the questionnaire. The high rate of return from the individuals that received the questionnaire may be as a result of these individuals being particularly interested in the topic, being Green Building professionals, and that the questionnaire was formulated to be considerably simple to complete.

In order to improve the response rate, attempts were made on several fronts:

1. The design of the questionnaire itself in terms of layout and structure, incorporating where possible the convenience of closed questions.
2. The questionnaire was formulated in such a manner that when received via email it could be completed simply and timeously by means of a series of drop down answers and tick boxes for the closed questions.

3. A comprehensive covering letter identifying the subject to engage the intrinsic interest of the subject.

Each response that came back via email was allocated a name and entered into the email database in order to efficiently quantify the number of responses.

The second stage of the process involved formulating a numerical spreadsheet in Microsoft Excel where every possible response was assigned a unique number from each question. This is illustrated clearly in the table below.

Table 4.1: Numerical spreadsheet representation

Question NO.	Answer NO.	Ranking	Description
1	0		Male
1	1		Female
2	2		<22
2	3		22-25
2	4		26-30
2	5		31-40
2	6		41-50
2	7		51-60

This method was utilised in order to avoid any confusion and systematically quantify and analyse the data from each questionnaire.

Once this was completed, which involved assigning numbers 0 to 110 for each respective question, stage three comprised capturing the data of every questionnaire according to the numbers assigned from the above table for each possible answer. By applying this methodical process it enabled the following crucial statistical calculations to be determined for the data analysis:

- minimum score
- maximum score
- mean
- variance
- standard deviation
- standard distribution

- z-score
- correlation coefficient

These measures were used as they allowed for a comprehensive analysis of the data.

The table from which this data was calculated is illustrated as follows:

Table 4.2: Capturing answers for each questionnaire

Questionnaire number (participant)	Q1	Q2	Q3	Q4	Q5
Questionnaire 3	0	7	12	21	30
Questionnaire 4	0	6	11	21	23
Questionnaire 5	0	7	11	17	23
Questionnaire 6	0	8	15	19	30
Questionnaire 7	1	3	9	18	23
Questionnaire 8	0	6	13	20	30
Questionnaire 9	1	5	10	20	23
Questionnaire 10	1	6	12	19	23
Questionnaire 11	0	7	15	21	28

Inevitably there were questions that were more subjective which did not fit the closed answer questions. These classificatory questions provided open ended answers in certain areas such as Green Building knowledge; understanding of building procurement systems; and inclusive comprehension of client satisfaction. These open ended answers were of particular importance as they gave clear insight into the overall expertise of the sample, which gave further substance to the other answers given by the sample.

4.2 Method to analysis of data

Step 1) Avoid non-sampling errors:

Within the data the sample must give answers with a similar probability to that of the entire population. This is given through argumentation to justify why this sample and population was picked. However, through this argumentation it is obvious that non-sampling errors have been avoided as the population members are all green building professionals registered with the GBCSA and so are all the members of the sample.

Step 2) Avoid sampling errors:

This is performed solely through calculations in order to determine that the answers given were representative of the population and not a complete accident. This is calculated through the confidence interval and significance test. These tests must be performed on individual questions and the particular questions chosen to perform these tests on are determined through hypotheses from the literature review.

Step 2a)

The confidence interval is determined through the 95% confidence interval scale on each question chosen. Throughout this study the confidence level is standardised as ninety five percent (95%). This confidence level sets the limits of the actual confidence interval, and is most commonly set at ninety five percent (95%) in order to correspond with the five percent (5%) convention of statistical significance in the hypothesis testing (statsdirect.com). This forms the rationale for utilising the ninety five percent (95%) which means that there is a ninety five percent (95%) certainty level that the answers given are not by pure chance.

Step 2b)

The significance/variance test is utilised to determine the level of certainty that there is in fact one population for the chosen questions. If there is a large significance pointing towards more than one population this must be stated. This is done through the use of the Pearson coefficient test and the two sample t-test.

Step 3) The Pearson coefficient test

Step three involves the application of the Pearson co-efficient test to determine the relationship between certain questions for determining whether there is one overall sample and for objective cross-tabulation.

Step 4) The two sample t-test

The two sample t-test is utilised in order to further breakdown the sample into clients and the rest of the sample. This test is used to statistically and objectively express whether there is any significance within the answers given by these two data sets.

Step 5) The Chi-squared test

The Chi-squared test asks whether the observed proportions are significantly different to the expected proportions from non-interval scales. In this case the Chi-squared test was applied in order to determine if there is any significant difference between each of the various professions and what they find to be the most appropriate building procurement system for Green Building in South Africa as well as the least appropriate.

4.3 Data Analysis of Questionnaire

4.3.1 Background of Respondents

The respondents' most commonly came from the age group 31-40, with seventy five percent (75%) of the respondents greater than the age of thirty. Sixty five percent (65%) are male and thirty five (35%) are female. Of which thirty percent (30%) are Engineers, twenty two percent (22%) Architects, fifteen percent (15%) consultants, nine percent (9%) Quantity Surveyors, seven percent (7%) Construction or Project Managers and the remaining seventeen percent (17%) have other professional backgrounds. The sample is generally highly educated with thirty percent (30%) holding a master's degree and twenty six percent (26%) an honours degree.

4.3.2 Analysis of survey

Although the questionnaire comprised of a total of twenty five questions not every question was analysed in detail as this is not necessary. The following questions and graphs are crucial to the overall study in numerous ways and therefore are examined in greater detail to form valuable information, key findings and conclusions.

Background Questions

Question 2

Age

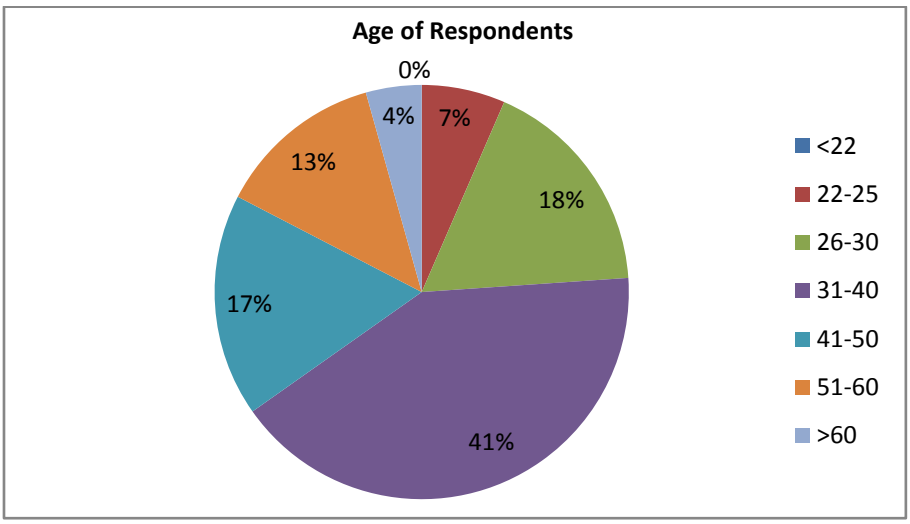


Figure 4.1: Respondents Age

This question was asked in order to determine which age group is predominantly involved in the Green Building professional environment and how this could affect factors such as choice and use of particular building procurement systems.

From figure 4.1 it can be seen that the age group thirty one to forty is the most represented age group within the South African Green Building Professionals industry and seventy five percent (75%) are greater than the age of 30.
As proved by Rose (2010) age is an important factor in the adoption of innovative methods of construction.

Habitual Routine: is one of the grounding factors that affect the adoption of the Green concept in South Africa with regards to age and the older generation. The older generation, through repetitive behaviour, have established routines that are familiar, safe, comfortable and predictably reliable. In addition, these routines are generally inefficient concerning long-term objectives on sustainable development on account of a continued resistance. Moreover, these habitual routines mean that professionals often cannot invest in the learning process as it will affect an already established activity that is critical to the individual's work function (Hoffman and Henn, 2008).

Fear of the unknown: is one of the driving forces behind the resistance to the green building movement as both internal and external change that cannot be predicted can negatively influence individuals within an organisation. Furthermore, adding non- traditional technologies increases the risk an organisation must bear with the result of management professionals naturally resisting the risk of adopting these technologies (Hoffman and Henn, 2008). As it has been proved by Wilton (2010) that members of the older generations have difficulty trusting in change, it is obvious that there will be a resistance to the adoption of alternative procurement systems by these generations. This can result in increased client dissatisfaction on account of incorrect procurement systems and therefore a subsequent lack of Green Building implementation across South Africa.

With all this in mind it can be put forward that certain age groups can have a substantial influence on the integration of any method of construction within the Green Building environment. As a large portion of this sample form part of the older generations it may be an integral factor in the choice of procurement system, however this should be studied in further detail.

Question 3

How many years experience do you have in the construction industry?

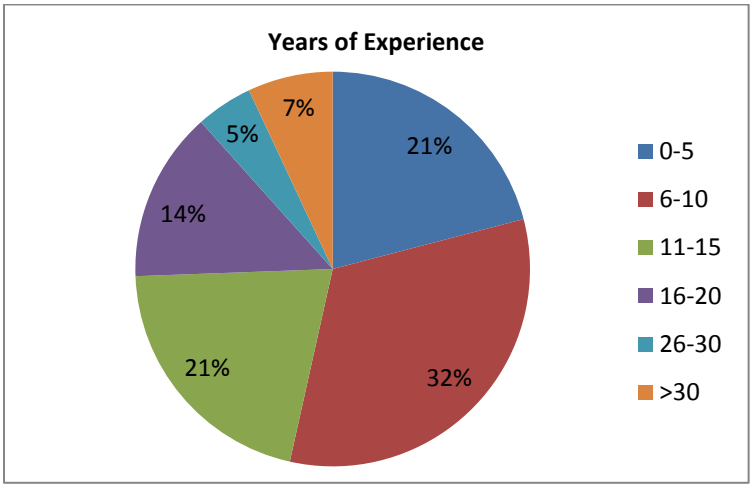


Figure 4.2: Respondents Experience in the Construction Industry

This question was asked to establish how long the participant has been exposed to the construction industry and whether this has an influence on the knowledge, awareness and understanding of Green Building, client satisfaction and procurement systems in practice. This additionally illustrates to a degree the expertise that the sample has acquired.

Figure 4.3 clearly illustrates that the category six to ten years work experience is the highest percentage, with a large majority having acquired more than ten years of work experience. Seventy percent (70%) of the sample have 15 years or less experience, leaving thirty percent (30%) with at least 16 years' experience in the construction industry. This gives a clear demographic of the sample.

Question 6

How would you describe your professional background?

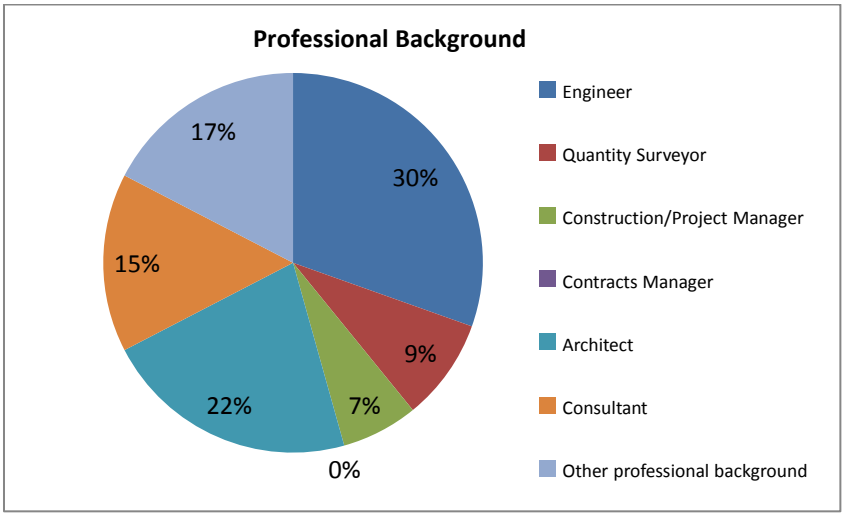


Figure 4.3: Professional Background

This question was used to determine which profession has the largest proportion of involvement as Green Building professionals in South Africa. Furthermore, certain professions may lend themselves more to certain building procurement systems and additionally influence the overall integration of Green Building.

Figure 4.3 illustrates that Engineers are the highest number of participants in the survey while architects comprised of twenty two percent (22%) of the sample. Through the use of the two sample t-test it was determined that there was no particular group of professionals that gave any significantly different answers compared to those of the other groups in the sample. This means that it is possible to determine whether certain types of professions lean toward a particular type of procurement system or whether the sample can be treated as one whole group that all agree on the most appropriate and least appropriate systems.

Roles in construction and Green Building

Question 7

How would you best describe your current role in the development and delivery of buildings?

