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**A Study on Factors Undermining the Incorporation of Green  
Principles into the Design Development Stage of Building Projects in  
the Gauteng Province of South Africa**

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## ABSTRACT

Design development is a stage of the construction procurement process where the requirements of a project are specified including the technical and performance specifications. Thus the design development stage provides a significant opportunity in construction to incorporate green principles into building procurement to achieve energy efficiency, resource efficiency and environmental friendliness in the life cycle of built assets thus producing green buildings. However, this does not always happen in practice and in South Africa some of the reasons underlying this problem have not yet been fully researched and understood. Therefore, the purpose of this research was to conduct a study into factors that undermine the incorporation of green principles into building projects at the Design Development Stage.

This research aims to examine the factors in the Design Development Stage in projects that undermine it from producing green buildings in South Africa's construction industry, the Gauteng province being the focus of the study. The study investigated what is required from procurement processes generally to result in green buildings, then further narrowed down what is specifically required from actions undertaken at the Design Development Stage of projects to produce green buildings. Actions undertaken by the main practitioners involved in the Design Development Stage in Gauteng was then investigated in order to determine the factors within the Design Development Stage that undermine it from producing green buildings.

Based on the critical review of the literature, six factors were systematically identified to facilitate each phase of the Design Development Stage producing green buildings, namely; "green concepts", "green design", "green specifications", "green cost systems", "green financial viability systems" and "green programmes".

Based on the knowledge acquired from the literature about the processes involved in the Design Development Stage, questions were developed to enable semi-structured interviews and a questionnaire survey to be conducted. The questionnaire was designed and administered online to architects and quantity surveyors using the Qualtrics software which also supports the analysis of data provided by respondents. Data collection for the study was restricted to the Gauteng Province of South Africa which contains the country's largest city, Johannesburg, its administrative capital, Pretoria, and a population of around 12.3 million. Hence there is a significant concentration of building projects and professionals in this Province to provide a useful setting for the collection and analysis of data to achieve the study objectives.

Results flowing from the analysis of information collected from 25 architects and 20 quantity surveyors indicate that the main factors undermining the incorporation of green principles in the Design Development Stage are “Green cost systems”, “Green financial viability systems” and “Green Programmes”. The six factors identified that facilitate the Design Development Stage producing green buildings were as follows; “Green concepts”, “Green design”, “Green specifications”, “Green cost systems”, “Green financial viability systems” and “Green programmes”. Although the findings indicate that the incorporation of green principles at the Financial Planning Phase and Project Programme Phase are the main hindrance towards producing green buildings; this must be looked at with care as the Design Phase offers the greatest chance to produce green buildings.

It is recommended that further research to other provinces with a larger sample size and frame is undertaken to gain a more accurate depiction of South Africa’s construction industry. Furthermore a study to *why* these factors are underperforming and how they can be configured to work to green buildings is recommended.

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## LIST OF DEFINITIONS

**Design Development Stage:** The third stage of a construction project as outlined by PROCSA (2013), it involves the development of the approved concept to finalise the design, the outlining of specifications, cost plans, financial viabilities and the programme to be used for the project.

**Energy efficiency:** The increased use of renewable resources and minimisation and efficient use of non-renewable resources.

**Environmentally responsible:** The elimination, reduction and minimisation of the effect construction and buildings have on the environment i.e. to land, water and the atmosphere.

**Green buildings:** Energy efficient, resource efficient and environmentally responsible buildings (Green Building Council SA, 2013).

**Procurement:** The process which creates, manages and fulfils contracts relating to the provision of goods, services and construction works or disposals or any combination thereof (BSI, 2009).

**Resource efficiency:** The efficient use of land, water and materials in construction and in buildings.

**Stakeholders:** Groups or individuals who are directly involved in the project and/or are affected by it (BSI, 2011).

**Supply chain:** Network of suppliers, including subcontractors (BSI, 2010).

**Sustainability:** State in which components of the ecosystem and their functions are maintained for the present and future generations (BSI, 2009).

**Sustainable construction:** construction that facilitates economic growth, social progress and protection of the environment (BSI, 2008).

**Sustainable development:** Development that meets the needs of the present without compromising the ability of future generations to meet their own needs (BSI, 2008).

**Sustainable procurement:** A process whereby organisations meet their needs for goods, services, works and utilities in a way that achieves value for money on a whole life basis in terms of generating benefits not only to the organisation, but also to society and the economy, while minimising damage to the environment (Sustainable Procurement Task Force, 2006) as cited by (CIRIA, 2011).

**Life cycle analysis:** Any technique that allows assessment of a given solution, or choice from among alternative solutions, on the basis of all relevant economic consequences over the service life of an asset (CIRIA, 2011).

**Life cycle costs:** The total cost of an asset throughout its life including planning, design, acquisition, operation and maintenance and disposal, less any residual value (CIRIA, 2011).

**Whole-life cost:** The total cost of an asset or its parts throughout its life, including the costs of planning, design, acquisition, operation and maintenance and disposal, less any residual value (CIRIA, 2011).

## GLOSSARY OF CONCEPTS

**Green concepts:** The incorporation of green principles into developing the approved concept.

**Green design:** The incorporation of green principles into design.

**Green principles:** Green building and sustainable principles such as energy efficiency, resource efficiency, environmental friendliness, resource management, life-cycle design and social concerns.

**Green programme:** The incorporation of green principles into developing project programmes.

**Green cost systems:** The incorporation of green principles into producing cost plans.

**Green specifications:** The incorporation of green principles into providing specifications.

**Green financial viability system:** The incorporation of green principles into conducting financial viabilites.

## LIST OF ABBREVIATIONS

|               |                                                            |
|---------------|------------------------------------------------------------|
| <b>BIM:</b>   | Building Information Model                                 |
| <b>BoM:</b>   | Bill of Materials                                          |
| <b>BoQ:</b>   | Bill of Quantities                                         |
| <b>BRE:</b>   | Building Research Establishment                            |
| <b>BSI:</b>   | Building Standards Institution                             |
| <b>CIDB:</b>  | Construction Industry Development Board                    |
| <b>CIOB:</b>  | The Chartered Institute of Building                        |
| <b>CIRIA:</b> | Construction Industry Research and Information Association |
| <b>CSI:</b>   | Construction Specifications Institute                      |
| <b>EIA:</b>   | Environmental Impact Assessment                            |
| <b>EMS:</b>   | Environmental Management Systems                           |
| <b>EU:</b>    | European Union                                             |
| <b>Fpdd:</b>  | Fixed Price Contracts Based on Detailed Designs            |
| <b>GBCSA:</b> | Green Building Council of South Africa                     |
| <b>GCC:</b>   | General Conditions of Contract Construction                |
| <b>GCG:</b>   | Green Construction Guideline                               |
| <b>GGP:</b>   | Green Government Procurement                               |
| <b>GPP:</b>   | Green Public Procurement                                   |
| <b>IFOA:</b>  | Integrated Form of Agreement                               |
| <b>ILO:</b>   | International Labour Organisation                          |
| <b>IPD:</b>   | Integrated Project Delivery                                |
| <b>IRR:</b>   | Internal Rate of Return                                    |
| <b>IT:</b>    | Information Technology                                     |
| <b>JBCC:</b>  | Joint Building Contracts Committee                         |
| <b>LCC:</b>   | Life Cycle Costing                                         |

## THE DESIGN DEVELOPMENT STAGE AND GREEN BUILDINGS

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|                 |                                                                                           |
|-----------------|-------------------------------------------------------------------------------------------|
| <b>NEC:</b>     | New Engineering Contract                                                                  |
| <b>NHBRC:</b>   | National Home Builder Registration Council                                                |
| <b>NPV:</b>     | Net Present Value                                                                         |
| <b>O&amp;M:</b> | Operation and Maintenance                                                                 |
| <b>PROCSA:</b>  | Professional Consultant Services Agreement Committee                                      |
| <b>ROE:</b>     | Return on Equity                                                                          |
| <b>ROI:</b>     | Return on Investment                                                                      |
| <b>SACAP:</b>   | The South African Council for the Architectural Profession                                |
| <b>SACQSP:</b>  | The South African Council for the Quantity Surveying Profession                           |
| <b>SCM:</b>     | Supply Chain Management                                                                   |
| <b>SIMAP:</b>   | Système d'Informations sur les Marchés Publics (Information System on Public Procurement) |
| <b>SME:</b>     | Small and Medium Enterprises                                                              |
| <b>SoR:</b>     | Schedule of Rates                                                                         |
| <b>SPC:</b>     | Sustainable Performance Criteria                                                          |
| <b>WACC:</b>    | Weighted Average Cost of Capital                                                          |
| <b>WLC:</b>     | Whole Life Costing                                                                        |

## **1. CHAPTER 1: INTRODUCTION**

### **1.1. Background to Study**

#### **1.1.1. Procurement, the Design Development Stage and Project Delivery**

The Design Development Stage is key towards successful project delivery as it forms an important component of procurement. As highlighted by PROCSA (2013), its activities involve the development of the approved concept to finalise the design, outlining of specifications, cost plan production, conducting financial viabilities and the establishment of programmes for projects.

Procurement as defined by BSI (2009) is the process which creates, manages and fulfils contracts. It is as a succession of logically related actions performed in a definite manner and which concludes in the completion of a major deliverable or the attainment of a milestone.

Procurement systems, its processes and subsequent methods and procedures undertaken within developments govern how projects are delivered. Project delivery methodology as outlined by Horman *et al.* (2009) is significant as it determines the working relationships and strategies undertaken to achieve objectives. Procurement systems as highlighted by Mathonsi and Thwala (2012) govern the delivery processes of construction projects and thus set the basis for successful project delivery. It is through these processes that materials, services etc. that are required for the completion of projects are identified, selected and commissioned (Multiproject, 2012).

Several authors such as (Carayannisa and Popescub, 2005), (Mbachu and Raymond, 2007) and (Eriksson and Westerberg, 2011) highlight and identify traditional procurement as being characterised by several deficiencies resulting in poor project performance and project delivery. Traditional procurement thus creates a problem towards successful project delivery.

#### **1.1.2. Brief Context of the Construction Industry in South Africa**

The delivery of products i.e. property, makes up the property industry and occurs via the construction industry. There is an inherent link between the construction and property industry that cannot be overlooked. Construction industries are characterised as being large, diverse and complex. Furthermore its size and complexity is further complicated by the vast number and range of employees in the industry. There is an evident gulf in the size and nature of the companies and institutions working within the South African construction industry (CETA, 2008).

At the heart of the industries complexities are the differences that exist in:

- Internal organisational structures
- Variety in training and development needs and priorities
- Differences in professional networks and inter-organisational relationships
- The variety in the policy and regulatory frameworks which govern the various sub sectors
- The differences in training and professional development traditions

Due to these complexities that exist within the construction industry, factors that contribute towards the successful delivery of projects such as planning, managing and developing workplace skills need to be taken cognisance of (CETA, 2008). Only 50% of South African tenders are evaluated on quality, based on the Construction Industry Development Board (CIDB) CII's report, indicating a problem that currently exists with procurement within South Africa's construction industry (CIDB, 2013). According to CETA (2008), it is estimated that there are over 35 000 employers in the construction industry, and approximately 330, 120 employees. While the industry has large employers, about 95% of the industry can be considered as micro to small enterprises.

There is an increasing concern regarding sustainable development and the impact businesses have on society and the environment. The focus on these topics is evident from the trends depicted in the media, business practices and academic literature (Brammer and Walker, 2012). As highlighted by Sev (2009), sustainable construction revolves around three philosophies; economic growth, social progress and the protection of the environment. Furthermore as traditional construction is a major contributor to the degradation of the environment, sustainable development within the construction industry presents an avenue to reduce the negative impacts it has on the environment.

As procurement and more specifically the Design Development Stage governs the delivery of projects and sustainability increases in importance, "green" procurement presents a solution to tackle the environmental issues construction projects present. "Green" procurement is a holistic process that integrates environmental criteria from inception to the end life of a product. Projects are looked at beyond their physical completion; the use, its maintenance and eventual end life is all considered and taken into account. "Green" procurement considers lifecycle assessment of a product and aims to achieve high quality construction in conjunction with efficiency (Manoliadis *et al.*, 2012).

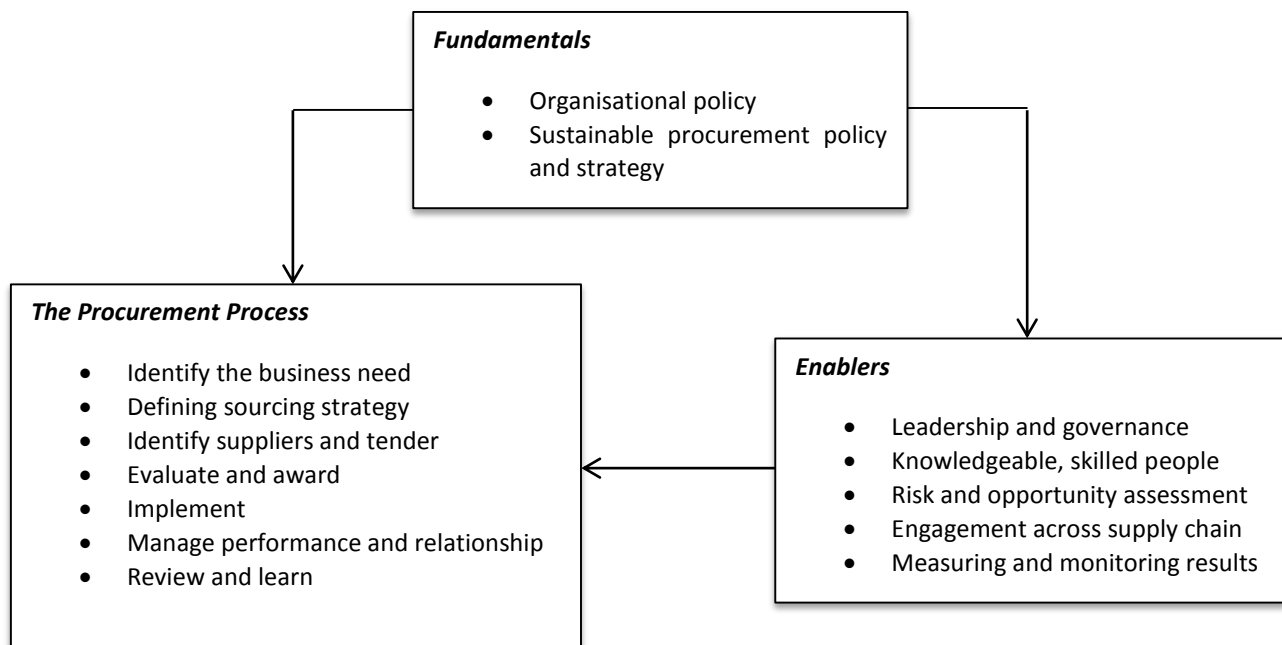
"Green" construction and the subsequent green buildings that follow satisfy the core principles of sustainability, "green" development can thus be used as part of an overall plan for sustainable development.

### 1.1.3. Sustainability in the Construction Industry

Sustainability as defined by The Construction Industry Research and Information Association (CIRIA) (2011), is about finding a balance between economic, social and environmental needs. Its principles require that in meeting our current needs it is not to the detriment to our needs in the future.

“Green” and sustainable procurement aims to bring about long-term value to an organisation, individual or end user by the use of purchasing power. It involves understanding and analysing the effect products and services stemming from its supply chain have on the community, environment and economy, it then takes steps to mitigate expected negative impacts and promote welfare. In addition the inclusion of sustainable considerations alongside usual criteria such as purchasing price and quality needs to be taken heed of when making purchasing decisions in order to achieve best value for money over the lifetime of goods and services (CIRIA, 2011).

Within the context of construction, sustainable procurement requires the value chain in its entirety from the client to the lowest tier to have an appreciation and commitment towards the sustainability agenda. Traditionally any requirement, such as sustainability, would stem solely from the client, the role of the supply chain being to respond to the client’s requirements. To further facilitate sustainability, the development of more integrated approaches to projects is imperative, relying on all participants within the value chain being proactive (CIRIA, 2011). Figure 1 provides a framework for procuring sustainably.



**Figure 1 Framework for Procuring Sustainably**

(BSI, 2010)

### 1.1.4. Significance of Green Buildings in South Africa

Green buildings are buildings which are energy efficient, resource efficient and environmentally responsible (Green Building Council SA, 2013). *Energy efficiency* involves the increased use of renewable resources and the minimisation and efficient use of non-renewable resources, *resource efficiency* involves the efficient use of land, water and materials in construction and in buildings and *environmental responsibility* involving the elimination, reduction and minimisation of the effect construction and buildings have on the environment i.e. to land, water and the atmosphere.

Sustainable buildings are buildings which are environmentally friendly, socially responsible and ensure economic growth (Sev, 2009). As both “green” and sustainable buildings ultimately seek to achieve the same outcomes the terms can be used interchangeably.

The development of property within the South African economy is primarily subjected to traditional construction practices (Mbachu and Raymond, 2007), the negative impacts traditional construction practices and their subsequent products have; such as environmental degradation, inefficient energy usage etc. thus impact the economy inherently (OECD, 2007). In order for the construction industry to remain in touch with international standards and remain competitive it is of grave importance South Africa’s construction industry stays in touch with changes in procurement processes and subsequently the Design Development Stage within it.

Green buildings provide a solution to the negative impacts of traditional processes and practices as they are designed for optimum energy efficiency and are constructed with a preference for natural, reclaimed, and recycled materials (Hwang and Ng, 2013). As sustainability increasingly becomes a focal point in construction and property internationally, procurement practices and processes within South Africa will follow suit and seek to achieve “green” / sustainable property development. There is already a movement internationally and locally (within South Africa) within the construction and industry towards “green” and sustainable buildings. Green buildings are buildings which are energy efficient, resource efficient and environmentally responsible (Green Building Council SA, 2013). Sustainable buildings are buildings that satisfy and revolve around the triple bottom line of sustainability i.e. economic growth, social progress and the protection of the environment (Chatterjee, 2009); for the purpose of this report the two being synonymous.

There are a number of “green” products slowly being introduced into the South African construction industry with an aim towards greater sustainability and thus less harmful towards the environment, indicative of the direction the construction industry is moving towards. ThermaGreen Steel Structures is a “green” product which is a fully recyclable “green” building system with pre-insulated light gauge steel framing. The system is made up of only lightweight steel and Expanded Polystyrene moulded

into a strong, light weight building component. The aim of the system is to reduce/eliminate the harmful effects of construction (ThermaGreen, 2012).

The presence of bodies within South Africa such as the Green Building Council of South Africa (GBCSA) is indicative of the diffusion of “green” and sustainable practices within the construction industry. Furthermore there is a growing trend towards energy-efficient building design and construction in South Africa (MediaClubSouthAfrica, 2013). The Green Building Council of South Africa is an independent organisation which was established to ensure that the construction and use of buildings are done in an environmentally friendly way within the South African economy. The rating system works on the basis of the GBCSA employing independent assessors to rate buildings. Certification is awarded for **four-star, five-star or six-star** Green Star SA ratings (Green Building Council SA, 2013). A **four-star rating** indicates "best standard practice"; **five-star rating** recognising "South African Excellence" and **six-star rating** indicating that the project is a world leader (MediaClubSouthAfrica, 2013).

In the year 2009, South Africa was awarded its first certified green building, that number is expected to have grown to over fifty by the year 2014 (Green Building Council SA, 2013). The Aurecon Century City Office in Cape Town is the first property development to receive a five-star rating for its office design. In addition Nedbank's new regional head office at the Menlyn Maine precinct development in Pretoria obtained a four-star rating award from GBCSA for its green office design as well, becoming Nedbank's third building to receive a four-star rating, joining the Nedbank head office in Sandton, Johannesburg and the Nedbank Ridgeside office development in Umhlanga, Durban (MediaClubSouthAfrica, 2013). Furthermore the first green star certification to a refurbished building in South Africa was awarded by the Green Building Council of South Africa. The Millennia Park office building situated in the heart of Stellenbosch achieved a 5 Star Green Star SA Office v1 “Design” certification (South Africa Commercial Property News, 2012).

In 2013 South Africa's construction industry introduced new building regulations aimed at moving the construction industry towards greener practices. These standards have been defined by the South African Bureau of Standard's SANS 10400 XA standard document, and to be enforced in terms of the National Building Regulations and Building Standards Act. The standards defined will not be compulsory as yet as its stipulations are more demanding in terms of methods and materials used; instead it is the standards the construction industry aims to work towards over the next eight to 10 years (MediaClubSouthAfrica, 2013).

The diffusion of “green” practices within the South African construction industry is evident within past and current literature and media. The importance of “green” procurement can thus not be overlooked

as it provides a route towards producing green buildings i.e. buildings that have the potential to achieve green buildings certification. For this reason it is of importance one takes cognisance of what is required from the Design Development Stage to produce green buildings.

### **1.2. Problem Statement**

As highlighted sustainability is a concept gaining momentum in various industries internationally and locally in order to combat the negative effect industries have on the economy, environment and society, construction industries being no exception. As the South African construction industry is characterised by having traditional buildings which in itself is characterised by having an adverse impact on the environment (Brammer and Walker, 2012), sustainability and green principles is inherently important as the construction industry has a major impact on economic growth, social progress and the environment (OECD, 2007). Furthermore as the Design Development Stage provides the most significant chance to achieve project objectives, it thus provides the greatest opportunity to incorporate green principles into building procurement and produce green buildings.

Results from previous research such as Eriksson and Westerberg's (2011) and Eriksson *et al.* (2009) highlight the need to reconfigure traditional procurement to improve successful project delivery, highlighting factors such as an integrated approach required to further facilitate successful project delivery.

The focus of the research problem thus pertains to traditional buildings not being "green", economic, socially progressive and environmentally friendly. Further to this traditional procurement, more specifically the Design Development Stage is subject to several deficiencies in South Africa resulting in poor project delivery and not producing green buildings. The Design Development Stage being concentrated on in projects not producing green buildings within South Africa's construction industry, the Gauteng province being the focus. The purpose of the study is to develop a better understanding of the extent to which the "green" and sustainability agenda has diffused into procurement and the Design Development Stage more specifically within the construction industry. The aim of the research to determine the factors within the Design Development Stage in projects that undermine it from producing green buildings in the Gauteng province.

Identifying the requirements for procurement processes and the Design Development Stage more specifically towards green buildings is imperative before one can determine what undermines the Design Development Stage from producing green buildings. An Investigation on current practice at the Design Development Stage in Gauteng's construction industry is then required to subsequently establish these limitations.

### **1.3. Aim and Objectives**

The aim of the study is to:

Determine the factors within the Design Development Stage undertaken in projects within Gauteng, South Africa's construction industry that undermine it from producing green buildings.

The objectives of the study are to:

- Identify what is required from the Design Development Stage to produce green buildings.
- To determine the extent to which green principles are incorporated into the Design Development stage by practitioners in Gauteng.
- To determine the reasons for green principles not being or being incorporated into the Design Development Stage by practitioners in Gauteng.

### **1.4. Research Questions**

#### **1.4.1. Primary Research Question**

The research question to be addressed by the study is as follows:

- What factors within the Design Development Stage in projects undermine it from producing green building in Gauteng's construction industry?

#### **1.4.2. Key Research Questions**

The following questions are key research questions intended to be answered by the study:

- What is required from the Design Development Stage to produce green buildings?
- To what extent are green principles incorporated into the Design Development Stage by practitioners in Gauteng?
- What are the reasons for green principles not being or being incorporated into the Design Development Stage by practitioners in Gauteng?

## 1.5. Brief Overview of Research Approach

### 1.5.1. Design and Methods

Research design and methodology involves the overall plan of how one intends on going about answering research questions, it is the “the blueprint”. Research design and methodology comprises of clear objectives derived from research questions and stipulates the sources intended to collect data and subsequently analyse from (Bhattacharjee, 2012).

The research onion as detailed by Lewis, Saunders and Thornhill (2012) was used as a basis to determine the research design and methods for the study, systematically identified based on the aims and objectives of the study and the research questions.

The nature of the report’s research design is that of a **descriptive study** as the study gains further insight into actions at the Design Development Stage of projects to produce green buildings. As outlined by Lewis, Saunders and Thornhill (2012), the emphasis on descriptive research is to gain an accurate understanding of the framework of events, persons or situations. The methodological choice for the research is that of a mono model method, the analytical procedure being that of a qualitative study, the research strategy being that of a survey, comprising of interviews and a survey based questionnaire to collect data.

Based on the critical review of the literature on the Design Development Stage, questions were developed to enable semi-structured interviews and a questionnaire survey to be conducted. Similar research, as highlighted in table 1 made use of a Likert scale. The research instrument used for the study thus incorporated a 5 point Likert scale to collect more accurate data. The research’s questionnaire scale ranging from “very poor”-1, “poor”- 2, “fair”-3, “good”-4 and “very good”-5, “fair” indicating the minimum required level of performance for a factor to be effective.

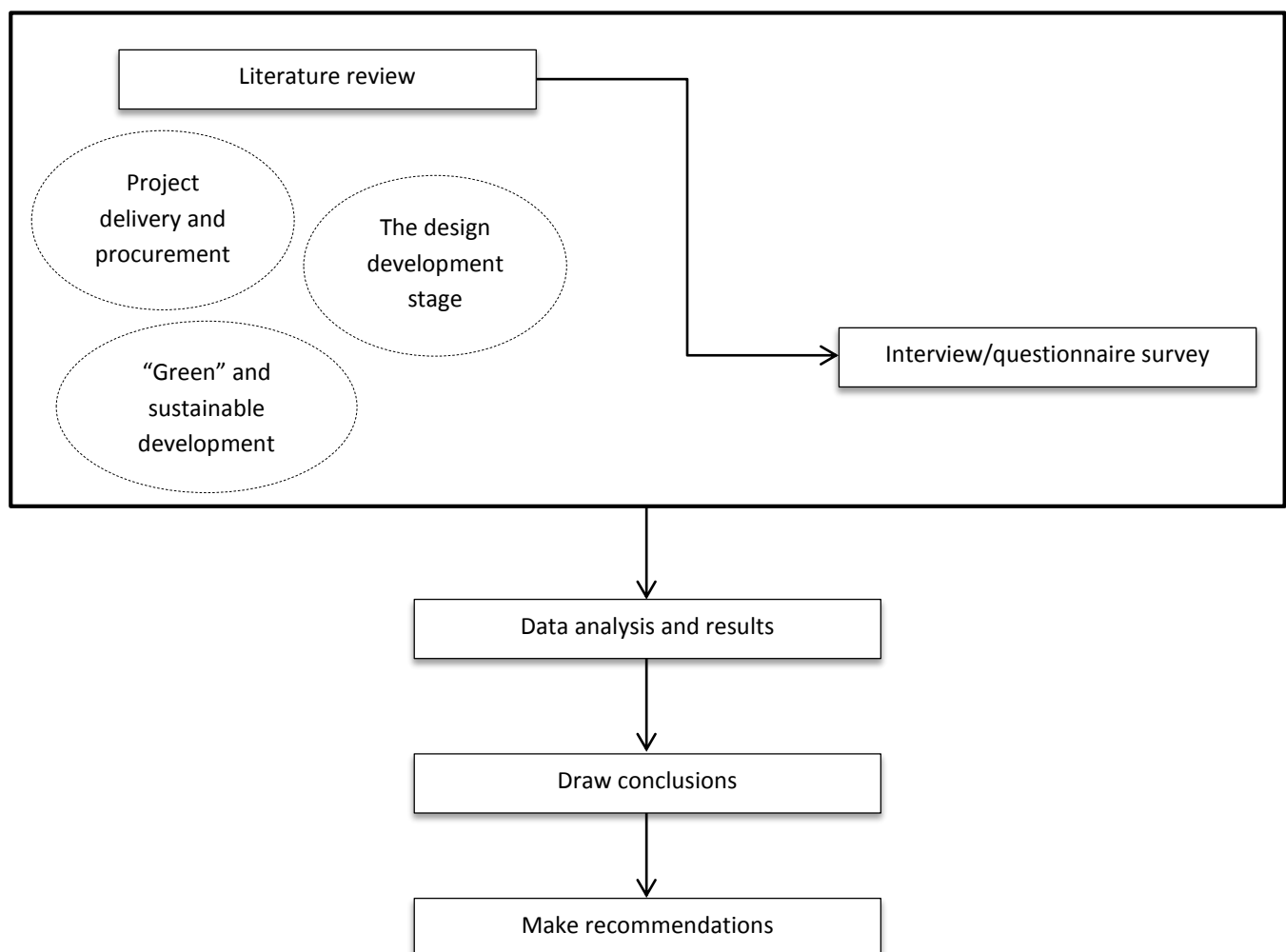
**Table 1 Research Containing Likert Scale**

| Researchers                     | Topic containing Likert scale        |
|---------------------------------|--------------------------------------|
| (Eriksson <i>et al.</i> , 2009) | Cooperative Procurement              |
| (Chan <i>et al.</i> , 2010)     | Green specifications in construction |
| (Jorge <i>et al.</i> , 2010)    | Contractors’ green innovation        |
| (Chan <i>et al.</i> , 2011)     | EMS and green specifications         |
| (Mathonsi and Thwala, 2012)     | Selection of Procurement Systems     |
| (Huang <i>et al.</i> , 2013)    | Green construction                   |
| (Hwang <i>et al.</i> , 2013)    | Green construction                   |

### 1.5.2. Data Collection

The literature review sets out the context of the study and clarifies the framework in which the interview questions and questionnaire survey was developed. Based on the literature review, questions were developed for discussion and sent out to key stakeholders within Gauteng's construction industry in order to plug the gaps in terms of the research question. The sample frame for the investigation comprises of architects and quantity surveyors with knowledge and experience of Gauteng's construction industry, as these are the main practitioners involved at the Design Development Stage of projects.

Data collected will be analysed in order to determine *the factors within the Design Development Stage that undermine it from producing green buildings in Gauteng's construction industry?* Figure 2 provides the framework to which the study will follow.



**Figure 2 Data Collection**

### 1.6. Scope of the Work

#### 1.6.1. Scope

The scope of work for the research revolved around concepts relating to the Design Development Stage of projects and green buildings. Literature in an international and local context was reviewed to gain an understanding of concepts and practices pertaining to building procurement, the Design Development Stage, the sustainability revolution in the construction industry, the incorporation of green principles in procurement and what green buildings entail.

Green principles incorporate any and all concepts that facilitate or promote “green” initiatives in the construction industry, such as sustainability and green building criteria. Sustainability hinges on three key elements, namely; economic growth, social progress and the protection of the environment, known as the triple bottom line (Sev, 2009), green buildings being buildings which are energy efficient, resource efficient and environmentally responsible (Green Building Council SA, 2013).

The investigation was then narrowed down to Gauteng’s construction industry in order to determine the factors within the Design Development Stage that undermine it from producing green buildings. The sample frame for the study is restricted to architects and quantity surveyors as these are the key contributors at the Design Development Stage of projects within the construction industry.

#### 1.6.2. Limitations

All studies are subject to potential limitations that impact the reliability of their findings. In terms of “green” and sustainable delivery, several variables have the potential to influence the outcome of “green” and sustainable performance. It is for this reason a quality study would require a sample size in the thousands. By necessity such a large study would be required to be done over a number of years. In addition the design of the study would have to be done in a manner that caters for lapses in time between implementation and results (Horman *et al.*, 2009). The scope of this study is restricted and is thus subject to the following limitations:

##### Internal Factors

- Not all stakeholders in the industry have been included within the **sample frame** of the study; the study is limited to architects and quantity surveyors within the construction industry with and having experience with the Design Development Stage in construction projects.

### External Factors

- Different ***economic climates*** affect the outcome of sustainability; the impact of the same variable in one economy may thus have a different effect on South Africa's property industry. The ***application*** of green principles may be less effective in Gauteng, South Africa as inherent differences exist between different economies, thus affecting the validity of findings, this may be due to various factors such as available skills, technology etc.

### 1.7. Chapter Summary

This chapter provides a background to the study by providing a brief introduction to project delivery, procurement, the Design Development Stage, sustainability, green buildings and green concepts. Research questions and consequent data collection techniques are then identified. Furthermore the chapter outlines the significance of the study in relation to the South African construction industry before presenting the scope and limitations of the study.

## **2. CHAPTER 2: LITERATURE REVIEW**

### **2.1. Introduction**

This chapter provides the context of the study; it provides a critical review of the literature by linking the existing literature to the research problem, research questions and what other researchers have done, furthermore the research gaps in knowledge are identified and discussed. Project delivery is discussed firstly to provide an overview on the process of delivering construction projects. Procurement, as it is determined to be a critical factor towards successful project delivery is then presented to provide an understanding of its role, importance and components. The Design Development Stage is then looked at in detail. A discussion on sustainability then follows presenting the climate in which construction industries are currently subjected to. Green buildings and green principles is then presented followed by the vehicles used to achieve it.