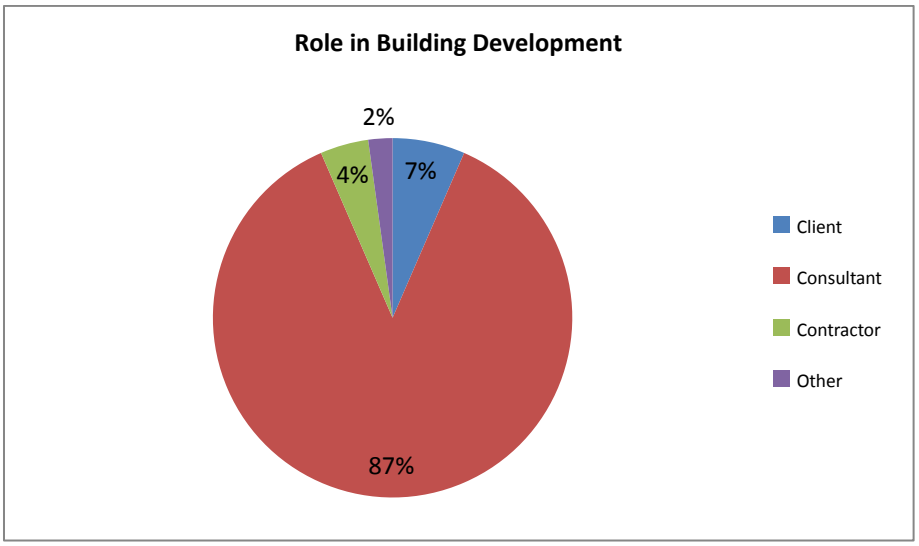


Figure 4.4: Role in building development

On the building development role, the clearest observation is the very high level of consultancy represented at eighty seven percent (87%) of the responses. This leads support to the idea of the construction industry as being closely aligned to the ideal of independent experts serving a lay clientele (Root, 1992). As these consultants are generally completely independent parties of the entire building development process, it results in a very segregated approach to a Green Building. This can cause issues as the development of a Green Building requires a collaborative approach to the process in order to have the greatest chance of meeting the buildings goals.

Question 14.1

If you have been involved in a Green Building project, in what role were you involved?

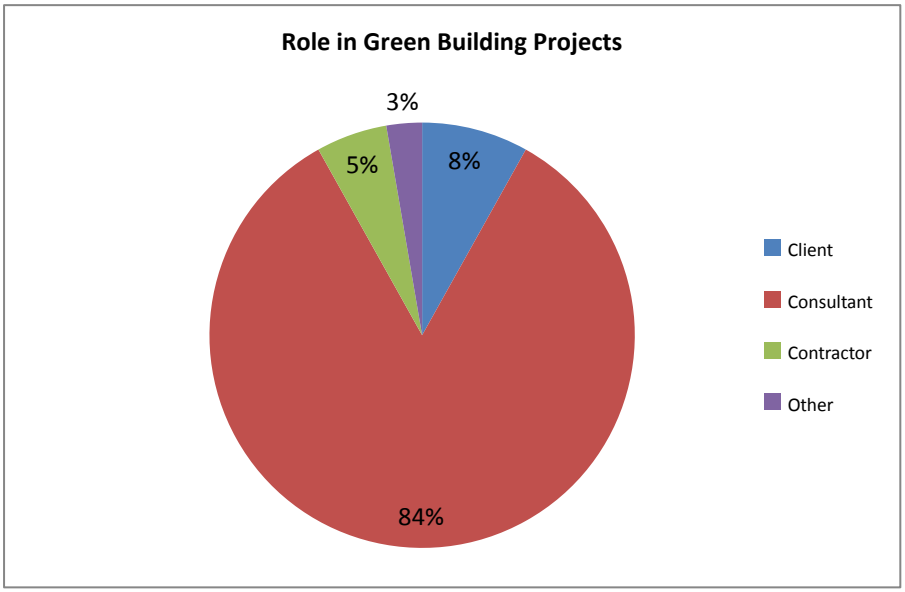


Figure 4.5: Role in Green Building

This question links considerably closely with that of the participants' role in the development of building. Again, the consultant is by far the most involved role at eight four percent (84%) of the sample. As these consultants are often independent individuals giving expert advice within the construction industry, they are no different in their approach to a Green Building which leads to a somewhat segregated process. This further exacerbates that these consultants have a far reaching effect on the procurement of a Green Building as well as the implementation of Green Building as a whole across South Africa. Therefore a large emphasis must be put on these Green Building consultants to understand the entire process and what the most appropriate method of procuring a Green Building is in order to achieve the key objectives of a Green Building. Without which client satisfaction will not be reached and the Green Building movement will be continually curbed.

Expertise of the sample

Question 4

What is the highest level of education that you have attained?

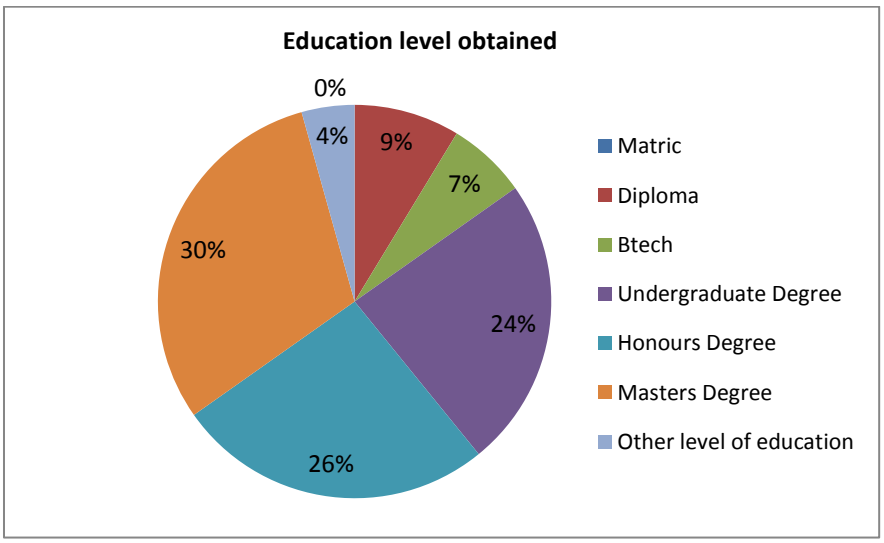
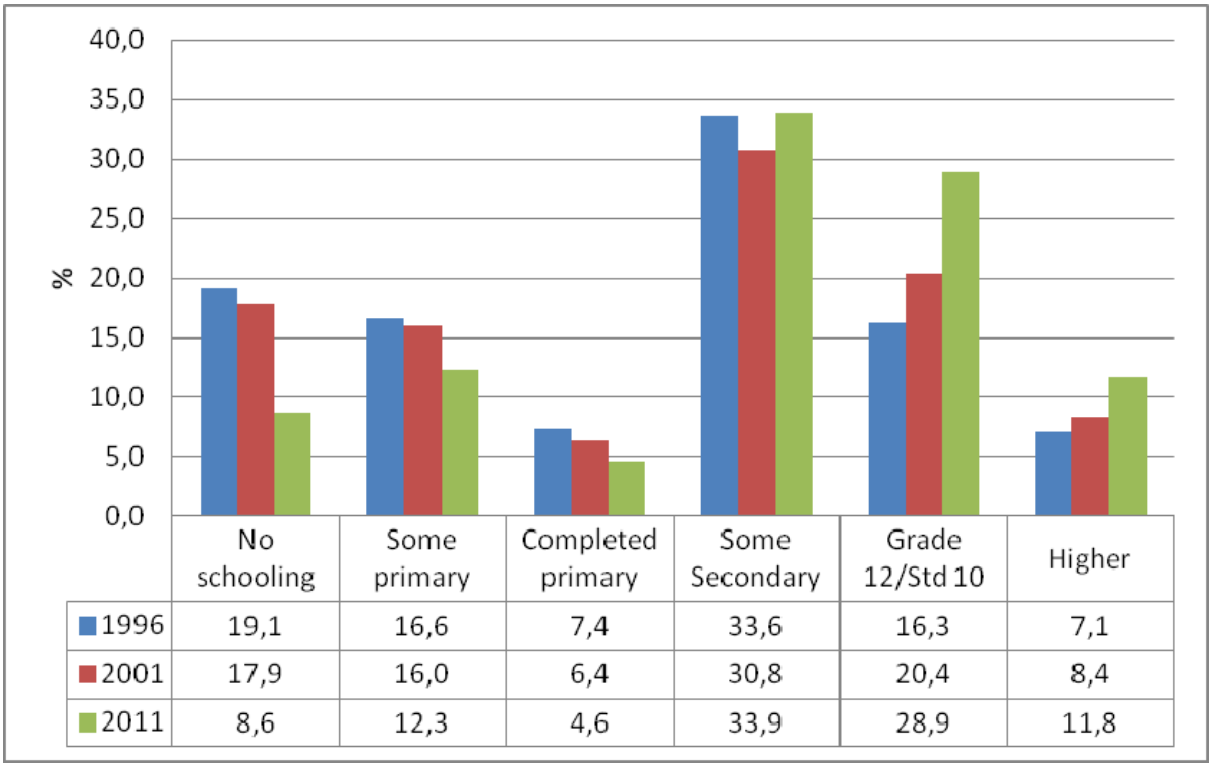


Figure 4.6: Highest level of education attained

This question was used to find out the level of education of the participants and whether this affects the type of answers given to questions such as, what is the most appropriate building procurement system to apply for Green Building in South Africa.

The majority of participants have obtained a master's degree at higher education representing thirty percent (30%) of the professions. Twenty six percent (26%) of the sample have acquired an honours degree and twenty four percent (24%) have obtained an undergraduate degree. This translates into eighty percent (80%) of the participants have an undergraduate, honours or master's degree which is particularly encouraging as this illustrates that the members involved within this sample as Green Building professionals in South Africa generally have a high level of education.

This data reinforces the expertise of this particular sample. This is clearly depicted by comparing the samples level of education versus that of South Africa as a whole. As the entire sample has an age of greater than 22 years it can be compared to the data compiled by StatsSA. The graph below shows the distribution of education within South Africa over 1996, 2001 and 2011.



	No schooling	Some primary	Completed primary	Some Secondary	Grade 12/Std 10	Higher
1996	19,1	16,6	7,4	33,6	16,3	7,1
2001	17,9	16,0	6,4	30,8	20,4	8,4
2011	8,6	12,3	4,6	33,9	28,9	11,8

Figure 4.7: Percentage distribution of persons aged 20 years and older by level of education. (Source:http://www.statssa.gov.za/Publications/P03014/P030142011.pdf)

The year 2011 is the latest and therefore the most beneficial for comparison to the Green Building professional sample. From the graph it is determined that the majority of South Africans above the age of 20 in 2011 have some secondary education and 11,8% of the population have obtained a higher level of education. On the contrary, the majority of the sample of Green Building professionals acquired master's degree, while ninety six percent (96%) of the sample have obtained a higher level of education. This means that the sample is far more educated than the average South African and therefore gives greater credit to the answers given within this sample.

Question 11

Which of the following building procurement systems are you familiar with? You may choose more than one answer by checking the boxes.

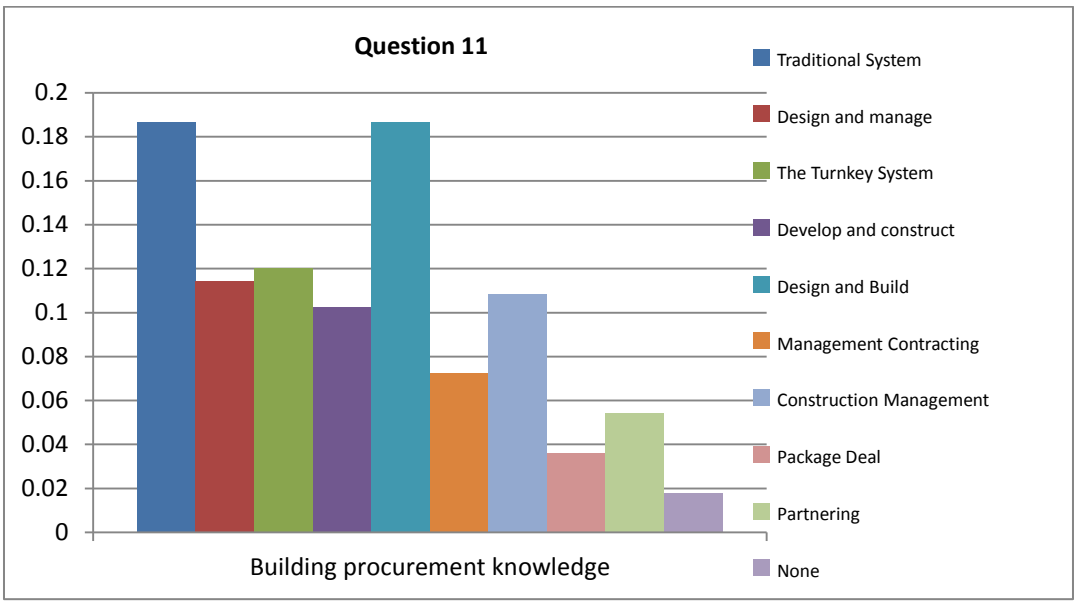


Figure 4.8: Knowledge of building procurement systems

This question forms a clear view of the expertise of the sample on the subject of the many various types of building procurement systems available. The participants were most familiar with the traditional system and the design and build system at nineteen percent each (19%). This information can be used in order to not only determine the participants' awareness of these building systems but also how this familiarity of certain systems affects understanding and furthermore application in practice. Careful consideration must be taken here with regards to habitual routine and fear of the unknown, as these factors link closely to familiarity or past knowledge and ultimately the application of a certain building procurement systems in practice. If a particular procurement method is applied simply out of familiarity, often the system that is far from most appropriate will be applied. This further increases the risk of client dissatisfaction and therefore the adoption of Green Building across South Africa will be negatively affected.

Question 14

How many Green Buildings have you been involved in?

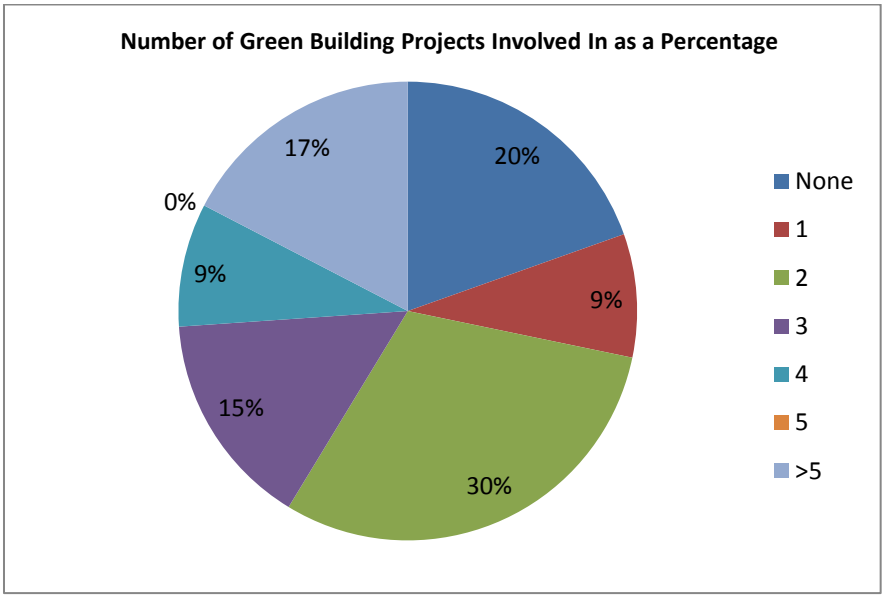


Figure 4.9: Number of Green Buildings involved in

This question was asked in order to determine the actual number of Green Buildings that Green Building professionals have experience on. This further illustrates the expertise or lack of expertise from these professionals within practical Green Building in South Africa.

The sample depicts a relatively high level of practical experience on Green Buildings across South Africa as eighty percent (80%) of the sample have been involved in the development of at least one Green Building. This gives further credit worthiness to the answers given by the sample regarding Green Building in practice. Forty one (41%) percent have been involved in at least three Green Buildings and seventeen percent (17%) have experience on greater than five South African Green Buildings.

This question is used further in cross-tabulation in order to determine whether the number of Green Buildings a particular individual had been involved in affected various answers given, for example the extent to which the individual agreed or disagreed that there is a link between the building procurement system utilised and client satisfaction.

4.3.3 Qualitative analysis

Question 8

What do you understand to be *sustainable development in an urban context?*

This question is part of the qualitative research in order to obtain a more holistic view on the expertise of the sample and subsequently aid in avoiding non-sampling errors. In order to succinctly analyse this qualitative information one must have a basis definition from which the sample answers can be examined. With this in mind throughout this study the overall concept of sustainable development has been defined as reducing the detrimental effect of construction activities and buildings on the environment. Glavinich (2008) further defined sustainable development with regards to building development on a social, economic and environmental level as-

Meeting the needs of the present without compromising the ability of future generations to meet their own needs.

The majority of the sample showed an in depth knowledge, giving answers that not only focused on environmentally friendly building but also on the all-inclusive nature of sustainable development. The participants often emphasised the central role of Green Building within the concept and then elaborated on how this method of construction is integrated with other forms of infrastructure. One such participant stated:

Sustainable development is the efficient use of existing natural resources without impacting negatively on the environment with a key focus on energy efficiency through green building principles. This includes transportation and infrastructure.

Another participant took the concept and understanding of sustainable development further, stating that sustainable development is:

development which is appropriate for its purpose and surroundings, serves a greater purpose than being just an isolated building serving its occupants. Procurement, design and construction are done with responsible consideration to the environment, the development's surroundings, the people who occupy the building and the space around it. Basically the 3 pillars of sustainability are: environment, human, financial.

Both of these answers concisely encapsulate the notion of sustainable development in the urban context, highlighting the thorough knowledge of the sample. However one participants' definition was of particular significance as it encompassed a great deal of the definition by Glavinich (2008). The participants' clear understanding of sustainable development was as follows:

Sustainable development is the development of urban environment that meets the needs of the present without compromising future generations. This development should be based on energy efficiency, resource preservation, renewable energy use, social equity, cost-effectiveness.

These three answers summarise the samples overall expertise within the field of sustainable development in an urban context. This therefore indicates that the answers given by the sample were in fact given on the basis of thorough knowledge and understanding.

Question 9

What do you understand by the term *Green Building?*

Further to that of sustainable development it was imperative to clearly determine the knowledge of the sample regarding a key subject within the study's hypothesis- that of Green Building. This qualitative information reveals greater value to the answers given by the sample throughout this data analysis.

The respondents' technical understanding of Green Building was particularly comprehensive which is most likely on account of the entire sample being Green Building professionals. This technical understanding of the term Green Building was emphasised by the following answer given by a participant:

Green Building is implementing environmentally responsible as well as energy and resource-efficient principles throughout the various stages of the life cycle of a building.

This answer has numerous elements of one Green Building definition utilised within this dissertation, whereby Glavinich (2008) defines a Green Building as

A building that provides the specified building performance requirements while minimising disturbance to and improving the functioning of local, regional, and global ecosystems both during and after its construction and specified service life.

Along these lines the understanding by the sample is given through the following statement:

'green' generally refers only to the environmental aspect of sustainability, e.g. energy efficient, water efficient, responsible procurement of materials (and labour) and good design principles.

These answers summarise the overall technical understanding of the sample. However, when looking at the term Green Building it is often essential to encompass more than merely the technical aspects of the concept.

One definition that does this states:

A green building is a building which is energy efficient, resource efficient and environmentally responsible- which incorporates design, construction and operational practices that significantly reduce or eliminate its negative impact on the environment and its occupants. Building green is an opportunity to use resources efficiently and address climate change while creating healthier and more productive environments for people to live and work in

(http://www.gbcsa.org.za/about/about.php).

The general sample focused on the technical aspects of the term Green Building, however one participant had a more holistic view on Green Building:

Green Building is building which is energy and resource efficient, environmentally and socially responsible, economically sustainable, which incorporates design, construction and operational practices that significantly reduce its negative impact on the environment and enhance the well-being of its occupants.

The answers given by the sample indicate a clear understanding of the technical aspects of Green Building and therefore illustrate the level of expertise within this sample, supporting the avoidance of non-sampling errors.

Question 10

What do you understand by the term *building procurement systems*?

As it has been ascertained that the building strategy utilised on a particular project is a defining factor in its overall success it is important to determine the knowledge of this concept in practice. Procurement as an activity within the construction industry has come to mean the tendering and systems required to develop and obtain a building. A common definition of building procurement has been identified as

The organisational structure adopted by the client for the management of the design and construction of a building project.

(Turner, 1990:3)

This definition can be compared to the various answers given by the sample of South African Green Building professionals in order to obtain a clear view on the overall expertise. Although the sample had quite sufficient knowledge on sustainable development and Green Building, the understanding of building procurement systems sometimes lacked in certain areas. One participant recognised building procurement to be the *Systems in place that used to purchase and source building materials, electrical and mechanical systems and building fittings.*

Despite this type of answer the majority of the sample did have a general understanding of the term building procurement systems. This level of expertise is illustrated in the following response: *The term describes the organisational elements that are necessary to design, construct and manage a building project.*

Another common response illustrated greater knowledge, whereby certain procurement systems were given mention to. One such response was as follows:

These are systems that should be followed in order to realise the building, e.g. the process by the client to determine the type of building he requires, through tender/quotation procedures and construction to maintenance appointments etc. Different procurement systems may be design and build, turnkey, etc.

Although in select cases the understanding on this topic was limited, the overall sample did in fact show a general understanding of building procurement systems. This does bode well for the answers given, however a greater knowledge should be obtained in order to successfully recognise which procurement system to apply on certain projects and how to use that particular system most effectively.

4.3.4 Rationale for Data analysis.

Determining the number of samples in the study

In chapter one of this study it was set out that the hypothesis and research question were determined to be as follows:

Hypothesis

The procurement system applied on a Green Building has an effect on client satisfaction.

Incorrect building procurement systems have a negative effect on client satisfaction and therefore have a detrimental effect on Green Building implementation in South Africa.

Research Question

Does the procurement system applied on a Green Building have an effect on client satisfaction? How does the procurement system applied and client satisfaction affect the implementation of Green building in South Africa?

From this there are specific questions within the questionnaire that are of particular significance in proving the hypothesis and answering the research question. These questions were identified to be question 13, 18, 19 and 20.

In order to determine the number of samples within the data analysis these questions were utilised through the application of the Pearson coefficient test. This statistical test produces the correlation between variables. In this case the variables are particular questions and answers. This correlation is used in order to prove whether there is one sample throughout data analysis. This is determined by testing these questions against the basic background questions, being age, profession, number of Green Building projects and role on a Green Building project. A significant correlation of greater than 0.7 would prove more than one sample, while very low correlation of below 0.3 proves that there is only one sample. This is numerically illustrated as follows against question 13, 18, 19 and 20.

Question 13

In your opinion is there a link between the building procurement system utilised and client satisfaction?

CORRELATION TO AGE	**-0.08**
CORRELATION TO PROFESSION	**0.18**
CORRELATION TO NUMBER OF GREEN BUILDING PROJECTS	**0.14**
CORRELATION TO ROLE ON A GREEN BUILDING	**0.21**

Question 18

Please indicate to what extent you agree with the following statement: "The type of building system utilised on a green building project will affect the level of client satisfaction attained on that project".

CORRELATION TO AGE	**-0.17**
CORRELATION TO PROFESSION	**0.30**
CORRELATION TO NUMBER OF GREEN BUILDING PROJECTS	**0.25**
CORRELATION TO ROLE ON A GREEN BUILDING	**-0.02**

Question 19

Please indicate to what extent you agree with the following statement: "Client satisfaction/dissatisfaction affects the implementation of Green Building as a whole in the South African construction industry".

CORRELATION TO AGE	**-0.14**
CORRELATION TO PROFESSION	**0.07**
CORRELATION TO NUMBER OF GREEN BUILDING PROJECTS	**0.14**
CORRELATION TO ROLE ON A GREEN BUILDING	**-0.21**

Question 20

Please indicate to what extent you agree with the following statement: "Certain building procurement systems are more appropriate for Green Building projects than others".

CORRELATION TO AGE	**0.11**
CORRELATION TO PROFESSION	**0.23**
CORRELATION TO NUMBER OF GREEN BUILDING PROJECTS	**0.35**
CORRELATION TO ROLE ON A GREEN BUILDING	**0.02**

In summary what has been illustrated above for question 13, 18, 19 and 20, which are the most significant questions for the hypothesis and research question, clearly depicts no large correlation or difference of correlation that is of any significance. The Pearson coefficient scores range from -0.21 to +0.35, with no particular outliers. From this it can be determined that overall throughout this data analysis there is in fact one sample for analysis.

Determining one sample- Clients versus Others

A major share of this study involved the notion of client satisfaction and therefore it is important to determine whether there is any significant difference between the answers given by the clients and the answers given by the rest of the individuals. In order to determine this, a further test from the Pearson coefficient must be performed by utilising the two sample t-test.

The two-sample test is used to make inferences about populations from which samples are drawn. It must be noted that the particularly small sub-sample of clients can cause restrictions in the statistics calculated as there is a large difference in the size of the client sub-sample and the sub-sample of remaining respondents. This could mean that the two sample t-test may lack as an indicator for central tendency. However, the use of this technique is widespread in science, engineering and social sciences where it is applied in order to determine any differences in data sets (Williams, Sweeney and Anderson, 2006). By utilising the two sample t-test it has been determined that there is no difference of any significance between the clients' given answers and the rest of the sample.

In order to come to this conclusion the two sample t-test requires a null hypothesis and an alternative hypothesis. Therefore in this case the null hypothesis, (H0) = There is no difference between the answers given by the clients and the answers given by the rest of the individuals in the sample. On the contrary the alternative hypothesis, (Ha) = There is a difference between the answers given by the clients and the answers given by the rest of the individuals in the sample. Within statistics one cannot prove the null hypothesis – one can only *fail to reject* it.