### **2.2. Literature Link to Research Problem and Research Questions**

In order to critically review the literature the link between existing literature and the research problem, research questions and what other researchers have done was established. From this basis it was possible to identify and establish the research gap in which the study is to contribute towards existing literature.

#### **Research Problem**

The focus of the research problem is traditional buildings not being “green”, economic, socially progressive and environmentally friendly. Further to this traditional procurement, more specifically the Design Development Stage is subject to several deficiencies in South Africa resulting in poor project delivery and not producing green buildings.

The key areas thus needing to be investigated for the study being (1) Project Delivery, (2) Procurement, (2) The Design Development Stage and (4) Green buildings.

#### **Research Questions**

##### ***Primary Research Question***

The research question to be addressed by the study is as follows:

- What factors within the Design Development Stage in projects undermine it from producing green buildings in Gauteng, South Africa’s construction industry?

### ***Key Research Questions***

The following questions are the key research questions intended to be answered by the study:

- What is required from the Design Development Stage to produce green buildings?
- To what extent are green principles incorporated into the Design Development Stage by practitioners in Gauteng?
- What are the reasons for green principles not being or being incorporated into the Design Development Stage by practitioners in Gauteng?

### **Literature Review**

In order to solve the research problem and answer the research questions the following research areas were looked at:

- ***Procurement and Project Delivery***

This research area was investigated in order to understand what is required from the construction industry and from projects in order to achieve successful project delivery and the role procurement plays towards successful project delivery. This area links towards the research problem and research questions by understanding what is fundamentally required to achieve successful project delivery in the construction industry.

- ***Procurement***

As procurement is identified as a major contributor towards successful project delivery in the construction industry (Anderson and Oyetunji, 2004); this area was further examined to understand the dynamics of procurement, identify its key components and to determine what is required from procurement to work effectively and efficiently. This area links towards the research problem and research questions by understanding what is required from procurement to achieve successful project delivery.

- ***The Design Development Stage***

Further to procurement, the Design Development Stage is seen as a key component in procurement as it presents the greatest chance towards achieving project objectives. The Design Development Stage plays a key role in procurement as actions undertaken in stages to follow hinge on information provided from this stage (CIDB, 2011; PROCSA, 2013). Actions undertaken in this stage were thus investigated to understand what occurs in the stage and what is required from the stage to achieve project objectives. This area links towards the research problem and research questions by identifying factors within the Design Development Stage that contribute towards successful project delivery.

- ***Sustainability***

As sustainability continues to grow in importance in the construction industry (Chatterjee, 2009), this area of research was investigated as it falls under the umbrella of green buildings and subsidiary “green” concepts (Green Building Council SA, 2013). This area links towards the research problem and research questions by understanding the broader framework in which construction and green buildings are subject to and what is required for sustainability to take place.

- ***Green Buildings***

Green buildings are at the forefront in the construction industry and represent a solution to the problems traditional buildings bring (Green Building Council SA, 2013). This area links towards the research problem and research questions by understanding what green buildings exactly are and what performance is required from buildings to be considered “green”.

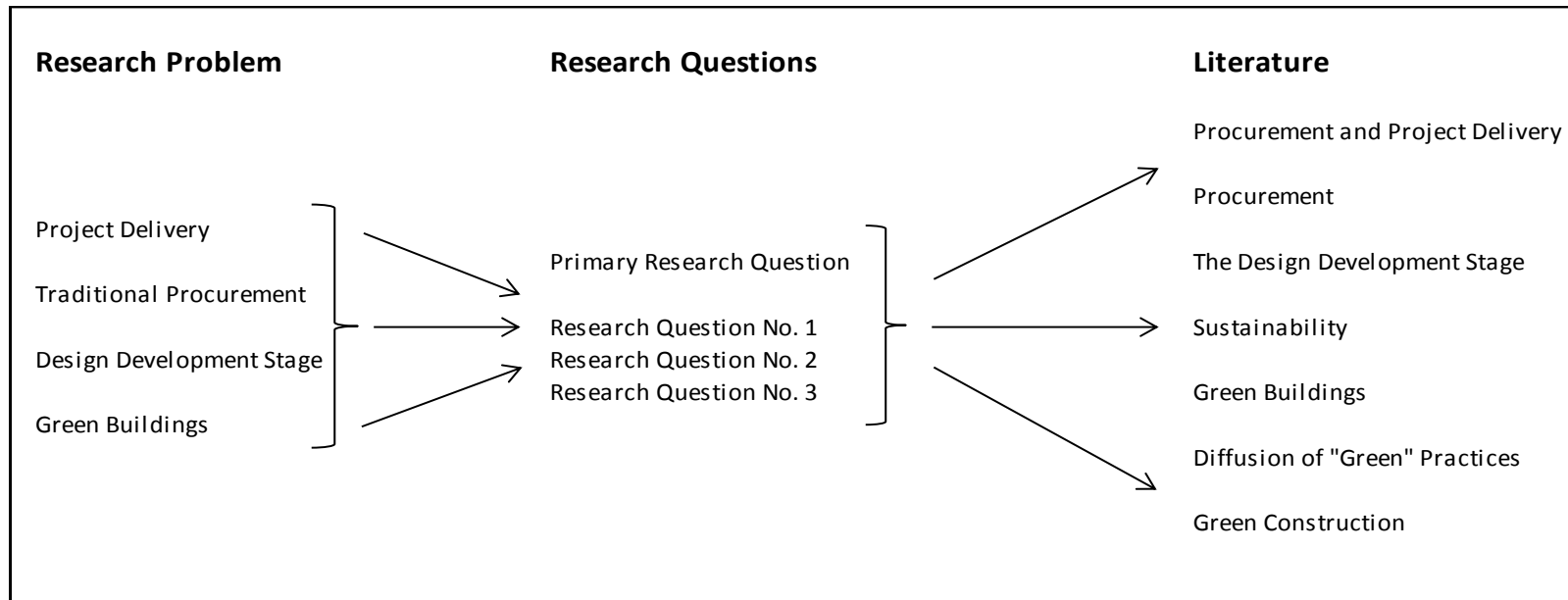
- ***Diffusion of "Green" Practices***

In order for procurement activities to translate into the production of green buildings, “green” practices need to be diffused into procurement processes and subsequently the Design Development Stage to facilitate the production of green buildings. “Green” practices entail activities such as “green” procurement and “green” designs (CIRIA, 2011; Doberstein and Geng, 2008; GGGC, 2014; Chiu *et al.*, 2013). This area of research links towards the research problem and research questions by linking procurement processes and subsequently the Design Development Stage directly towards what is required from these activities for the production of green buildings.

- ***Green Construction***

Construction is the vehicle through which projects are physically delivered. For this reason it is imperative its processes and procedures are effective and efficient to ensure successful project delivery and to facilitate the production of green buildings via “green” construction (Huang *et al.*, 2013). This area of research links towards the research problem and research questions as construction methodology and materials hinge on information provided from the Design Development Stage. Furthermore by identifying what is required for “green” construction to take place one can determine how procurement and the Design Development Stage should be configured to facilitate “green construction”.

Figure 3 shows the link between the literature reviewed and the research problem and research questions.



**Figure 3 Literature Link to Research Problem and Research Questions**

### 2.3. Procurement and Project Delivery

This area of research links towards the research problem and research questions as it helps to identify what is required from the construction industry and from projects in order to achieve successful project delivery. By identifying these factors it allows the study determine how the construction industry should be configured to facilitate successful project delivery.

#### 2.3.1. Stages of Development

The delivery of construction projects can be clearly outlined via stages; these stages follow sequentially but in reality are iterative and are indicative of procurement processes undertaken when delivering projects to completion. To ensure successful project delivery, procurement strategies and policies need to be taken cognisance of prior to the implementation of a project.

Professional Consultant Services Agreement Committee (PROCSA) is a professional body that regulates the terms of engagement between the client and consultants involved within construction projects in order to promulgate standardisation and good practice throughout the industry. PROCSA recognises six defined stages common to all disciplines throughout the life cycle of a project. Provided below are the six stages:

- Stage 1: Inception
- Stage 2: Concept and viability
- Stage 3: Design development
- Stage 4: Documentation and procurement
- Stage 5: Construction
- Stage 6: Close out

(PROCSA, 2013)

Discussed below are the activities that take place at each stage as outlined by PROCSA (2013).

#### Stage 1: Inception

At the inception stage the client requirements and preferences are established. The requirements for the user needs and options are assessed and evaluated. Appointment of necessary consultants required for the project is done at this stage. The project brief is established at this stage along with the project objectives, priorities, constraints, assumptions, aspirations and strategies.

### **Stage 2: Concept and viability**

The concept and viability stage involves the preparation and finalisation of the project concept in alignment with the brief including the scope, scale, character, form, function and preliminary programme and viability of the project.

### **Stage 3: Design development**

At the Design Development Stage, consultants develop the approved concept to finalise the design, outline the specifications, produce the cost plan, conduct the financial viability analysis, and programme to be used for the project.

### **Stage 4: Documentation and procurement**

The documentation and procurement stage involves the preparation of the construction and procurement documentations to be used for the project. Confirmation and subsequent implementation of the procurement strategies and procedures is employed to ensure effective and timeous procurement of the necessary resources for the execution of the project.

### **Stage 5: Construction**

At the construction stage, consultants manage, administer and monitor the contracts and processes, including the preparation and co-ordination of the procedures and documentation to facilitate practical completion of the works.

### **Stage 6: Close-out**

The close-out stage, the final stage of a project, encompasses the fulfilment and completion of the works to close-out the project. It involves the preparation of the necessary documentation to facilitate effective completion, handover and operation of the project.

The Chartered Institute of Building (CIOB) like PROCSA is a professional body within the construction industry; it is the leading professional body for managers in construction, with more than 42,000 members from across the world. CIOB recognises eight distinct stages within a construction project. Provided below are the eight stages of a construction project as outlined by CIOB:

- Stage 1: Inception
- Stage 2: Feasibility
- Stage 3: Strategy
- Stage 4: Pre-construction

- Stage 5: Construction
- Stage 6: Engineering services and commissioning
- Stage 7: Completion, handover and completion
- Stage 8: Post completion, review and close out

(CIOB, 2013)

Figure 4 shows how the project stages as outlined by PROCSA and CIOB correlate to each other.

| <b>PROCSA<br/>Stage</b> | <b>Designation</b>            | <b>CIOB<br/>Stage</b> | <b>Designation</b>                    |
|-------------------------|-------------------------------|-----------------------|---------------------------------------|
| 1                       | Inception                     | 1                     | Inception                             |
| 2                       | Concept and viability         | 2                     | Feasibility                           |
| 3                       | Design development            | 3                     | Strategy                              |
| 4                       | Documentation and Procurement | 4                     | Pre-construction                      |
| 5                       | Construction                  | 5                     | Construction                          |
|                         |                               | 6                     | Engineering services & commissioning  |
| 6                       | Close out                     | 7                     | Completion, hand over & occupation    |
|                         |                               | 8                     | Post-completion, review and close out |

**Figure 4 PROCSA and CIOB Stages**

(PROCSA, 2013)

### **2.3.2. Successful Project Delivery**

It is acknowledged as highlighted by Anderson and Oyetunji (2004) that; (i) the procurement path, (ii) its processes and (iii) contracting strategies undertaken within a project are major contributors towards successful project delivery as they set the basis for how a project will be implemented. These three factors determine how project teams are formed, the nature of working relationships within a project, the level of collaboration and the level of incentivisation to perform and meet project objectives. A study conducted by Horman *et al.* (2009) on “green” project delivery, further identifies the importance of the associations between *project delivery attributes* and *project performance*. The level of procurement performance and characteristics of the project in question determining the level of success of a project. As identified by Belout and Gauvreau’s (2004) study, there are various factors to which the success of projects can be measured against such as the project mission, management support, project schedule, client acceptance, personnel, technical tasks, communication, monitoring, trouble shooting and client consultation.

Research by Mbachu and Raymond (2007) identifies 10 success factors for projects to be considered successful, namely; project definition and formulation, project finance, contracting, legal agreements,

human factors, project implementation and management, politics and social factors, schedule and urgency, schedule duration and planning. Furthermore how the client responds to these factors inherently impacts performance and how consultants and contractors respond to these factors.

The two most prevalently used project delivery methods (procurement systems) in construction industries are (i) **design, bid and build** and (ii) **design and build**. Design, bid and build is a project delivery method in which the client contracts a design team i.e. architects/engineers etc. to provide design and supervision services based on the clients requirements. The documents are then used for tenders to contract with construction companies/contractors to carry out the works. Design/build is a project delivery method in which the owner provides requirements for the project and contracts with a company/contractor to both design and construct the project. The former requires two contracts whereas the latter makes use of one contract. Gibson *et al.* (2009) study which compares the performance of design/bid/build and design/build concludes the design/build method to being superior when used on building projects as it is subject to more efficient time and cost controls.

A study conducted by Gerber and Kent (2012) investigates the current position of Integrated Project Delivery (IPD), its use, future adoption, knowledge and experience level within the construction industry. IPD is a project delivery method used to enhance the performance of construction projects by means of a collaborative approach by aligning the incentives and objectives of the project via shared risk and reward, early participation of all team members, and mutual agreement. It is identified as a project delivery method to be used in order to facilitate the effective collaboration of project participants.

IPD facilitates the use of Building Information Modelling (BIM) for construction projects. BIM is a computer software model that provides professionals with a facility to simulate the design, construction, and operation of a project. It is not only a tool but also a process that enables project team members to collaborate over the life of a project (Gerber and Kent, 2012).

Various IPD contracts have been developed to facilitate collaboration and coordination. ConsensusDOCS was one of the first standard construction documents to address Integrated Project Delivery. Another contract that facilitates IPD is that of the Integrated Form of Agreement (IFOA), a relational Integrated Project Delivery contract that creates the contractual and financial framework for effective collaboration between contracting parties (Gerber and Kent, 2012).

### 2.3.3. Project Delivery in South Africa

Traditional procurement is the most undertaken procurement path in the South African construction industry, indicative of clients and professionals reluctance to implement different or new procurement paths and processes. Reasons for this including professionals' reluctance to implement unfamiliar procurement paths and processes due to uncertainty of its performance.

Client dissatisfaction in the South African construction industry can be characterised by a lack of project objectives been achieved due to constraints. According to Mbachu and Raymond's (2007) study, consultants' and contractors' acts of omission or commission is the most influential and most frequently occurring factor constraining successful project delivery in the South African construction industry. Further constraints include that of disputes and adversarial relationships.

Provided below are factors constraining successful project delivery in South Africa as identified by Mbachu and Raymond (2007):

#### **Controllable (internal) factors**

- (1) Project characteristics
- (2) Service providers' (consultants and contractors) influences
- (3) Client organisational influences

#### **Uncontrollable (external) factors**

- (1) Socio-cultural issues
- (2) Unforeseen circumstances
- (3) Economic and global dynamics
- (4) Governmental/statutory controls

### 2.4. Procurement

This area of research links towards the research problem and research questions as it helps to identify what is required from procurement within the construction industry and projects to ensure performance. By understanding the dynamics of procurement, its components and what is required from procurement to perform optimally the study can determine how procurement should be configured in order to achieve successful project delivery.

### 2.4.1. Definition of Procurement

BSI (2009) defines procurement as the process which creates, manages and fulfils contracts relating to the provision of goods, services and construction works or disposals or any combination thereof, further to this BSI (2010) and CIRIA (2011) defines procurement as the process of acquiring goods, works and services from suppliers (internal or external).

The procurement strategy for construction as defined by BSI (2011) refers to the overarching plan of action for an organisation, its management, funding, selection of and payment of supply chains for design, construction and the operations of facilities to achieve the objectives of a project. Processes fall within the scope of “procurement strategy”. As detailed by BSI (2009) processes are underpinned by methods (documented and systematically ordered collection of rules or approaches) and procedures (formal steps to be taken during the performance of a precise task); moreover these two features are shaped by the policies of an organisation.

### 2.4.2. Role of Procurement

Procurement is of importance as it is these systems that govern the delivery of projects and thus plays a key role in determining the success or failure of projects; furthermore it sets the basis for cooperation between clients and contractors. The choice of a suitable procurement path contributes considerably towards successful project delivery (Lacouture *et al.*, 2009). The procurement path and processes chosen in essence should reflect the requirements and needs of the project in question in order to promote efficiency and working relations. More over when looking at procurement with an intention towards sustainability, the project team has to look deeper into structures and processes undertaken in projects.

Eriksson *et al.* (2009) study underlines the importance of cooperative procurement towards achieving project goals. Procurement can be critically analysed from various facets, from the view and aim to achieving cooperative relationships, to “green” procurement in order to achieve sustainability. A hybrid of the two creates a scenario in which the construction processes results in sustainable products and improved relationships, inherently improving efficiency. In contrast traditional procurement procedures are competitive, resulting in conflicts, adversarial relationships and poorer project performance.

### 2.4.3. Procurement Performance

Eriksson and Westerberg's (2011) research examined how a broad range of procurement related factors affects project performance criteria. **Procurement related success factors** are those inputs to the management system that leads to successful project delivery whereas **project performance criteria** are the measures by which the success and failure of a project will be determined.

Furthermore Eriksson and Westerberg (2011) identify traditional procurement as being characterised by having an adversarial climate and being subjected to several inefficiencies, resulting in a waste of resources, such as capital, materials and time. Inefficiencies from the outcome of constructions projects ranges from inadequate client satisfaction to time delays, cost overruns, poor product quality and low productivity. A collaborative procurement approach within construction projects is believed to stimulate efficiency and promote successful project delivery (Gerber and Kent, 2012). One can only infer that the successful implementation of "green" procurement towards green buildings will require a collaborative framework and alliance between contracting partners.

Procurement is key to the planning, coordination, and management of costs, quality and risk in projects. Procurement success factors can be considered to revolve around cooperation and thus relate to joint specification, direct negotiation, soft parameters, joint subcontractor selection, incentive-based payment, collaborative tools, and supplier self-control. One of the requirements from projects needed to achieve goals such as sustainability via procurement is the mutual cooperation between participants in projects. Incentive based compensation; limited bidding options, partner selection and cooperation are ways in which procurement can establish a cooperative relationship between clients and contractors in construction projects. Without such coordination participants in a project cannot collate together to solve problems in projects (Eriksson and Westerberg, 2011).

The client's role towards effective procurement cannot be understated as the client's decisions on procurement ultimately overarch and govern procurement's implementation, thus depending on the client's decisions. The authority, roles and responsibilities within projects may differ, thus impacting the level of integration and cooperation among project participants (Eriksson and Westerberg, 2011).

The most commonly employed procurement path in construction projects is that of the traditional, design and build, management contracting and construction management procurement (Building, 2002). As highlighted in research conducted by Balfors *et al.* (2012), traditionally procurement procedures in construction are competitive and characterised by adversarial relationships and inefficiency. Furthermore traditional procurement processes tend to result in sub-standard project delivery due to such issues.

Previous literature discusses the use of alternative procurement processes towards successful project delivery due to the inefficiencies of traditional procurement (Eriksson *et al.*, 2009). There are a number of procurement paths that can be implemented in construction projects (Multiproject, 2012). The procurement path and processes undertaken within a project should reflect the requirements of the project in question in order to achieve successful project delivery.

The development of standards for common practice across industries is significant as it sets the benchmark for service and product quality. The British Standard Institution (BSI) is an organisation that publishes standards to be taken cognisance of in various industries within the United Kingdom. Within the construction industry, standards are published regarding procurement and sustainability. Publications relating to construction procurement includes that of BSI's (2009) publication, which presents standards for construction procurement, processes, methods and procedures and that of the BSI's (2011) publication, which presents standards for construction procurement policies, strategies and procedures. Publications regarding sustainable procurement and sustainable construction are that of BSI's (2010) publication on principles and framework for procuring sustainably and BSI's (2008) publication on sustainability in building construction.

#### **2.4.4. Types of Procurement**

There are a number of procurement paths that can be undertaken to deliver projects successfully, all projects need to select an overarching procurement strategy, procurement route and a contract strategy prior to implementing any procurement activity. Ultimately these are the documents that will determine the level of integration within a project's teams, the consultants to be hired, their supply chain, the risk allocation, payment methodology for suppliers etc. (CIRIA, 2011).

Different procurement paths available for project implementation are discussed below:

- ***Design, bid and build***

Design, bid and build is a project delivery method in which the client contracts a design team, i.e. architects/engineers etc. to provide design and supervision services based on the clients requirements. The documents are then used for tenders to contract with construction companies/contractors to carry out the works. This method is mostly popular among small and middle sized construction projects.

- ***Design and build***

Design and build requires the contractor to both design and build based on requirements and an outline provided by the client. This method is popular among middle sized and larger projects.

- ***Construction management***

Construction management entails the contractor acting as a consultant; they are required to manage the construction works undertaken by subcontractors but are not directly responsible for subcontractors. Construction management is still commonly applied, especially in technologically complex projects, where early completion is crucial.

- ***Management contracting***

Management contracting is a hybrid, being a fusion between traditional method and construction management.

- ***Private finance initiative***

Private Finance Initiative entails the use of Design and Build for large projects, where the contractor provides an investment in return for licence to charge fare for using the facilities for a designated period of time.

- ***Public private partnership***

Public Private Partnerships are a form of long-term cooperation between government and private organisations, e.g. modernisation and maintenance of London underground.

- ***Framework contracting***

Framework contracting is used on large projects, contractors are chosen based on selective criteria and not specifically on prices alone. It is usually associated with long-term cooperative contracts including many different projects.

- ***Prime contracting***

Prime contracting is an expanded traditional form of procurement including long-term partnership. The contractor is usually required to undertake construction works and subsequent building maintenance. It is primarily used by government institutions.

- ***Lump sum contract***

A lump sum contract entails a contractor completing the works based on a detailed plan provided by the client at a pre-determined cost. The contractor is not required to make any decisions regarding the project, as it may put him at risk of having to redo the works if the client does not approve. Small projects mainly make use of Lump Sum contracts (Multiproject, 2012).

- **Turnkey contract**

A turnkey contract is one in which a project is delivered in its completed state, a developer is hired to complete and handover a fully operational project without any input from the owner, in addition the developer is separate from the owner or final operator of the end product. The use of turnkey contracts ranges from small buildings to large scale developments (WiseGeek, 2013).

### **2.4.5. E-Procurement**

The advancement of internet technology and connectivity has increased the efficiency of the procurement for goods and services globally. Access to information and the subsequent reduction of barriers to entry within markets all play a role in increasing competition within markets. Carayannisa and Popescub (2005) identify electronic procurement, predominantly in the public sphere as an effective tool to increase countries' productivity, remove domestic barriers to international trade, and ultimately improve efficiency. Tools of the internet provide a vehicle for improved information sharing, reduction in transaction costs and savings in time.

The adoption of e-procurement in the construction industry is low despite the efficiency gains and technological advances it provides to its users. Construction industries in developing countries are categorised by Small and Medium Enterprises (SMEs) which frequently present low levels of readiness to effectively adopt Information Technology (IT) such as e-commerce. Regulations, legislation and policies are important tools that can be used to increase implementation of e-procurement. In conjunction with these tools e-procurement can only be practiced effectively once the construction industry is in a state of "readiness" to absorb IT practices (Ekram *et al.*, 2011).

There are four general stages that take place within the e-procurement process as identified in Carayannisa and Popescub's (2005) study, namely; (i) public procurement announcement system; (ii) document distribution (bidding documents), (iii) electronic bid submission and (iv) full electronic processing, including on-line purchasing and post-bid contract management. Carayannisa and Popescub (2005) demonstrate the importance of e-procurement and its role in supporting effective delivery of public procurement and promoting perfect competition, highlighting the benefits for the diffusion of e-procurement within industries.

The use of e-procurement has already been implemented in Europe; as highlighted by Carayannisa and Popescub's (2005) study, tools such as Système d'Informations sur les Marchés Publics (SIMAP) which translates to "Information System on Public Procurement" already exists within industries. SIMAP is a European Union website on electronic procurement, launched by the European

Commission in order to promote the use of information technologies for public procurement in the EU.

SIMAP provides the following benefits:

- ***Increased efficiency of notification and quality of notices***

SIMAP reduces the time information is processed and increases in the quality of notices as automatic checking of the system occurs.

- ***Facilitates the distribution of public procurement information, and the electronic data exchange between purchaser and suppliers***

SIMAP allows for public procurement notices to be submitted directly over the Internet for publication. In addition it allows users of the system to search for potential procurement opportunities.

- ***Lower transaction costs***

SIMAP provides new sources of supply by making procurement information available to firms which may not have otherwise been exposed to. This creates an opportunity to procure lower priced goods from contracting entities.

- ***Improve information on procurement markets***

Access to wider information is created, such as background information on operating procedures, participation rules regarding procurement processes and specific procurement legislation.

Three factor roles are identified by Ekram *et al.* (2011) study for e-procurement to take place, the Government aspect, the Organisational aspect and the Technological aspect. These factor roles are key to moving the industry to a state of “readiness” for implementation.

- ***Government aspect***

The role of the government towards e-procurement cannot be over looked. Through policies, regulations and support, governments can influence the absorption of e-procurement. Government leadership in terms of funding, resourcing, planning, management and implementation support creates a climate where procurement modernisation and change can occur. Efforts from governments to make provisions for training and education greatly enhance human resource performance. Government e-commerce initiative towards the private sector is imperative to enhance IT infrastructure especially in developing countries where issues such as quality, availability, and cost of accessing such infrastructure is not up to the required standard.

- **Organisation aspect**

Making changes and re-engineering processes within the organisational structure in developing countries is required to set up a structure capable of absorbing e-procurement. The decision makers' attitude towards e-procurement influences its uptake such as the managers' attitudes towards technology and risk. In addition their level of commitment, awareness and support are all factors that influence the absorption of e-procurement. Internal organisational characteristics, type of enterprise, ownership, organisational structure, organisational culture and operational scope are factors that impact the view of firms and the level of complexity for implementing e-procurement. The uptake of e-procurement by an organisation can be viewed as a function of its environment including economic, social, and political factors. Thus the position of the industry such as the level of e-procurement absorption in competitors and business partners is most likely to prompt organisations to follow suit.

- **Technology aspect**

The perceived benefits to be received and challenges expected to be faced by using new technologies such as e-procurement are factors that determine the level of e-procurement absorption within the construction industry. Positive views will result in increased absorption whereas negative views will hinder the implementation of e-procurement.

There are a number of barriers towards the implementation of e-procurement tools such as SIMAP, Ekram *et al.* (2011) study identifies the following barriers towards e-procurement's implementation.

- **Technology**

Technological issues hinder the up-take up of e-procurement within construction industries, while concerns such as the security of data transactions cause potential users to be reluctant. Challenges thus exist in finding affordable technical solution, prompting the need for cost investments. Furthermore the possibility of a lack of system integration, standardisation, and compatibility issues for users creates barriers for e-procurements use.

- **Management**

A lack of managerial leadership, knowledge, top commitment, technical expertise and strategic management hinders the effective use of e-procurement and its subsequent use in the future due to bad experiences.

- **Organisation**

The challenge of shifting the mind-set of people wanting to stay with the current systems presents a unique barrier towards e-procurement implementation. A change in the mind set may be required when introducing new technological advances.

- **Environment**

Poor IT infrastructure, a lack of a national IT policy, legal and regulatory systems creates barriers towards e-procurement absorption as there is no climate stimulating its use in the construction industry. It should be noted that a lack of suppliers and demand from clients, customers and competitors provides one of the biggest barriers as it reduces the market for e-procurement.

### 2.4.6. Procurement Processes

Discussed below as identified by Eriksson and Westerberg's (2011) study, are general procurement processes undertaken during construction projects. In addition collaborative tools are included in order to facilitate collaborative efforts within a project.

- **Design**

Involving contractors into the design process with the client and consultant team facilitates solutions with high constructability, an approach known as joint specification or concurrent engineering. Joint specification allows for innovation, cost and time reduction by bringing a holistic view of the project in terms of design and construction.

- **Tendering**

The tendering process is time consuming when several bidders are involved whereas direct negotiations allows for the possibility of early construction by reducing the time frame for tendering.

- **Bid evaluation**

When evaluating tenders it is imperative to allow for parameters other than just price for successful project delivery. Parameters such as technical competence, management capability, earlier experience, references, environmental and quality management systems, financial stability and collaborative skills should be taken cognisance of.

- **Sub-contractor selection**

Suppliers and subcontractors typically perform 70-80% of the gross work done in construction projects. Selection of sub-contractors by both the client and contractor is thus imperative to allow for both parties interests to be considered. Increased integration of sub-contractors will thus inherently increase efficiency towards project performance.

- ***Type of payment***

Fixed priced contracts and reimbursement contracts present two extremes of payment methodologies. Alternative methods of payment falling somewhat in between the two such contracts allowing for bonus opportunities and gain share/pain share agreements connected to a target price present opportunities to incentivise contractors to perform better and more efficiently.

- ***Collaborative tools***

Clients and contractors are required to interact in order to deliver a product successfully. The use of collaborative tools for joint action thus presents an opportunity to increase efficiency and performance. Examples of collaborative tools that can be implemented in projects is that of joint objectives, joint office building, team building activities, partnering facilitator, joint IT-tools, joint risk management and the use of a partnering agreement.

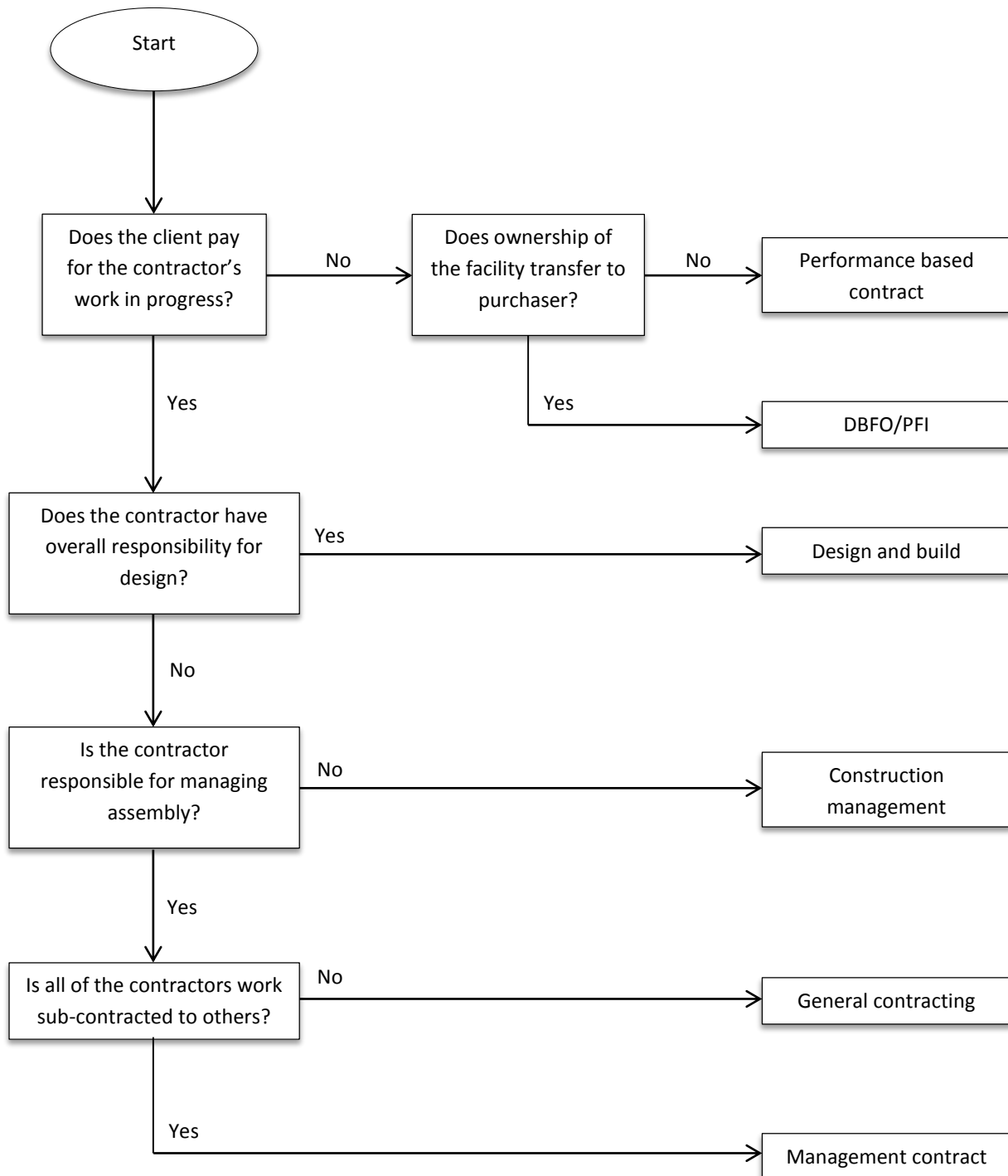
- ***Performance evaluation***

Tight monitoring of contractors' performance by the client hampers cooperation. In contrast increased reliance on contractors' self-control reduces cost, saves time and enhances quality. Increased efficiency occurs as self-control results in increased concern and commitment to quality by the contractor. In addition it facilitates early identification of defects and reduces required comprehensive end inspections.