The *level of significance* is used to find the *critical value* of the z statistic which determines the threshold for rejecting the null hypothesis to be $\alpha = 0.05$.

The level of significance is then compared with the p-value calculated. If the p-value is smaller than α, the sample contradicts the null hypothesis, and therefore H0 is rejected. (Williams, Sweeney and Anderson, 2006).

This test is again performed on the questions that are most crucial to the study's overall hypothesis and research question, these being question 13, 18, 19 and 20 within the questionnaire. The p-value from the two sample t- test, assuming unequal variances, for question 13 is 0.285. This illustrates that there is a 28.5 % probability that the difference in

means between the clients and the rest of the sample is by pure chance. This p-value is greater than the accepted significance level of 0.05 which means that the null hypothesis cannot be rejected. Therefore the null hypothesis is utilised stating that there is no difference between the answers given by the clients and the answers given by the rest of the individuals in the sample. For question 18 the p-value is calculated as 0.728, which is greater than the 0.05 threshold, resulting in the null hypothesis not being rejected again. The p-value for question 19 is 3.79521 x10-09. In this case the p-value is far less than the 0.05 level of significance level threshold. This means that null hypothesis is rejected from the statistics. However, when the question is analysed closer it becomes clear why the p-value is so low in this case. Question 19 asked the individuals to please indicate to what extent you agree with the following statement: "The type of building system utilised on a green building project will affect the level of client satisfaction attained on that project". Out of the three clients that answered this all three answered "Strongly Agree" to the statement. As one hundred percent (100%) of the clients gave the same answer it is evident that it is extremely difficult and unlikely for every single other participant within the sample to give the answer "Strongly Agree". In this case a statistical difference is likely and easily explained. Therefore, although the p-value rejects the null hypothesis statistically this value is not of particular importance when considering the circumstances in greater detail.

Question 20 was analysed and the p-value calculated as 0.0783. Once more this is greater than the level of significance threshold and therefore the null hypothesis is failed to be rejected.

In conclusion, through the two sample t-test as well as further observation it is evident that the null hypothesis (H0) cannot be rejected. Therefore, in this case the study will stay with the null hypothesis. With this in mind it depicts that there is no difference statistically significant enough to separate the clients and the rest of the sample. Therefore, it is concluded that there is certainly one sample.

Crucial questions to the research question and hypothesis

Question 13

In your opinion is there a link between the building procurement system utilised and client satisfaction?

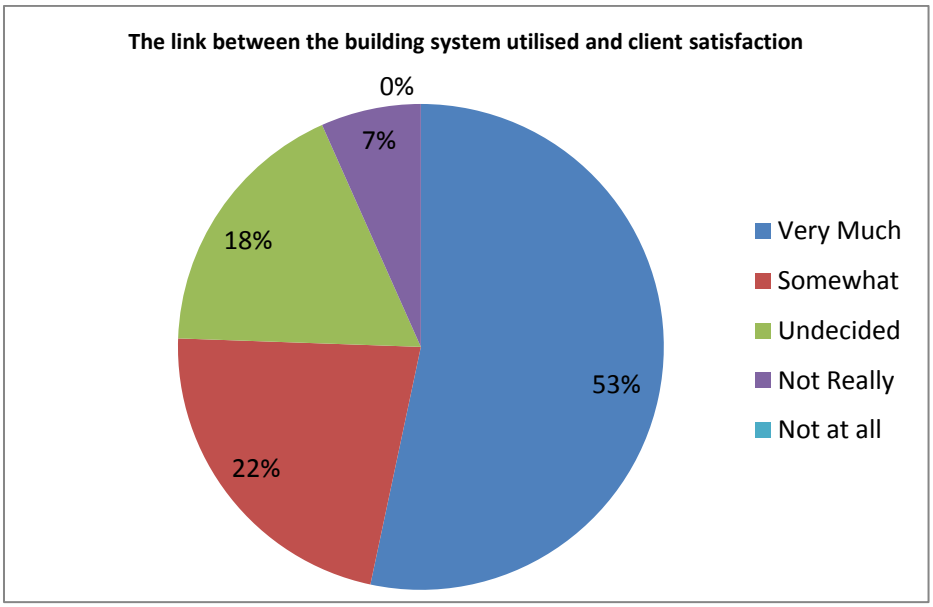


Figure 4.10: Link between building system utilised and client satisfaction

As this question was of particular significance for the hypothesis statistical calculations were performed for descriptive statistics. The minimum score for this question is 52, the maximum is 55 and the mean is determined to be 52.78. The variance from the mean is calculated as 0.95 and the standard deviation as 0.97.

The question was asked in order to accurately determine how the relationship between building procurement systems and client satisfaction in theory compares to this relationship in actual practice. Through the literature it has been established that there is a strong and vital relationship between the building procurement systems utilised and client satisfaction. In fact Kwakye (1991) established the choice of procurement system to be the defining factor for a client's needs being met and ultimately overall client satisfaction. Although this was discovered in literature, this notion must be tested in practice for the South African context. Therefore, this question revealed the degree to which the answers given by the professionals in practice supported the literature.

The vast majority answered that there certainly is a relationship in practice throughout South Africa between the building procurement system and client satisfaction. Fifty three percent (53%) of the sample answered that there is very much a relationship between the building procurement system utilised and client satisfaction. Not one participant answered that there is no relationship at all. This is particularly noteworthy as the answers given by the Green Building professionals certainly support what has been discovered in literature. With this in mind it is imperative to utilise the most appropriate building procurement system on a South African Green Building.

Question 18

Please indicate to what extent you agree with the following statement: "The type of building system utilised on a green building project will affect the level of client satisfaction attained on that project".

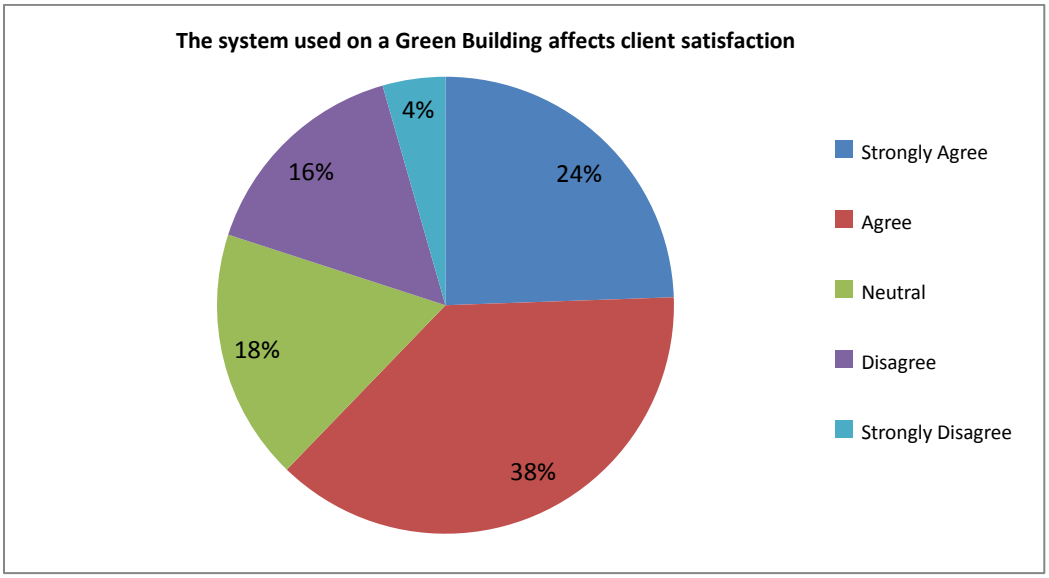


Figure 4.11: System used on a Green Building affects client satisfaction

The statistical calculations performed on this question illustrate that the minimum is 96, the maximum is 100 and the mean is 97.38. The variance is calculated as 1.33 and the standard deviation 1.15.

Figure 4.11 illustrates that a significant majority, sixty two percent (62%) of the sample, either strongly agree or agree that the type of building system utilised on a green building project will affect the level of client satisfaction attained on that project. This concurs with the literature and further answers the research questions as well as proves the hypothesis on a practical level. Of the sample only four percent (4%) strongly disagree with the statement.

This is particularly significant as it is evident that in South African practice it is paramount to implement the most fitting building procurement system on a Green Building project as it will directly affect overall client satisfaction. Therefore, once more the literature is supported in practice, illustrating that the appropriate building procurement system is key to achieving the goals of a project, without which client satisfaction cannot be reached. Furthermore, without sufficient levels of client satisfaction, innovative building methods such as Green Building will be continually curbed.

Question 19

Please indicate to what extent you agree with the following statement: "Client satisfaction/dissatisfaction affects the implementation of Green Building as a whole in the South African construction industry".

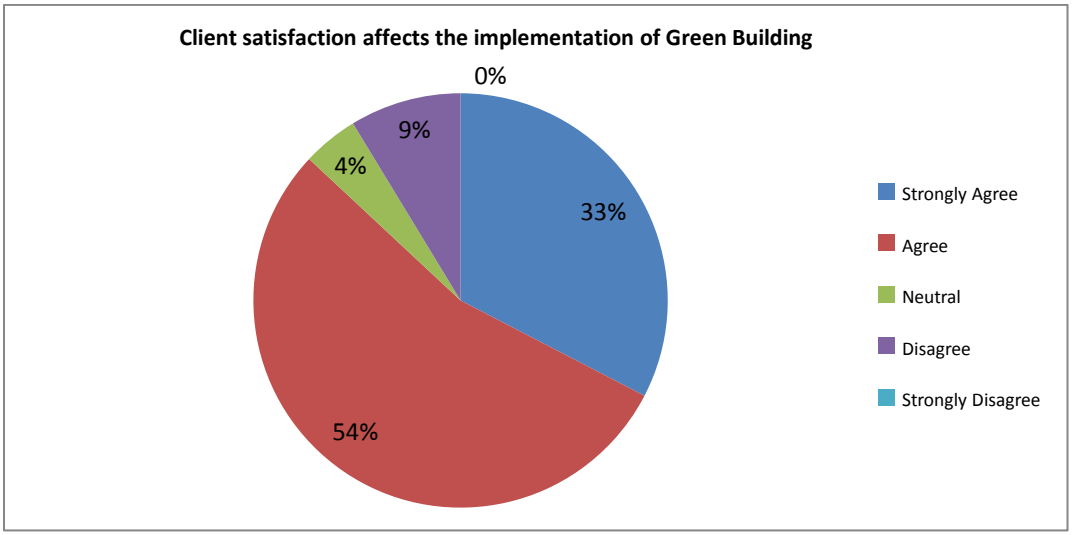


Figure 4.12: Client satisfaction affects implementation of Green Building in SA

The statistical calculations performed on this question gave a minim of 101, maximum of 104 and a mean of 101.89. The variance from the mean is 0.72 and the standard deviation is 0.84.

Figure 4.12 supports the literature on the strong relationship between client satisfaction and Green Building implementation, as fifty four percent (54%) of the participants agreed with the statement and thirty three percent (33%) strongly agreed. This translates into a resounding eighty seven percent (87%) of the sample agreeing on various levels that client satisfaction/dissatisfaction affects the implementation of Green Building as a whole in the South Africa. Only eleven percent (11%) disagreed, stating that client satisfaction/dissatisfaction would not affect Green Building implementation in South Africa. Additionally, not one participant strongly disagreed. This is a crucial finding for the South African Green Building environment as it is now clear how vital client satisfaction on each and every project is for the overall implementation of Green Building throughout South Africa. Simply put without achieving satisfactory levels of client satisfaction, Green Buildings in South Africa will not be built to the extent that they should be.

Question 20

Please indicate to what extent you agree with the following statement: "Certain building procurement systems are more appropriate for Green Building projects than others".

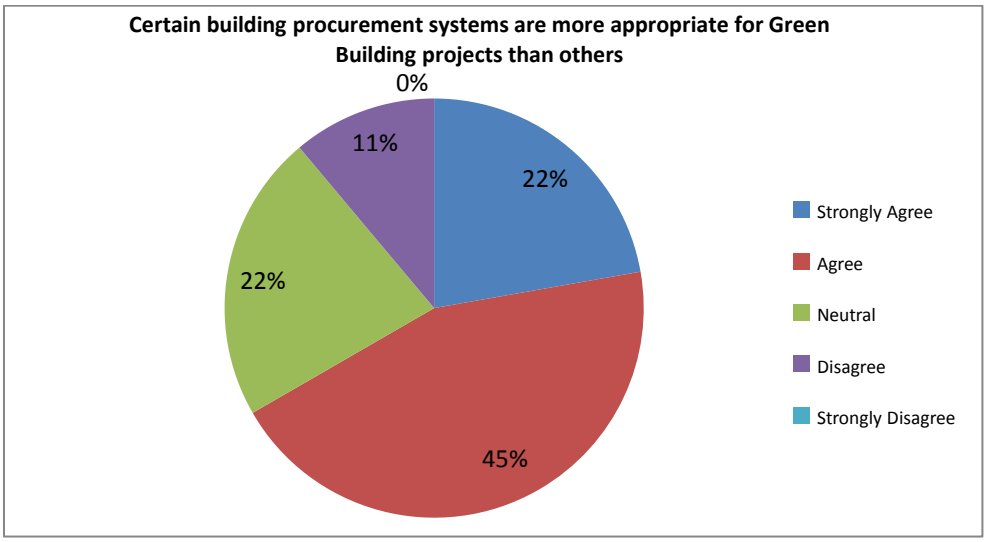


Figure 4.13: Certain procurement systems more appropriate for Green Buildings

The minimum for this data set is 106, the maximum is 109 and the mean is 107.22. A variance of 0.86 is determined with a standard deviation of 0.93.