### **2.4.7. Identifying Procurement Methods**

BSI's (2011) publication on construction procurement policies, strategies and procedures, provides a framework for identifying procurement methods to be used in projects based on specific project characteristics. Although the framework does not identify routes to all types of procurement, it provides a basis for understanding how to identify procurement methods to be used.

Figure 5 provides the framework as developed by BSI:



**Figure 5 Identifying Procurement Methods**

(BSI, 2011)

### 2.4.8. Procurement Procedures

There are a number of procedures that can be implemented when appointing contractors and consultants. Standard procurement procedures as highlighted by BSI (2009) are as follows:

- ***Negotiation procedure***

The client negotiates the terms of the contract with bidders.

- ***Competitive selection procedure***

This type of procedure relates to any procurement procedure in which the contract is awarded to the contractor who submits the lowest financial offer or scores the highest tender evaluation points.

- ***Competitive negotiation procedure***

This type of procurement procedure reduces the number of tenderers competing for the contract through a sequence of negotiations, up until the tenderers which remain are invited to submit final offers for consideration.

- ***Electronic auction procedure***

Tender submissions are first and foremost evaluated using specified methods and criteria. Tenderers submitting suitable offers are re-invited simultaneously by electronic means to submit new tenders based on different evaluation parameters. Subsequent tender evaluation scores, but not identity is made known to other tenderers. Furthermore tenderers may adjust their offers up until the auction is closed.

### 2.4.9. Tender Evaluation methods

When evaluating tenders, a point scoring system is usually used to determine the ideal candidate. BSI (2009) identifies standard evaluation methods to be used within the industry.

- ***Financial offer***

The financial offer evaluation method ranks tender offers from the best to least favourable comparative offer. The highest ranked tenderer is recommended for award of the contract.

- ***Financial offer and quality***

The financial offer and quality evaluation method scores quality, rejecting all tender offers that fail to score the minimum number of points for quality as stated in the tender data. In addition scores are attributed towards tender evaluation for financial offers. The total tender evaluation points are then calculated and tender offers ranked from highest to lowest tender evaluation points obtained. The tenderer with the highest number of tender evaluation points is then recommended for award of the contract.

- ***Financial offer and preferences***

The financial offer and preferences evaluation method scores tender evaluation points for financial offers. Confirmation is done for tenderers eligibility for the preferences claimed, and if eligible, tender evaluation points are then scored for preferencing. The total tender evaluation points are then calculated. Tenderer offers are then ranked from highest to lowest evaluation points obtained. Tenderers with the highest number of tender evaluation points are then recommended for award of the contract.

- ***Financial offer, quality and preferences***

This evaluation method firstly scores quality, rejecting all tender offers that fail to meet the minimum number of points for quality as stated in the tender data, if any. Tender evaluation points are then scored for financial offers. As with the previous method, confirmation is done for tenderers eligibility for the preferences claimed, and if eligible, tender evaluation points are then scored for preferencing. Total tender evaluation points are then calculated and tenderers offers ranked from highest to the lowest tender evaluation points. Tenderers obtaining the highest number of tender evaluation points are then recommended for award of the contract.

### **2.4.10. Procurement in South Africa**

The choice of procurement path systems and processes used within the South African construction industry is mainly governed by internal and external factors. Factors from the *internal environment* pertain to the client's and project's characteristics which can be further broken down into sub categories, with the client's characteristics comprising variables such as the client's level of knowledge and control, familiarity with procurement systems, political and social climate, government, competition, (public/private sector projects), risk allocation and funding arrangements. Project characteristics comprise factors such as the size and complexity of a project, the expected project life cycle, accelerated project delivery, time, cost and quality. Regarding the *external environment*, variables such as the current and expected market conditions, competition, Information Technology, regulatory environment and the international construction framework all influence the choice of procurement system to be implemented (Mathonsi and Thwala, 2012).

Mathonsi and Thwala's (2012) study further identifies five main factors that affect the choice of procurement systems in South Africa when narrowed down, namely; socio-economic considerations, client requirements, capital cost/cash flow, procurement policy and project characteristics.

## **2.5. The Design Development Stage**

This area of research links towards the research problem and research questions as it helps to understand the dynamics of the Design Development Stage, its phases and what actions are undertaken in each phase, thus allowing the study to determine the factors within the Design Development Stage that govern its performance towards achieving project objectives.

### **2.5.1. Overview of the Design Development Stage**

The Design Development Stage involves six key activities; (1) the development of the approved concept, (2) finalising of the design, (3) delivery of the specifications, (4) cost plan production, (5) financial viability analysis and (6) the programme to be used for the project. This stage allows the designer to finalise the space and function of a development, while focusing on the technical aspects of materials and building systems. Furthermore it enables the client to understand how the project will function as well as giving more detail regarding how the development will look like (OGS, 2014). Listed below are the six main activities as outlined by (Procsa, 2013) that are undertaken in the Design Development Stage.

1. Development of approved concept
2. Finalising design
3. Specifications
4. Cost plan
5. Financial viability
6. Programme

PROCSA (2013) has been used as a guideline to what occurs at the Design Development Stage of projects. It should be noted that although these activities are discussed sequentially they may occur simultaneously and iteratively in order to streamline the Design Development Stage process.

### **2.5.2. Development of Approved Concept**

At this phase of the Design Development Stage the accepted concept is developed in detail to finalise the design i.e. the preliminary design is developed. The detailed form is established, its character, function, functional relationships and all components defined in terms of overall size, typical detail, performance, specifications outlined and provisional schedules. The client's acceptance of the design development report is finalised and obtained at this phase (CIDB, 2011). The Preliminary design builds upon the outcome of the concept and viability stage, namely, the approved project scope, project feasibility, project execution plan and the approved procurement method appropriate to the nature

of the project (CIDB, 2014). The conclusion of this phase should confirm all the required functional relationships, areas, principal building systems and specialist systems (Imperial College London, 2014).

During the design process architects are responsible for receiving, appraising and reporting on the employer's requirements with particular attention being paid to site information, planning, statutory regulations and the budget. Furthermore architects are to advise the client on procedures to meet their requirements as well as the technical and functional characteristics of the project as proposed. When developing the conceptual design architects are required to do so in conjunction with the other consultants appointed in order to achieve project objectives. The conceptual design outlines and shows the intended space provisions, the planned relationships and the materials and services intended to be used (CIDB, 2014).

For bigger and more complex projects an emphasis is placed on civil and mechanical design along with architectural design. Designs of all the mechanical processes (e.g. water systems) are completed at this phase in order to ensure that they are integrated effectively into projects. Architectural concepts are developed further at this phase along with the identification of structural systems (FAO, 2013). If necessary, executing the proposed works in phases is considered (Imperial College London, 2014).

Depending on the size and complexity of a project, a number of preliminary drawings are completed at this phase in order to communicate the design concepts. A preliminary design report is then prepared with the drawings which defines all the structural components and mechanical processes of the facility, and how they interrelate. The report should include an outline of materials and specifications which can be used as a basis for revising previous construction cost estimates for the cost plan and financial viability analysis (FAO, 2013).

Completion of this phase requires a design development report; the design development report translates the concept report into a document which provides clarity on what is expected to be delivered for the project. The report describes how structures, services or buildings and related site works, systems, subsystems, assemblies and components are to function, how they are to be safely constructed and how they are to be maintained (CIDB, 2011).

### **2.5.3. Finalising Design**

At this phase the detailed architectural drawings of all components of the project are finalised. This phase of the Design Development Stage is where all unresolved issues are sorted out. The final design should aim to minimise the possibility of any major modifications to be made during the documentation and procurement stage as well as during the construction stage (OGS, 2014). The final design provides the final detailing, performance definition, specification, sizing and positioning of all

systems and components enabling either construction or the production of manufacturing and installation information for construction, the clients accepts or declines the final design at this phase of the Design Development Stage (CIDB, 2011). Finalising the detailed design ensures the project, cost plan and design proposals have been reconciled and are consistent (Imperial College London, 2014).

When finalising the design architects develop the design concept in sufficient detail to outline the construction of the building, spatially co-ordinate the work designed by consultants and specialists and review the design with the appropriate authorities (CIDB, 2014). In some projects, depending on their size and complexity it may be necessary to prepare a written final design report in conjunction with the final designs in order to provide further clarity and summarise the facility as designed (FAO, 2013).

Most design problems should be resolved at this phase. Sufficient detail should be provided by the drawings and the report to allow accurate estimates for construction and operating costs for the financial viability analysis, cost plan production as well as for the construction programming. At this phase, if necessary all revisions to construction materials, machinery, and equipment specifications should be made. The updated specifications, cost estimates and programme should be contained in the final design report (FAO, 2013).

Changes at this phase are most costly as the final Design Phase is the most expensive of the planning processes. It is thus of importance that complete and detailed attention is given throughout the final Design Phase. If final design drawings have to be considerably changed or re-done, the costs are excessively higher when compared to the costs of originals (FAO, 2013).

### **2.5.4. Specifications**

Specifications are detailed written instructions that set out the scope of work and inform the contractor on what and how material or building components are to be used on a project. During this phase the specifications that fix and describe the size and character of the components of a development are finalised. Designers provide specifications which are subsequently used in latter phases and stages. The specifications in conjunction with the drawings provide greater detail and clarity of developments (OGS, 2014).

The National Home Builders Regulation Council (NHBRC) is a regulatory body in South Africa that governs the minimum standard and specifications to be followed for the construction of buildings, specification provided by designers are required to adhere to NHBRC standards, failing to comply, allowing recourse to be taken by the consumer against the team responsible for the construction of the building in question (NHBRC, 2014).

There are a number of ways specifications can be written to communicate project requirements, discussed below are some of the ways specifications can be conveyed.

- ***Performance specifications***

These types of specifications describe and state the requirements of a product without mentioning any specific manufacturer, such as the product required to meet a specific wind load, colour range, or structural loading. There is not limit as to how these requirements are to be met in terms of methodology; results and compliance playing more of a factor.

- ***Descriptive specifications***

These types of specifications are a written description of the required properties of a product, material, or equipment and the workmanship required to ensure correct installation. They describe exact properties of materials and methods of installation without using any product names.

- ***Prescriptive specifications***

These types of specifications describe the means and methods of construction and composition of the concrete mix or plaster mix rather as opposed to defining performance requirements.

- ***Reference specifications***

Reference specifications refer to an authority, trade association, government or other industry reference standards and provide a generic description in terms of meeting those standards e.g. SANS.

- ***Proprietary specifications***

There are two versions of proprietary specifications; closed and open versions. They are defined as follows; Closed - specifications name only one product with no substitutions being accepted whereas Open - specifications name one product as a basis of design; with a variety of other products being named as suitable substitutions with/or a list of proprietary brand names of one or more manufacturers.

(DTRCS, 2014)

### **2.5.5. Cost Plan**

This phase involves the controlling and monitoring of project costs. The production of a comprehensive cost plan is further developed from previous estimates as more information becomes available and the designs are finalised. The cost plan is confirmed or revised from the concept report. Estimates are usually broken down into major trades or systems such as the foundations, external structure, finishes, plumbing electrical work etc. Cost plans include all expected cost to be incurred for a project outside construction cost such as professional fees. Estimates may include an analysis of the client's budget, with recommendations for changes based on the site, marketplace, or other unusual conditions the development may be subject to (OGS, 2014).

When producing cost plans quantity surveyors use preliminary and final designs depending on the position of the project and what is available at the time. The client provides information to the quantity surveyors in terms of project objectives and budget, the quantity surveyor then advises on various courses of action and procedures to suit the particular requirements of the project along with providing financial design criteria advice and preparation of estimates for construction and project costs. When final designs become available the quantity surveyor prepares a detailed estimate of construction and project costs along with advice on costs that may be required prior to the commencing construction (CIDB, 2014).

Cost management is conducted throughout the Design Development Stage in order to stay in line with the projects objectives. Cost limits are set as based on benchmarking for each design option, having considered:

- Identified risks
- Proposed value improvement ideas
- Life cycle cost data inputs
- Programme and procurement implications

- Sustainability criteria.
- VAT liability

(Imperial College London, 2014)

As the quantity surveyor develops the cost plan based on the drawings and specifications provided, the designs are continually reviewed, cost deviations projected from the estimate and regular periodic reports provided to the project manager. This process should include a review of the contingency allowances made for risk and any realised value improvements, in conjunction with cost and value engineering as required and where possible (Imperial College London, 2014).

Where necessary and required, whole life cycle cost studies are undertaken, with the quantity surveyors generally assisting the design consultants in evaluating future operating and maintenance costs for the project (Imperial College London, 2014).

### **2.5.6. Financial Viability**

This phase involves the establishment of the financial viability of the project in question. Costs and scheduling revisions are compared at this phase with the original financial objectives and constraints to ensure that the project remains financially feasible. The total capital outlay versus the projected income, where applicable such as for income generating buildings, over the life span of the building in order to determine whether or not a development is financially viable or not. If the project is not financially viable then the concept and designs may have to be altered.

In some cases, perhaps after soil tests, it may appear that the project is not financially viable. At this point it is more reasonable to terminate the project, or to re-plan and revise the goals of the project (FAO, 2013).

At the final Design Phase it is necessary to verify that the project remains economically viable. If not, then a decision needs be made to either revise designs, concepts or to terminate the project.

A method to ensure the financial viability of a development is by constructing the project in phases. By ensuring each step of the construction programme is financially viable it ensures the whole project maintains financially viable. It should be noted however, that even while doing this, it is often cost effective to design and construct certain basic facilities during the first phase (FAO, 2013).

### 2.5.7. Programme

Planning sets the basis for successful projects, which without makes it difficult for projects to run smoothly and be completed within time and budget. The main reasons for planning in construction works is to improve management of the works and resources, the sequence of activities required to take place and the consequences of any changes that may take place, programmes help establish a realistic completion date by setting out what needs to be done, it improves efficiency, facilitates the risk assessment of projects and provides a basis for solving contractual claims resulting from delays (Multiproject, 2014).

There are various ways programmes are developed, for small to middle sized projects a “Gantt chart” or “Bar chart” is made use of, both names referring to the same technique. Techniques applied for large projects are arrow diagrams, precedence diagrams, line of balance, time-change diagrams (Multiproject, 2014).

Programmes can be classified as being either a Master programme or a Detailed Programme depending on the type and precision of the information provided. A Master programme is a general project plan that does not include any great detail and only displays the main stages of the works. It is mainly useful for clients and consultants supervising the completion time. A detailed programme is an expansion of a Master Programme, including all activities and details of the works towards completion. Due to the large amount of information it contains, the detailed programme is often prepared to only embrace a specific period of time (e.g. 1 or 2 weeks of works) (Multiproject, 2014).

A correctly designed programme chart or diagram provides all the necessary information to complete a project. Furthermore when designed appropriately a programme chart or diagram will indicate the critical tasks in a project, i.e. tasks that determine whether or not a project is completed in time. These tasks form part of a "critical path", thus allowing more attention to be given to more critical tasks. To enhance a programme each task should indicate the necessary resources, workers, equipment and material which facilitate the placing of orders and workforce management. Additionally a programme chart or diagram may include or form the basis for a comprehensive analysis of financial flow in a project as well as for risk management (Multiproject, 2014).

The use of software packages makes it possible to expand the functions of project programmes, such as the inclusion of project risk management. Scenario analysis allows the project team to prepare for problems that may occur in a project, e.g. analysing the consequences of delays and how to subsequently deal with them. Such analysis allows the project team to comprehensively understand

the dynamics of a project and allows them to prepare alternative plans should such problems occur (Multiproject, 2014).

Risk analysis can be summed up with the following:

- Hazard identification
- Probability and consequences estimate
- Deciding on risk management method (avoidance, reduction, sharing and retention)
- Management and supervision
- Conclusion and report

(Multiproject, 2014)

### **2.5.8. Phases in the Design Development Stage**

Three phases can be identified that take place within the Design Development Stage, namely (1) Design, (2) Financial Planning and (3) the Development of the Project Programme. As design defines the characteristics of a building, its elements and systems (GGGC, 2014), one can infer that the Design Phase at the Design Development Stage is the most important phase to incorporate green principles when producing green buildings, as phases and stages after it are built upon its detail.

## **2.6. Sustainability**

This area of research links towards the research problem and research questions as it helps to understand the framework in which construction industries are currently working in, by understanding the sustainability agenda in the construction industry and what constitutes being sustainable, it thus allows the study to determine what is required from procurement and the Design Development Stage to achieve sustainability.

### **2.6.1. Definition of Sustainability**

Sustainability revolves around three key principles, namely; economic growth, social progress and the protection of the environment, known as the triple bottom line. In addition sustainability looks at fulfilling current needs while not hindering the needs of the future. It is imperative to take cognisance of the fact that current needs may differ to that of future generations (Chatterjee, 2009).

There is an evident relationship between sustainable buildings and the construction industry as construction is of high economic significance and has strong environmental and social impacts (Sev, 2009).

When striving towards sustainability there are various performance criteria that can be used to measure against. Ying Chen *et al.* (2010) study identifies social awareness and environmental concerns as growing in importance when considering selecting construction methods. Furthermore the study indicates that Sustainable Performance Criteria (SPC) can be grouped into seven dimensions, namely, *economic factors*: (1) long-term cost, (2) constructability, (3) quality, (4) first cost; *social factors*: (5) impact on health and community, (6) architectural impact and *environmental factors*: (6) environmental impact. These groupings provide a framework in which to measure sustainable performance (Ying Chen *et al.*, 2010).

### 2.6.2. Environmental Degradation

The global environment is presently facing a decline in its state; there is growth in energy usage, the continuous consumption of fossil fuels and the subsequent emission of greenhouse gasses across all industry sectors. Although greenhouse gas emissions and the subsequent climate change that follows are not the only environmental problems facing the energy sector, they are the most widespread and pressing (OECD, 2007).

Construction is a major consumer of non-renewable resources, in particular energy; it is a source of waste, a polluter of air and water, contributes significantly to global ecological degradation and emits greenhouse gasses (Chatterjee, 2009). In China, every ten thousand square meters of construction area produces approximately 500-600 tons of solid wastes (Jorge *et al.*, 2010). Construction contributes significantly towards the economy and impacts society significantly. Furthermore buildings form part of the environment and thus should not be treated as a separate entity (Sev, 2009). Sustainable development has thus become increasingly important globally and put on the agenda as the framework for several company and government policies.

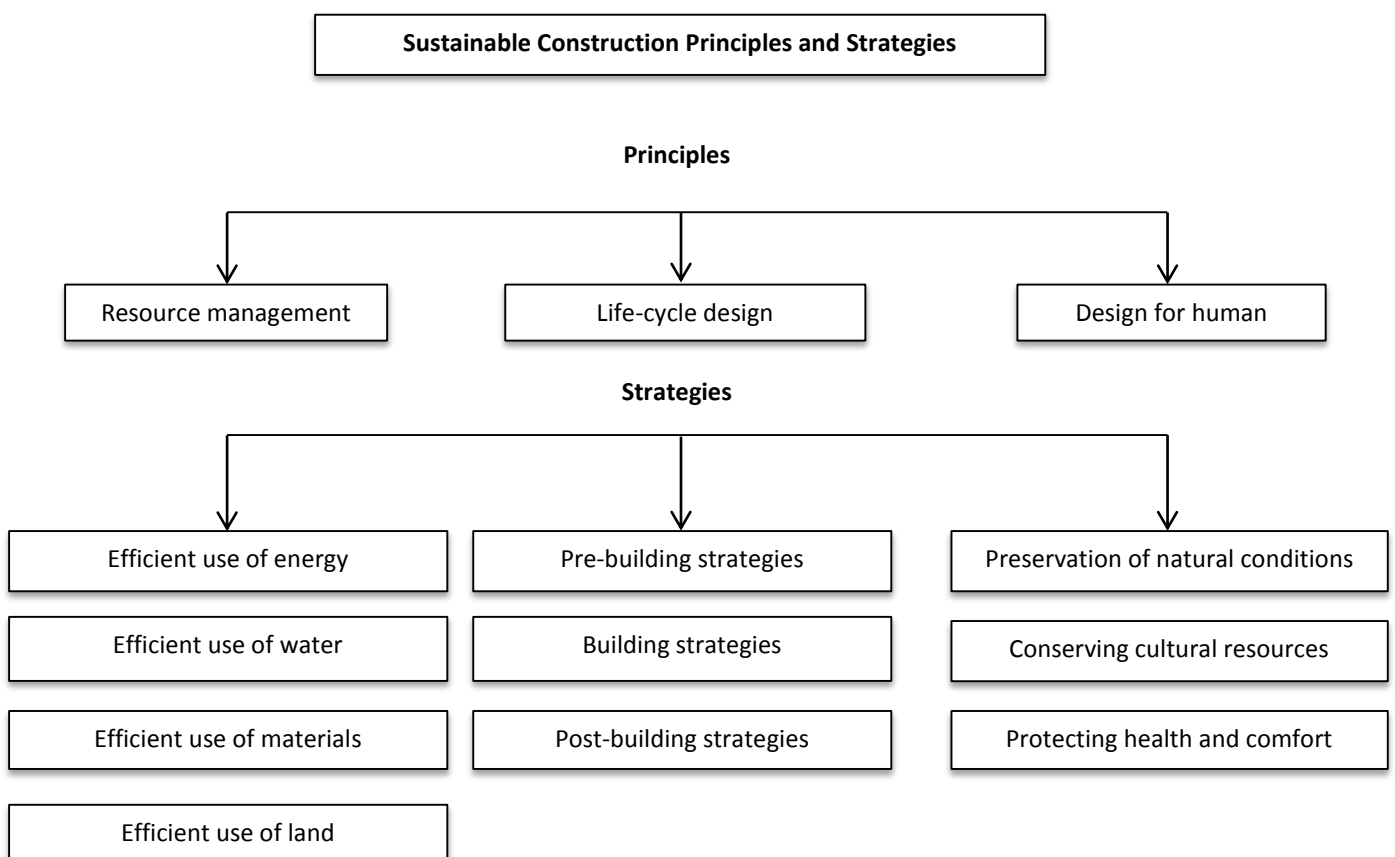
### 2.6.3. Sustainable Construction Framework

**Project performance criteria** have traditionally revolved around three key areas namely; time, cost and quality. As sustainability has become increasingly important along with long term competitive advantages these three areas used in isolation become too limited when determining the level of success of projects.

Sustainable development aims to meet the needs of the present without compromising the ability of future generations to meet their own needs (BSI, 2008), it encompasses various facets, one of which pertaining to the reduction or elimination of resources used on projects (Eriksson *et al.*, 2009). Literature identifies three more aspects to measure project success against; (1) the environmental impact, (2) the working environment and (3) innovation (Eriksson and Westerberg, 2011).

There are numerous frameworks that have been developed to unpack sustainable construction. A study conducted by Sev (2009) develops a conceptual framework for implementing sustainable principles and strategies for the construction industry from a life-cycle approach to contribute to sustainable development. The framework relies on three basic principles, namely; (1) resource management, (2) life-cycle design and (3) design for humans and the environment. These principles are further broken down into strategies that pertain to each principle used to achieve sustainability. Resource management principle is based on the efficient use of energy, water, materials and land. The Life Cycle Costing principle revolving around pre-building strategies, building strategies and post-building strategies. In order to achieve the design for human principle, preservation of natural conditions is required along with the conservation of cultural resources and the protection of health and comfort.

Figure 6 presents Sev's (2009) framework for sustainable construction:



**Figure 6 Sustainable Construction Principles and Strategies**

(Sev, 2009)

### 2.6.4. Achieving Sustainability

Research conducted by Chatterjee (2009) discusses the importance and nature of sustainability in the construction industry. Construction activities produce several forms of waste and increase the level of greenhouse gases in the atmosphere. It is broadly estimated that buildings worldwide consume about 40 per cent of the planet's materials resources and 30 per cent of its energy. Waste is not only limited to on-site activities but also arises from off-site and operational activities. Construction and its subsequent products are major contributors towards environmental degradation. Sustainable practices and green buildings have thus emerged in recent times to tackle the effects of construction (Green Building Council SA, 2013).

Traditional methods of construction as highlighted previously is detrimental to the environment and has created the current climate of movement towards sustainable practices to combat its effects, evident by the use of "green" products currently being released in the market (ThermaGreen, 2012).

When choosing the type of construction method to be undertaken the professional team has to look beyond material, labour and transportation costs and take into account other factors such as the long-term cost, life cycle costs, health and safety, effects on energy consumption and the subsequent environmental impact of a project (Chen *et al.*, 2010).

Chen *et al.* (2010) research identifies SPC for construction methodology selection for concrete buildings in order to help achieve greater sustainability. The criterion is based on the triple bottom line of sustainability; economic, social and environmental concerns forming the key elements of the triple bottom line. The use of prefabricated components are identified as having social and environmental benefits, such as lower risks for chronic health issues and energy savings over their service life in comparison to conventional components.

Furthermore the use of prefabricated components helps to shorten construction time, lower overall construction cost, improve quality, durability, occupational health and safety, material conservation, lessen construction site waste, lessen environmental emissions and reduce the amount of energy and water consumption (Chen *et al.*, 2010).

As society is constantly evolving it is imperative buildings are able to adjust with the changing needs of society, this is a difficult task as no-one can predict the future with certainty, construction products thus have to be flexible in nature to overcome changes. For this reason it is imperative sustainable buildings be flexible in design, construction practices and be able to adapt to change in order to avoid becoming functionally obsolete (Chatterjee, 2009).

## **2.7. Green Buildings**

This area of research links towards the research problem and research questions as green buildings provide a solution to the problems faced by traditional buildings. Prior to determining how procurement and the Design Development Stage should be configured to produce green buildings It is imperative to understand what green buildings are and their characteristics in order to understand the what constitutes being “green”. Thus further allowing the study to determine what is required from procurement and the Design Development Stage to produce green buildings.

### **2.7.1. Definition of Green Buildings**

Green buildings as defined by the Green Building Council of South Africa are buildings which are 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. Green buildings offer the chance to reduce operational and maintenance costs as well as improving the wellbeing of individuals when implemented properly (Green Building Council SA, 2013). Furthermore green buildings seek to attain the highest levels of energy efficiency as possible while being constructed predominantly with recyclable and natural materials. Furthermore Green buildings seek to maximise the use of resources such as energy, water and raw materials (Hwang and Ng, 2013).

As highlighted by Horman *et al.* (2009), “green” / sustainable development as a core objective encompasses additional measures of success in which to measure projects. The processes and methodology of procurement and subsequently the Design Development Stage thus differs inherently when “green” / sustainable criteria is placed as a primary objective and measuring standard for the success of projects.

Performance outcomes such as sustainable rating, final cost, project schedule and operating performances should be statistically correlated to project delivery practices as it provides insight for owners on how to establish their project team to achieve “green” objectives (Horman *et al.*, 2009).

### **2.7.2. Green Contracts: Property**

The importance of “green” leases cannot be overstated as it ensures property that is designed to be sustainable i.e. green buildings, is operated in a “green” way to achieve the intended benefits of green buildings. As highlighted by EPROP (2013), “green” leases aim to ensure that the property owner commits to managing the property in a sustainable manner while the tenant pledges to use the property in a sustainable manner to minimise the adverse environmental impacts of property as

further highlighted by BBP (2013) in areas such as energy, water and waste. In short “green” leases are leases in which the relationship between contracting parties foster sustainability.

In places such as Australia and the United states “green” leases are becoming the norm. Whereas within the South African property industry it is still a relatively new concept, with the Green Building Council of South Africa only introducing the “green lease” credit in the Green Star SA in 2009 (Myproperty, 2013).

As discussed by WSP (2013), green buildings provide several benefits to the landlord, such as an enhanced corporate/brand image, these benefits being linked to the behaviour of tenants as their actions further ensure sustainable measures are implemented, e.g. tenants actively recycling, thus further highlighting the importance of “green” leases. Similarly, green buildings provide several benefits to the tenant, these benefits relying on the systems provided by the landlord i.e. ensuring all elements are energy efficient, and non-threatening to the environment (Greenpoint, 2014). It should be noted, neither the landlord nor the tenant will realise the benefits from owning or occupying a green building if they do not understand, and act for their shared benefit. Provided below are some of the benefits received from green buildings and “green” leases (WSP, 2013).

- ***Asset value***

Green buildings and leases allow landlords to charge rental premiums to tenants due to the increased value provided by such buildings and demand that follows suit, it inherently reduces vacancy rates and thus improves sales value (WSP, 2013).

- ***Reduced utility cost***

The nature of green buildings and leases inherently reduces energy and water consumption thus reducing such costs (WSP, 2013).

- ***Productivity***

As green buildings and leases aim to improve general health as one of its objectives, reduced sick leave inherently follows. Furthermore by improving the work environment it allows companies to have a reduced staff turnover. Increased general productivity thus naturally follows (WSP, 2013).

- ***Reputation***

By being “green” it allows companies to improve their image, this works towards marketing as companies are able to brand themselves as “green”. In addition by being “green” it safeguards companies from regulations being imposed in the future, this is of importance as there is a general shift globally towards “green” practices within the construction industry (WSP, 2013).

### 2.7.3. Green Buildings in South Africa

Green building rating tools are used to rate how “green” a building is, these tools set standards and benchmarks for green buildings, and enables an objective assessment to be made on the degree to which a building is “green”. There are several green rating systems and tools as highlighted by the Green Building Council of South Africa (2013), systems used internationally include that of BREEAM from the UK, CASBEE from Japan, Green Star from Australia and LEED from the US (Green Building Council SA, 2013).

South Africa bases its “green” rating system on the Green Star rating tool from Australia, customising it in order to fit within the South African context. Further to this, Green Star SA comprises of specific Green Star rating tools to reflect the different market sectors buildings are subject to, i.e. office, retail, multi unit residential, etc. Based on these tools points are awarded towards specific criteria in order to determine the star rating of a building, a green star rating of four indicating “best practice”, five indicating “South African excellence” and six “world leadership” if achieved at all (Green Building Council SA, 2013).

Points for rating buildings are allocated and based on the following nine criteria; (1) management, (2) indoor environmental quality, (3) transport, (4) water, (5) material, (6) land use and ecology, (7) emissions, (8) energy efficiency and (9) innovation (Green Building Council SA, 2013).

## 2.8. Diffusion of “Green” Practices

This area of research links towards the research problem and research questions as it outlines what is required from procurement and the Design Development Stage to produce green buildings. By understanding what constitutes as being “green” practice, it allows the study to determine how procurement and the Design Development Stage should be configured to produce green buildings.

### 2.8.1. Definition of Green Procurement

“Green” procurement in the construction industry is procurement that integrates environmental criteria when making decisions throughout all the stages of the life cycle of a product, from its design, production, use and maintenance to its end life. It aims to achieve both high quality construction and efficient performance in building operations (BSI, 2010).

Manoliadis *et al.* (2012) allude to the fact that in order for sustainable procurement to work efficiently it requires and involves a higher degree of collaboration and engagement between all parties in a supply chain to ensure its success. Brammer and Walker’s (2012) study further discusses the importance of Supply Chain Management (SCM) towards environmental issues. The study indicates

that sustainable SCM contributes towards sustainability; its effective implementation dependent on communication, integration, and collaboration with suppliers.

Green Public Procurement (GPP) shapes the production and consumptions of goods and services due to the high purchasing power of public authorities. As the demand for environmentally friendly products rises a shift in supply occurs to respond to changes in demand. As demand orientates to innovative solutions and products, production subsequently moves with it in the same direction (Bratt *et al.*, 2013) and (Daddi *et al.*, 2012). GPP inherently encourages the spread of environmental technologies and the development of environmentally sound products by seeking to make use of products and procedures that have the least possible impact on the environment throughout their whole life cycle (Manoliadis *et al.*, 2012).

Ideally procurement procedures should be tailored to match project specifications, due to a lack of knowledge of alternative procurement processes, such as “green” procurement, traditional procurement paths and processes tend to be undertaken. Two factors that influence the use of alternative procurement paths and processes is the level of confidence clients have on how to use alternative systems and their attitude towards the positive outcomes from using alternative paths and processes (Eriksson and Westerberg, 2011).

### **2.8.2. Green Procurement Abroad**

Research conducted by Doberstein and Geng (2008) traces the development of Green Government Procurement (GGP) and its spread. The study identifies the European Union (EU) community as having promoted the concept of GGP since 1992 while the United States has seen a widespread of GGP requirements since the first initiative in 1993. Furthermore some of the countries that have been exposed to GGP in earlier years and have a legal obligation to comply include that of Canada, Germany Sweden, Denmark and Norway. In contrast GGP only began to spread to developing countries later throughout the mid-1990s, particularly in East and Southeast Asia to places such as Taiwan, South Korea and Singapore (Brent and Geng, 2008).

As identified by Emery *et al.* (2007) study, places such as the United Kingdom have also been subject to a “green” revolution, indicative by the presence of bodies such as the Government’s Sustainable Buildings Task Group. In 2003 the institution set a benchmark requirement for a minimum of 10% recycled content (by material value) for construction projects via building regulations and public sector procurement, demonstrating the significance and influence such bodies have on “green” development.

China has implemented a competitive and partnership model for implementing Green Public Procurement. The competitive model pertains to prices offered by bidders whereas the partnership model seeks to build a long-term collaboration relationship between the suppliers and government procurement departments. Consideration for other factors, such as delivery, performance and better quality at similar cost is still taken cognisance of in order to ensure quality and timeous delivery of requirements occurs while still minimising total costs (Doberstein and Geng, 2008).

A study conducted by Jorge *et al.* (2010) further indicates that in recent years China have introduced a number of environmental laws such as the environment protection law, the cleaner production promotion law, the pollution prevention law and reproducible energy law. Furthermore the Green Building Evaluation Standard and the Green Construction Guideline (GCG) have been developed to aid the development of Green Buildings. The Green Construction Guideline and Green Building Evaluation Standard are documents that provide an assessment framework for “green” construction and green buildings respectively (Jorge *et al.*, 2010)

Greece established a National Action Plan for the promotion of Green Public Procurement, through legal and institutional frameworks they have been able to govern the way sustainable procurement is undertaken in Greece. Their action plan presents a model that can be used as a framework and reference point to promote “green” procurement in South Africa (Manoliadis, Mavridis and Vatalis, 2012).

### **2.8.3. Adopting Green Procurement**

In order to understand what is required from procurement processes and subsequently the Design Development Stage to produce green buildings it is imperative to understand what traditional procurement processes entail. From this basis it allows one to establish how to configure traditional procurement processes towards green buildings.

Inherent problems exist within the traditional procurement path as “price” is usually the primary driver when procuring. As highlighted previously traditional procurement can be characterised as “competitive”, involving the invitation of numerous bidders to prepare lump sum contract proposals based on detailed design documents prepared by the client and their consultants. The subsequent bid evaluation being primarily based on price, the lowest lump sum price typically awarded the contract (Eriksson *et al.*, 2009).

“Green” and sustainable procurement is progressively on the agenda for purchasing and supply managers pursuing to exhibit corporate social responsibility in their supply chains (Johnsen *et al.*, 2012).

Prior to implementing “green” procurement it is imperative project participants fully understand what “green” and sustainable requirements of projects entail and how these are to be used to develop procurement strategies. In order to facilitate “green” procurement, ensure performance and streamline the process, these requirements should be developed in the planning stage. Furthermore the requirements should then be reflected in the design and subsequently adopted and managed throughout the construction and commissioning stages of the project (CIRIA, 2011).

Governments play a key role in economic welfare and are able to influence the market socially and environmentally as they are large scale consumers of supplies, services and have considerable purchasing power within any economy, it is thus only natural governments should play a key role towards the implementation of “green” procurement. “Green” tendering and contracts awarded based on sustainable criteria for supply and services contracts are some of the methods in which “green” procurement can be promulgated (Doberstein and Geng, 2008).

As not everyone has the expertise to implement “green” procurement in its entirety, it is imperative to establish “green” criteria to which “green” procurement decisions can be made relatively quickly and easily, this can be done by developing a common set of environmental performance criteria. Easy to use Eco-labelling programmes have been developed for this reason, common examples being that of the EU eco-label “flower”, Germany’s Blue Angel programme, the Nordic Swan programme, Canada’s Environmental Choice Programme etc. (Doberstein and Geng, 2008).

Horman *et al.* (2009) study developed metrics identifying the association between project delivery attributes (i.e. process indicators and control variables) and project performance as summarised in Figure 7. Process indicators determine how successful the control variables in a project (i.e. its characteristics) are handled as it is through these processes that a project is delivered. The performance metrics on provides a framework to measure how successful project delivery has been.

| PROJECT DELIVERY ATTRIBUTES                              |                                |                                 |
|----------------------------------------------------------|--------------------------------|---------------------------------|
| Process Indicators                                       | Control Variables              |                                 |
| Owner commitment                                         | Project type                   | Onerous contract clauses        |
| Project delivery system                                  | Building use                   | Building system characteristics |
| Project team procurement                                 | Building size                  | Building green features         |
| Contract conditions                                      | Location                       | Completion rate of CDs          |
| Design integration                                       | Project complexity             |                                 |
| Project team characteristics                             | Pool of qualified contractors  |                                 |
| Construction process                                     | Regulations/ Legal constraints |                                 |
| PROJECT PERFORMANCE                                      |                                |                                 |
| Performance Metrics                                      |                                |                                 |
| Schedule performance                                     |                                |                                 |
| Cost performance                                         |                                |                                 |
| Safety                                                   |                                |                                 |
| Quality performance                                      |                                |                                 |
| <i>High levels of green performance (sustainability)</i> |                                |                                 |

**Figure 7 Green Building Delivery Evaluation Metrics**

(Horman *et al.*, 2009)

As highlighted in Doberstein and Geng's (2008) study, in order to facilitate the uptake of Green Government Procurement by governments, a systemic approach considering all participants' concerns needs to be established. Such an approach would involve but not be limited to the following:

- ***Legal framework***

Developing a framework to enforce "green" procurement to some degree will help to promote GGP. In addition detailed descriptions required from the main bodies responsible for implementing GGP, their responsibilities, and relevant preferable measures for GGP should be established.

- ***Standards on GGP***

Standards need to establishment to guide stakeholders on how to implement "green" procurement.

- ***Information platform***

The provision of an information platform for stakeholders regarding "green" procurement should be established in order to respond to any queries and to further enhance knowledge on "green" procurement.

- ***Priority over non-green competitors***

Priority for government procurement contracts to “green” procurement implementers helps to promote and further prompt the diffusion of “green” procurement within industries.

- ***Subsidies***

Subsidies for “green” products and services helps to reduce cost of “green” procurement thus helping to prompt its use via cost incentive and increase profits, it should be noted that this may not be needed when Life Cycle Costing is taken into account.

- ***Preferable tax policies***

Preferable tax policies act as an incentive to reduce cost and thus increase profits, thus inherently stimulating the implementation of “green” procurement.

- ***Capacity building***

Capacity building includes the strengthening of institutions, managerial systems and human resources. It involves developing effective means to facilitate public participation, communication and promoting the implementation of favourable policies for the environment. Furthermore awareness-raising activities should be carried out periodically to help build a better understanding of GGP.

### **2.8.4. Green Design**

Green design aims to tackle the challenges of climate change, resource use, economic prosperity and social well-being. It is critical the decision to construct a green building is made early on the design process to maximise the green potential, minimise redesign, and assure the overall success and economic viability of the green elements of the building project. Ideally the decision should be made prior to the site being selected as several green criteria is dependent on the nature of the site (GGGC, 2014).

Green design encompasses more than just the assembly of green technologies or materials. It is an iterative process in which every element of the design is first optimised, the interrelationship of various elements and systems within the building and site are evaluated, integrated, their impact assessed and then optimised for the building to reach its full potential. For example the relationship between the site, its characteristics, the path of the sun, the location and orientation of the building and elements such as windows and shading has an impact on natural daylight, solar loads and the energy efficiency of a building (GGGC, 2014).

Green design can be characterised by design for remanufacturing, disassembly and recycling. The incorporations of cleaner production principles such as the reduction of toxins, enhanced durability

thus leading towards ecologically sound designs and lower fossil carbon footprints buildings (Chiu *et al.*, 2013)

A document developed by Sustainable City Team (2006) on sustainable building design and construction discusses principles to be incorporated when designing towards sustainable buildings and subsequent required construction techniques. Issues around energy, waste, recycling, water, pollution, materials and environmental assessment methods are discussed and how to incorporate these aims into design. In summary designs should achieve the following:

- Reduce energy consumption and maximise renewable energy supply and use,
- Minimise waste production and maximise recycling during construction and occupation,
- Conserve water resources, enhance water quality, incorporate water sensitive design,
- Minimise polluting emissions to the environment , minimise noise and light pollution, and
- Maximise use of materials from sustainable resources.

There are five major elements of green buildings, namely; (1) sustainable site design, (2) water conservation and quality, (3) energy and environment, (4) indoor environmental quality, and (5) conservation of materials and resources (GGGC, 2014).

### **Sustainable site design**

The key principles to be adhered to here relate to the minimising of urban spread. Urban sprawl and subsequent low-density developments results in the needless destruction of valuable land, habitat and green space. Environmental components should be preserved through careful examination of each site. Designs should aim to preserve green space, not interrupt habitats, and associated eco-systems that are vital to sustaining life. Furthermore design and construction processes should minimise site disturbances. Listed below are the key strategies and technologies to achieve these goals:

- Efficient use of space,
- Avoid sites that play a key role in the local or regional ecosystem,
- Higher density developments in urban areas,
- Location and orientation of building,
- Buildings and sites should be pedestrian and bike friendly, and
- Reduce building and site development footprint.

(GGGC, 2014)

### **Water quality and conservation**

Key principles for water quality and conservation relate to the following; designs should preserve the existing natural water cycle through maintaining the natural design of elements such that they imitate the site's natural hydrological systems as much as possible. Furthermore designs should place an emphasis on the retention of storm water along with on-site infiltration and ground water recharge by emulating natural systems as much as possible. Listed below are the key strategies and technologies to achieve these goals:

- Design encompassing natural features,
- Preserve natural hydraulic features,
- Minimise building footprint, site improvements, construction area, excavation, soil disturbance and compaction of existing topsoil,
- Optimise use of low-impact storm water, and
- Establish water budget – design minimising use of potable water.

(GGGC, 2014)

### **Energy and environment**

Key principles relating to energy and the environment pertain to the following; designs should minimise the negative impact buildings have on the environment through optimum site selection, material selection and use of energy conservation measures. Furthermore designs should maximise the use of renewable energy sources and other low impact energy sources. Listed below are the key strategies and technologies to achieve these goals:

- Optimise solar orientation,
- Maximise natural day lighting through orientation, shape, design etc.,
- Use high performance low-e glazing for energy savings,
- Optimise the value of exterior insulation and the overall thermal performance,
- Use energy efficient bulbs, and
- Consider on site small-scale wind, solar etc. energy generators.

(GGGC, 2014)

### **Indoor environmental quality**

Key principles for indoor environmental quality relate to the following; designs should work towards a healthy, comfortable and productive indoor environment for occupants and visitors. Furthermore design should facilitate the best possible conditions for indoor air quality, ventilation, thermal

comfort, access to natural ventilation and day lighting. Listed below are the key strategies and technologies to achieve these goals:

- Use materials which are environmentally friendly,
- Maximise natural day lighting,
- Maximise natural ventilations, and
- Smoke free buildings.

(GGGC, 2014)

### **Materials and resources**

Key principles for materials and resources relate to the following; designs should minimise the use of non-renewable construction materials and resources through efficient designing. Recycled content should be used for building materials as much as possible. Further to this materials used should be re-usable, renewable, sustainably managed and bio-based. Listed below are the key strategies and technologies to achieve these goals:

- Optimise the use of engineered material,
- Efficient use of materials,
- Reduction of waste through waste plan,
- Use recycled materials for building structure and finishes, and
- Use local goods where practical (transport).

(GGGC, 2014)

In summary it seeks to achieve the following:

- Energy efficiency,
- Resource efficiency,
- Environmentally friendly,
- The sustainable sourcing of materials,
- Sustainable materials,
- Mitigate the impact on climate change,
- Protect and enhance biodiversity and green infrastructure,
- Provide buildings and spaces that are pleasant and healthy for occupants and users,
- Ensure the sustainable sourcing of materials, and
- Minimising of waste.

(Ecodesign, 2012)

### 2.8.5. Life Cycle Assessment

Green Public Procurement as highlighted previously is a sustainable approach that stimulates the general principles of sustainable development and addresses environmental issues through the purchasing and facilitation of the use of environmentally friendly services and products. It is a policy tool used for reducing the environmental impacts of services and products throughout their whole life cycle (Loprieno *et al.*, 2011). One of the fundamentals of GGP is that of Life Cycle Costing (LCC). Life Cycle Costing considers the total cost of products: purchasing costs, Operation and Maintenance (O&M) costs, and final disposal costs. Factors such as design, product lifetime, operation, social costs, disposal costs etc. need to be all considered when determining the LCC (Doberstein and Geng, 2008).

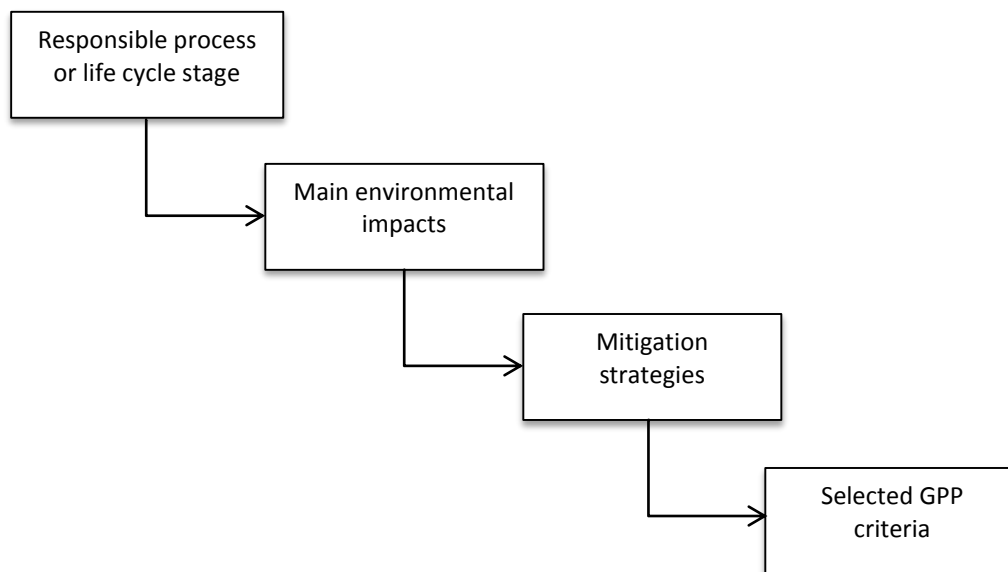
The Life cycle of a product can be characterised by the following five phases:

1. Design
2. Production process phase: Input material, energy use, transport, emission and waste
3. Use phase
4. Maintenance
5. End of life

Analysis and assessment of a product's Life Cycle Cost should be used as a basis for costing, benchmarking and option selection (Chan *et al.*, 2010).

A case study conducted by Loprieno *et al.* (2011) presents a method to establish relevant criteria for Green Public Procurement from a life cycle perspective. Although the case study pertains to windows the principles can be used as a framework to establish criteria for construction materials. The **first step** is to identify the **processes** within the life cycle of a product from its inception to disposal (end life), for example, identifying brick production in the production phase of a product to determine its environmental criteria. **Step two** requires an analysis of the **environmental impacts** each process may have on the environment, following the identification of brick production, greenhouse gas emission, for example, could be identified as impacting the environment. **Step three** requires one to establish **mitigation strategies** to combat the environmental impacts each process has; in this case, increasing the content of recycled materials and the use of best practices are ways to reduce greenhouse gas emissions. In **step four** Green Public Procurement criteria is subsequently established based on the most fitting mitigation strategies established in step three to achieve the desired goal.

Figure 8 depicts a life cycle approach to select relevant environmental criteria for Green Public Procurement:



**Figure 8 Selecting Environmental Criteria**

(Loprieno *et al.*, 2011)

### 2.8.6. Green Procurement Tools

#### Environmental impact assessments

Balfors *et al.* (2012) study addresses the significance of coordination between Environmental Impact Assessments (EIA) and “green” procurement within the construction industry. EIAs are the primary tools used to evaluate the impact a project may have on the environment and thus helps the project team to plan and mitigate potential and possible impacts. In addition EIAs are used as a pre-construction planning tool by many companies for design features, site and routing strategy, mitigation plans which are carefully examined prior to the final design and project budgeting utilised to identify predict and evaluate the possible significant environmental and socio-economic impacts that may result from construction. EIAs link to procurement as it governs the way procurement will be undertaken e.g. the type of materials to be sourced for a project.

The link between project planning and implementation cannot be understated as a substantial difference is often experienced between the project plans and their implementation and the subsequent environmental impact (Balfors *et al.*, 2012).

Based on Balfors *et al.* (2009) study, the environmental criteria in tender evaluation is less common and seldom affect the award decisions whereas the environmental evaluation criteria that do occur

often relate to the contractors capabilities of managing the environmental work in the project, further highlighting traditional flaws in the construction industry that exist.

### **Ecodesign tools**

Ecodesign tools are primarily used to highlight potential environmental problems and facilitate a choice for different environmental aspects, for both product development and procurement. It may be used to advise design alternatives, assess environmental impacts or to compare environmental improvement alternatives.

In a study conducted by Byggeth and Hochschorner (2006) on Ecodesign tools, fifteen different Ecodesign tools were analysed for their inclusion of valuations to support decision making regarding different types of trade-off situations and whether or not the tools provide support from a sustainable point of view. Nine of the fifteen tools provided insufficient support; furthermore life cycle perspectives and frameworks for sustainability were lacking indicating room for improvement from Ecodesign tools in general.

During product development and procurement processes, there are many elements to consider and frequently trade-offs are necessary when choices have to be made between different alternatives. Trade-offs occur when a product developer and the purchaser need to consider different criteria for a product or product concept such as price, quality, product lifespan, materials, maintenance and environmental performance. Trade-offs becomes necessary when a sacrifice in one area is required to obtain benefits in another. Optimisation in all areas is unlikely as one environmental area can result in negative impacts in another. Trade-offs for products may be between material requirements, material requirements and energy performance and between material requirements and cost (Byggeth and Hochschorner, 2006).

*Trade-offs in the **procurement** process:* When determining the environmental requirements a product should possess, the purchaser may have to choose between different qualities. This may occur when determining which environmental aspects are most vital, e.g. the recycled content, energy efficiency, water consumption and air pollution control. Furthermore the required interaction between environmental requirements may cause further trade-offs to occur such as legislative and quality requirements (Byggeth and Hochschorner, 2006).

*Trade-offs in the **product development** process:* Freedom of design reduces as the product development process moves forward. It is thus imperative to identify key requirements as early as possible. Functional requirements and costs usually have the largest influence and thus set the limits on other elements such as shape, material and production methods. Identifying the most important

elements sets the framework for design and subsequently helps to integrate other elements to reach the optimal solution (Byggeth and Hochschorner, 2006).

### **Performance indicators**

Project performance evaluation methods for construction projects have traditionally been used primarily in the construction stage. The use of performance indicators (PI) provides an opportunity to improve processes and take a holistic view of projects from the design to the end life of projects. Performance indicators monitor, measure and evaluate performance. It is one of many tools that can be used and is needed to improve project performance evaluation methods (Manoliadis *et al.*, 2012).

### **2.8.7. Key Players towards Green Procurement**

Although all stakeholders play a role towards the implementation of “green” procurement no matter how minor, there are key players that directly influence the diffusion of green principles into procurement. These players in the construction industry are responsible for the decisions that ultimately underpin the level of “green” performance from properties (CIRIA, 2011). Discussed below are the key stakeholders.

#### **The role of the client**

Clients have the greatest influence on projects as it is through them that the scope of a project is determined. Clients are responsible for setting the project’s goals, its objectives, specifications and procurement path to be undertaken. In addition it is through the client that the project team is ultimately put together. Prior to making these decisions the client needs to consider the site and physical location of the proposed project. Through these decisions the link between sustainability and procurement is established (CIRIA, 2011).

#### **The planning system**

Local planning departments can influence the level of sustainability construction projects and their subsequent products have on the environment through planning conditions. By dictating sustainable deliverables that projects should adhere to, it inherently promotes the diffusion of “green” procurement within the industry. Planning conditions may include standards on how construction should look, integrate with its surroundings and protect the environment (CIRIA, 2011).

### **The role of consultants**

Consultants influence sustainable procurement within construction as they are responsible for upholding the framework projects operate within. Several types of consultants can be used within construction projects, but it is the designers, architects, cost consultants and project managers that ultimately have the largest impact on procurement requirements (CIRIA, 2011).

- ***Designers and architects***

“Green” procurement requires designers to consider the function of buildings/infrastructures in its entirety. The expected performance and operational efficiency in conjunction with the implications projects may have on society and the environment should all be considered when designing. This can be achieved by designing to promote health and the well-being of end users, incorporating waste collection into design, designing towards discouraging crime, vandalism and further social ills. Good design should consider the negative impacts construction and properties have, and subsequently design towards enabling the construction process and operations of properties to be as sustainable as possible.

- ***Cost consultants***

Cost consultants can influence sustainable procurement in a positive manner by focusing on the whole-life cost of projects, from inception, to disposal as opposed to initial costs in isolation. Whole-life costing (WLC) should be used as a basis to make procurement decisions across all levels of a project. It should be noted that inaccurate cost assumptions and calculations lead to fundamental flaws which filters into procurement decisions thus compromising the sustainability of projects.

- ***Project managers***

Project manager take the mantle of leadership within projects, being responsible for the management and co-ordination of the project team. Project managers should ensure sustainable practices take place across all tiers within a project, thus promoting the implementation of “green” procurement.

### The role of contractors and suppliers

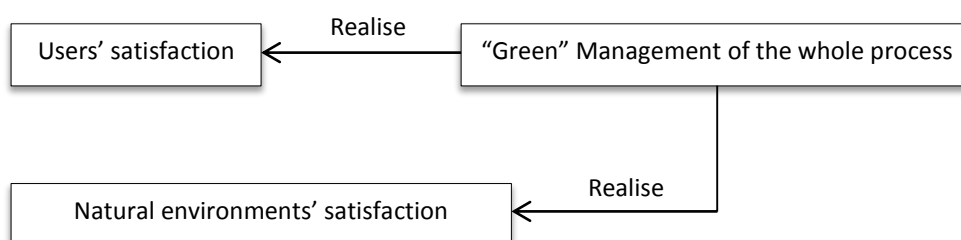
Contractors are the vehicle through which projects are physically delivered; contractors along with their suppliers have a major role towards delivering sustainable building projects through ensuring sustainable practices are implemented throughout their organisations thus promoting “green” procurement (CIRIA, 2011).

#### 2.8.8. Green Management-Whole Life Cycle

“Green” management is a vital component of “green” construction for projects achieving sustainability and green rating. “Green” management takes measures on the whole process of construction and takes a life cycle approach. Post construction is subject to high levels of energy usage, primarily from the user of the building, most energy being expelled during this stage. Energy consumption accounts for approximately 80% of this phase within the life cycle. “Green” management is thus imperative for efficiency and daily energy consumption to be improved in order to achieve energy savings (Ha *et al.*, 2012).

Ha *et al.* (2012) study applies the theory of “whole life cycle” in order to divide the whole process of construction into four sub-phases to identify a management system to construct green buildings. Being “customer orientated” is identified as a significant characteristic of “green” management. Being “customer orientated” requires the manager to pay attention to customer requirements, preferences and the impact construction generally has. Customers do not only include that of the user, but the natural environment as well.

The “customer first” principle is shown in figure 9:



**Figure 9 Customer Orientated Green Management**

(Ha *et al.*, 2012)

As identified by Ha *et al.* (2012) study, the flow of “green” management on the whole life cycle of construction can be generally classified into four phases; (1) conception, (2) preparing, (3) construction and (4) ending.

### Green management of the conception making phase

The processes that take place within this phase pertain to the defining of a new project or new phase of an existing project. “Green” management of the “conception making” phase can be divided into four parts. **Firstly**, an environmental impact analysis for the proposed project needs to be conducted; in addition an evaluation standard should be developed by the project team, the standards should not be less than the evaluating criteria for green buildings. **Secondly**, a decision based on the feasibility studies while considering the environmental impact analysis is required; the consideration of the EIA is of importance as it plays a significant role in decision making, design, construction, operations and maintenance. **Thirdly** the scope of the project needs to be established and the objectives and evaluation criteria of “green” management refined. **Fourthly**, a methodology programme for “green” management should be developed. The programme should include the organisational structure, division of responsibilities, monitoring procedures, rewards and punishment system (Ha *et al.*, 2012).

### Green management of the preparing phase

The processes within the “preparing” phase results in the course of action required to achieve project objectives developed. This phase is an extension of the conception phase while forming the basis for the construction phase. Two avenues deserve attention in this phase; (1) one can select qualified design teams and contractors, the organisations having more green building experience being given preferred consideration, (2) one can invite experienced contractors, with operating and maintenance organisations to participate in the “green” design, with their recommendations being taken into account in order to achieve the optimal performance on the whole life cycle (Ha *et al.*, 2012).

### Green management of the construction phase

The processes performed during the “construction” phase primarily include the development of a project management plan to satisfy project specifications. **Firstly**, mechanisms for “green” management need to be established by the contractor; **secondly**, measures for preventing and controlling pollution from construction is required; **thirdly**, the development of comprehensive plans to enhance energy efficiency and reduce resource consumption; **fourthly**, supervision management need to track, review, regulate and inspect progress of the works and subsequent performance, special attention should be given to ensure that the selection of materials are “green” and pollution is prevented (Ha *et al.*, 2012).

### **Green management of the ending phase**

The operations in this phase require the establishment of an operating and maintenance network platform to reduce daily energy consumption; in addition further training of the user is required to ensure environmental practices continue (Ha *et al.*, 2012).

#### **2.8.9. Green Management-Knowledge and Skills**

As the number of “green” projects increase within the construction industry so too will the number of competent professionals required to design, construct and manage these projects. According to Frank (2002), as cited by Hwang and Ng (2013), the project manager has a direct influence over 34-47% of the success of projects. There is thus an evident relationship between project success and construction project management competencies. One can thus identify a competent project manager as being vital to the success of “green” construction. It should be noted that a clear distinction exists between required knowledge areas and skills by project managers; knowledge is acquired during training/education whereas skills are developed through experience (Hwang and Ng, 2013).

As the environment in which project managers have to work in is constantly subject to change, project managers need to be able to adapt to the ever changing demands of the industry. Advancements in information, communication technologies, increasing awareness on sustainability and climate change requires the use of altered and additional skill sets. Traditional knowledge and skills thus need to be supplemented with those required to manage projects in the most efficient and effective manner towards sustainability (Hwang and Ng, 2013).

The results of the study conducted by Hwang and Ng (2013) ranked the importance of *knowledge* and *skills* required from competent project managers to execute “green” projects successfully. Table 2 shows the results of the study:

**Table 2 Managerial Knowledge and Skills Ranking**

| <b>Required managerial knowledge<br/>for “green” construction</b> | <b>Rank</b> |
|-------------------------------------------------------------------|-------------|
| Cost management                                                   | 1           |
| Communication management                                          | 2           |
| Schedule management and planning                                  | 3           |
| Health and safety management                                      | 4           |
| Risk management                                                   | 5           |
| Conflict and dispute management                                   | 6           |
| Stakeholder management                                            | 7           |
| Materials resources management                                    | 8           |
| Claims management                                                 | 9           |
| Human resources management                                        | 10          |

| <b>Required managerial skills<br/>for “green” construction</b> | <b>Rank</b> |
|----------------------------------------------------------------|-------------|
| Decision making                                                | 1           |
| Delegation                                                     | 2           |
| Analytical                                                     | 3           |
| Team working                                                   | 4           |
| Problem solving                                                | 5           |
| Leadership                                                     | 6           |
| Negotiation                                                    | 7           |
| Human behaviour                                                | 8           |
| Chairing meetings                                              | 9           |
| Presentation                                                   | 10          |

(Hwang and Ng, 2013)

Discussed below as highlighted by Hwang and Ng's (2013) study are some of the challenges project managers may face when managing "green" developments:

- "Green" construction practices and materials can cost up to 25% more than traditional methods of construction.
- Often "green" construction requires complicated techniques and construction processes; technical difficulty thus presents a major challenge towards performance.
- There is an inherent risk if design has been locked as "green" construction requires the inclusion of "green" criteria within the contracts used, changes to design at later stages greatly increases cost.
- Lengthy approval process for new "green" technologies and recycled materials diminishes the performance of projects.
- Unfamiliarity of the project team regarding the level of performance required by "green" technologies impacts the outcome of projects.
- A higher degree of integration amongst project team members is required to deliver green buildings successfully.
- More time is required due to increased monitoring to ensure "green" construction practices take place on site.

### 2.8.10. Barriers towards the Diffusion of "Green" Practices

The following barriers as highlighted by Daddi *et al.* (2012) and Doberstein and Geng's (2008) studies hinder the implementation of "green" practices within the construction industry.

- **Awareness**  
A lack of awareness on "green" procurement initiatives and tools impacts the choice to adopt "green" procurement.
- **Knowledge**  
A lack of understanding of environmental principles and the benefits of "green" procurement reduces the successful implementation of "green" procurement. Furthermore a lack of necessary guidelines and available information reduces its performance.
- **Suppliers**  
Although organisations may be willing to implement "green" procurement, a lack of "green" products and related technology on the market hinders the application of "green" procurement.

- ***Loopholes***

Loopholes that exist within the environmental legal system prevent the effective absorption of “green” procurement. The cost to be law abiding should not be higher than operating illegally and paying fines. In addition adequate staff and clear guidelines are required to enforce these policies.

- ***Resources***

A lack of organisational resources such as time and money for training hinders the implementation of “green” procurement by organisations.

- ***Cost***

When market costs are only taken into consideration and not the costs of the whole life cycle, it deters individuals from the use of “green” products. “Green” products tend to be priced higher because of the application of new technologies and higher promotion costs.

### **2.8.11. Drivers towards the Diffusion of “Green” Practices**

The following drivers promote the diffusion of “green” practices within the construction industry.

- ***External Drivers***

Pressure exerted by the general public, customers, government regulations, legislation and the desire to gain competitive advantages drive firms towards “green” and sustainable practices and procurement (Crespin-Mazet and Dontenwill, 2012).

- ***Stakeholder expectations and awareness***

Stakeholder expectations and awareness puts considerable pressure on organisations to consider the impact their businesses have on the environment and society and to subsequently implement “green” and sustainable initiatives (BSI, 2010).

- ***Consumer pressure***

Consumer pressure is considered to be one of the major drivers for more environmental friendly products produced, supplied and used. As public authorities have considerable consumer power, increased focus on public procurement has developed as an important contributor to consumer pressure. The degree to which environmental information is required for tenders and subsequently the degree to which the information is actually used in the final selection of suppliers is indicative of the level of “green” procurement taking place (De Boer and Ottar, 2009).

- **Risk**

“Green” procurement aims to mitigate risks exposed to organisations such as legislative problems, financial liabilities, ethical concerns, supply security, price volatility, reputational degradation and the potential loss of licencing to operate (BSI, 2010).

- **Internal Drivers**

A personal commitment by managers and investors along with their desire to reduce costs by minimising waste and pollution acts as a driver towards sustainability (Crespin-Mazet and Dontenwill, 2012).

- **Organisational policy commitments and targets**

“Green” procurement policies and strategies help to promote and reflect the ethos and values of how an organisation operates. Examples of policy commitments might include carbon reduction, innovation, supply chain engagement etc. (BSI, 2010).

- **Financial drivers**

“Green” procurement provides financial drivers through operational cost savings, reduced end of life disposal costs; increased efficiency in the supply chain and increased competitiveness from organisations (BSI, 2010).

- **Benefits**

The spread of sustainable initiatives such as GGP can be attributed to positive economic and competitive benefits gained from its implementation. A reduction in overall costs of procurement and subsequent disposal costs can be further compounded by long-term competitive benefits such as facilitating higher export sales (Doberstein and Geng, 2008).

- **Marketing**

The implementation of “green” procurement enhances the environmental and social credentials of an organisation; in turn this helps to increase sales targeting specific markets that exist for sustainable products further creating a positive image for organisations. Furthermore this helps to differentiate organisations from others and build a competitive advantage while attracting and retaining skilled labour (BSI, 2010).

### 2.9. Green Construction

This area of research links towards the research problem and research questions as “green” construction is the vehicle through which green buildings are physically brought to life. By understanding what “green” construction is, it further allows the study to determine how procurement and the Design Development Stage should be configured in order to facilitate the production of green buildings i.e. the construction of green buildings.