This is a notably important question in order to answer the research question and the hypothesis. Sixty seven percent (67%) of the sample agreed or strongly agreed, with not one participant strongly disagreeing with the notion of certain procurement systems being more appropriate than others for Green Buildings. This supports the literature and exemplifies how critical the correct selection of procurement system is on a Green Building in South African practice. Without which the key objectives of the project cannot be successfully achieved and therefore overall project success is at risk from the onset. Furthermore, with this in mind the use of incorrect building procurements can certainly be a major constraint to the implementation of a Green Building and subsequently the implementation of Green Building in general across South Africa. The key point within this process is that Green Buildings are fundamentally different to traditional buildings and therefore require a fundamentally different procurement system that is most appropriate to bring about project success

Question 20.1

If you STRONGLY AGREE/AGREE to the above question, which of the following procurement systems do you consider most appropriate for Green Building projects? Please rank your top 3 most appropriate. 1 being the most appropriate.

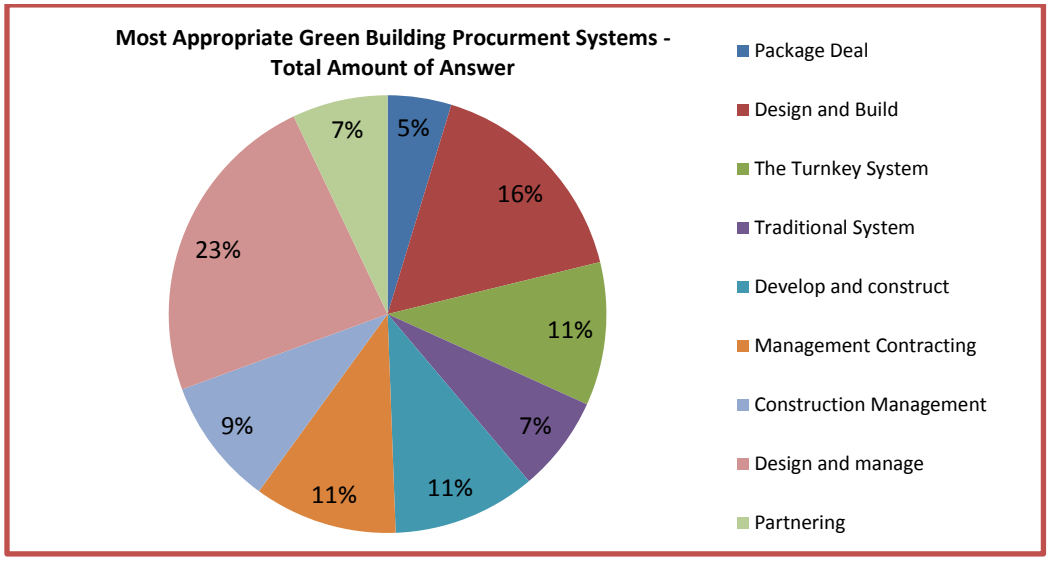


Figure 4.14: Most appropriate procurement system for Green Building in SA- Total answers

The question involved all the different building procurement systems taken from the literature review. The answers are considerably positive as it supports the literature with the majority of the sample answering that design and manage as well as design and build are the two most appropriate procurement systems in total to apply on Green Buildings in South Africa. These are both collaborative systems and therefore it is particularly encouraging that Green Building professionals recognise these types of procurement systems as the most appropriate. Furthermore, the most appropriate procurement systems for Green Building in South Africa have now been identified and therefore should be widely used in practice with great success.

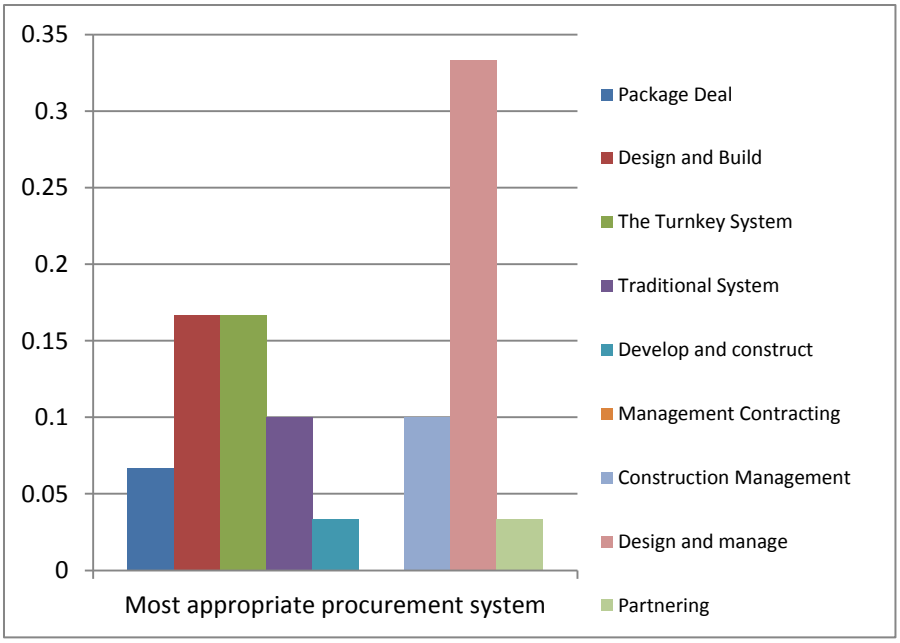


Figure 4.15: Most appropriate procurement system- Rank 1

From this question it was noteworthy to determine the absolute scenario, or the number one most appropriate system out of all the building procurement systems to apply on a South African Green Building. The design and manage system was determined to be the most appropriate system by a considerable margin (33%), followed by the design and build method (17%) and the turnkey system (17%). These are all integrated systems by nature, where a huge emphasis is placed on integrating all parties within the design and construction of a building- very little segregation within the management or development of this design and construction process takes place under these procurement systems.

Figure 4.14 and 4.15 support the literature with regards to the nature of a procurement system which is required to successfully develop a Green Building. Furthermore, it must be noted that the Green Building professionals across South Africa have cognisance of this and an understanding of which systems are more appropriate for Green Building.

Question 20.2

If you STRONGLY AGREE/AGREE to question 20, which of the following procurement systems do you consider LEAST appropriate for Green Building projects? Please rank the 3 least appropriate. 1 being the least appropriate.

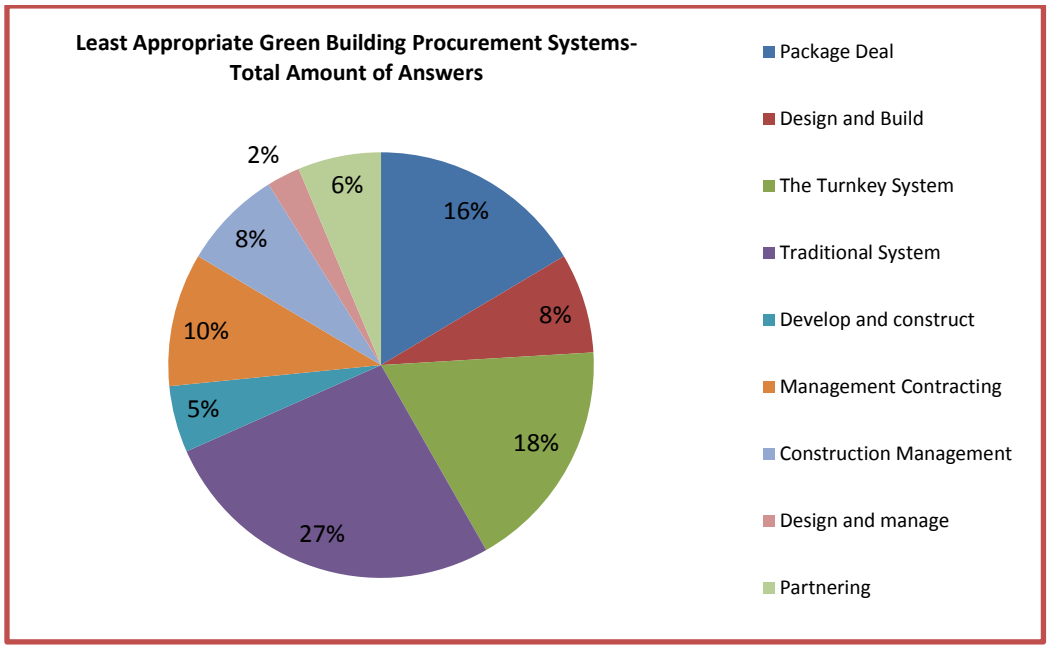


Figure 4.16: Least appropriate procurement system for Green Building in SA- Total answers

It is also crucial to determine what the least appropriate procurement system is for Green Building projects. This is not the absolute scenario but illustrates that the traditional system was chosen the most number of times as the least appropriate, second least appropriate or third least appropriate building procurement system for application on a Green Building. This is considerably higher than any of the other building procurement systems and depicts that the traditional system is certainly shown to be the least appropriate building system to use in practice on a Green Building within South Africa on an overall basis.

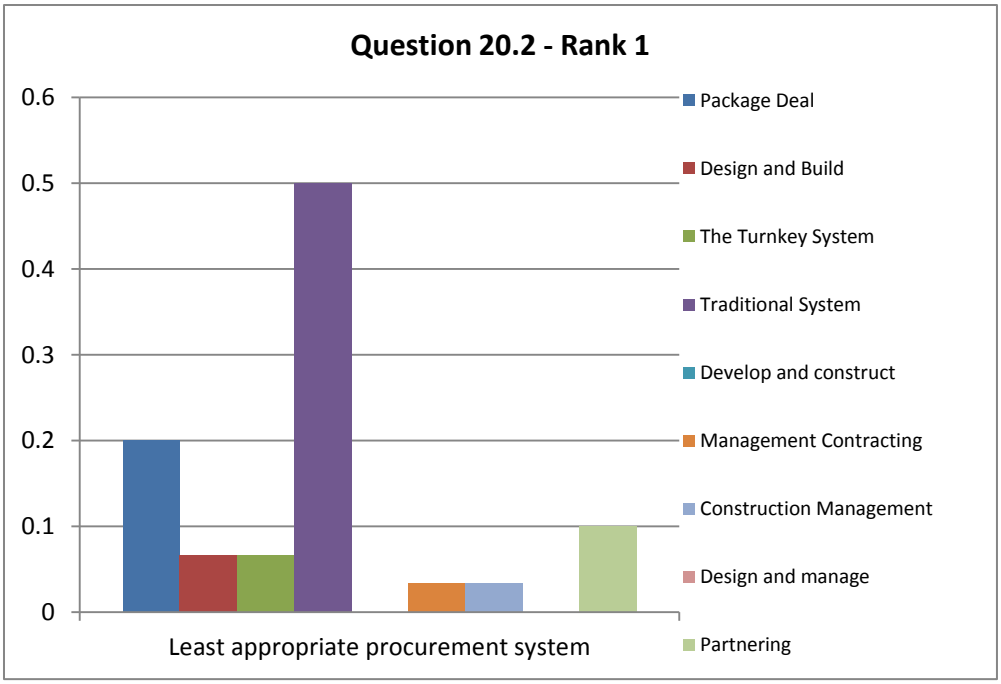


Figure 4.17: Least appropriate procurement system- Rank 1

On the absolute basis, the traditional system was overwhelmingly the outright least appropriate building procurement system to apply on a Green Building as it was chosen by fifty percent (50%) of the sample. The traditional system is segregated by nature and therefore falls within the classification of a segregated building procurement system. This means that there is a complete separation in responsibility, whereby the project development activities are performed sequentially one after the other with very little integration from the various parties. This system has been recognised to be the least appropriate for a Green Building in theory and furthermore the least appropriate in practice by Green Building professionals which include clients, consultants and contractors throughout South Africa. Once more it is greatly encouraging and beneficial to the South African Green Building industry that its participants recognise this. The crucial factor in all of this is whether these professionals can actually apply this knowledge in practice.

Chi Squared

The Chi-squared test was applied in order to determine if there is any significant difference between each of the various professions and what they find to be the most appropriate building procurement system for Green Building in South Africa as well as the least appropriate. This means that it is possible to determine whether certain types of professions lean toward a particular type of procurement system or whether the sample can be treated as one whole group that all agree on the most appropriate and least appropriate systems.

The Chi-squared test asks whether the observed proportions are significantly different to the expected proportions from non-interval scales. In order to determine this, a null hypothesis and alternative hypothesis is required.

In this case the hypotheses for the analysis on the most appropriate system are as follows:

Null hypothesis (H0) = There is no difference between each professions given answers for the most appropriate building procurement system for a Green Building in South Africa.

Alternative hypothesis, (Ha) = There is a difference between each professions given answers for the most appropriate building procurement system for a Green Building in South Africa.

When the various professions are analysed against the answers given for most appropriate procurement system the Chi-squared value is 0.710. This is greater than the 0.05 threshold and therefore the null hypothesis cannot be rejected. Therefore it can be said that there is no difference in what the various professionals see to be the most appropriate procurement system. This is particularly beneficial as it illustrates that all the professionals agree as a collective that the design and manage system is the clearly the most appropriate system to utilise on a Green Building and the Design and Build system is the second most appropriate.

Hypothesis for least appropriate system:

Null hypothesis (H0) = There is no difference between each professions given answers for the least appropriate building procurement system for a Green Building in South Africa.

Alternative hypothesis, (Ha) = There is a difference between each professions given answers for the least appropriate building procurement system for a Green Building in South Africa.

In this case the chi-squared value is calculated as 0.981. This is far greater than the 0.05 threshold and therefore the null hypothesis cannot be rejected. This again illustrates that no particular profession differs on portraying what the least appropriate procurement system is. Therefore it is clear that the sample as a collective agrees that the least appropriate building procurement system to utilise on a Green Building is the traditional system.

Most appropriate procurement system and the system utilised

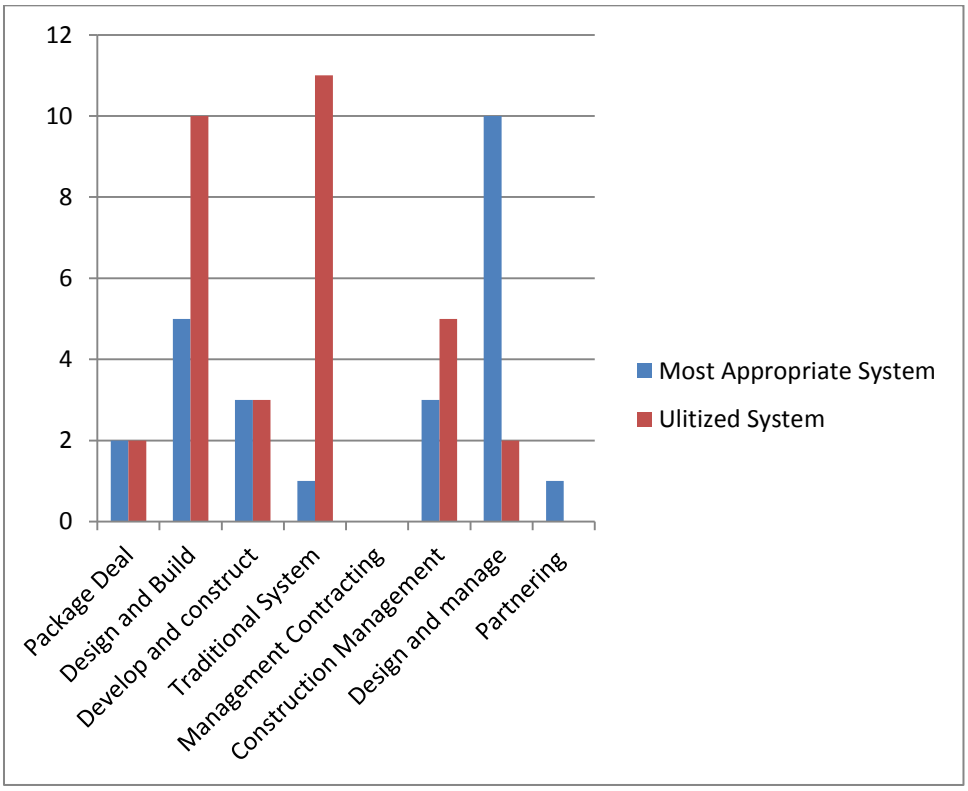


Figure 4.18: Most appropriate procurement system and system utilised

Figure 4.18 shows an interesting graphic presentation, where it is clear that the Green Building professionals do not utilise the systems that they themselves find to be the most appropriate for Green Building. The most noteworthy relationship is that of the Design and Manage system which is found to be the most appropriate system but is very rarely utilised.

When statistically calculating this relationship it is determined that the correlation is 0.019937172. This illustrates an extremely low correlation, in fact almost none at all, which clearly indicates that there is almost no relationship between the system that is known to be the most appropriate and what is actually being utilised in practice.

Least appropriate procurement system and the system utilised.

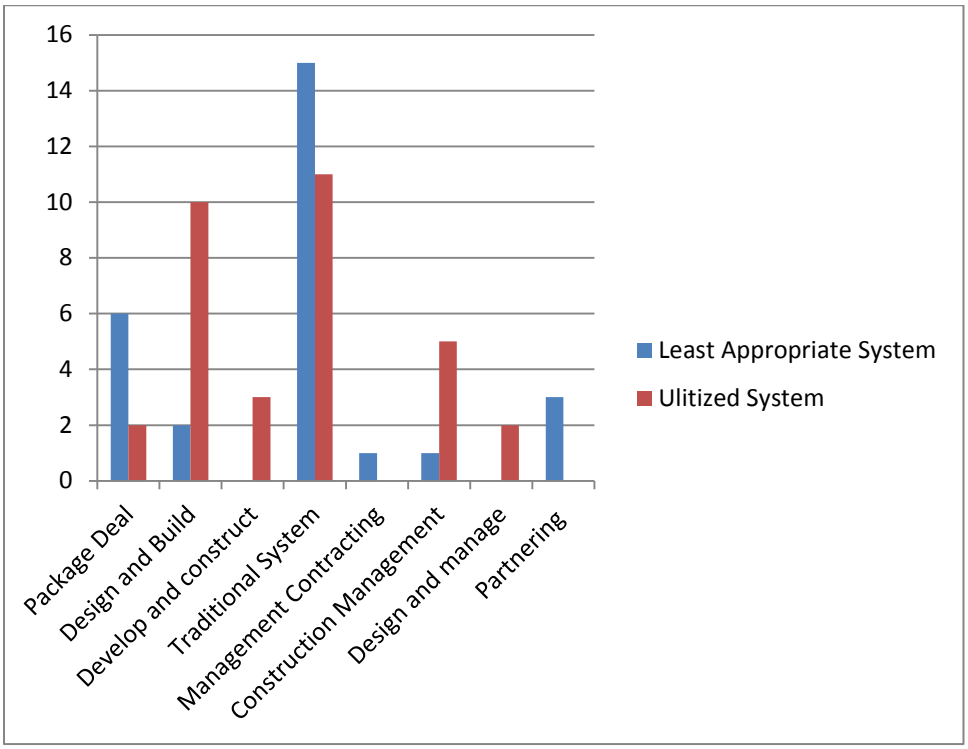


Figure 4.19: Least appropriate procurement system and system utilised

This figure is particularly significant as it illustrates the crux of the problem statement. Despite the fact that the Green Building professionals know that the traditional system is the least appropriate for Green Building it is utilized the most out of any building procurement system.

The correlation between these two variables is calculated as 0.086066806. While this is not an extremely strong correlation it is more than 4 times that of the correlation for the most appropriate system and the system actually utilised. This is evidently a problem as the system that is known to be the least appropriate is being utilised the most which means that there is very little chance for the goals of Green Building projects to be achieved. This results in client dissatisfaction which in turn effects the implementation of Green Building with South Africa.

4.4 Summary of key findings

The data produced in chapter four was gathered through the means of questionnaires which were directed at the participants in order to gain quantitative and qualitative information. This data analysis set out to answer the overall research as well as the following sub-questions under the hypothesis:

- Is there a relationship between building procurement systems and client satisfaction
- Does the type of building system utilised on a green building project affect the level of client satisfaction on that project
- Will client satisfaction and dissatisfaction affect the implementation of Green Building as a whole in the South African construction industry
- Are certain building procurement systems more appropriate for Green Building projects than others
- What is the most appropriate building procurement system to utilise in South Africa for Green Building development
- What is the least appropriate building procurement system to utilise in South Africa for Green Building development
- What issues have arisen from the current state of affairs in the Green Building environment with regards to the relationship building procurement systems, client satisfaction and Green Building implementation?

These questions are not only imperative to this study but also for the future of the Green Building movement throughout South Africa. The data produced through these questions gives clear insight for government, stakeholders, professionals and contractors into the problems and solutions surrounding the relationship between building procurement systems, client satisfaction and Green Building in South Africa.

From the data presented throughout this chapter, results have been established that support the literature provided within this study on numerous levels. Firstly, these results have illustrated that there certainly is a link between building procurement systems and client satisfaction in the South African context which correlates with the literature. A noteworthy finding within this section is that not one participant within the survey strongly disagreed to the notion of there being a link between the building procurement system utilised and client satisfaction.

When investigating this concept in greater detail it was determined that sixty two percent (62%) of the sample conclude that the type of building system utilised on a green building project will affect the level of client satisfaction attained on that project. This is particularly significant as it is evident that in South African practice it is paramount to implement the most fitting building procurement system on a Green Building project as it will directly affect overall client satisfaction.

Although it is clear that the building procurement system employed on a project directly affects the client's satisfaction, the effects of this are greatly important. Through the data produced and analysed it has been determined that client satisfaction, and on the other hand client dissatisfaction, does affect the implementation of Green Building throughout South Africa. This is a crucial finding as it immediately proves the hypothesis of this study. Furthermore, it is now clear to the South African Green Building environment how imperative client satisfaction is for the overall development of Green Building throughout South Africa.

As Green Building is a fundamentally different method of building development to that of traditional building it had to be determined whether certain building procurement systems are more appropriate for Green Buildings in South Africa than others. Sixty seven percent (67%) of the sample agreed or strongly agreed with the notion of certain procurement systems being more appropriate than others for Green Buildings. Not one participant disagreed with this statement. In order to study this concept further, the procurement systems which are most appropriate and least appropriate for use on South African Green Buildings must be established.

The sample agreed that the most appropriate system is the design and manage, followed by the design and build system. This supports the literature as these are both collaborative systems which enable a holistic approach to the development of a Green Building. In addition the information given by the sample for the least appropriate systems concurs with the theory in literature as the majority of the sample found the least appropriate procurement system to be the traditional system. The fact that both these data sets correspond with the literature illustrates the credit worthiness of the answers given. Additionally, it is apparent that the design and manage system or design and build system should be adopted for the development of a Green Building in South Africa, and the traditional system certainly should not.

Although the professionals have cognisance of this it is not being implemented in practice. Despite the fact that the traditional system is the least appropriate for Green Building it is the most utilised in practice by a great margin. This is evidently a problem as the system that is known to be the least appropriate is being utilised the most which means that there is very little chance for the goals of Green Building projects to be achieved.

In conclusion, the research question has been answered throughout this chapter and significant findings have been established. There is a fundamental cause for concern as the most appropriate systems for Green Building in South Africa are not being applied in practice, in fact the least appropriate system is being utilised most. It is clear that without a shift towards procurement systems that ensure client satisfaction, Green Building in South Africa will be continually curbed.

Chapter 5: Conclusions and Recommendations

5.1 Introduction

Throughout this study it has been vital to foresee the path being ploughed for countries, cities, societies, governments and generations to come. There are currently approximately 7.1 billion people inhabiting the earth, consuming its finite resources needed to sustain life and generating exponential amounts of waste (McKevitt and Ryan, 2014). The current urbanisation rate will result in over 6.4 billion people living within cities across the planet by the year 2050 (City of Melbourne and Victorian Department of Transport, 2010). South Africa is no exception to this rapid rate of urbanisation. In fact it falls within the region that has the highest urbanisation rate of planet, where the urban population is expected to increase from 387 million inhabitants in 2010 to 705 million by 2025 in Sub-Saharan Africa. In essence what has been built in the entire timeline of modern civilisation must now be built in a very short space of time and therefore it is paramount that this is executed sustainably. Green Buildings are the Built Environment's major contribution to the planet for achieving this building in a sustainable manner (Biello, 2008). However, it has been discovered within this study that there are numerous issues that need to be rectified in order for Green Buildings to be successfully implemented in South Africa.