### 2.9.1. Adopting Green Construction

“Green” procurement presents a holistic view for producing green buildings; whereas “green” and sustainable construction is part and parcel of “green” procurement, comprising a major component towards the development of green buildings.

The process of construction alters the natural environment and disrupts its surroundings; furthermore the built environment influences our lifestyle, the way we move, work and operate. Taking cognisance of the significance construction plays in shaping sustainable communities is thus of importance (CIRIA, 2011).

“Green” and sustainable construction as highlighted by BSI (2008), seeks to achieve sustainability’s primary goals by reducing the negative impact construction has on the environment, promoting social welfare and contributing towards the growth of the economy. The Green Construction Guideline issued by the Ministry of Construction (MOC) in China in 2007, as highlighted in Huang *et al.* (2013) study further classifies “green” construction into six components; (1) construction management, (2) environmental protection, (3) material conservation and utilisation, (4) water conservation and utilisation, (5) energy conservation and utilisation and (6) land conservation and construction using land protection. An aspect that cannot be overlooked when implementing “green” construction is the incorporation of “green” criteria into design, specifications, and contract documents such as EMS and EIA as it is imperative towards successfully implementing “green” construction.

CIRIA (2011) further highlights twelve sustainability themes relevant in construction, while not all themes apply to all projects due to projects’ inherent difference in characteristics; the themes represent issues procurement processes and subsequently the Design Development Stage should seek to address. These themes tie into the categories of the Green Star SA rating system. The themes are as follows:

- ***Climate change mitigation and adaption***

This theme revolves around projects aiming to minimise the emission of greenhouse gases as well as integrating flexible design for potential climate change.

- ***Water***

Projects should aim to minimise usage of water during the construction and operation of buildings.

- **Waste**

Waste should be minimised by reducing, reusing, recycling and recovering materials etc. in projects.

- **Materials**

Environmentally and socially responsible materials should be identified, sourced and used for projects.

- **Biodiversity and ecology**

Projects should aim to protect and improve biodiversity and provide environmental benefits through their life cycle.

- **Land, air, water, noise**

This theme revolves around projects maximising and minimising positive and negative effects respectively on land, air, water and noise throughout their life cycle.

- **Supporting communities**

Projects should consider the social, economic and environmental impacts they may have on communities; in addition projects should develop ways to benefit communities within their area.

- **Transport and mobility**

It is imperative opportunities for sustainable transport of labour and materials throughout the building phase are considered, as well as opportunities in design to improve walking, cycling and public transport in use.

- **Access**

Design should accommodate people from all walks of life, regardless of faith, disability etc.

- **Equality, diversity, employment and skills**

Projects should aim to create employment from construction. Initiatives such as training programmes should be developed in order to provide skills and stimulate businesses.

- **Health and well-being**

Property should promote a healthy environment and lifestyle for users and operators. It is imperative health and safety requirements for all site workers are taken cognisance of, other ways to promote healthy lifestyles for construction workers such as eliminating hazardous materials, offering healthy food on site, health checks and education programmes should also be considered and implemented.

- **Labour standards**

Clients, contractors and their respective supply chains should all strive to meet internationally accepted labour standards such as that of the International Labour Organisation (ILO) standards.

Huang *et al.* (2013) study investigates the issues associated with the adoption of “green” construction. Based on the Huang *et al.* (2013) literature review, the main barriers of “green” construction identified and subsequently classified were economics, technology, awareness and management. The results of the study based on a questionnaire survey to the three major groups of stakeholders in Shanghai, i.e. clients, contractors and construction supervision engineers identified additional cost, incremental time, limited availability of “green” suppliers and information as the primary barriers to “green” construction.

Studies indicate a positive relationship between sustainable performance and business performance thus presenting a growing market for sustainable investment. The relationship between sustainable construction practice and contractors’ competitiveness becomes pressingly more relevant as sustainability grows in stature within the construction industry (Tan and Yao, 2011).

To promulgate green buildings strong national policies and industry standards are required to facilitate “green” construction (Tan and Yao, 2011).

Contractors contribute towards reducing the negative impacts construction projects have on the environment as they are the vehicles through which projects physically materialise. Tan and Yao’s (2011) study develops a framework on how contractors can improve their competitiveness through implementing sustainable construction practices. Tan and Yao (2011) identify that **sustainability principles and legislation** first and foremost has to be the overarching umbrella governing policies, strategies and actions. Organisations then need to have **sustainability policies** in place to ensure commitment from top management for goals to be achieved. In complying with sustainability policies, a clear **sustainability strategy** on how contractors will achieve their sustainable goals is then required. The strategies should be designed to improve sustainable performance and improve the link between them. With a clear sustainable strategy in place contractors should identify and select their specific **sustainable construction practices** to remain true to their commitments (Tan and Yao, 2011).

Jorge *et al.* (2010) study reports managerial concerns and environmental regulations as playing a key role towards the level contractors will commit and place their resources towards “green” and sustainable construction. Although stakeholder pressure is identified as a primary driver in previous

literature, the results of the study indicate that it cannot be considered a major driving force in comparison to managerial concerns and environmental regulations.

Contractors “green” innovation comprises of management innovation and technological innovation. Research indicates that fines and penalties for non-compliance have resulted in better performance towards “green” construction by contractors. In addition research indicates firms within regulated industries tend to incorporate more environmental issues into their managerial strategies as opposed to those in less regulated industries (Jorge *et al.*, 2010).

### **2.9.2. Green Contracts: Construction**

Incorporating “green” practices into construction project contracts facilitates successful project delivery based on “green” and sustainable principles. Contract management pertaining to “green” and sustainable projects is a novelty in its own right and thus presents potential for issues such as disputes. Problems referred to court increases cost and diminishes the success of projects (American Bar Association, 2014). As traditional contracts are tailor made to handle traditional projects, “green” and sustainable projects require contracts that take cognisance of “green” and sustainable issues. As construction projects differ in nature inherently each contract used for projects should seek to accurately reflect its project requirements (The Green Economy Post, 2014)

Despite implementing “green” procurement tools, building contractors may not deliver “green” and sustainable construction because of environmentally unfriendly contracts. Balfors *et al.* (2009) study explores the current practice, problems and opportunities of “green” procurement of construction contracts. The study indicates that contractors are unlikely to undergo practices that are not contractually bound on them, more so if such practices may impact on their returns from a project. The application of “green” specifications in contract management complemented by EMS is thus required to achieve sustainable construction.

Two fundamental features of “green” and sustainable construction that need to be taken cognisance of are post construction liability and construction insurance. As the energy consumption of maintenance (post construction) accounts for about 12% of total construction, the responsibility of warranty for “green” construction is thus increased. As a result the contractual and liability problems of “green” construction thus need to be resolved (Huang *et al.*, 2013).

### **2.9.3. Green Specifications and Environmental Management Systems**

“Specifications” in construction pertains to clear information for tendering, construction quality and handover requirements. Specifications are used to express written directions on the prescribed material, practices, personnel, equipment, and workmanship including tolerances (Chan *et al.*, 2011).

“Green” specifications are required to provide a conduit for translating the theory of sustainability into practice for green building. As the need and importance of sustainability continues to grow, the need for more comprehensive “green” specification within contract documentation is required in order to achieve greater “green” performance. The introduction of “green” specifications is thus imperative in order to advance and improve “green” performance in the construction industry via contract management (Chan *et al.*, 2011).

“Green” specifications set out the construction process and the requirements of materials to achieve sustainable development. Chan *et al.* (2010) research identifies five factor categories in order of importance for successful specification of “green” construction to take place; (1) “green” technology and techniques, (2) reliability and quality of specification, (3) leadership and responsibility, (4) stakeholder involvement and (5) guide and benchmarking systems. There are a number of institutional bodies that publish “green” specification guidelines as well as green building assessment tools such as the Building Research Establishment (BRE) in the UK and the Construction Specifications Institute (CSI) in the US.

Traditionally the use of Environmental Management Systems (EMS) has been recognised as an approach to achieve sustainable development in the construction industry. Environmental Management Systems are used as a tool for sustainable construction. To ensure its successful implementation towards sustainability it should be based on sustainability principles and used in conjunction with other environmental tools such as Environmental Impact Assessments and Eco-labelling. Furthermore materials and required practices to achieve sustainability should be specified into construction contracts (Chan *et al.*, 2011). Although the effects of EMS can be extensive, it is clear its use in isolation does not reach the optimum environmental performance from construction. As discussed by Chan *et al.* (2011) study, the environmental issues which are not addressed by merely implementing EMS requires the use of “green” specification in construction projects.

### **2.10. Research Gap**

Table 3 shows a mixed picture of studies previously done on “green” procurement regarding its configuration and implementation. There is no previous research on the Design Development Stage directly, its configuration or its contribution towards green buildings. Further research is therefore needed to understand the Design Development Stage and how it should be configured to facilitate the production of green buildings.

Although “green” procurement has been well documented in some contexts, namely in Europe and Asia where construction takes place in developed countries such as Sweden and China respectively, the implementation of “green” procurement in less developed countries is largely unknown. Further to this the benefits of “green” procurement have been articulated in several studies and documents e.g. (Doberstein and Geng, 2008; De Boer and Ottar, 2009; BSI, 2010; CIRIA, 2011; Crespín-Mazet and Dontenwill, 2012) but as studies have focused on procurement as a whole there is not enough evidence to suggest the extent to which green principles have been incorporated into the Design Development stage specifically nor the reasons for why green principles have or have not been incorporated into this stage.

With findings mostly based on procurement; its “green” agenda, GPP, barriers to its implementation, the roles of stakeholders, the supply chain and performance indicators, there is a need for more research into the incorporation of green principles into the Design Development Stage of projects.

With the intention of covering the above mentioned research gap, this study therefore intends to;

- Identify what is required from the Design Development Stage to produce green buildings.
- To determine the extent to which green principles are incorporated into the Design Development stage by practitioners in Gauteng.
- To determine the reasons for green principles not being or being incorporated into the Design Development Stage by practitioners in Gauteng.

**Table 3 Summary of Previous Studies on “Green” Procurement**

| Author(s)                             | Title                                                                                                          | Methodology                                  | Findings                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------------------|----------------------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (Byggeth and Hochschorner, 2006)      | Handling trade-offs in Ecodesign tools for sustainable product development and procurement.                    | Qualitative                                  | Nine out of 15 Ecodesign tools were analysed and found to support choice of trade-off characteristics, the support being provided not sufficient.                                                                                                                                                                                                                                                                                                                                                                                 |
| (Doberstein and Geng, 2008)           | Greening government procurement in developing countries: Building capacity in China.                           | Qualitative - case study                     | GGP is in its infancy in China, further to this there are several barriers towards the implementation of GGP that exists in China such as a lack of awareness by procurement staff of the benefits of GGP.                                                                                                                                                                                                                                                                                                                        |
| (Balfors et al., 2009)                | EIA and green procurement: Opportunities for strengthening their coordination.                                 | Systematic literature review                 | The introduction of green procurement during the pre-decision phase of an EIA is required in order to strengthen their coordination.                                                                                                                                                                                                                                                                                                                                                                                              |
| (De Boer and Ottar, 2009)             | Green procurement in Norway; a survey of practices at the municipal and county level.                          | Quantitative - survey                        | Green procurement is significantly more established in large municipalities than in small ones.                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| (Loprieno <i>et al.</i> , 2011)       | A life cycle approach to Green Public Procurement of building materials and elements: A case study on windows. | Qualitative - case study                     | Life cycle assessment is imperative to identify the key environmental impacts of building elements and key responsible processes. In order to reduce these impacts on windows some of the following actions should take place; increasing the recycled content of window frames, using the best practices for materials production or extending the window service life are all suitable strategies for reducing the primary energy used in the window production phases.                                                         |
| (Crespin-Mazet and Dontenwill, 2012). | Sustainable procurement: Building legitimacy in the supply network.                                            | Qualitative – action research and case study | Sustainable development is dependent upon relationships with other stakeholders in the sustainable development setting and in particular with non-business stakeholders. The integration of sustainable development purchasing strategies fosters a change towards more partnerships and joint value creation. Top management support to commit the firm to sustainable development is imperative. Furthermore in terms of managerial implications, these findings have direct consequence on the purchasing behaviour of buyers. |

|                                   |                                                                                                                               |                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (Daddi <i>et al.</i> , 2012).     | What factors influence the uptake of GPP (green public procurement) practices? New evidence from an Italian survey.           | Quantitative and qualitative - questionnaires and interviews | Public authorities and the level of awareness of the existing tools for supporting GPP have a positive and significant effect of GPP practices being adopted.                                                                                                                                                                                                                                                                                                                                                                                               |
| (Johnsen <i>et al.</i> , 2012)    | Sustainable procurement: Past, present and future.                                                                            | Systematic literature review                                 | Sustainable procurement is on the rise and is increasing on the agenda for purchasing and supply managers internationally.                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| (Manoliadis <i>et al.</i> , 2012) | Project performance indicators as an innovative tool for identifying sustainability perspectives in green public procurement. | Qualitative - questionnaire                                  | Performance indicators are essential and form one of many tools needed to improve project performance evaluation methods.                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| (Bratt <i>et al.</i> , 2013)      | Assessment of criteria development for public procurement from a strategic sustainability perspective.                        | Qualitative - case study                                     | Criteria development process for public procurement in Sweden is transparent, well-documented and encourages a high level of participation by the members of the working groups. However, the assessment also points to several weaknesses of the process such as a limited impact perspective and lack of a clear definition of sustainability objectives. Furthermore the development process results in criteria which fall outside the context of long-term objectives thus resulting in no strategies being developed to prepare for future processes. |

## **2.11. Green Building Principles**

### **2.11.1. Incorporating Green Building Principles**

As highlighted previously three main criteria i.e. energy efficiency, resource efficiency and environmental responsibility need to be met in order for a building to be “green” along with subsidiary green point allocation criteria to be met (Green Building Council SA, 2013). Further to this Sustainability principles need to be met for a building to be “green” (GGGC, 2014). Listed below are components of green principles to be integrated into green buildings.

- ***Green principles***
  - ***Green building criteria***
    - Energy efficient
    - Resource efficient
    - Environmentally responsible
  - ***Sustainability***
    - Economic growth
    - Social progress
    - Protection of the environment

### 2.11.2. Incorporating Green Principles into Procurement Processes

Literature highlights a link between successful project delivery and procurement (Horman *et al.*, 2009), the Design Development Stage forming part of the procurement process (PROCSA, 2013). When green buildings are placed as a primary objective, procurement and thus the Design Development Stage can be seen as a primary driver towards green buildings.

Based on the literature, four factors were systematically identified as facilitating procurement processes successfully incorporate green principles towards green buildings. Discussed below are the factors and their components that facilitate the Design Development Stage producing green buildings.

- **Operating framework**

The operating framework “the environment” in which procurement is subject to facilitates the diffusion of green principles as it sets the tone to how “green” and sustainable the construction industry is. In order to increase green buildings the operating frame work needs to facilitate the diffusion of green principles in a construction industry. Components that make up and used to evaluate this factor include the following:

- The use of electronic procurement to increase efficiency as a basis towards green buildings (Ekram *et al.* 2011).
- The diffusion of “green” and sustainability principles into project objectives (Mbachu and Raymond, 2007).
- The level of governance of project delivery methodology by institutions and regulatory bodies (Emery *et al.* 2007).
- The placement of "green" and sustainable deliverables in planning conditions for projects by local planning departments (CIRIA, 2011).
- The number of subsidies given to projects falling under “green” government policies (Doberstein and Geng, 2008).
- Amount of preferable tax allowance given to projects falling under “green” government policies (Doberstein and Geng, 2008).

- **Stakeholders**

Stakeholders facilitate procurement producing green buildings as it is ultimately through stakeholders that green buildings are brought about, directly or indirectly. Components that make up and used to evaluate this factor include the following:

- Government and green public procurement (Daddi *et al.*, 2012).
- Clients' emphasis on projects being “green” and sustainable (CIRIA, 2011).
- Consultants’ incorporation of sustainable principles when providing services (CIRIA, 2011).

- Contractors' and suppliers implementation of sustainable practices (CIRIA, 2011).

- ***“Green” and sustainable knowledge***

In order for procurement to produce green buildings it is imperative stakeholders have the requisite base knowledge of “green” and sustainable principles, without which procurement processes cannot work effectively towards green buildings. Components that make up and used to evaluate this factor include the following:

- Stakeholders' knowledge of green buildings and its core principles (CIRIA, 2011).
- Stakeholders' knowledge of sustainability and its core principles (Chen *et al.*, 2010).
- Number of information platforms for stakeholders to learn about "green" and sustainable principles, issues etc. (Doberstein and Geng, 2008).
- Stakeholder's familiarity with green building evaluation standards (Jorge *et al.*, 2010).
- Stakeholder's familiarity with green construction guidelines (Daddi *et al.*, 2012) and (Doberstein and Geng, 2008).
- Number of institutional bodies publishing "green" specifications (Chan *et al.* 2011).
- Stakeholders' awareness of the benefits received from being “green” and sustainable (Doberstein and Geng, 2008).
- Stakeholders' knowledge of green building and sustainable project requirements (Doberstein and Geng, 2008).
- Stakeholders' knowledge of additional measures of success used for green buildings (Green Building Council SA, 2013).
- Whole life cycle approach taken by all tiers of management (CIRIA, 2011).
- Possession of necessary knowledge and skills to manage “green” by all tiers of management (Hwang and Ng, 2013).

- ***Green practices***

Although “green” and sustainable knowledge is imperative, it is redundant without “green” practices being implemented in conjunction with it. Green practices refer to the implementation of green principles into the services provided at the Design Development Stage. Components that make up and used to evaluate this factor include the following:

- An integrated approach between all stakeholders involved when delivering projects i.e. from suppliers to contractors, to consultants, clients etc. (CIRIA, 2011).
- The amount of “green” technology available for "green" and sustainable developments (Doberstein and Geng, 2008).
- The incorporation of "green" criteria into design and specifications (Chan *et al.* 2011).

- "Green" requirements adopted and managed throughout the construction and commissioning stages of projects (PROCSA, 2013).
- "Green" and sustainable practices diffused across supply chains (Johnsen *et al.*, 2012)
- The life cycle assessment of buildings (Doberstein and Geng's, 2008).
- The use of "green" procurement tools to facilitate "green" procurement (e.g. EIA, ecodesign tool etc.) (Byggeth and Hochschorner, 2006) and (Manoliadis *et al.*, 2012).
- The use of environmental criteria to evaluate tenders (Balfors *et al.*, 2009).
- The development of "green" requirements for projects in the planning stage (CIRIA, 2011).
- The implementation of "green" projects plans (Balfors *et al.*, 2012).
- The use of "green" materials in developments (GGGC, 2014).
- The use of "green" contracts for construction (Balfors *et al.*, 2009).
- The use of "green" leases for property (EPROP, 2013).

### **2.11.3. Incorporating Green Principles into the Design Development Stage**

In order for the Design Development Stage to work effectively towards green buildings, green principles have to be diffused into the actions that take place at each phase of the Design Development Stage. Each phase and subsequent action needs to satisfy green building criteria i.e. achieve energy efficiency, resource efficiency and environmental friendliness, in order for the Design Development Stage as a whole to work effectively towards green buildings (Green Building Council SA, 2013).

Based on a critical review of the literature, six factors were further identified that facilitate each phase of the Design Development Stage producing green buildings. These variables reflect the extent to which green principles are incorporated into the Design Development Stage of building projects. Discussed below are the factors that facilitate each phase of the Design Development Stage producing green buildings.

- **Green concepts**

The "green concept" factor involves the incorporation of green principles into actions that take place when developing of the approved concept. Energy efficiency, resource efficiency and environmental responsibility should all be considered and diffused into the approved concept (Green Building Council SA, 2013).

- ***Green design***

Green design relates to the diffusion of green principles into actions that take place when finalising the design i.e. the incorporation of energy efficiency, resource efficiency and environmental responsibility when finalising the design (Green Building Council SA, 2013).

- ***Green specifications***

This factor involves the incorporation of green principles into actions that take place when providing specifications in projects i.e. the diffusion of energy efficiency, resource efficiency and environmental responsibility into specifications provided (Green Building Council SA, 2013).

- ***Green cost systems***

Green cost systems relates to the diffusion of green principles into actions that take place when producing cost plans i.e. the long term cost benefits received from green buildings as opposed to traditional buildings (Green Building Council SA, 2013).

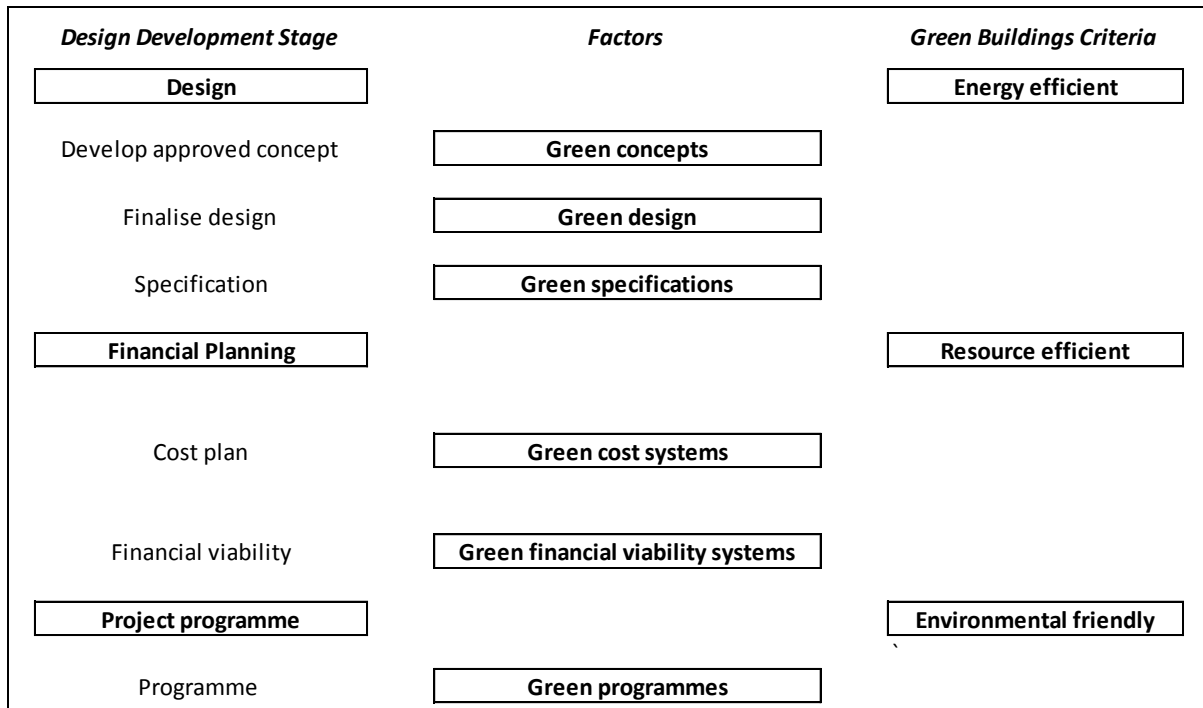
- ***Green financial viability systems***

Green financial viability system relates to the diffusion of green principles into actions that take place when conduction financial viabilities i.e. the long term cost and revenue stream benefits received from green buildings as opposed to traditional buildings (Green Building Council SA, 2013).

- ***Green programmes***

Green programmes relate to the diffusion of green principles into actions that take place when developing project programmes i.e. the incorporation of energy efficient, resource efficient and environmental responsible criteria to be adhered to when developing the programme. Detailed programmes should ensure the methodology followed to execute the works is in accordance with green principles e.g. Health and safety (Green Building Council SA, 2013).

Figure 10 indicates the framework required in order for the Design Development Stage to work effectively towards green buildings.



**Figure 10 Design Development Stage working towards Green Buildings**

### 2.12. Chapter Summary

This chapter provides a critical review of the literature by linking the existing literature to the research problem, research questions, what other researchers have done and subsequently identifying the research gaps in knowledge. This chapter reviewed literature on project delivery, procurement, the Design Development Stage, sustainability, green buildings and green principles. Further to this, the chapter provides an overview on project delivery and its requirements for successful performance before discussing the Design Development Stage, green buildings, the diffusion of green practices, green construction, and procurement and the Design Development Stage producing green buildings. Procurement and the Design Development Stage more specifically is identified as a critical component towards successful project delivery and green buildings inherently.

### **3. CHAPTER 3: RESEARCH DESIGN AND METHODS**

#### **3.1. Introduction**

This chapter outlines and justifies the research design and methods respectively. The available/potential research techniques are discussed and subsequently narrowed down to the techniques used for the study. In short the nature of the report's research design is that of a descriptive study with the choice of methodology being that of a mono model method comprising of qualitative research. An interview/questionnaire survey was thus made use of as the primary tool for gathering data to further examine the Design Development Stage in projects producing green buildings in Gauteng's construction industry.

In order to determine the applicable research design and method to be used for the study, it was necessary to first investigate literature on potential research designs and methods. The research onion as described in detail by Lewis *et al.* (2012) is used as a basis for the research design and methods discussed and subsequently used for this study. As previously stated research design and methodology involves the overall plan of how one intends on going about answering research questions, it is the "the blueprint". Research design and methodology comprises of clear objectives derived from research questions and stipulates the sources intended to collect data and subsequently analyse from. Further to this it must specify at least three processes; (1) the data collection process, (2) the instrument development process and (3) the sampling process (Bhattacharjee, 2012).

#### **3.2. Research Questions**

Bhattacharjee (2012) discusses in detail the research process and more specifically the research design process, ultimately the research design and method to be applied for a study hinges on the study's research problem and subsequent research questions. Thus it is imperative before one determine the research design and method to be applied the research problem, research questions and subsequent literature review that follows should be understood.

Identifying the research gap from existing literature in terms of what other researchers have done is required in order to develop research questions that ultimately result in a contribution to research theory. Further to this, an analysis of the research problem and the research questions is imperative prior to answering the research question, conducting the literature review and subsequently determining the research design and method.

### **Gaps in literature**

In order to contribute to existing literature it's imperative to find the research gap existing in current literature, thus allowing examination on research areas in need of investigation and developing appropriate research questions for a study.

As procurement is vital towards successful project delivery (Anderson and Oyetunji, 2004), the Design Development Stage presenting the greatest chance to achieve project objectives as it form an important component of procurement (PROCSA, 2013), it is imperative actions undertaken within this stage are effective and efficient.

Several studies have been conducted by researchers on procurement in relation to the "green" agenda in the construction industry; no research having being conducted in relation to the Design Development Stage more specifically in relation towards the "green" agenda and ultimately green buildings. A gap in literature thus exists highlighting the need to further investigate the Design Development Stage and the "green" agenda towards green buildings. Previous studies conducted of note are shown in Table 3.

### **Research problem and research questions**

The focus of the research problem is traditional procurement, more specifically the Design Development Stage being subject to several deficiencies in South Africa resulting in poor project delivery, further to this not producing green buildings. The primary research question and subsidiary research question are as follows:

- **Primary research question**
  - What factors within the Design Development Stage in projects undermine it from producing green building in Gauteng's construction industry?
- **Key research questions**
  - What is required from the Design Development Stage to produce green buildings?
  - To what extent are green principles incorporated into the Design Development Stage by practitioners in Gauteng?
  - What are the reasons for green principles not being or being incorporated into the Design Development Stage by practitioners in Gauteng?

### **3.3. Potential Research Designs and Methods**

#### **3.3.1. Nature of Studies**

##### **Exploratory studies**

Exploratory research provides a valuable means to ask open ended questions in order to ascertain what is occurring and gain further insight about ones topic of interest. It is particularly useful to clarify ones understanding of the nature of a problem. Exploratory studies can be conducted in a number of ways i.e. literature research, interviews with “experts” on the topic and in depth interviews with individuals or groups. It should be noted due to the nature of exploratory studies interviews are likely to be relatively unstructured and will predominantly rely on the quality of the contributions from the participants (Lewis *et al.*, 2012).

##### **Descriptive studies**

Descriptive research examines the what, where, and when of a phenomenon (Bhattacharjee, 2012). The objective of descriptive research is to gain an accurate understanding of the framework of events, persons or situations. This may be an extension of, a forerunner to, a piece of exploratory research or more often, a piece of explanatory research. It is imperative one has a clear understanding of the phenomenon on which one wishes to investigate prior to the collection of data (Lewis *et al.*, 2012).

##### **Explanatory studies**

Explanatory studies seek to explain observed phenomena, problems, or behaviours. The emphasis of this type of research is investigating a situation or problem in order to explain the relationship between factors (Bhattacharjee, 2012).

### 3.3.2. Research Philosophies and Approaches

#### Philosophies

Research philosophy as described by Lewis *et al.* (2012) pertains to the development of knowledge and the nature of that knowledge; it entails assumptions made by researchers that subsequently influence the way in which one views their research. Assumptions made ultimately underpin ones research strategy and the methods chosen as part of their strategy, discussed below are the different types of research philosophies:

- **Pragmatism**

Pragmatism emphasises that concepts are only relevant where they support action, the underlying meaning being that the importance of an idea (or a research finding) lies with its practical consequence (Kelemen and Rumens, 2008).

- **Objectivism**

Objectivism is a branch of Ontology which is concerned with the nature of reality, objectivism represents the position that social entities exist in reality external to and independent of social factors (Lewis *et al.*, 2012).

- **Subjectivism**

Like objectivism, subjectivism is a branch of Ontology; unlike subjectivism it takes the view that the objective aspects of research are less important as opposed to perceptions and consequent actions of social actors (Lewis *et al.*, 2012).

- **Positivism**

Positivism is a branch of epistemology which is concerned with what constitutes acceptable knowledge in a field of study. This philosophy adopts the philosophical stance of the natural scientist. It involves collecting data regarding an observable reality and searching for regularities and casual relationships in data to create generalisations (Gill and Johnson, 2010).

- **Realism**

Realism like positivism is a branch of epistemology; it assumes a scientific approach to the development of knowledge. The essence of realism pertains to what we sense as reality, that objects have an existence independent to that of the human mind (Lewis *et al.*, 2012).

- ***Interpretivism***

Interpretivism falls under Epistemology as well; this philosophy advocates that it is necessary for the researcher to understand and take cognisance of the differences between humans in our role as social actors (Lewis *et al.*, 2012).

### **Approaches**

Research approaches as detailed by Lewis *et al.* (2012) and Bhattacharjee (2012) pertain to how one views theory; discussed below are the different types of research approaches:

- ***Deduction (Theory testing)***

Deduction involves the development of theory that is subjected to a rigorous test through a series of propositions. Conclusions are derived logically from a set of premises. It should be noted that it is the dominant research approach in the natural sciences, where laws present the basis of explanation, allow the anticipation of phenomena, predict their occurrence and therefore permit them to be controlled (Lewis *et al.*, 2012).

- ***Induction (Theory building)***

Induction is the process of drawing conclusions based on facts or observed evidence. It involves the analysis of data obtained; the results of the analysis is used to formulate theory, often expressed as a conceptual framework (Bhattacharjee, 2012).

- ***Abduction***

Abduction combines the deduction and induction approach simultaneously in its research approach (Lewis *et al.*, 2012).

### **3.3.3. Quantitative and Qualitative Research**

#### **Quantitative research**

Quantitative research examines the relationship between variables which are measured numerically and analysed using a range of statistical techniques. Quantitative research is principally associated with experimental and survey research strategies. It tends to incorporate controls to safeguard validity of the data. As data is collected in a standard manner, it is imperative to ensure that questions are stated clearly so that they are understood in the same manner across the sample population. The quantitative method often makes use of probability sampling techniques to ensure generalisability. The researcher is seen as independent from those being researched, often referred to as the respondents (Lewis *et al.*, 2012).

### Qualitative research

Qualitative research examines participants' meanings and the relationships between them, using a variety of data collection techniques and analytical procedures to develop a conceptual framework. Data collection is non-standardised in order to prevent questions and procedures from being rigid, subsequently enabling it to change during the research process that is both naturalistic and interactive. Qualitative research often uses non-probability sampling techniques. In addition the success of the researcher is dependant not only on gaining physical access to participants but also building rapport with those involved in the study (Lewis *et al.*, 2012).

#### 3.3.4. Methodological Choices

Research methodologies pertain to the research design to be undertaken in terms of quantitative and qualitative research. Discussed below are the various research methodologies available:

- ***Mono-method***

The use of the mono-method entails the use of either quantitative or qualitative research in isolation to answer ones' research question.

- ***Multiple methods***

Multiple methods as discussed by Tashakkori and Teddlie (2010) entails the use of more than one data collection technique and analytical procedure to answer ones' research question. Under the umbrella of multiple methods exists ***multi-method*** research and ***mixed method*** research. ***Multi-method*** research encompasses the use of more than one data collection technique with associated procedures, but restricted within either a quantitative or qualitative design i.e. either a multi-method quantitative study or multi-method qualitative study. ***Mixed methods*** research encompasses the combined use of both quantitative and qualitative research design i.e. the use of either a mixed model research design or mixed method research design (simple or complex).

### 3.3.5. Research Strategies

Denzin and Lincoln (2005) discuss research strategies. A strategy in general terms is defined as a plan of action to achieve a goal; a research strategy pertaining to the plan of action of how a researcher ultimately goes about answering their research question. Research strategies are thus the methodological link between one's philosophy and subsequent choice of methods to collect and analyse data. The available research strategies for studies are discussed below:

- **Experiment**

Hakim (2000) as cited by Lewis *et al.* (2012) describes experiments as tending to be once off and artificial in nature, these types of studies investigate the probability of a change in an independent variable causing a change in another, dependant variable. Experiments make use of hypotheses as opposed to research questions as the researcher anticipates whether or not a relationship exists between the variables. Experiments tend to be used for exploratory and explanatory research to answer "what", "how" and "why" questions. Furthermore experiments make use of experimental groups and control groups to conduct studies.

- **Survey**

The survey method can be used for descriptive, exploratory, or explanatory research (Bhattacharjee, 2012), it is most frequently used to answer "what", "who", "where", "how much" and "how many" questions. It therefore tends to be used for explanatory and descriptive research. Surveys tend to make use of questionnaires to collect quantitative data, its use in qualitative research is also applicable, it allows the collection of standardised data from the population in an economical manner. Surveys may also make use of structured observations and structured interviews.

- **Archival research**

Archival research makes use of administrative records and documents as a primary source of data. Archival research strategy allows research questions which focuses on the past and changes over time to be answered, whether exploratory, descriptive or explanatory.

- **Case study**

Yin (2009) describes the use of case studies; case studies are used for exploring research topics or phenomenon within their context, or within a number of real-life contexts. Furthermore case studies are considered useful when answering questions to "why", "what" and "how". For this reason case studies are primarily used on exploratory and explanatory studies. Quantitative and qualitative methods or a mix of these methods may be used to collect and analyse data. Interviews, observations, documentary analysis and questionnaires may be made use of. It should be noted that when using case studies one may be required to

triangulate multiple sources of data i.e. the use of different data collection techniques within one study.

- ***Ethnography***

Ethnography is an interpretive research strategy inspired by anthropology its emphases being on the research phenomenon being studied within the context of its culture. Ethnography is used to study groups of people that interact with each other (Bhattacharjee, 2012).

- ***Action research***

Action research takes the view that complex social phenomena are best understood by intervening in phenomena and observing the effects of those interventions. Action research is an emerging research strategy; it is an iterative process of inquiry that is designed to find and develop solutions to problems faced by real organisations, this type of research requires a participative and collaborative approach (Bhattacharjee, 2012).

- ***Grounded theory***

Grounded theory research is usually associated with an inductive approach, this type of research strategy process is used to analyse, interpret and explain the meanings individuals/groups develop to make sense of their everyday experiences in particular situations. Furthermore it is used to develop theoretical explanations of social interactions and processes in a wide range of contexts (Lewis *et al.*, 2012).

- ***Narrative inquiry***

Narratives are stories which pertain to personal accounts which aim to interpret an event or sequence of events. Narrative inquiries are associated with qualitative research interviews, this strategy collects and analyses complete stories from participants as opposed to bits of data that stem from specific interview questions, which are subsequently fragmented during data analysis (Lewis *et al.*, 2012).

### **3.3.6. Data Collection Techniques and Procedures**

There are a number of data collection techniques available when acquiring data, discussed below are the techniques available as outlined by Lewis *et al.* (2012) and Bhattacharjee (2012).

- ***Secondary data***

Secondary data refers to data that has already been collected for some other purpose, it includes both raw data and published summaries, once this data is obtained it can be further used to provide additional or different knowledge (Bhattacharjee, 2012).

- **Observations**

Observation data collection allows researchers to answer research questions and objectives concerning with what people do, as the obvious way to determine this would be to watch them do it (Lewis *et al.*, 2012).

- **Interviews**

Research interviews pertain to a purposeful discussion between two or more individuals. Interview scripts may contain special instructions for the interviewer that is not seen by respondents; furthermore it allows the interviewer to clarify any issues raised by the respondent (Bhattacharjee, 2012).

- **Questionnaires**

A questionnaire is a research instrument consisting of a set of questions intended to capture responses from respondents in a standardised manner (Bhattacharjee, 2012). Questionnaires are often made use of within the survey strategy; however experiments and case study research strategies can make use of questionnaires as well (Lewis *et al.*, 2012).

### 3.3.7. Time Horizons

Time horizons as discussed by Lewis *et al.* (2012) and Bhattacharjee (2012) refer to the time frame in which research is conducted, i.e. does one's research pertain to a "snap shot" taken at a particular time or does it pertain to a series of "snap shots" representing events over a given period of time. These two types of time-frames are referred to as cross-sectional and longitudinal studies respectively.

- **Cross-sectional studies**

Cross sectional studies pertain to the research of a particular phenomenon or phenomena at a particular point in time (Bhattacharjee, 2012).

- **Longitudinal studies**

Longitudinal studies take place over time. These types of studies provide inherent strengths such as enabling one to study change, development and can be used to survey the same set of respondents at different times (Bhattacharjee, 2012).

## 3.4. Research Design and Method Applied

### 3.4.1. Nature of Study

The nature of the research design is that of a **descriptive study** as the research gains an accurate understanding into the actions undertaken at the Design Development Stage in projects producing green buildings. The aim of the research is to determine the factors within the Design Development

Stage undertaken in projects within Gauteng's construction industry that undermine it from producing green buildings

### 3.4.2. Research Philosophy and Approach

#### Philosophy

As the study collects data from architects and quantity surveyors on the Design Development Stage in projects producing green buildings, to identify actions that occur at the Design Development Stage in Gauteng's construction industry, the research philosophy for the study is inherently that of interpretivism. As highlighted previously, interpretivism advocates that it is necessary for the researcher to understand and take cognisance of the differences between humans in our role as social actors (Lewis *et al.*, 2012).

#### Approach

In order to answer the research question and satisfy the research objectives, the data collected was used to build theory on the Design Development Stage in projects and green buildings in Gauteng's construction industry. The research is thus subject to an inductive research approach. As highlighted previously, induction involves the analysis of data obtained; the results of the analysis being used to formulate theory (Lewis *et al.*, 2012).

### 3.4.3. Research Methodology

#### Qualitative Research

##### Qualitative study

As outlined by Bhattacharjee (2012), qualitative studies hinge on understanding a phenomenon, rather than predicting or explaining. As required by research to answer the research question i.e. understanding and subsequently determining the factors within the Design Development stage that undermine it from producing green buildings in Gauteng's construction industry, a **qualitative** study was conducted.

##### Qualitative research strategy

Based on the norms of qualitative research as highlighted by Lewis *et al.* (2012), a survey research strategy was made use of. The research techniques that could have been used for the study revolved around one of the following; a survey research strategy conducted through the use of questionnaires and/or structured interviews, or structured observations. Semi-structured interviews and

questionnaires were made use of as it allowed for an investigation as to what precisely occurs at the Design Development Stage in Projects in Gauteng.

### **Mono Method Research**

The methodological choice for the research study's data is that of a mono method research structure as qualitative research for the study was conducted to collect data. The methodological choice used for the research is developed primarily from the objectives of the study, inherently requiring qualitative research.

#### **3.4.4. Research Strategy**

##### **Justification of Survey Research Strategy**

As stated the required data is subject to qualitative research. As qualitative research is principally associated with interviews, given the feasibility of using the survey research strategy, interviews and questionnaires were made use of as they cater for descriptive research as opposed to exploratory research, thus interviews in conjunction with the questionnaire was considered appropriate to investigate what actions take place at the Design Development Stage in Gauteng and the degree to which green principles are incorporated into the Design Development Stage. The data collection techniques for the survey research that could have been used for the study revolved around one of the following; a survey research strategy conducted through the use of questionnaires, structured interviews or structured observations. Due to the cross-sectional nature of the research, the implementation of the survey strategy via interviews and questionnaires offered a chance to collect valuable data from a sizable population in an economical manner within the specified time frame. The survey strategy thus presented a means to achieve the study's objectives effectively.

#### **3.4.5. Advantages and Disadvantages of Research Strategy**

The survey research strategy has several inherent advantages and disadvantages for its use in research, discussed below are the advantages and disadvantages the survey research strategy is subject to.

##### **Advantages**

The survey research strategy has several inherent strengths; (1) surveys serve as an excellent medium for measuring a range of unobservable data, (2) survey research makes it possible to collect data from a population that is too large to observe directly, (3) as they are unobtrusive in nature surveys via questionnaires allow respondents to respond at one's convenience, (4) surveys via interviews may be the only way of reaching certain population groups allowing data to be collected from samples such

as homeless or illegal immigrants, (5) survey research is economical in terms of researcher time, effort and cost as opposed to other methods such as experimental research and case research (Bhattacharjee, 2012).

Furthermore survey research is subject to a high degree of external validity, i.e. the degree to which observed associations can be generalised from the sample to the population is high (Bhattacharjee, 2012)

### **Disadvantages**

As discussed by Bhattacharjee (2012) in detail survey research has unique disadvantages as it is subject to a large number of biases such as (1) non-response bias - as survey research is usually subject to low response rates, (2) sampling bias - as randomly selecting individuals or entities from a sample frame may exclude respondents that may otherwise have contributed to the research, (3) social desirability bias - as respondents may not want to expose information they may feel is negative towards themselves or area they are involved in and (4) recall bias - as responses to survey questions often depend on respondent's motivation, memory.

### **3.4.6. Research Population and Sample**

#### **Population**

The research population refers to the set of all items or units of interest in a research problem (Research Connections, 2014). As the study aims to determine the factors within the Design Development Stage undertaken in projects within Gauteng's construction industry that undermine it from producing green buildings, the population of the study encompasses architects and quantity surveyors within Gauteng's construction industry as they are the professions primarily involved at the Design Development Stage. The population in question for architects and quantity surveyors in the South African construction industry is 1,654 and 3,267 respectively. Tables 4 and 5 indicate the number of candidate and registered architects and quantity surveyors in the various South African provinces as captured by their respective professional bodies; The South African Council for the Quantity Surveying Profession (SACQSP, 2013) and the South African Council for the Architectural Profession (SACAP, 2013). As indicated in the tables 4 and 5, the Gauteng province has the highest number of both candidate and professional architects and quantity surveyors in South Africa, highlighting the importance Gauteng plays within South Africa's construction industry.

Table 4 Architecture Population - South Africa

| Category                                        | EC         | FS        | GAU        | KZN        | LP        | MP        | NC        | NW        | WC         | Other     | Total       |
|-------------------------------------------------|------------|-----------|------------|------------|-----------|-----------|-----------|-----------|------------|-----------|-------------|
| Candidate Architectural Draughtspersons         | 6          | 5         | <b>70</b>  | 11         | 14        | 12        | 2         | 9         | 13         | 1         | 143         |
| Candidate Architectural Technologists           | 12         | 4         | <b>55</b>  | 48         | 8         | 4         | 3         | 4         | 22         | 2         | 162         |
| Candidate Senior Architectural Technologists    | 5          | 3         | <b>46</b>  | 10         | 2         | 1         | 2         | 1         | 20         | 0         | 90          |
| Candidate Architects                            | 12         | 10        | <b>94</b>  | 32         | 0         | 3         | 1         | 2         | 50         | 4         | 208         |
| <b>Sub-total Candidates</b>                     | <b>35</b>  | <b>22</b> | <b>265</b> | <b>101</b> | <b>24</b> | <b>20</b> | <b>8</b>  | <b>16</b> | <b>105</b> | <b>7</b>  | <b>603</b>  |
| Professional Architectural Draughtspersons      | 17         | 10        | <b>109</b> | 47         | 21        | 17        | 6         | 12        | 52         | 0         | 291         |
| Professional Architectural Technologists        | 15         | 3         | <b>59</b>  | 36         | 8         | 5         | 0         | 5         | 30         | 0         | 161         |
| Professional Senior Architectural Technologists | 14         | 2         | <b>81</b>  | 36         | 6         | 2         | 0         | 0         | 50         | 3         | 194         |
| Professional Architects                         | 26         | 18        | <b>198</b> | 35         | 3         | 9         | 4         | 4         | 96         | 12        | 405         |
| <b>Sub-total Professionals</b>                  | <b>72</b>  | <b>33</b> | <b>447</b> | <b>154</b> | <b>38</b> | <b>33</b> | <b>10</b> | <b>21</b> | <b>228</b> | <b>15</b> | <b>1051</b> |
| <b>Total</b>                                    | <b>107</b> | <b>55</b> | <b>712</b> | <b>255</b> | <b>62</b> | <b>53</b> | <b>18</b> | <b>37</b> | <b>333</b> | <b>22</b> | <b>1654</b> |

Table 5 Quantity Surveying Population - South Africa

| Region                         | PrQS        | Candidate QS | Total       |
|--------------------------------|-------------|--------------|-------------|
| Eastern Cape                   | 136         | 134          | <b>270</b>  |
| Free State                     | 79          | 48           | <b>127</b>  |
| <b>Gauteng</b>                 | <b>844</b>  | <b>616</b>   | <b>1460</b> |
| Kwazulu-Natal                  | 237         | 237          | <b>474</b>  |
| Limpopo Province               | 46          | 56           | <b>102</b>  |
| Mpumalanga                     | 48          | 51           | <b>99</b>   |
| North West Province            | 38          | 27           | <b>65</b>   |
| Northern Cape                  | 18          | 14           | <b>32</b>   |
| Outside RSA                    | 86          | 32           | <b>118</b>  |
| Western Cape                   | 327         | 193          | <b>520</b>  |
| <b>Total as at 31 Dec 2013</b> | <b>1859</b> | <b>1408</b>  | <b>3267</b> |

### Sample

A sample refers to a subset of the population in question (Research Connections, 2014). The key stakeholders that make up the sample frame for the study was identified from the literature review, the sample comprising of architects and quantity surveyors with knowledge and experience on the Design Development Stage undertaken within the Gauteng province.

### **Sampling Design**

The research question and literature review was used as a basis to establish the sampling design. Respondents required for the study comprised of architects and quantity surveyors in the construction industry with knowledge and experience of the Design Development Stage undertaken in Gauteng, South Africa. Architects and quantity surveyors were identified for data collection as these are the main practitioners involved at the Design Development Stage of projects.

### **Sample Size**

The sample size in question as highlighted previously comprises of architects and quantity surveyors. As indicated in tables 3 and 4 the sample size of architects and quantity surveyors in Gauteng is 712 and 1,460 respectively.

#### **3.4.7. Research Instrument**

Several authors have provided sound reviews through the use of survey questionnaires and interviews. Brammer & Walker's (2012) study on the relationship between sustainable procurement and e-procurement in the public sector identifies studies in relation to procurement and sustainability that made use of questionnaires (5) and interviews (5) in isolation to collect data indicating the validity of these research instruments.

### **Design of Instruments**

The research instruments used for data collection were that of semi-structured interviews and a questionnaire survey. Questions were based on the six activities that take place at the Design Development Stage as identified by Procsa (2013) previously; the objective of the questions were to determine the extent to which green principles are incorporated into the Design Development Stage of projects in Gauteng's construction industry. Questions did not ask directly what green principles are incorporated at each phase in order not to prompt responses, the idea being that if practitioners considered the incorporation of green principles important they would mention it directly or indirectly in their responses.

A Likert scale was made use of for respondents to indicate the degree to which they believed green building criteria is incorporated into each of the six activities in the Design Development Stage, the Likert scale ranging from "very poor" to "poor", "fair", "good" and "very good".

Questions used for the interviews and questionnaires sent out were the same. Questions directed to architects were on the Design Phase of the Design Development Stage as that is the phase they are

primarily involved in, whereas questions directed to quantity surveyor were on the Financial and Project Programme Phase as these are the phases of the they are primarily involved in.

Prior to developing questions used for the data collection, a summary of the research areas was made. The literature review conducted was used in order to identify the factors that facilitate procurement processes generally towards green buildings. The research areas being the following:

- Project delivery
- Procurement
- The Design Development Stage
- Sustainability
- Green buildings
- Green procurement
- Green construction

Based on the critical review of the literature, four factors were systematically identified that facilitate procurement processes producing green buildings. The factors being the following:

- Operating framework
- Stakeholders
- Green and sustainable knowledge
- Green practices

Further to the above, six factors were identified as facilitating the Design Development Stage producing green buildings, these variables being used to determine the extent to which green principles are incorporated into the Design Development Stage of building projects in Gauteng. The factors being the following:

- Green concepts
- Green design
- Green specifications
- Green cost systems
- Green financial viability systems
- Green programmes

Based on these factors and actions that occur within the Design Development Stage, questions were developed in order to determine where the current position of Gauteng's construction industry is in

terms of the Design Development Stage producing green buildings. To prevent ambiguity questions were expressed clearly to ensure they were understood in the same way.

### **3.4.8. Time Horizon**

#### **Cross-Sectional Study**

The study collected data to be analysed at a single point in time, the study thus being subject to a cross-sectional study.

### **3.4.9. Ethics**

As defined by Lewis *et al.* (2012), ethics refers to the norms or standards of behavior that guide moral choices regarding behavior and the relationships one has with others. Ethics regarding research pertains to how one formulates and clarifies their research, ensuring the way one designs their research is both methodologically sound and ethically defensible to all those involved. Discussed below are the steps that were taken to ensure that ethical standards were upheld for the research.

#### **Information Sheet**

In order to comply with ethics, an information sheet was distributed to participants involved with the study. An information sheet contains details regarding the purpose of the study. The information sheet distributed to the respondents provided details on exactly who the researcher was and the institution in which the researcher was coming from. The objective of the research was stated as well as the population to which the research was targeted. Further information regarding the lack of risk the participants were subject to and what the subsequent information obtained from the participants was to be used for was discussed on the sheet.

As anonymity was assured for this research, participants were not required to provide their details on the questionnaire, which was discussed on the sheet. Further information provided on the information sheet pertained to the reason the study was being conducted i.e. for academic purposes. In addition the names and contact details of the researcher and supervisor involved with the study were provided. Voluntary participation for the research was made clear to participants; with subsequent participation of the study meaning consent had been given to the researcher.

#### **Informed Consent**

In order to ensure informed consent by participants, where emails were used to collect data and questionnaires sent out, the information sheet was attached to the email. In the case of physical hand outs of questionnaires, participants were briefed about the research and given the information sheet to read.

### **3.4.10. Pilot Study**

A pilot study was conducted in order to pre-test the research instrument in order to ensure its efficacy. Two interviews were conducted, one with an architect and one with a quantity surveyor; furthermore questionnaires were given out to the respective practitioners. Analysis of the results from the pilot indicated that the questions needed to be slightly altered in order to provide clarity in what the questions were precisely asking. Further to this, discussions with both practitioners after the interviews provided further insight into how the research instrument could be structured to improve data collection.

### **3.4.11. Research Data**

#### **Data Collection Procedures**

Data was collected from architects and quantity surveyors in Gauteng, South Africa. Physical interviews and the research programme Qualtrics was used to collect data from the sample group, the survey being subsequently sent via email from the programme. Prior to sending the survey to practitioners, they were contacted telephonically to help increase the response rate.

The theme of the questions used for the questionnaires sent out and the interviews conducted was on the Design Phase of the Design Development Stage as this is the phase architects are primarily involved in, whereas the theme of the questions used for the questionnaires sent out and the interviews conducted with the quantity surveyor was on the Financial Planning and Project Programme Phase as these are the phases quantity surveyors are primarily involved in The Design Development Stage.

Responses from the interviews conducted were transcribed, the main points being noted for the subsequent analysis of the data from the interviews that took place.

#### **Sorting of data**

Data was stored and sorted automatically on the statistical programme Qualtrics which kept track of the number of surveys distributed along with the number of responses and responses in progress.

#### **Coding of data**

Data pertaining to each research statement question was coded on a scale of 1 to 5 ranging from “very poor-1” to “poor-2”, “fair-3”, “good-4” and “very good-5” on the Likert scale, “fair” indicating the minimum required level of performance for a factor to be effective.

### **Storage of Data**

Data collected via emails was stored in password protected computers and the data from the interviews kept in locked facilities at the researcher's home. Eventual access to the results of the research is to the University of Witwatersrand community, the report being eventually stored at the Wits main Library.

### **Analysis of Data**

Qualitative data was analysed via the use of content analysis, content analysis refers to the systematic analysis of the content of a text (Bhattacharjee, 2012).

Data was collected through questionnaires and semi-structured interviews, the content of the data being textualised and subsequently analysed.

### **3.5. Chapter Summary**

This chapter discussed the research design and method applied to the study. An overview of what research design and methods entails is firstly presented before discussing the research design and methods applied for the study.

## 4. CHAPTER 4: DATA ANALYSIS AND RESULTS

### 4.1. Introduction

This chapter analyses the data collect from the sample group and presents the results. Interviews and questionnaires were conducted with and sent out to architects and quantity surveyors with knowledge and experience in Gauteng's construction industry.

### 4.2. Analysis of Questionnaires and Interviews

10 interviews were conducted, 5 with quantity surveyors and 5 with architects, furthermore questionnaires being sent out electronically with 20 responses from architects and 15 responses from quantity surveyors. Practitioners in the industry seemed to be reluctant to have interviews and fill out questionnaires as the majority of them stated they had no time. 154 questionnaires were sent out to architects, 20 being received, giving a response rate of 13%. 167 questionnaires were sent out to quantity surveyors, 15 being received, giving a response rate of 9%.

Table 6 shows the data collected from architects and quantity surveyors from the questionnaire survey and the face to face interviews conducted.

**Table 6 Data Collected**

| <b>Practitioners</b> | <b>Questionnaire Survey</b> | <b>Face to Face Interviews</b> | <b>Total</b> |
|----------------------|-----------------------------|--------------------------------|--------------|
| Architects           | 20                          | 5                              | 25           |
| Quantity Surveyors   | 15                          | 5                              | 20           |
| <b>Total</b>         | 35                          | 10                             | 45           |

The data from the interviews and questionnaires sent out were recorded and captured into the statistical programme Qualtrics for analysis. The responses from the interviews and questionnaires have been analysed together as the same questions were asked to both sets of practitioners.

### 4.3. Analysis of Practitioners' Perspective

Data collected from the interviews and questionnaires were analysed in conjunction with green principles and factors identified in the literature that facilitate the Design Development Stage producing green buildings. An analysis of the above enabled the research to determine the factors in the Design Development Stage that undermine it from producing green buildings.

### 4.3.1. Years of Experience

#### Architects

Architects involved with the study had an average of 3.95 years' experience.

#### Quantity Surveyors

Quantity surveyors involved with the study had an average of 3.40 years' experience.

### 4.3.2. Design: Development of Approved Concept

Tables 7 and 8 highlight what architects take cognisance of and work towards when developing the approved concept.

The tables indicate the results from the questionnaire survey and the interviews respectively from each respondent regarding developing the approved concept at the Design Development Stage of projects. Each respondent is indicated with an "R", R1 indicating respondent 1, R2 respondent 2 and so forth.

Findings from the data collected from questionnaires identified that 8 out of the 20 architect respondents incorporate green principles when developing the approved concept. Of the interviews, findings identified that 2 out of the 5 architect respondents incorporate green principles when developing the approved concept. 40% of the respondents in total thus incorporate green building principles at this phase of the Design Development Stage.

*Questionnaires: When developing the approved concept, what is looked at?*

**Table 7 Architect Questionnaire Responses: Developing Approved Concept**

| Responses                               | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 | R11 | R12 | R13 | R14 | R15 | R16 | R17 | R18 | R19 | R20 |
|-----------------------------------------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Client objectives and requirements      |    |    | x  |    |    | x  |    | x  | x  |     | x   |     | x   | x   |     |     | x   | x   | x   |     |
| Viability                               |    |    |    |    |    |    |    |    |    |     |     |     |     | x   |     |     | x   |     |     |     |
| Budget                                  |    |    | x  |    |    |    |    |    |    |     | x   |     |     |     |     |     |     |     |     | x   |
| Building zone                           |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     | x   |
| Use of building                         |    |    |    |    |    |    |    | x  |    |     |     | x   |     |     |     |     |     |     |     |     |
| Aesthetics                              |    |    |    |    |    | x  | x  |    |    | x   |     |     |     |     |     |     |     |     |     | x   |
| Impact concept will have on the site    |    |    |    |    | x  |    |    |    |    |     |     |     |     |     |     | x   |     |     |     |     |
| Economical to manage                    |    |    |    |    |    |    | x  |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Site                                    |    |    |    |    |    | x  |    |    |    | x   |     |     |     | x   |     |     |     | x   |     |     |
| Maximizing site                         |    |    |    | x  | x  |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Orientation                             | x  |    |    | x  |    |    |    |    |    | x   |     |     |     |     |     |     |     |     |     | x   |
| Shape of building                       | x  |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Size of buildings                       |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     | x   |
| Adaption to the surrounding environment |    |    |    |    |    |    |    |    | x  |     |     |     |     |     |     |     |     |     |     |     |
| Maximizing natural lighting             | x  |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Energy efficiency of building           |    |    |    | x  |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Water consumption and collection        |    |    |    | x  |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Materials                               |    | x  |    | x  |    | x  |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Finishes                                |    | x  |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Glazing area compared to opaque areas   | x  |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Construction technology                 |    | x  |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Sustainable methods                     |    |    |    |    |    |    |    | x  |    |     |     |     |     |     | x   |     |     |     |     |     |
| Public                                  |    |    |    |    |    |    |    |    |    |     |     |     |     |     | x   |     |     |     |     |     |

*Interviews: When developing the approved concept, what is looked at?*

**Table 8 Architect Interview Responses: Developing Approved Concept**

| Responses                          | R1 | R2 | R3 | R4 | R5 |
|------------------------------------|----|----|----|----|----|
| Client objectives and requirements |    |    |    |    | x  |
| Viability                          |    |    |    | x  |    |
| Budget                             | x  |    |    |    |    |
| Efficient planning                 |    |    |    | x  |    |
| Use of building                    |    |    | x  |    | x  |
| Aesthetics                         |    | x  | x  |    |    |
| Flexibility in design              |    |    |    | x  |    |
| Low maintenance                    |    |    |    | x  |    |
| Site                               |    |    | x  |    |    |
| Volume of spaces                   |    |    | x  |    |    |
| Sun angles                         |    |    | x  |    |    |
| Reduced electrical usage           |    |    |    | x  |    |
| Water consumption and collection   |    |    |    | x  |    |
| Materials                          |    | x  |    |    |    |
| Finishes                           |    | x  |    |    |    |
| Duration                           |    |    | x  |    |    |

Table 9 provides an analysis of the findings from the questionnaire survey and interview responses for what is looked at and worked towards when developing the approved concept in Gauteng's construction industry in relation to the incorporations of green principles.

**Table 9 Analysis: Developing Approved Concept**

| <b>Findings</b>                       | <b>Green principles incorporated</b>         |
|---------------------------------------|----------------------------------------------|
| Client objectives and requirements    | -                                            |
| Viability                             | -                                            |
| Budget                                | -                                            |
| Efficient planning                    | Energy, resource and environment             |
| Building zone                         | -                                            |
| Use of building                       | -                                            |
| Aesthetics                            | -                                            |
| Impact concept will have on the site  | Resource efficient, environmentally friendly |
| Flexibility in design                 | Resource efficient                           |
| Economical to manage                  | Sustainability                               |
| Low maintenance                       | Resource efficient                           |
| Site                                  | -                                            |
| Maximising site                       | Resource efficient                           |
| Orientation                           | Resource efficient                           |
| Shape of building                     | Resource efficient                           |
| Size of buildings                     | -                                            |
| Volume of spaces                      | -                                            |
| Adaption to environment               | Resource efficient, environmentally friendly |
| Maximising natural lighting           | Resource efficient, environmentally friendly |
| Sun angles                            | Energy efficient                             |
| Energy efficiency of building         | Energy efficient, green points               |
| Reduced electrical usage              | Energy efficient                             |
| Water consumption and collection      | Resources, environment, green points         |
| Materials                             | -                                            |
| Finishes                              | -                                            |
| Duration                              | -                                            |
| Glazing area compared to opaque areas | -                                            |
| Construction technology               | -                                            |
| Sustainable methods                   | Sustainability                               |
| Public                                | Sustainability                               |

Findings from both questionnaires and interviews indicate that green principles are incorporated when developing the approved concept. Furthermore findings indicate that there are architects in Gauteng that incorporate green principles into their services when developing the approved concept, further to this there are architects in the construction industry within Gauteng that specialise in green design.

- ***Incorporation of green building criteria when developing the approved concept.***

A mean scoring of 3.20 was given to this phase by all respondents i.e. the questionnaire survey and interviews. The lowest scoring being 2 and the highest 5 from 25 responses, the results are indicated in tables 10, 11 and 12.

**Table 10 Questionnaires - Incorporation of Green Building Criteria when Developing the Approved Concept**

| # | Answer    |  | Response | %    |
|---|-----------|--|----------|------|
| 1 | Very Poor |  | 0        | 0%   |
| 2 | Poor      |  | 2        | 10%  |
| 3 | Fair      |  | 10       | 50%  |
| 4 | Good      |  | 7        | 35%  |
| 5 | Very Good |  | 1        | 5%   |
|   | Total     |  | 20       | 100% |

**Table 11 Interviews - Incorporation of Green Building Criteria when Developing the Approved Concept**

| Respondent   | Response |
|--------------|----------|
| Respondent 1 | Poor     |
| Respondent 2 | Poor     |
| Respondent 3 | Fair     |
| Respondent 4 | Fair     |
| Respondent 5 | Fair     |

**Table 12 Incorporation of Green Building Criteria when Developing the Approved Concept**

| Statistic       | Value |
|-----------------|-------|
| Min Value       | 2     |
| Max Value       | 5     |
| Mean            | 3.20  |
| Total Responses | 25    |

### 4.3.3. Design: Finalising Design

Tables 13 and 14 highlight what architects take cognisance of and work towards when finalising designs.

The tables indicate the results from the questionnaire survey and the interviews respectively from each respondent regarding finalising the designs at the Design Development Stage of projects. Each respondent is indicated with an “R”, R1 indicating respondent 1, R2 respondent 2 and so forth.

Findings from the data collected from questionnaires identified that 6 out of the 20 architect respondents incorporate green principles when finalising the design. Of the interviews, findings identified that 0 out of the 5 architect respondents incorporate green principles when finalising the design. 24% of the respondents in total thus incorporate green building principles at this phase of the Design Development Stage.

*Questionnaires: When finalising the design, what is looked at?*

**Table 13 Architect Questionnaire Responses: Finalising the Design**

| Responses                              | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 | R11 | R12 | R13 | R14 | R15 | R16 | R17 | R18 | R19 | R20 |
|----------------------------------------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Client objectives and requirements     |    |    | x  |    |    |    |    |    |    |     |     |     | x   | x   |     |     |     | x   | x   |     |
| Budget                                 |    | x  | x  |    | x  |    |    | x  | x  |     |     |     |     |     |     |     |     |     | x   | x   |
| Time line of construction              |    |    |    |    |    |    |    |    | x  |     |     |     |     |     |     |     |     |     |     |     |
| Use of building                        |    |    |    |    |    |    |    |    |    |     | x   |     |     |     |     | x   |     |     |     |     |
| Aesthetics                             |    |    |    |    |    |    |    |    |    | x   |     |     |     |     |     |     |     |     |     |     |
| Maximizing site                        |    |    |    | x  |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Orientation                            |    |    |    | x  |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Sustainable building                   |    |    |    |    |    |    | x  |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Feasibility                            |    |    |    |    |    | x  |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Building type and function             |    |    | x  |    |    |    |    |    |    |     |     | x   |     |     |     |     |     |     |     |     |
| Structure                              |    |    |    |    |    | x  |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Optimal use of natural elements        | x  |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Minimum use of non-renewable resources | x  |    |    | x  |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Environmentally friendly               |    |    |    |    |    |    | x  |    | x  |     |     |     |     |     |     |     |     |     |     |     |
| Water consumption and collection       |    |    |    | x  |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Building industry regulations          |    |    | x  |    |    |    |    |    |    |     |     |     |     |     |     |     |     | x   |     |     |
| Materials                              |    |    |    | x  |    | x  |    |    |    |     |     |     |     |     | x   |     |     |     |     | x   |
| Special construction techniques        |    |    |    |    |    | x  |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Construction technology                |    | x  |    |    |    | x  |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Construction methodology               |    |    |    |    |    |    |    |    |    |     |     |     |     |     | x   |     |     |     |     |     |
| Detailed design                        |    |    |    |    |    |    |    |    | x  |     |     |     |     |     |     |     |     |     |     |     |
| Constraints                            |    |    |    |    |    |    |    |    | x  |     |     |     |     |     |     | x   |     |     |     |     |

*Interviews: When finalising the design, what is looked at?*

**Table 14 Architect Interview Responses: Finalising the Design**

| <b>Responses</b>                   | <b>R1</b> | <b>R2</b> | <b>R3</b> | <b>R4</b> | <b>R5</b> |
|------------------------------------|-----------|-----------|-----------|-----------|-----------|
| Client objectives and requirements |           |           |           | x         | x         |
| Budget                             |           |           | x         | x         |           |
| Use of building                    | x         |           |           |           | x         |
| Feasibility                        | x         |           |           |           |           |
| Materials                          | x         |           | x         |           |           |
| Construction methodology           |           | x         |           |           |           |
| Detailed design                    |           | x         |           |           |           |

Table 15 provides an analysis of the findings from the questionnaire survey and interview responses for what is looked at and worked towards when finalising designs in Gauteng's construction industry in relation to the incorporations of green principles.