This study was undertaken to determine how to enhance client satisfaction through procurement systems in order to increase Green Building implementation in South Africa. In Chapter 1, the foremost and specific objectives of this study were listed; these objectives were addressed during the course of this study, and are concluded through reference to the various sections. Specifically, the key objectives of this study were as follows:

1. To determine the doctrine principles that govern procurement choice and what dynamics affect successful procurement.
2. To investigate the factors that involve client satisfaction and how it is achieved within the built environment.
3. To explore the factors that impact the application and implementation of Green Building
4. To establish these three objective's findings within the South African context

This chapter concludes the study by linking these objectives to the results that have been achieved. It expressly focuses on the main objective as well as concentrates on the specific objectives. These specific objectives gave rise to the following outcomes:

1. There is a consensus on how building procurement systems affect client satisfaction.
2. There is a consensus on how client satisfaction affects the implementation of Green Building in South Africa.
3. The procurement systems currently being utilised on Green Building projects in South Africa were identified.
4. A clear view on the most and least appropriate building procurement systems to utilise on Green Building projects was established.

These outcomes were concluded through a systematic analysis on the literature presented within Chapter 2 and the results provided throughout Chapter 4. These results and findings within Chapter 4 were ascertained through a questionnaire which was submitted via email to the various participants. These questionnaire was directed at individuals, all registered as professionals with Green Building Council of South Africa. The key research findings from the literature and the data analysis are presented in the following section.

5.2 Research Findings

This study has identified a number of crucial dynamics in order to clearly outline practical solutions to enhance Green Building in SA. Firstly, it has been illustrated that the client is the key to whether a project is developed and how it is procured. Moreover, it has been established that the choice of procurement strategy is the defining factor in the successful outcome of a project and ultimately the outcome of client satisfaction or dissatisfaction. This successfully proves that the procurement system applied on a Green Building has an effect on client satisfaction.

Secondly, it has been established through the literature and data analysis that there is a very real and integral relationship between building procurement systems, client satisfaction and the implementation of Green Building in South Africa. Within this it was proved that incorrect building procurement systems have a negative effect on client satisfaction which in turn has a detrimental effect on Green Building implementation in South Africa.

Therefore, it is evident that without the correct procurement system to achieve client satisfaction on Green Building projects, the future of the South African Green Building industry is certainly at risk. However, this study has achieved the aim of determining how to apply appropriate building procurement systems to achieve client satisfaction and therefore enhance the implementation of Green Building in South Africa.

When breaking down the significant factors within this study it was highlighted that the literature from abroad portrays a relationship between the building procurement system and client satisfaction. The existence and extent of this relationship was therefore tested in the South African context with substantial results. This was tested through the use of a questionnaire distributed to South African Green Building Professionals and Clients. Within the data analysis it was illustrated that a great majority answered that there is a very strong relationship between the building procurement system utilised and client satisfaction. Not one participant answered that there is no relationship at all. This is particularly noteworthy as the answers given by the Green Building professionals certainly support what has been discovered in literature. There is definitely a strong relationship between the procurement system utilised and client satisfaction in the South African context which has not been proved before this study.

Although it is clear that the building procurement system employed on a project directly affects the client's satisfaction, the effects of this are greatly important. This was highlighted as an overwhelming majority of the sample agreed on various levels that client satisfaction/dissatisfaction affects the implementation of Green Building as a whole in South Africa. Not one participant strongly disagreed. This is a crucial finding as it immediately proves the hypothesis of this study. Furthermore, it is now clear to the South African Green Building environment how imperative client satisfaction is for the overall development of Green Building across South Africa. Simply put without achieving satisfactory levels of client satisfaction, Green Buildings in South Africa will not be built to the extent that they should be.

Within the literature it was determined that Green Building is a fundamentally different method of building development to that of traditional building and therefore requires a different system of procurement.

The literature suggests that for a procurement system to have a great chance of success on a Green Building project it must be collaborative by nature. This highlighted that a segregated system such as the traditional system would not be appropriate for use on a Green Building project. When determining this in practice it was found that the most appropriate system is the design and manage, followed by the design and build system. These are both highly collaborative systems and therefore reinforce what was discovered in theory. Furthermore, the majority of the sample found the traditional system to be the least appropriate for utilising on a Green Building project in South Africa. Therefore, it is apparent that the design and manage system or design and build system should be adopted for the development of a Green Building in South Africa, and the traditional system certainly should not.

Although this is apparent and the professionals have cognisance of it, there is a large issue at play- it is not being implemented in practice. Through the data produced and analysed it was illustrated that in practice the design and manage procurement system is one of the least utilised procurement system on Green Building projects in South Africa, when it should in fact be the most utilised. What is even more concerning is that the traditional system, which is shown to be the least appropriate system, is being utilised the most across South Africa on Green Building projects by a substantial margin. Therefore it is obvious that although the individuals that are involved in the South African Green Building industry know that the traditional system is the incorrect system to use, they are still applying it to the majority Green Buildings. This is a fundamental cause for concern as the most appropriate systems for Green Building in South Africa are not being applied in practice, in fact the least appropriate system is being utilised most. If this resolute application of the traditional system continues, client satisfaction will not be achieved and subsequently Green Building in South Africa will be continually curbed. However, this study has found a means to reversing this. It has found the methods that enhance client satisfaction which in turn will greatly benefit the implementation of Green Building throughout South Africa. By utilising the design and manage system or the design and build system, Green Building projects have a far greater chance of overall success and client satisfaction. This study has pioneered the discovery of building procurement systems that enhance client satisfaction on Green Buildings within South Africa. Therefore by applying these particular systems the increased adoption of Green Building practices in South Africa is certainly achievable.

5.3 Recommendations

The core notion of this study was to determine whether there is a relationship between building procurement systems, client satisfaction and Green Building. Furthermore, it was conducted in order to determine how the mechanisms of this relationship function. This study has certainly addressed these factors and therefore must make recommendations on how to apply the findings going forward.

There is a clear issue within the South African Green Building environment whereby Green Buildings are not being implemented to the degree that they should be. There is vast potential for South Africa to become a large player in the worldwide Green Building movement if the findings of this study are utilised and applied in practice. However, this can only be successfully achieved if greater knowledge on Green Building is acquired by key role players in the South African built environment. Further training needs to be provided across South Africa, in order for people to truly understand the concepts of implementing Green Building, without which there will be a continued resistance. Therefore, further research should be undertaken on how to practically give the correct information to the right people.

Additionally, it has been discovered that there are numerous barriers to the implementation of Green Building. This study has focused on the barriers of client satisfaction and building procurement systems. It is therefore recommended that a further study be conducted on the overall barriers to Green Building and sustainable development in South Africa.

Some of the barriers illustrated within this study were fear of the unknown, habitual routine and mindset. These barriers are extremely detrimental to sustainable development and as such it is recommended that an investigation into the methods of breaking through barriers to sustainable development be undertaken.

It is of the belief of the author that to break through these various barriers with any substance in South Africa the government must be far more involved. The use of the correct legislation and incentives is critical to successfully enhancing the adoption of Green Building concepts. It has been proved all over the world and South Africa is certainly no different in this regard. Consequently it is vital for research to take place on reshaping national and municipal legislation to cultivate a Green generation. Additionally, the application of incentives to promote Green Building and sustainable development should be investigated.

In conclusion, this study has revealed the most appropriate and least appropriate procurement systems to apply on Green Buildings. It is clear that by persistently using the systems that are currently being applied in South Africa Green Building will be continually curbed. However, by applying the findings from this study this can be altered with significant benefits to the entire Green Building sector of South Africa. Furthermore, there are also numerous benefits of growing the Green Building sector for the entire natural and economic environment of South Africa, such as reduced carbon emissions and exponential job creation. South Africa has vast potential to become a key role player in Sustainable Development and Green Building on the African continent. This certainly can be achieved by utilising the outcomes of this study and forming clear plans to implement these outcomes in practice. Green Buildings reduce the negative effects of buildings, on the environment and global warming specifically, and have therefore become the Built Environment's major contribution to the planet on a sustainable level (Biello, 2008). This study has outlined methods for South Africa to maximise this contribution to planet, create jobs and sustainably manage the inevitable urbanisation which South Africa's cities will face.

5.4 Benefits of the findings throughout this study

The concern about the environment as a whole as well as the future of the planet has become a focal point amongst Governments, industries and individuals. Despite the overall severity of resource exhaustion and pollution on a global scale, a number of significant environmental, social and economic issues have the evident ability to create global conflict do exist. One considerable issue that has been identified is Global warming. Green Buildings reduce the negative effects of buildings, on the environment and global warming specifically, and have therefore become the major contribution by the Built Environment to the planet on a sustainable level. With this in mind this study benefits not only the micro society of construction professionals but also society in general. The building industry has become the largest single consumer and polluter of the planet's limited natural resources (Van Wyk, 2009). By utilising the findings within this study, South Africa can enhance the overall implementation of Green Building and greatly reduce the detrimental impacts of building on the country's finite raw material reserves.

5.5 Problems associated with the study

Despite the fact that there were significant findings and benefits generated from this study, naturally there were also difficulties encountered. Certain of these issues cannot be ignored and therefore are made clear in order to be utilised and perhaps avoided in further research.

The first problem encountered within this study is that the literature available in the research area is predominantly only available from abroad. Although Green Building is a concept that is universal, the intricacy of how to apply the concept varies between countries. It was therefore often difficult to get a clear understanding of how to apply the literature within the South African context. This required far greater research into the literature while thoroughly comparing the data gathered to the literature from abroad.

Although there is significant research on the relationship between building procurement systems and client satisfaction, the fact that this study pioneered the effects of this relationship on Green Building proved to be particularly demanding. The existing literature does not give a clear path on how to enhance the implementation of Green Building through client satisfaction and building procurement systems. Therefore a great deal of insight into the workings of these three elements was required in order to extrapolate how these components

actually affect one another. Despite the fact that it was particularly challenging to do this with limited literature it proved to be attainable through thorough research.

With regards to the data gathered, it was evident that South Africa has implemented far less Green Buildings than many other countries. This meant that there are not a great deal of professionals and particularly clients that have sufficient experience and knowledge in this area. Furthermore, the accessibility of these people and cases is not particularly easy. The Green Building Council of South Africa proved to be a great source to utilise, however a large number of the professionals associated with this council have not updated their details. This meant that many of the individuals registered could not actually be contacted.

Although there were problems encountered within this study, the extent of these issues did not prove to be significantly curbing to the overall findings achieved.

5.6 Possibilities for further research

In order to expand this body of knowledge the following are suggested as areas of further investigation:

- An investigation into the methods of breaking through barriers to sustainable development in South Africa.
- An exploration into the reasons for certain procurement systems being applied across various building projects.
- An investigation into how Green Building's affect people's state of mind
- Is the client's lack of expressed interest towards sustainable development and environmentally friendly building the major barrier to the successful integration of Green Building?
- How to change the mind-set of the older generation towards Green Building and formulate a strategy to making this concept more attractive.
- Reshaping national and municipal legislation to cultivate a Green generation through the use of incentives to promote Green Building and sustainable development.
- A case study on utilising different building procurement systems on Green Buildings in practice.
- Determine an original bespoke method of building procurement specifically for Green Buildings.

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Appendices

Appendix 1: Questionnaire covering letter

Green Building Research

Matthew Rose <Matthew.Rose@students.wits.ac.za>

Dear Green Building Professional,

My name is Matthew Rose. I am conducting this research in order to fulfil my master's degree at the University of the Witwatersrand. I would like you, as a Green Building professional, to be apart of this research. My field of interest is the relationship between Client Satisfaction and Green Building Procurement Systems.

By partaking in this research you will be contributing to the research in the South African Green Building sector, which will be of particular value as this topic has not yet been covered in the South African context.

In order to contribute to this research please do the following:
1. Download the attached questionnaire (Microsoft Word document)
2. Fill out the questionnaire on your computer. This will take 10 to 15 minutes
3. Save the document and reply to this email with your attached questionnaire.

If you feel anyone else would also like to contribute to this research, I welcome you to forward this email onto them.

I really appreciate your participation in this study, and look forward to your response.
Many thanks

Regards
Matthew Rose

You may also contact my Supervisor: Professor David Root via email- David.Root@wits.ac.za

Appendix 2: Research survey questionnaire

University of the Witwatersrand
Questionnaire

My name is Matthew Rose. This research is for the fulfilment of my master's degree at the University of the Witwatersrand and is used in order to determine the relationship between client satisfaction and Green Building procurement systems.
This is an invitation to partake in this questionnaire. Please note that all the information within this questionnaire is confidential and no personal or company information is required i.e. Name or Company's name.

You do not have to answer any question that you do not want to but when answering the questions please refrain from using any source but your own knowledge as an individual. The questions are formed to be simply answered on your computer with no printing at all.

Do you understand the above and agree to partake in this questionnaire on a completely anonymous basis? Simply click on the box next to your answer.
Yes ☐ No ☐

NB! You may choose more than one answer to the relevant questions.