**Table 15 Analysis: Finalising the Design**

| <b>Findings</b>                        | <b>Green principles incorporated</b> |
|----------------------------------------|--------------------------------------|
| Client objectives and requirements     | -                                    |
| Budget                                 | -                                    |
| Time line of construction              | -                                    |
| Use of building                        | -                                    |
| Aesthetics                             | -                                    |
| Maximising site                        | Resource efficient, sustainability   |
| Orientation                            | -                                    |
| Sustainable building                   | Sustainability                       |
| Feasibility                            | -                                    |
| Building type and function             | -                                    |
| Structure                              | -                                    |
| Optimal use of natural elements        | Energy and resource efficient        |
| Minimum use of non-renewable resources | Energy efficient, green points       |
| Environmentally friendly               | Environmentally friendly             |
| Water consumption and collection       | Resource, environment, green points  |
| Building industry regulations          | Sustainability                       |
| Materials                              | -                                    |
| Special construction techniques        | -                                    |
| Construction technology                | -                                    |
| Construction methodology               | -                                    |
| Detailed design                        | -                                    |
| Constraints                            | -                                    |

Findings primarily from questionnaire responses indicate that green principles are incorporated when finalising the design. Furthermore findings indicate that there are architects in Gauteng that incorporate green principles into their services when finalising designs.

- ***Incorporation of green building criteria when finalising the design.***

A mean scoring of 3.16 was given to this phase by respondents. The lowest scoring being 2 and the highest 5 from 25 responses, the results are indicated in tables 16, 17 and 18.

**Table 16 Questionnaires - Incorporation of Green Building Criteria when Finalising the Design**

| # | Answer    |                                                                                   | Response | %    |
|---|-----------|-----------------------------------------------------------------------------------|----------|------|
| 1 | Very Poor |                                                                                   | 0        | 0%   |
| 2 | Poor      |  | 5        | 25%  |
| 3 | Fair      |  | 9        | 45%  |
| 4 | Good      |  | 4        | 20%  |
| 5 | Very Good |  | 2        | 10%  |
|   | Total     |                                                                                   | 20       | 100% |

**Table 17 Interviews - Incorporation of Green Building Criteria when Finalising the Design**

| Respondent   | Response |
|--------------|----------|
| Respondent 1 | Fair     |
| Respondent 2 | Poor     |
| Respondent 3 | Good     |
| Respondent 4 | Fair     |
| Respondent 5 | Good     |

**Table 18 Incorporation of Green Building Criteria when Finalising the Design**

| Statistic       | Value |
|-----------------|-------|
| Min Value       | 2     |
| Max Value       | 5     |
| Mean            | 3.16  |
| Total Responses | 25    |

### 4.3.4. Design: Specifications

Tables 19 and 20 highlight what architects take cognisance of and work towards when providing specifications.

The tables indicate the results from the questionnaire survey and the interviews respectively from each respondent regarding providing specifications at the Design Development Stage of projects. Each respondent is indicated with an “R”, R1 indicating respondent 1, R2 respondent 2 and so forth.

Findings from the data collected from questionnaires identified that 6 out of the 20 architect respondents incorporate green principles when providing specifications. Of the interviews, findings identified that 3 out of the 5 architect respondents incorporate green principles when providing specifications. 36% of the respondents in total thus incorporate green building principles at this phase of the Design Development Stage.

*Questionnaires: When providing specifications, what is looked at?*

**Table 19 Architect Questionnaire Responses: Providing Specifications**

| Responses                                     | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 | R11 | R12 | R13 | R14 | R15 | R16 | R17 | R18 | R19 | R20 |
|-----------------------------------------------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Client objectives and requirements            |    |    | x  |    |    |    |    |    |    |     |     |     |     |     |     |     | x   |     | x   |     |
| Budget                                        |    | x  |    |    | x  |    |    |    |    | x   |     |     |     |     |     |     | x   |     |     | x   |
| Building trends                               |    |    |    |    |    |    |    |    |    |     |     | x   |     |     |     |     |     |     |     |     |
| Building use                                  |    |    | x  |    |    |    |    |    |    |     | x   |     |     |     |     |     | x   |     |     |     |
| Aesthetics                                    |    |    |    |    |    |    |    |    |    | x   |     | x   | x   |     |     |     | x   |     |     |     |
| Technologies to incorporate into the building | x  |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| The National Building standards               |    |    | x  |    | x  |    |    |    | x  |     |     |     |     |     |     | x   |     |     |     | x   |
| Performance                                   |    |    |    | x  | x  |    |    |    |    |     |     |     |     |     |     | x   |     |     |     |     |
| Fenestration calculations                     |    |    |    |    | x  |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Quality                                       |    |    |    |    |    | x  |    |    |    |     |     |     | x   |     |     |     |     |     |     |     |
| Durability                                    |    |    |    |    |    | x  |    |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Materials                                     |    |    |    |    |    | x  |    | x  | x  |     |     |     |     |     | x   |     |     | x   |     | x   |
| Sustainable materials                         |    |    |    |    |    |    | x  |    |    |     |     |     |     |     |     |     |     | x   |     |     |
| Finishes                                      |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |     | x   |     |     |
| Construction methodology                      |    |    |    |    |    |    | x  | x  |    |     |     |     |     |     |     |     |     |     |     |     |
| Energy efficiency                             |    |    |    |    |    |    | x  |    |    |     |     |     |     |     |     |     |     |     |     |     |
| Safety                                        |    |    |    |    |    |    |    |    |    |     |     |     | x   |     |     |     |     |     |     |     |
| Maintenance                                   |    |    |    |    |    |    |    |    |    |     |     |     | x   |     |     |     |     |     |     |     |

*Interviews: When providing specifications, what is looked at?*

**Table 20 Architect Interview Responses: Providing Specifications**

| <b>Responses</b>                | <b>R1</b> | <b>R2</b> | <b>R3</b> | <b>R4</b> | <b>R5</b> |
|---------------------------------|-----------|-----------|-----------|-----------|-----------|
| Budget                          |           |           | x         | x         |           |
| Building trends                 |           |           |           |           |           |
| Building use                    |           | x         |           | x         | x         |
| Aesthetics                      | x         |           |           |           |           |
| Functionality                   | x         |           |           |           |           |
| Workability                     | x         |           |           |           |           |
| Innovation                      | x         |           |           |           |           |
| Availability of materials       |           |           | x         |           |           |
| Delivery times                  | x         |           |           |           |           |
| The National Building standards |           | x         |           |           |           |
| Performance                     |           |           |           |           | x         |
| Materials                       | x         |           |           |           |           |

Table 21 provides an analysis of the findings from the questionnaire survey and interview responses for what is looked at and worked towards when providing specifications in Gauteng's construction industry in relation to the incorporations of green principles.

**Table 21 Analysis: Providing Specifications**

| <b>Findings</b>                               | <b>Green principles incorporated</b> |
|-----------------------------------------------|--------------------------------------|
| Client objectives and requirements            | -                                    |
| Budget                                        | -                                    |
| Building trends                               | -                                    |
| Building use                                  | -                                    |
| Aesthetics                                    | -                                    |
| Functionality                                 | -                                    |
| Workability                                   | -                                    |
| Innovation                                    | Green building point allocation      |
| Availability of materials                     | Resource efficient, green points     |
| Delivery times                                | -                                    |
| Technologies to incorporate into the building | -                                    |
| The National Building standards               | -                                    |
| Performance                                   | Resource efficient                   |
| Fenestration calculations                     | Energy efficient, green points       |
| Quality                                       | -                                    |
| Durability                                    | -                                    |
| Materials                                     | -                                    |
| Sustainable materials                         | Resource efficient, sustainability   |
| Finishes                                      | -                                    |
| Construction methodology                      | -                                    |
| Energy efficiency                             | Energy efficient, green points       |
| Safety                                        | Sustainability                       |
| Maintenance                                   | Resource efficient, sustainability   |

Findings primarily from questionnaire responses indicate that green principles are incorporated when providing specifications. Furthermore findings indicate that there are architects in Gauteng that incorporate green principles into their services when providing specifications.

- ***Incorporation of green building criteria when providing specifications.***

A mean scoring of 3.28 was given to this phase by respondents. The lowest scoring being 1 and the highest 5 from 25 responses, the results are indicated in tables 22, 23 and 24.

**Table 22 Questionnaires - Incorporation of Green Building Criteria when Providing Specifications**

| # | Answer    |                                                                                   | Response | %    |
|---|-----------|-----------------------------------------------------------------------------------|----------|------|
| 1 | Very Poor |  | 1        | 5%   |
| 2 | Poor      |  | 3        | 15%  |
| 3 | Fair      |  | 7        | 35%  |
| 4 | Good      |  | 6        | 30%  |
| 5 | Very Good |  | 3        | 15%  |
|   | Total     |                                                                                   | 20       | 100% |

**Table 23 Interviews - Incorporation of Green Building Criteria when Providing Specifications**

| Respondent   | Response |
|--------------|----------|
| Respondent 1 | Fair     |
| Respondent 2 | Poor     |
| Respondent 3 | Good     |
| Respondent 4 | Fair     |
| Respondent 5 | Fair     |

**Table 24 Incorporation of green building criteria when providing specifications**

| Statistic       | Value |
|-----------------|-------|
| Min Value       | 1     |
| Max Value       | 5     |
| Mean            | 3.28  |
| Total Responses | 25    |

### 4.3.5. Financial Planning: Cost Plan

Tables 25 and 26 highlight what quantity surveyors take cognisance of and work towards when producing cost plans.

The tables indicate the results from the questionnaire survey and the interviews respectively from each respondent regarding producing cost plans at the Design Development Stage of projects. Each respondent is indicated with an “R”, R1 indicating respondent 1, R2 respondent 2 and so forth.

Findings from the data collected from questionnaires identified that 3 out of the 15 quantity surveyor respondents incorporate green principles when producing cost plans. Of the interviews, findings identified that 1 out of the 5 quantity surveyor respondents incorporate green principles when producing cost plans. 20% of the respondents in total thus incorporate green building principles at this phase of the Design Development Stage.

*Questionnaires: When producing cost plans, what is looked at?*

**Table 25 Quantity Surveyor Questionnaire Responses: Producing Cost Plans**

| <b>Responses</b>      | <b>R1</b> | <b>R2</b> | <b>R3</b> | <b>R4</b> | <b>R5</b> | <b>R6</b> | <b>R7</b> | <b>R8</b> | <b>R9</b> | <b>R10</b> | <b>R11</b> | <b>R12</b> | <b>R13</b> | <b>R14</b> | <b>R15</b> |
|-----------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|------------|------------|------------|------------|------------|
| Scope of works        |           |           |           |           |           |           |           | x         | x         | x          |            |            |            |            |            |
| Budget                | x         | x         |           |           | x         | x         |           | x         | x         |            |            |            |            |            |            |
| Trades                |           |           |           |           |           |           |           | x         |           |            |            | x          |            |            |            |
| Building elements     |           |           |           |           |           |           |           |           |           |            |            | x          |            |            |            |
| Building use          | x         |           |           |           |           |           |           |           |           |            |            |            |            |            |            |
| Time frame of project | x         |           |           |           |           |           |           | x         |           |            |            |            |            |            |            |
| Design                |           |           | x         |           |           |           |           |           | x         | x          | x          |            | x          | x          | x          |
| Quality               | x         | x         |           |           |           |           |           |           |           | x          | x          |            |            |            |            |
| Location              |           |           |           |           |           |           |           |           | x         |            |            |            |            |            |            |
| Materials             |           |           |           |           |           |           | x         | x         |           |            |            |            | x          | x          |            |
| Labour                |           |           |           |           |           |           | x         | x         |           |            |            |            | x          | x          |            |
| Economy               |           |           |           |           |           |           |           |           |           | x          |            |            |            | x          |            |
| Distance of project   |           |           |           |           |           |           |           | x         |           |            |            |            |            |            |            |
| Preliminaries         |           |           |           |           |           |           | x         |           |           |            |            |            |            |            |            |
| Professional fees     |           |           |           |           |           |           |           |           |           |            |            |            | x          |            |            |
| Resource availability |           | x         |           |           |           |           |           |           |           |            |            |            |            |            |            |
| Cost engineering      |           |           |           | x         |           |           |           |           |           |            |            |            |            |            | x          |
| Specifications        |           |           |           |           |           |           |           |           |           |            |            |            |            | x          |            |
| Profit margins        |           |           |           |           |           |           |           | x         |           |            |            |            | x          |            |            |
| Viability             |           |           |           | x         |           |           |           |           |           |            |            |            |            |            |            |

*Interviews: When producing cost plans, what is looked at?*

**Table 26 Quantity Surveyor Interview Responses: Producing Cost Plans**

| <b>Responses</b>                     | <b>R1</b> | <b>R2</b> | <b>R3</b> | <b>R4</b> | <b>R5</b> |
|--------------------------------------|-----------|-----------|-----------|-----------|-----------|
| Scope of works                       |           | x         |           |           |           |
| Budget                               |           | x         |           |           |           |
| Design                               | x         |           | x         | x         | x         |
| Layout                               | x         |           |           |           |           |
| Location                             | x         |           |           |           |           |
| Materials                            | x         | x         | x         |           | x         |
| Labour                               |           |           | x         |           | x         |
| Waste                                |           |           |           |           | x         |
| Economy                              |           |           |           |           | x         |
| Inflation                            | x         |           |           |           |           |
| Pre and post construction escalation | x         |           |           |           |           |
| Contingencies                        | x         |           |           |           |           |
| Preliminaries                        | x         | x         |           |           |           |
| Professional fees                    | x         | x         |           |           |           |
| Cost engineering                     |           | x         |           |           |           |
| Specifications                       |           |           | x         |           |           |
| Plant                                |           |           | x         |           |           |
| Profit margins                       |           |           |           |           | x         |
| Productivity                         |           |           | x         |           |           |

Table 27 provides an analysis of the findings from the questionnaire survey and interview responses for what is looked at and worked towards when producing cost plans in Gauteng's construction industry in relation to the incorporations of green principles.

**Table 27 Analysis: Providing Cost Plans**

| <b>Findings</b>                      | <b>Green principles incorporated</b> |
|--------------------------------------|--------------------------------------|
| Scope of works                       | -                                    |
| Budget                               | -                                    |
| Trades                               | -                                    |
| Building elements                    | -                                    |
| Building use                         | -                                    |
| Time frame of project                | -                                    |
| Design                               | -                                    |
| Quality                              | -                                    |
| Layout                               | -                                    |
| Location                             | -                                    |
| Materials                            | -                                    |
| Labour                               | -                                    |
| Waste                                | -                                    |
| Economy                              | -                                    |
| Distance of project                  | -                                    |
| Inflation                            | -                                    |
| Pre and post construction escalation | -                                    |
| Contingencies                        | -                                    |
| Preliminaries                        | -                                    |
| Professional fees                    | -                                    |
| Resource availability                | Resource efficient                   |
| Cost engineering                     | Resource efficient                   |
| Specifications                       | -                                    |
| Plant                                | -                                    |
| Profit margins                       | -                                    |
| Viability                            | -                                    |
| Productivity                         | -                                    |

Findings from both questionnaires and interviews indicate that green principles are generally not incorporated when producing cost plans. Furthermore there is no mention of any life cycle cost comparison analysis of the benefits green buildings may have over traditional buildings in the long run, an important action required to produce green buildings.

• ***Incorporation of green building criteria when producing cost plans.***

A mean scoring of 2.30 was given to this phase by respondents. The lowest scoring being 1 and the highest 4 from 20 responses, the results indicated in tables 28, 29 and 30.

**Table 28 Questionnaires - Incorporation of Green Building Criteria when Producing Cost Plans**

| # | Answer    |                                                                                   | Response | %    |
|---|-----------|-----------------------------------------------------------------------------------|----------|------|
| 1 | Very Poor |  | 1        | 7%   |
| 2 | Poor      |  | 6        | 40%  |
| 3 | Fair      |  | 7        | 47%  |
| 4 | Good      |  | 1        | 7%   |
| 5 | Very Good |  | 0        | 0%   |
|   | Total     |                                                                                   | 15       | 100% |

**Table 29 Interviews - Incorporation of Green Building Criteria when Producing Cost Plans**

| Respondent   | Response  |
|--------------|-----------|
| Respondent 1 | Very poor |
| Respondent 2 | Poor      |
| Respondent 3 | Very poor |
| Respondent 4 | Poor      |
| Respondent 5 | Poor      |

**Table 30 Incorporation of Green Building Criteria when Producing Cost Plans**

| Statistic       | Value |
|-----------------|-------|
| Min Value       | 1     |
| Max Value       | 4     |
| Mean            | 2.30  |
| Total Responses | 20    |

### 4.3.6. Financial Planning: Financial Viability

Tables 31 and 32 highlight what quantity surveyors take cognisance of and work towards when conducting financial viabilities.

The tables indicate the results from the questionnaire survey and the interviews respectively from each respondent regarding conducting financial viabilities at the Design Development Stage projects. Each respondent is indicated with an “R”, R1 indicating respondent 1, R2 respondent 2 and so forth.

Findings from the data collected from questionnaires identified that 2 out of the 15 quantity surveyor respondents incorporate green principles when conducting financial viabilities. Of the interviews, findings identified that 0 out of the 5 quantity surveyor respondents incorporate green principles when conducting financial viabilities. 10% of the respondents in total thus incorporate green building principles at this phase of the Design Development Stage.

*Questionnaire: When conducting financial viabilities, what is looked at?*

**Table 31 Quantity Surveyor Questionnaire Responses: Conducting Financial Viabilities**

| Responses                          | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 | R11 | R12 | R13 | R14 | R15 |
|------------------------------------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|
| Budget                             | x  |    |    |    |    |    |    |    |    |     |     |     |     |     |     |
| Time                               | x  |    |    |    |    |    |    |    |    |     |     |     |     |     |     |
| Total capital outlay               |    |    |    |    |    |    |    | x  |    | x   |     | x   |     |     | x   |
| Development cost                   |    |    |    |    |    |    |    |    |    | x   |     | x   |     |     | x   |
| Operating costs                    |    |    |    |    |    |    |    |    |    | x   |     | x   |     |     | x   |
| Income over the life of a property |    |    |    |    |    |    |    |    |    | x   |     |     |     |     |     |
| Cash flow                          |    |    |    |    |    |    |    | x  |    | x   | x   | x   |     |     |     |
| Internal rate of return (IRR)      |    | x  |    |    |    |    |    |    |    | x   |     |     | x   |     | x   |
| Net present value (NPV)            |    | x  |    |    |    |    |    |    |    | x   | x   |     |     |     |     |
| Return on investment (ROI)         |    | x  | x  | x  |    |    |    | x  |    | x   | x   |     | x   |     | x   |
| Return on equity (ROE)             |    | x  |    |    |    |    |    |    |    | x   | x   |     | x   |     | x   |
| Functionality                      | x  |    |    |    |    |    |    |    |    |     |     |     |     |     |     |
| Use                                | x  |    |    |    |    |    |    |    |    |     |     |     |     |     |     |
| Profitability index                |    |    |    |    |    |    |    |    | x  |     |     | x   |     | x   |     |
| Escalation                         |    |    |    |    |    |    | x  |    |    |     |     |     |     |     |     |
| Time                               |    |    |    |    |    |    | x  |    |    |     |     |     |     |     |     |
| Sustainability of development      |    |    |    |    |    |    |    | x  |    |     |     |     |     |     |     |
| Residual value                     |    |    |    |    |    |    |    | x  |    |     |     |     |     |     |     |
| Different financial scenarios      |    |    |    |    |    |    |    |    |    |     |     |     | x   |     |     |

*Interviews: When conducting financial viabilities, what is looked at?*

**Table 32 Quantity Surveyor Interview Responses: Conducting Financial Viabilities**

| <b>Responses</b>                          | <b>R1</b> | <b>R2</b> | <b>R3</b> | <b>R4</b> | <b>R5</b> |
|-------------------------------------------|-----------|-----------|-----------|-----------|-----------|
| Total capital outlay                      | x         | x         |           |           | x         |
| Development cost                          | x         |           |           |           | x         |
| Operating costs                           | x         |           |           |           | x         |
| Income over the life of a property        | x         | x         |           |           | x         |
| Debt and equity                           | x         |           |           |           |           |
| Internal rate of return (IRR)             | x         | x         | x         | x         | x         |
| Net present value (NPV)                   | x         | x         | x         |           |           |
| Cap rate                                  | x         | x         |           |           |           |
| Return on investment (ROI)                | x         | x         | x         | x         | x         |
| Return on equity (ROE)                    |           | x         |           | x         | x         |
| Weighted average cost of capital (WACC)   |           | x         | x         |           |           |
| Profitability index                       |           |           | x         |           |           |
| Life cycle cost versus the income returns |           |           |           | x         |           |

Table 33 provides an analysis of the findings from the questionnaire survey and interview responses for what is looked at and worked towards when conducting financial viabilities in Gauteng's construction industry in relation to the incorporations of green principles.

**Table 33 Analysis: Conducting Financial Viabilities**

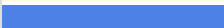
| <b>Findings</b>                           | <b>Green principles incorporated</b> |
|-------------------------------------------|--------------------------------------|
| Budget                                    | -                                    |
| Time                                      | -                                    |
| Total capital outlay                      | -                                    |
| Development cost                          | -                                    |
| Operating costs                           | -                                    |
| Income over the life of a property        | Sustainability                       |
| Debt and equity                           | -                                    |
| Cash flow                                 | -                                    |
| Internal rate of return (IRR)             | -                                    |
| Net present value (NPV)                   | -                                    |
| Cap rate                                  | -                                    |
| Return on investment (ROI)                | -                                    |
| Return on equity (ROE)                    | -                                    |
| Functionality                             | -                                    |
| Use                                       | -                                    |
| Weighted average cost of capital (WACC)   | -                                    |
| Profitability index                       | -                                    |
| Life cycle cost versus the income returns | Sustainability                       |
| Escalation                                | -                                    |
| Time                                      | -                                    |
| Sustainability of development             | Sustainability                       |
| Residual value                            | -                                    |
| Different financial scenarios             | -                                    |

Findings from both questionnaires and interviews indicate that green principles are generally not incorporated when conducting financial viabilities. The long term cost benefits and potential increase in revenue from being green in the construction industry has not been mentioned or alluded to in the findings.

• ***Incorporation of green building criteria when conducting financial viabilities.***

A mean scoring of 2.30 was given to this phase by respondents. The lowest scoring being 1 and the highest 4 from 20 responses, the results indicated in tables 34, 35 and 36.

**Table 34 Questionnaires - Incorporation of Green Building Criteria when Conducting Financial Viabilities**

| # | Answer    |                                                                                   | Response | %    |
|---|-----------|-----------------------------------------------------------------------------------|----------|------|
| 1 | Very Poor |  | 1        | 7%   |
| 2 | Poor      |  | 7        | 47%  |
| 3 | Fair      |  | 6        | 40%  |
| 4 | Good      |  | 1        | 7%   |
| 5 | Very Good |                                                                                   | 0        | 0%   |
|   | Total     |                                                                                   | 15       | 100% |

**Table 35 Interviews - Incorporation of Green Building Criteria when Conducting Financial Viabilities**

| Respondent   | Response  |
|--------------|-----------|
| Respondent 1 | Poor      |
| Respondent 2 | Poor      |
| Respondent 3 | Very poor |
| Respondent 4 | Poor      |
| Respondent 5 | Poor      |

**Table 36 Incorporation of Green Building Criteria when Conducting Financial Viabilities**

| Statistic       | Value |
|-----------------|-------|
| Min Value       | 1     |
| Max Value       | 4     |
| Mean            | 2.30  |
| Total Responses | 20    |

### 4.3.7. Project Programme: Programme

Tables 37 and 38 highlight what quantity surveyors take cognisance of and work towards when developing programmes.

The tables indicate the results from the questionnaire survey and the interviews respectively from each respondent regarding developing the programme at the Design Development Stage projects. Each respondent is indicated with an “R”, R1 indicating respondent 1, R2 respondent 2 and so forth.

Findings from the data collected from questionnaires identified that 4 out of the 15 quantity surveyor respondents incorporate green principles when developing programmes. Of the interviews, findings identified that 3 out of the 5 quantity surveyor respondents incorporate green principles when developing programmes. 35% of the respondents in total thus incorporate green building principles at this phase of the Design Development Stage.

*Questionnaires: When developing programmes for projects, what is looked at?*

**Table 37 Quantity Surveyor Questionnaire Responses: Developing Programmes**

| Responses                        | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 | R11 | R12 | R13 | R14 | R15 |
|----------------------------------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|
| Client requirements              |    |    |    | x  |    |    |    | x  |    |     |     |     |     |     |     |
| Scope of works                   |    |    |    |    |    |    |    |    |    |     |     | x   |     |     |     |
| Cost                             |    |    |    | x  |    | x  | x  |    |    |     |     |     |     |     |     |
| Pre-tender and post tender       |    |    |    |    |    | x  |    |    |    |     |     |     |     |     |     |
| Duration of project              |    |    |    |    |    |    |    | x  |    |     | x   | x   | x   | x   | x   |
| Timeline of construction         |    |    | x  |    |    |    |    | x  |    |     |     | x   |     | x   | x   |
| Completion in the specified time | x  |    |    |    |    |    |    |    |    |     |     |     |     |     |     |
| Resources availability           | x  | x  |    |    |    | x  | x  |    |    |     |     |     |     |     |     |
| Activities                       |    | x  |    |    | x  |    |    |    | x  |     |     |     |     |     | x   |
| Weather                          |    |    |    | x  | x  |    |    |    |    |     |     |     |     |     |     |
| Critical path                    |    |    |    |    |    |    |    |    |    | x   |     |     |     |     |     |
| Lead times                       |    |    |    |    |    |    |    | x  |    |     |     |     |     |     |     |

*Interviews: When developing programmes for projects, what is looked at?*

**Table 38 Quantity Surveyor Interview Responses: Developing Programmes**

| <b>Responses</b>          | <b>R1</b> | <b>R2</b> | <b>R3</b> | <b>R4</b> | <b>R5</b> |
|---------------------------|-----------|-----------|-----------|-----------|-----------|
| Scope of works            |           |           |           |           | x         |
| Cost                      | x         |           | x         |           |           |
| Occupants                 | x         |           |           |           |           |
| Duration of project       | x         | x         |           | x         | x         |
| Milestones                | x         | x         |           |           |           |
| Timeline of construction  |           |           |           |           | x         |
| Tender committee meetings | x         |           |           |           |           |
| Resources availability    |           |           |           |           | x         |
| Activities                |           | x         |           |           |           |
| Health and safety         |           | x         |           |           |           |
| Critical path             |           |           | x         |           |           |
| Lead times                |           |           | x         |           |           |
| Procurment path           |           |           | x         |           |           |
| Network node              |           |           | x         |           |           |
| Public holidays           | x         |           |           |           |           |
| Affected stakeholders     |           | x         |           |           |           |
| Surrounding works         |           | x         |           |           |           |

Table 39 provides an analysis of the findings from the questionnaire survey and interview responses for what is looked at and worked towards when developing programmes in Gauteng's construction industry in relation to the incorporations of green principles.

**Table 39 Analysis: Developing Programmes**

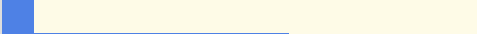
| <b>Findings</b>                  | <b>Green principles incorporated</b> |
|----------------------------------|--------------------------------------|
| Client requirements              | -                                    |
| Scope of works                   | -                                    |
| Cost                             | -                                    |
| Occupants                        | -                                    |
| Pre-tender and post tender       | -                                    |
| Duration of project              | -                                    |
| Milestones                       | -                                    |
| Timeline of construction         | -                                    |
| Tender committee meetings        | -                                    |
| Completion in the specified time | -                                    |
| Resources availability           | Resource efficient                   |
| Activities                       | -                                    |
| Health and safety                | Sustainability                       |
| Weather                          | -                                    |
| Critical path                    | -                                    |
| Lead times                       | -                                    |
| Procurement path                 | -                                    |
| Network node                     | Resource efficient                   |
| Public holidays                  | -                                    |
| Affected stakeholders            | Sustainability                       |
| Surrounding works                | Sustainability                       |

Findings from both questionnaires and interviews indicate that green principles are generally not incorporated when developing programmes. There is slight consideration of green principles such as health and safety as indicated above, but for the most part green principles are overlooked.

- Incorporation of green building criteria when developing programmes for projects.***

A mean scoring of 2.20 was given to this phase by respondents. The lowest scoring being 1 and the highest 4 from 20 responses, the results indicated in tables 40, 41 and 42.

**Table 40 Questionnaires - Incorporation of Green Building Criteria when Developing Programmes**

| # | Answer    |                                                                                    | Response | %    |
|---|-----------|------------------------------------------------------------------------------------|----------|------|
| 1 | Very Poor |  | 1        | 7%   |
| 2 | Poor      |   | 9        | 60%  |
| 3 | Fair      |   | 4        | 27%  |
| 4 | Good      |   | 1        | 7%   |
| 5 | Very Good |   | 0        | 0%   |
|   | Total     |                                                                                    | 15       | 100% |

**Table 41 Interviews - Incorporation of Green Building Criteria when Developing Programmes for Projects**

| Respondent   | Response  |
|--------------|-----------|
| Respondent 1 | Poor      |
| Respondent 2 | Poor      |
| Respondent 3 | Very poor |
| Respondent 4 | Poor      |
| Respondent 5 | Poor      |

**Table 42 Incorporation of Green Building Criteria when Developing Programmes for Projects**

| Statistic       | Value |
|-----------------|-------|
| Min Value       | 1     |
| Max Value       | 4     |
| Mean            | 2.20  |
| Total Responses | 20    |

### 4.3.8. Practitioners' Thoughts on Green Buildings

#### Architects

Responses from architects from questionnaires and interviews mostly highlighted the same issues on green buildings within Gauteng South Africa.

Respondents indicated that very few buildings are designed around green systems, the design and implementation of green building still being at an early stage within the industry. The decision to construct green buildings is seen as an afterthought, resulting in the projects trying to force green systems into the buildings. Respondents highlighted that there currently is a push towards green buildings in South Africa's construction industry.

Respondents highlighted that green principles are slowly diffusing into the industry but not at the required rate to increase the number of green buildings in the foreseeable future. Further to this there is not enough pressure in the industry for buildings to be green.

Responses highlighted that the incorporation of green principles with an eye towards green buildings is more prevalent amongst big corporations as they are able to afford green buildings whereas smaller corporations are not willing to bear the extra cost for going "green".

Findings highlight that green buildings consideration is more prevalent amongst new designers, the elder generation hindering the diffusion of green buildings within the industry. Initial capital cost is seen as a major barrier for green buildings entering the construction industry in Gauteng. Further to this the introduction of foreign concepts to clients presents a barrier, the extra work required to go "green" being seen as a barrier towards green buildings in the industry.

In order to increase green buildings within the industry information should be readily made available to stakeholders along with raising awareness of the importance of green building.

#### Quantity Surveyors

Like architects, responses from quantity surveyors from questionnaires and interviews mostly highlighted the same issues on green buildings within Gauteng South Africa.

Responses highlighted that green buildings are still somewhat of a novelty in the construction industry thus requiring time to diffuse into the industry. Responses highlighted that the environment in Gauteng is conducive towards green buildings for larger corporations as it is more prominent between larger firms and adds towards ones competitive advantage, there is competition between larger firms for a share of the market which being "green" allows one to access thus pushing corporations towards

green buildings. It is believed green building concepts are slowly diffusing into the industry but not at a rate for developments in the near future to be predominantly "green".