1. Gender:
Male ☐ Female ☐

2. Age:
CLICK HERE to choose from the following options>

3. How many years of experience do you have in the construction industry?
CLICK HERE to choose from the following options>

4. What is the highest level of education that you have attained?
CLICK HERE to choose from the following options>

If "OTHER" specify here:

5. Do you have any professional association?

- None ☐
- ASAQS ☐
- SACPMP ☐
- CIOB ☐
- RICS ☐
- SAIA ☐
- SAICE ☐
- CESA ☐

6. How would you describe your professional background?
CLICK HERE to choose from the following options>

If "OTHER" specify here:

7. How would you best describe your current role in the development and delivery of buildings?
CLICK HERE to choose from the following options>

If "OTHER" specify here:

8. What do you understand to be *sustainable development in an urban context*?
Type here:

9. What do you understand by the term *Green Building*?
Type here:

10. What do you understand by the term *building procurement systems*?
Type here:

11. Which of the following building procurement systems are you familiar with? You may choose more than one answer by checking the boxes.

- Traditional System ☐
- Design and manage ☐
- The Turnkey System ☐
- Develop and construct ☐
- Design and Build ☐
- Management Contracting ☐
- Construction Management ☐
- Package Deal ☐
- Partnering ☐
- None ☐



12. What is your understanding of the term *Client Satisfaction*?
Type here:

13. In your opinion is there a link between the building procurement system utilised and client satisfaction.
CLICK HERE to choose from the following options>

14. How many Green Building projects have you been involved in?
CLICK HERE to choose from the following options>

14.1. If you have been in a Green Building project, in what role were you involved?
CLICK HERE to choose from the following options>

If "OTHER" specify here:

15. If you have been involved in a Green Building project, on your last Green Building which building procurement system was utilised?
CLICK HERE to choose from the following options>

15.1 To what extent were the goals on this Green Building project achieved?
CLICK HERE to choose from the following options>

16. In your opinion what is driving the demand for Green Building? Please rank the below from 1-7. 1 being the most important and 7 being the least important.

1 CLICK HERE to choose from the following options>	Most important
2 CLICK HERE to choose from the following options>	-
3 CLICK HERE to choose from the following options>	-
4 CLICK HERE to choose from the following options>	-
5 CLICK HERE to choose from the following options>	-
6 CLICK HERE to choose from the following options>	-
7 CLICK HERE to choose from the following options>	Least important

17. What do you think is(are) the major barrier(s) to extensive use of Green Building in South Africa? Please select as many as you feel are applicable.

CLICK HERE to choose from the following options>
CLICK HERE to choose from the following options>
CLICK HERE to choose from the following options>
CLICK HERE to choose from the following options>
CLICK HERE to choose from the following options>
CLICK HERE to choose from the following options>
CLICK HERE to choose from the following options>



18. Please indicate to what extent you agree with the following statement: "The type of building system utilised on a green building project will affect the level of client satisfaction attained on that project".
CLICK HERE to choose from the following options>

19. Please indicate to what extent you agree with the following statement: "Client satisfaction/dissatisfaction affects the implementation of Green Building as a whole in the South African construction industry".
CLICK HERE to choose from the following options>

20. Please indicate to what extent you agree with the following statement: "Certain building procurement systems are more appropriate for Green Building projects than others".
CLICK HERE to choose from the following options>

20.1. If you STRONGLY AGREE/AGREE to the above question, which of the following procurement systems do you consider most appropriate for Green Building projects? Please rank your top 3 most appropriate. 1 being the most appropriate.

1. CLICK HERE to choose from the following options> Most appropriate
2. CLICK HERE to choose from the following options> -
3. CLICK HERE to choose from the following options> -

20.2. If you STRONGLY AGREE/AGREE to question 20, which of the following procurement systems do you consider LEAST appropriate for Green Building projects? Please rank the 3 least appropriate. 1 being the least appropriate.

1. CLICK HERE to choose from the following options> Least appropriate
2. CLICK HERE to choose from the following options> -
3. CLICK HERE to choose from the following options> -

20.3 If you STRONGLY AGREE/AGREE to question 20, why in your opinion are certain building procurement systems more appropriate for Green Building projects than others?
Type here:

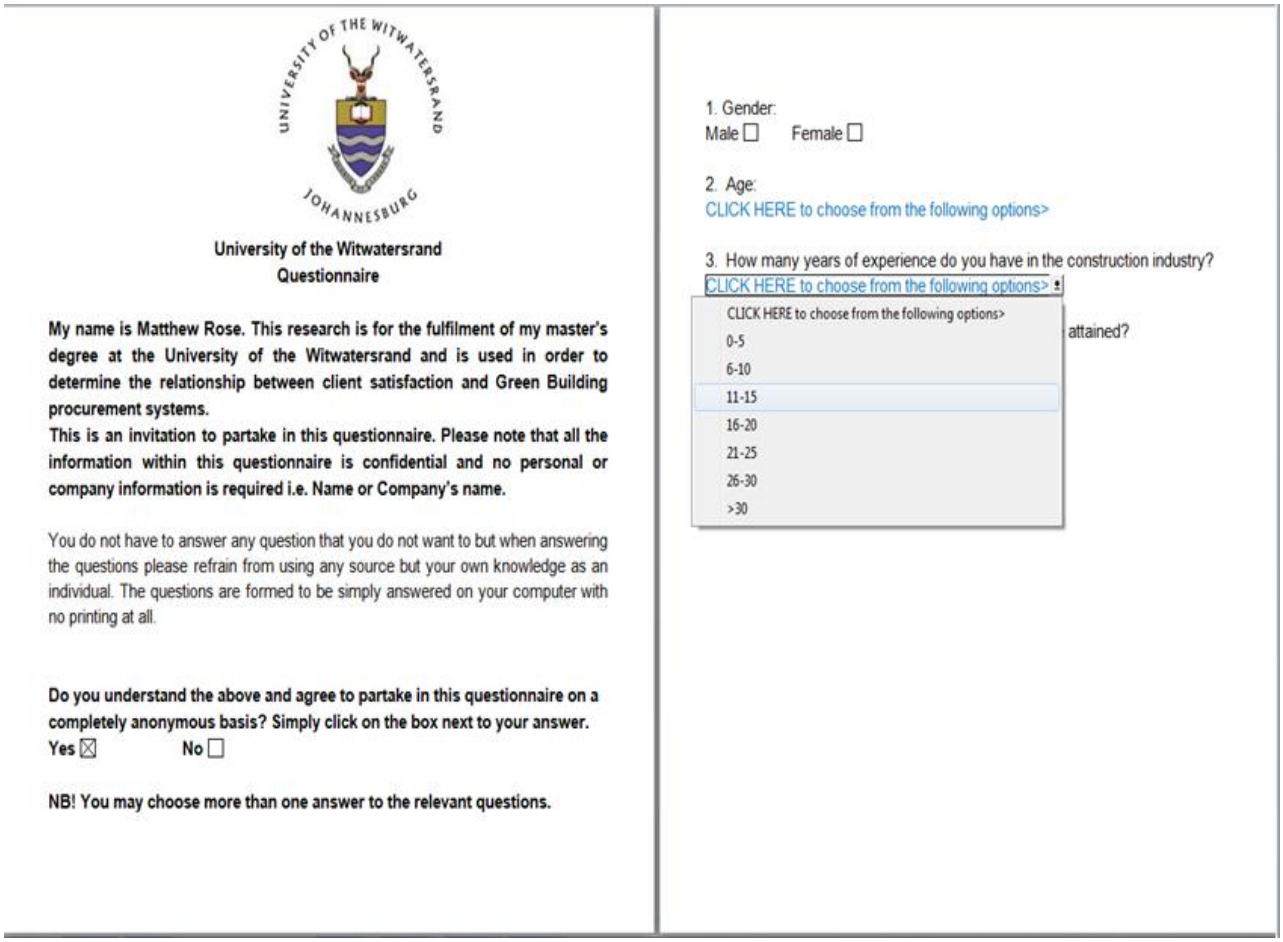
21. If you would like to add any further comments please do so in the space below
Type here:

If you are interested in speaking further on this matter then please provide your name and contact details below and we will be in contact. You may also contact my supervisor: Professor David Root- David.Root@wits.ac.za

Thank You



Appendix 3: Interactive illustration of research survey questionnaire



University of the Witwatersrand
Questionnaire

My name is Matthew Rose. This research is for the fulfilment of my master's degree at the University of the Witwatersrand and is used in order to determine the relationship between client satisfaction and Green Building procurement systems.
This is an invitation to partake in this questionnaire. Please note that all the information within this questionnaire is confidential and no personal or company information is required i.e. Name or Company's name.

You do not have to answer any question that you do not want to but when answering the questions please refrain from using any source but your own knowledge as an individual. The questions are formed to be simply answered on your computer with no printing at all.

Do you understand the above and agree to partake in this questionnaire on a completely anonymous basis? Simply click on the box next to your answer.
Yes ☒ No ☐

NB! You may choose more than one answer to the relevant questions.

1. Gender:
Male ☐ Female ☐

2. Age:
CLICK HERE to choose from the following options>

3. How many years of experience do you have in the construction industry?
CLICK HERE to choose from the following options>

CLICK HERE to choose from the following options>
0-5
6-10
11-15
16-20
21-25
26-30
>30

attained?

Appendix 4: Sample of the excel spreadsheet model for the individual questionnaire responses

	A	B	C	D	E
1		**Q1**	**Q2**	**Q3**	**Q4**
2	Questionnaire Response 1	0	5	11	18
3	Questionnaire Response 2	0	5	12	21
4	Questionnaire Response 3	0	7	12	21
5	Questionnaire Response 4	0	6	11	21
6	Questionnaire Response 5	0	7	11	17
7	Questionnaire Response 6	0	8	15	19
8	Questionnaire Response 7	1	3	9	18
9	Questionnaire Response 8	0	6	13	20
10	Questionnaire Response 9	1	5	10	20
11	Questionnaire Response 10	1	6	12	19
12	Questionnaire Response 11	0	7	15	21
13	Questionnaire Response 12	1	5	11	21
14	Questionnaire Response 13	1	5	10	22(PHD)
15	Questionnaire Response 14	1	5	9	21
16	Questionnaire Response 15	0	5	10	22(PHD)
17	Questionnaire Response 16	1	4	9	20
18	Questionnaire Response 17	0	6	14	21

Appendix 5: Illustration of the z-score formulation

	W	X	Y	Z	AA	AB	AC
1	**Q13**	**z-score 13**	**Q14**	**Q14.1**	**Q15**	**Q15.1**	**Q16-1 Most Important**
2	52	-0.7982	59	36	45	79	85
3	53	0.228056	63	36	42	77	85
4	52	-0.7982	59	36	46	78	84
5	52	-0.7982	63	36	76	78	82
6	54	1.254307	58	40	46	77	88
7	53	0.228056	61	36	42	78	82
8	52	-0.7982	63	36	76		82
9	52	-0.7982	61	36	42	78	86
10	54	1.254307	63	36	45		82
11	52	-0.7982	61	36	45	78	85
12	54	1.254307	60	36	46	78	82
13	54	1.254307	57				82
14	53	0.228056	59	36	46	79	88
15			57				82
16	53	0.228056	60	36	46	78	82
17	53	0.228056	60	36	43	78	82
18	52	-0.7982	61	36	48	77	82
19	52	-0.7982	57				82
20	52	-0.7982	58	36	42	78	82
21	52	-0.7982	59	40	46	78	82
22	52	-0.7982	59	36	48	78	82
23	53	0.228056	57				82
24	54	1.254307	58	36	42	78	82

Appendix 6: Sample calculation and graphical representation of the questionnaire data captured

	A	B	C	D	E	F	G
1	Question NO.	Answer NO.	Ranking	Description	# of answers	total of answers	Percentage
2	1	0		Male	30	46	0.652173913
3	1	1		Female	16	46	0.347826087
4	2	2		<22	0	46	0
5	2	3		22-25	3	46	0.066666667
6	2	4		26-30	8	46	0.177777778
7	2	5		31-40	19	46	0.422222222
8	2	6		41-50	8	46	0.177777778
9	2	7		51-60	6	46	0.133333333
10	2	8		>60	2	46	0.044444444
11	3	9		0-5	9	46	0.195652174
12	3	10		6-10	14	46	0.304347826
13	3	11		11-15	9	46	0.195652174
14	3	12		16-20	6	46	0.130434783
15	3	13		21-25	3	46	0.065217391
16	3	14		26-30	2	46	0.043478261
17	3	15		>30	3	46	0.065217391
18	4	16		Matric	0	46	0
19	4	17		Diploma	4	46	0.086956522
20	4	18		Btech	3	46	0.065217391
21	4	19		Undergraduate Degree	11	46	0.239130435
22	4	20		Honours Degree	12	46	0.260869565
23	4	21		Masters Degree	14	46	0.304347826
24	4	22		Other level of education	2	46	0.043478261
25	5	23		None	21	49	0.428571429
26	5	24		ASAQS	2	49	0.040816327
27	5	25		SACPMP	2	49	0.040816327
28	5	26		CIOB	0	49	0
29	5	27		RICS	4	49	0.081632653
30	5	28		SAIA	5	49	0.102040816
31	5	29		SAICE	5	49	0.102040816
32	5	30		CESA	10	49	0.204081633