Comments indicate that green buildings are primarily implemented by large corporations as its costs are too expensive for smaller firms to bear, the benefits received from green buildings believed to be not worth the effort for small companies.

Responses highlight cost and knowledge about green buildings being a barrier towards green buildings. Further to this working towards green buildings is seen as tedious as it requires time and a comprehensive paper trail. It is believed there is a general misconception of what green buildings are, with important components such as economic factors often being neglected. Green buildings are developed to obtain long term benefits whereas people want immediate results at a low cost.

### **4.3.9. Mean Scoring of Phases**

Findings from the data collected from questionnaires identified that 13 out of the 20 architect respondents and 8 out of the 15 quantity surveyor respondents incorporate green principles into the Design Development Stage of projects. Of the interviews findings identified that 4 out of the 5 architect respondents and 4 out of the 5 quantity surveyor respondents incorporate green principles into the Design Development Stage of projects. 68% of the architect respondents and 60% of quantity surveyor respondents in total thus incorporate green building principles into the Design Development Stage of projects.

Figure 11 shows the mean scoring given by all respondents for the degree to which they believe green criteria is incorporated into each component of the Design Development Stage. The graph highlights a lack of diffusion of green criteria into the Financial Planning and Project Programme Phase of the Design Development Stage whereas there is more green criteria diffused into the Design Phase undertaken in the construction industry in Gauteng, South Africa. The mean scoring of the development of the approved concept, finalising design, specifications, cost plan, financial viability and programme was **2.74**.

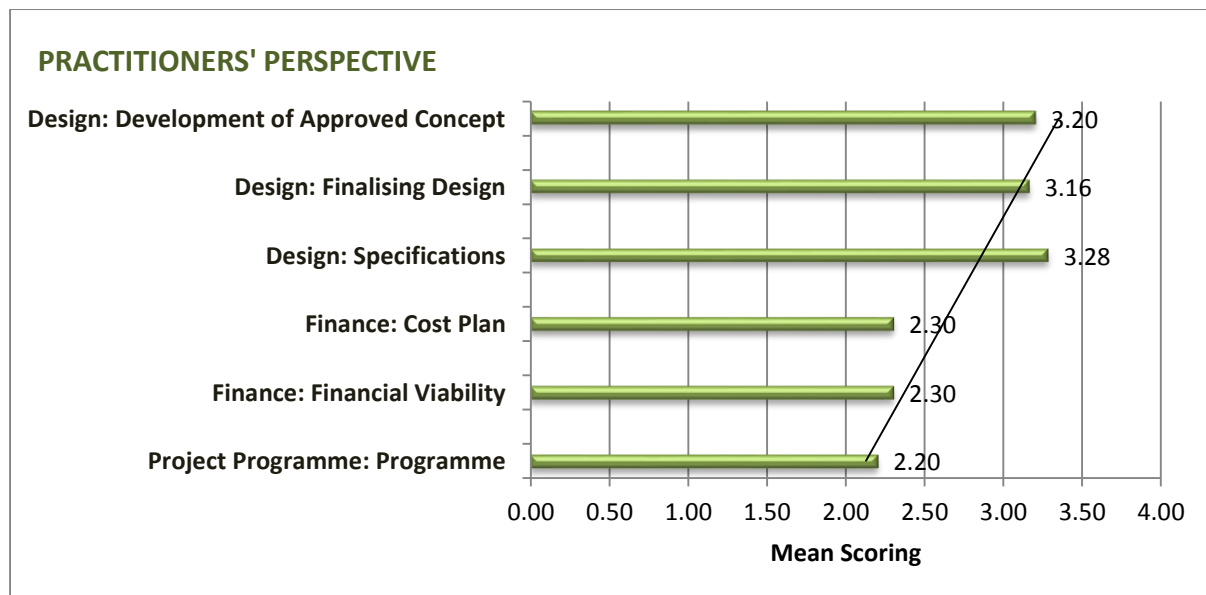


Figure 11 Practitioners' Perspective

#### 4.4. Results from Data Analysis

##### 4.4.1. Incorporation of Green Principles into the Design Development Stage

###### Design phase

Results of the data analysis indicate that when the Design Phase is undertaken in the Design Development Stage in Gauteng, green principles are sufficiently incorporated into it as the development of the approved concept, the finalising of the design and the provision of specifications by practitioners incorporate sufficient green principles to facilitate producing green buildings. “Green concepts”, “Green design” and “Green specifications” thus not undermining the incorporation of green principles into the Design Development Stage of building projects.

###### Financial planning phase

Results of the data analysis indicate that when conducting Financial Planning in the Design Development Stage in Gauteng, green principles is insufficiently incorporated into it as the production of cost plans and financial viabilities by practitioners do not incorporate sufficient green principles to facilitate producing green buildings. “Green cost systems” and “Green financial viability systems” thus undermining the incorporation of green principles into the Design Development Stage of building projects.

### Project programme phase

Results of the data analysis indicate that when developing Project Programmes in the Design Development Stage in Gauteng, green principles is insufficiently incorporated into it as the programmes developed by practitioners do not incorporate sufficient green principles into it to facilitate producing green buildings. “Green Programmes” thus undermining the incorporation of green principles into the Design Development Stage of building projects.

Where the incorporation of green principles is insufficient for the action in question in each phase, the subsequent factor does not facilitate the production of green buildings and vice versa. Table 43 identifies the results of the data analysis.

**Table 43 Results**

| <b>Phases</b>                                                                 | <b>Factors Facilitating Producing Green Buildings</b>       | <b>Incorporation of Green Principles</b> |
|-------------------------------------------------------------------------------|-------------------------------------------------------------|------------------------------------------|
| <b>Design</b><br>Develop approved concept<br>Finalise design<br>Specification | Green concepts<br>Green design<br>Green specifications      | Sufficient<br>Sufficient<br>Sufficient   |
| <b>Financial Planning</b><br><br>Cost plan<br>Financial viability             | <br>Green cost systems<br>Green financial viability systems | <br>Insufficient<br>Insufficient         |
| <b>Project programme</b><br><br>Programme                                     | <br>Green programmes                                        | <br>Insufficient                         |

## 4.5. Chapter Summary

This chapter critically analysed the data collected from participants of the research and presents the results of the data analysis. Findings highlighted that three of the six factors identified currently undermine the Design Development Stage from producing green buildings within Gauteng South Africa’s construction industry, the factors being “Green cost systems”, “Green financial viability systems” and “Green Programmes.

## **5. CHAPTER 5: DISCUSSION OF RESULTS**

### **5.1. Introduction**

This chapter discusses the results of the study and links the findings with the objectives of the study and literature reviewed.

Findings indicate that there is a lack of green principles incorporated generally into the Design Development Stage of building projects, more specifically the Financial Planning Phase and Project Programme Phase of the Design Development Stage of projects. Findings indicate that the Design Phase incorporates green principles. Results thus indicating that the Design Phase does not undermine the Design Development Stage from producing green buildings, it should be noted that further incorporation of green principles into this phase is still required to further promote the diffusion of green buildings within Gauteng's construction industry.

### **5.2. The Design Development Stage Producing green Buildings**

The Design Development Stage is an integral component of procurement as the design, financial layout of a project and project plan is conducted at this phase (PROCSA, 2013), thus setting the direction and character of building projects. The design phase of the Design Development stage offers the greatest chance to produce green buildings as subsequent phases and stages hinge on the information developed in this phase. Without designs and specifications; cost plans, financial viabilities and project programmes cannot be comprehensively completed.

As highlighted in literature by the Green Building Council SA (2013), GGGC (2014) and Sev (2009), green building criteria and sustainable principles need to be satisfied for a building to be green.

Literature highlights three fundamentals needing to be fulfilled in order for a building to be categorised as "green", three main criteria have to be satisfied i.e. (1) energy efficiency, (2) resource efficiency and (3) environmentally friendliness as outlined by the Green Building Council SA (2013), further to this there are five major elements of green buildings as outlined by (GGGC, 2014) namely; (1) sustainable site design, (2) water conservation and quality, (3) energy and environment, (4) indoor environmental quality, and (5) conservation of materials and resources. Sev (2009) outlines sustainable principles to be met, namely; resource management, life - cycle design and design for humans.

For the Design Development Stage to produce green buildings, green principles need to be incorporated into all phases of the stage. Design plays a crucial role towards the development of green buildings (GGGC, 2014). Further to this design allows accurate estimates, financial viability analysis, and project programming to take place (FAO, 2013).

As the Design Phase sets the basis for activities in other stages (CIDB, 2014), the impact of a lack of incorporation of green principles at the Financial Planning and Programme phase is not as disrupting as a lack of incorporation of green principles at the Design Phase.

### **5.3. Incorporation of Green Principles into the Design Development Stage by Practitioners**

Findings indicate that there is a lack of green principles incorporated generally into the Design Development Stage of building projects in Gauteng's construction industry. Findings from the architects and quantity surveyors interviewed supplemented the findings from the questionnaires from both sets of practitioners. Three factors primarily undermine the Design Development Stage in projects from producing green buildings in Gauteng's construction industry, namely "Green cost systems", "Green financial viability systems" and "Green Programmes".

The results of the study for the factors/variables as highlighted previously, that facilitates green principles being incorporated into the Design Development Stage of building projects are discussed below:

#### **Design Phase**

##### **Green concepts**

Findings indicate that when developing the approved concept architects generally incorporate green principles into their services; therefore green concepts do not undermine the Design Development Stage from producing green buildings in Gauteng's construction industry. Respondents highlighted the following green principles incorporated when developing the approved concept.

- Energy efficiency
- Resource efficiency
- Environmentally friendly
- Green building point allocation
- Sustainable principles

Respondents gave a mean scoring of 3.20 to this variable for the level of incorporation of green building criteria into developing the approved concept, further supporting the findings that green principles are incorporated into developing the approved concept. Results' thus indicating that the degree to which green building criteria is diffused into developing the approved concept in Gauteng is just above fair thus having space for improvement to further promote the diffusion of green principles into the Design Development Stage.

### **Green design**

Findings indicate that when finalising the design architects generally incorporate green principles into their services; therefore green designs do not undermine the Design Development Stage from producing green buildings in Gauteng's construction industry. Respondents highlighted the following green principles incorporated when finalising the design.

- Energy efficiency
- Resource efficiency
- Environmentally friendly
- Green building point allocation
- Sustainable principles

Respondents gave a mean scoring of 3.16 to this variable for the level of incorporation of green building criteria into finalising designs, further supporting the findings that green principles are incorporated into finalising designs. Results' thus indicating that the degree to which green building criteria is diffused into finalising the design in Gauteng is just above fair thus having space for improvement to further promote the diffusion of green principles into the Design Development Stage.

### **Green specifications**

Findings indicate that when providing specifications architects generally incorporate green principles into their services, therefore green specifications do not undermine the Design Development Stage from producing green buildings in Gauteng's construction industry. Respondents highlighted the following green principles incorporated when providing specifications.

- Energy efficiency
- Resource efficiency
- Innovation
- Green building point allocation
- Sustainable principles

Respondents gave a mean scoring of 3.28 to this variable for the level of incorporation of green building criteria into providing specifications, further supporting the findings that green principles are incorporated into providing specifications. Results' thus indicating that the degree to which green building criteria is diffused into finalising the design in Gauteng is just above fair thus having space for improvement to further promote the diffusion of green principles into the Design Development Stage.

### **Financial Planning Phase**

#### **Green cost systems**

Findings indicate that when producing cost plans quantity surveyors do not generally incorporate green principles into their services, green cost systems therefore undermines the Design Development Stage from producing green buildings in Gauteng's construction industry. Respondents highlighted the following green principles incorporated when providing cost plans.

- Resource efficiency

Respondents gave a mean scoring of 2.30 to this variable for the level of incorporation of green building criteria into producing cost plans, further supporting the findings that green principles are not generally incorporated into producing cost plans. Results' thus indicating that the degree to which green building criteria is diffused into finalising the design in Gauteng is poor and requires further incorporation of green principles in order to not undermine the Design Development Stage producing green buildings.

#### **Green financial viability systems**

Findings indicate that when conducting financial viabilities quantity surveyors do not generally incorporate green principles into their services, green financial viability systems therefore undermines the Design Development Stage from producing green buildings in Gauteng's construction industry. Respondents highlighted the following green principles incorporated when conducting financial viabilities.

- Sustainable principles

Respondents gave a mean scoring of 2.30 to this variable for the level of incorporation of green building criteria into conducting financial viabilities, further supporting the findings that green principles are not generally incorporated into conducting financial viabilities. Results' thus indicating that the degree to which green building criteria is diffused into financial viabilities in Gauteng is poor

and requires further incorporation of green principles in order to not undermine the Design Development Stage producing green buildings.

### **Project Programme Phase**

#### **Green programmes**

Findings indicate that when programmes are developed, generally green principles are not incorporated into their development, green programmes therefore undermines the Design Development Stage from producing green buildings in Gauteng's construction industry. Respondents highlighted the following green principles incorporated when developing programmes.

- Resource efficiency
- Sustainable principles

Respondents gave a mean scoring of 2.20 to this variable for the level of incorporation of green building criteria into developing programmes, further supporting the findings that green principles are not generally incorporated into developing programmes. Results' thus indicating that the degree to which green building criteria is diffused into project programmes in Gauteng is poor and requires further incorporation of green principles in order to not undermine the Design Development Stage producing green buildings.

In order to increase the incorporating of green principles into the Design Development Stage, the long term financial benefits of green buildings needs to be included within the Financial Planning Phase in order to promote the diffusion of green buildings within the construction industry in Gauteng. A lack of knowledge of the long term benefits of green buildings provides a barrier towards increasing the number of green buildings in Gauteng.

#### **Practitioners' Comments**

Comments provided by architects and quantity surveyors indicated that both sets of practitioners have similar points of view towards the diffusion of green buildings into Gauteng's construction industry.

It was highlighted that green buildings are still relatively new and will take time to be fully incorporated into Gauteng's construction industry. Further to this both set of practitioners pointed out, that presently the benefits of green buildings are only enjoyed by large corporations due higher initial capital costs and the benefits received commercially from going "green".

Cost, the additional work required and knowledge about green buildings was pointed out as key barriers for the diffusion of green buildings. In order to tackle these problems awareness initiatives are required in the industry.

Although results indicate that “Green cost systems”, “Green financial viability systems” and “Green Programmes” are the factors that undermine the Design Development Stage from producing green buildings, one must note that the Design Phase offers a greater chance to produce green buildings over the Financial Planning and Project Programme phase. “Green concepts”, “Green design” and “Green specifications” should thus be looked at in greater scrutiny for its incorporation of green principles.

### **5.4. Reasons why Green Principles are not incorporated into the Design Development Stage**

Grounded on the discussions with and comments provided by practitioners involved with the study, reasons why green principles are not incorporates into the Design Development Stage of projects in Gauteng’s construction industry were identified based on the four factors systematically developed from the critical review of the literature that facilitate the diffusion of green principles into procurement processes.

- ***Operating framework***

- Responses made no reference to the use of electronic procurement as this falls outside the scope of the Design Development Stage, it should be noted however that the use of electronic procurement increases efficiency (Ekram *et al.*, 2011), which would thus provide as a basis towards the successful delivery of green buildings in Gauteng. A lack of its usage in Gauteng would thus be a limitation.
- There is an evident lack of green project objectives in Gauteng, the diffusion of “green” and sustainability principles into project objectives thus needs to increase as project definition sets the tone for successful project delivery (Mbachu and Raymond, 2007).
- Responses had a lack of decisive regulatory bodies that promote the diffusion of green principles into procurement processes. The level of governance of project delivery methodology by institutions and regulatory bodies in Gauteng thus needs to be further tailored towards green buildings as regulatory bodies have the power to stimulate a “green” revolution (Emery *et al.*, 2007).
- Panning conditions sets the tone for a “green” construction industry as it sets the requirements to be adhered to (CIRIA, 2011). Responses pointed towards standard

regulatory bodies in the construction industry, highlighting the need for the placement of "green" and sustainable deliverables in planning conditions for projects by local planning departments.

- As highlighted by Doberstein and Geng's (2008) study, subsidies help to increase the uptake of "green" procurement. Responses had made no mention of subsidies provided by the government for green buildings indicating the need to increase or introduce subsidies given to projects that would fall under "green" government policies.
- Doberstein and Geng's (2008) also highlighted the need for preferable tax for "green" procurement. Responses had made no mention of preferable tax thus indicating there may be a need to increase or introduce preferable tax allowances for projects that would fall under "green" government policies.

- **Stakeholders**

- In order to further diffuse green principles into the Design Development Stage the Government needs to make use of green public procurement as green public procurement shapes the production and consumption of goods and services through its purchasing power (Daddi *et al.*, 2012).
- As clients arguably have the greatest influence on projects (CIRIA, 2011), it is clear that clients' in Gauteng need to place an emphasis on projects being "green" and sustainable."
- Responses pointed towards the need for consultants' to further incorporate sustainable principles when providing services as consultants are responsible for achieving the goals of a project (CIRIA, 2011).
- As contractors and suppliers are the vehicle through which projects come to fruition (CIRIA, 2011), it is imperative contractors' and suppliers implement sustainable practices to ensure the delivery of green buildings.

- **"Green" and sustainable knowledge**

- Responses pointed towards the need to increase stakeholders' knowledge of green buildings and its core principles amongst all stakeholders in the construction industry, as it is through stakeholders "green" procurement takes place (CIRIA, 2011).
- Responses pointed towards the need to increase stakeholders' knowledge of sustainability and its core principles amongst all stakeholders in the construction industry. More over professionals need to incorporate sustainability principles into their services to facilitate the production of green buildings (Chen *et al.*, 2010).
- Responses highlighted the need to increase the number of information platforms for stakeholders to learn about "green" and sustainable principles, issues etc." this is

specifically important as it allows for the response of queries and to enhance knowledge on “green” procurement (Doberstein and Geng, 2008).

- Responses alluded to the lack of stakeholder’s familiarity with green building evaluation standards, for this reason initiatives to increase awareness and the benefits posed by green buildings is required in Gauteng’s construction industry. By familiarising oneself with evaluation standards it further facilitates producing green buildings as it enables stakeholders to assess green construction and green buildings (Jorge *et al.*, 2010).
- Responses further alluded to the lack of stakeholder’s familiarity with green construction guidelines, thus further pointing towards the need to increase awareness of green buildings in Gauteng. This is imperative as a lack of awareness and knowledge hinders the implementation of “green” practices within the construction industry (Daddi *et al.*, 2012) and (Doberstein and Geng, 2008).
- Responses had no specific mention the availability of green specification in Gauteng, thus pointing towards the need to increase or introduce the institutional bodies publishing “green” specifications. Specifications and green specifications more specifically are imperative as they are used to express written directions on the prescribed material, practices, personnel, equipment, and workmanship including tolerances for projects (Chan *et al.*, 2011).
- Responses pointed towards the need to increase stakeholders’ awareness of the benefits received from being “green” and sustainable in order to promote the diffusion of green buildings, such benefits range from the reduction in overall costs of procurement and subsequent disposal to increased competitive benefits (Doberstein and Geng, 2008).
- Responses identified that there is a need to increase stakeholders’ knowledge of green building and sustainable project requirements in order to increase successful project delivery when putting green buildings as a primary objective (Doberstein and Geng, 2008).
- Stakeholders’ knowledge of additional measures of success used for green buildings needs to be improved as highlighted by respondents in order to facilitate the diffusion of green buildings; this is due to the fact that there are inherent difference between traditional buildings and green buildings (Green Building Council SA, 2013).
- A Whole life cycle approach taken by all tiers of management is imperative as it allows the total cost of an asset over its whole life to be considered thus allowing one to determine all costs to be incurred (CIRIA, 2011). Responses indicated that whole life cycles are considered when undergoing the Design Development Stage.

- Responses alluded to the need to improve the necessary knowledge and skills to manage “green” by all tiers of management in Gauteng. Knowledge and skills in green construction by management is imperative in order to execute projects successfully (Hwang and Ng, 2013).
- **Green practices**
  - As outlined by CIRIA (21011) an integrated approach between all stakeholders involved when delivering projects i.e. from suppliers to contractors, to consultants, clients etc. is required to further promote the success of projects. Responses alluded to an integrated approach being taken in Gauteng’s construction industry.
  - A lack of green technology provides barriers towards the diffusion of green building. (Doberstein and Geng, 2008), as green buildings are somewhat of a novelty in Gauteng as highlighted by the respondents and existing media (MediaClubSouthAfrica, 2013), the amount of “green” technology for "green" and sustainable developments needs to be increased in Gauteng.
  - As highlighted previously, specifications and green specifications more specifically are imperative towards successful project delivery (Chan *et al.*, 2011). Responses indicate that green" criteria needs to be further incorporated into design and specifications.
  - Findings allude to the fact that green requirements need to be further adopted and managed throughout the construction and commissioning stages of projects, this is of importance as these two stages execute the planning done in previous stages (PROCSA, 2013).
  - To ensure green buildings are delivered successfully in Gauteng it is imperative green and sustainable practices are diffused across the supply chain, (Johnsen *et al.*, 2012). Responses made no mention of the supply chain.
  - Responses highlight the life cycle assessment of buildings occurring in the Design Development Stage, an important activity required to fully appreciate the long term benefits of green buildings (Doberstein and Geng’s, 2008).
  - Byggeth and Hochschorner (2006) study and Manoliadis *et al.* (2012) study discuss the importance of various “green” procurement tools, Ecodesign tools and performance indicators respectively. Responses highlight the use of EIA’s specifically, thus indicating the need to further use of "green" procurement tools to facilitate "green" procurement.
  - Although responses did not mention tenders as it does not for part of the Design Development Stage, a lack of environmental criteria to evaluate tenders in Gauteng may play a role in the bigger scheme of “green” procurement (Balfors *et al.*, 2009).

- Gauteng's construction industry needs "green" requirements for projects in the planning stage to be further incorporated as alluded to by the responses, this is imperative as planning sets the tone prior to "green" procurement taking place. (CIRIA, 2011).
- There is an inherent link between project planning and implementation (Balfors *et al.*, 2012). Responses made no reference to the execution of project plans, when green project plans are developed it is imperative they are implemented to ensure successful projects delivery.
- Materials are highlighted as a recurring component in the Design Development stage, green material not specifically mentioned. To further promote green buildings in Gauteng, an increase in use of "green" materials in buildings is required as green material are crucial towards producing green buildings (GGGC, 2014).
- Balfors *et al.* (2009) study investigates current practice, problems and opportunities of "green" procurement of construction contracts, highlighting the need for the use of "green" contracts. Responses made no reference to contracts used as contract administration falls outside the Design Development Stage. However, the use of "green" contracts for construction projects may need to be increased/ introduced in Gauteng to further diffuse green buildings into the construction industry.
- As highlighted by EPROP (2013) previously, "green" leases ensure that the property owner commits to managing the property in a sustainable manner while the tenant pledges to use the property in a sustainable manner. Responses made no reference of the use of leases as this does not fall within the scope of the Design Development Stage; however it highlights the existing climate of the incorporation of green principles in procurement processes. "The use of "green" leases for property thus may need to be increased/ introduced into Gauteng.

In order for green principles to be effectively incorporated into procurement processes generally, these four factors as discussed above need to be satisfied in order to provide a platform for green principles to be incorporated into the Design Development Stage in projects more specifically.

### 5.5. Chapter Summary

This chapter discussed the results of the study. Results indicate a lack of green principles incorporated into the Design Development Stage of building projects in Gauteng's construction industry. Three factors within the Design Development Stage undermine it from producing green buildings, namely (1) "Green cost systems", (2) "Green financial viability systems" and (3) "Green Programmes".

## **6. CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS**

### **6.1. Introduction**

This chapter discusses the conclusions and recommendations developed from the outcome of the research. The aim of the study was to determine the factors within the Design Development Stage undertaken in projects within Gauteng, South Africa's construction industry that undermine it from producing green buildings. In order to identify these factors the study inherently had to answer the following subsidiary questions i.e. "what is required from the Design Development Stage to produce green buildings?", "to what extent are green principles incorporated into the Design Development stage by practitioners in Gauteng?" and "what are the reasons for green principles not being or being incorporated into the Design Development Stage by practitioners in Gauteng?" By answering these questions, it was possible to answer the research question.

The study is subject to limitations; due to the relatively low response rate, the degree to which the results of the study can be generalised beyond the research sample to the larger population in Gauteng's construction industry has been reduced.

### **6.2. Conclusions**

The study identified the following conclusions that can be made as per research question and subsidiary questions i.e. the key research questions.

#### **Research question**

- What factors within the Design Development Stage in projects undermine it from producing green buildings in Gauteng's construction industry?

Findings of the study identified that three of the six factors within the Design Development Stage currently undermines it from producing green buildings in Gauteng, the factors being; "Green cost systems", "Green financial viability systems" and "Green Programmes".

From the results one can conclude that cost plans do not facilitate the Design Development Stage producing green buildings. Green cost systems need to be implemented in order to facilitate the Design Development Stage producing green buildings. Furthermore financial viabilities conducted in the construction industry need to commit to green financial viability systems in order to facilitate and promote the Design Development Stage producing green buildings. Lastly green principles need to be further diffused into project programmes to promote green programmes and further facilitate the Design Development Stage working effectively towards green buildings within Gauteng.

### Key research questions

- What is required from the Design Development Stage to produce green buildings?

A critical review of the literature identified seven key areas that needed to be investigated in order to determine what facilitates procurement and the Design Development Stage producing green buildings, the areas being; project delivery, procurement, the Design Development Stage, sustainability, green buildings, “green” procurement and “green” construction.

In terms of these areas, four factors were identified that facilitate procurement processes producing green buildings. The factors are highlighted below:

- An operating framework “environment” that facilitates and promotes green buildings
- Stakeholders committed towards green buildings
- Green and sustainable knowledge
- Green practices

Further to this, six factors were identified that facilitate the Design Development Stage producing green buildings. The factors are highlighted below:

- Green concepts
- Green design
- Green specifications
- Green cost systems
- Green financial viability systems
- Green programmes

### Key research questions

- To what extent are green principles incorporated into the Design Development Stage by practitioners in Gauteng?

Results indicate that green principles are not generally incorporated into the Design Development Stage of projects by practitioners in Gauteng. Three factors were regarded as underperforming; the factors being; the “Green cost systems”, “Green financial viability systems” and “Green Programmes”. Three factors were found to not undermine the Design Development Stage from producing green buildings, the factors being; “Green principles”, “Green design” and “Green specifications”.

Results indicate that design phase is the only phase in the Design Development Stage to significantly incorporate green principles, the incorporation of green principles into the Financial Planning and Programme Phase are kept to the bear minimum.

### Key research questions

- What are the reasons for green principles not being or being incorporated into the Design Development Stage by practitioners in Gauteng?

The reason green principles are not sufficiently incorporated into the Design Development Stage of projects by practitioners in Gauteng is because there is not an effective platform to promote the diffusion of green principles into procurement processes, more specifically the Design Development Stage. The four factors; (1) the operating framework, (2) stakeholders, (3) “green” / sustainable knowledge and (4) green practices all need to be further tailored to increase the diffusion of green principles in order to facilitate the diffusion of green buildings into Gauteng’s construction industry.

The study investigated procurement processes and the Design Development Stage more specifically producing green buildings. The study aimed to determine the extent to which green principles are incorporated into the Design Development Stage and subsequently the factors that undermine the Design Development Stage from producing green buildings in South Africa, the Gauteng province being the focus.

Findings and conclusions for the study should be used to interpret the Design Development Stage in Gauteng’s construction industry producing green buildings solely amongst architects and quantity surveyors as other practitioners involved at this stage have been excluded from the study. Although other practitioners have been excluded architects and quantity surveyors are predominantly involved at this stage thus increasing the validity of the study.

### **6.3. Recommendations**

This research has focused on the Gauteng province in isolation, further research to other provinces is thus required in order to establish the factors within Design Development Stage in projects that undermine it from producing green buildings in South Africa as a whole. Furthermore a larger sample size of the population in the construction industry is required as it would enable one to obtain a clearer picture of the factors undermining the Design Development Stage from producing green buildings in Gauteng, South Africa.

### **6.4. Thoughts for Future Research**

The limitations of this study inherently create a chance for future research. This study has been limited to identifying the factors within the Design Development Stage that undermine it from producing green buildings in Gauteng, South Africa. Future research should consider an examination on reasons for *why* these factors are not incorporated into the Design Development stage. Furthermore, an examination of *how* these factors can be configured to produce green buildings within South Africa is recommended to gain further insight on the Design Development Stage.

## REFERENCES

- American Bar Association (2014), *Green Construction*, Retrieved 11 August 2014, <http://apps.americanbar.org/buslaw/blt/2007-11-12/steele.shtml>
- Anderson, S & Oyetunji, A (2004), Selection Procedure for Project Delivery and Contract Strategy, *Construction Resrach*, Vol.1, No.1, pp.1-9.
- Balfors, B, Faith-Ell, C & Varna's, A (2009), Environmental Consideration in Procurement Of Construction Contracts: Current Practice, Problems and Opportunities in Green Procurement in The Swedish Construction Industry, *Journal of Cleaner Production*, Vol.17, No.1, pp.1214-1222.
- Balfors, B, Faith-Ell, C, Uttam, K (2012), Eia and Green Procurement: Opportunities for Strengthening their Coordination, *Environmental Impact Assessment Review*, Vol.33, No.1, pp.73-79.
- Bassioni, G, (2012), A Study towards "Greener" Construction, *Applied Energy*, Vol.93, No.1, pp.132-137.
- Belout, A & Gauvreau, C (2004), Factors Influencing Project Success: The Impact of Human Resource Management, *International Journal of Project Delivery*, Vol.22, No.1, pp.1-11.
- Better Building Partnership (2013), *BBP Better Buildings Partnership*, Retrieved 19 August 2013, <http://www.betterbuildingspartnership.co.uk/working-groups/green-leases/>
- Bhattacharjee, A (2012), Social Science Research: Principles, Methods, and Practices, In *Social Science Research: Principles, Methods, and Practices*.
- Brammer, S Walker, H (2012), *The Relationship between Sustainable Procurement and E-Procurement in the Public Sector*, *Int. J. Production Economicst*, Vol.140, No.1, pp.256-268.
- Bratt, C, Broman, G, Hallstedt, S, Oldmark, J & Robèrt, KH (2013), *Assessment of Criteria Development for Public Procurement from a Strategic Sustainability Perspective*. *Journal of Cleaner Production*, Vol.1, No.1, pp.1-8.
- Building Standards Institution (2008), *Sustainability in Building Construction-General Principles*, London.
- Building Standards Institution (2009), *Construction Procurement- Part 1: Processes, Methods and Procedures*, London.
- Building Standards Institution (2010), *Principles and Framework for Procuring Sustainably - Guide*, London.
- Building Standards Institution (2011), *Construction Procurement Policies, Strategies and Procedures - Code of Practice*, London.
- Building Standards Institution (2012), *Principles and Framework for Procuring Sustainably - Guide*, London.

## REFERENCES

---

Building, TC (2002), *Code of practice for project management for construction and development third edition*. Oxfordshire: Blackwell Publishing.

Byggeth, S & Hochschorner, E (2006), Handling Trade-offs in Eco Design Tools for Sustainable Product Development and Procurement, *Journal of Cleaner Production*, Vol.14, No.1, pp.1420-1430.

Carayannisa, EG, Popescub, D (2005), Profiling a Methodology for Economic Growth and Convergence: Learning From The Eu E-Procurement Experience For Central And Eastern European Countries, *Technovation*, Vol.25, No.1, pp 1-14.

Chan, EH, Chau, CK, Chun, KP, Lam, PT & Poon, CS (2010), Factors Affecting the Implementation of Green Specifications In Construction, *Journal of Environmental Management*, Vol.91, No.1, pp.654-661.

Chan, EHW, Chau, CK, Chun, KP, Lam, PTI, Poon, CS (2011), Environmental Management System vs Green Specifications: How Do They Complement Each Other in The Construction Industry? *Journal of Environmental Management*, Vol.92, No.1, pp 788-795.

The Chartered Institute of Building (2013), Retrieved 06 February 2013, <http://www.ciob.co.za/>

Chatterjee, AK (2009), Sustainable Construction and Green Buildings on the Foundation of Building Ecology, *The Indian Concrete Journal*, Vol.1, No.1, pp.27-30.

Chen, Y, Okudan, GE & Riley, DR (2010), Sustainable Performance Criteria For Construction Method Selection In Concrete Buildings, *Sustainable Development*, Vol.16, No.1, pp.161-173.

Chiu, AS, Tan, RR, Tseng, ML & Siriban-Manalang, A (2013), Sustainable Consumption and Production for Asia: Sustainability through Green Design and Practice, *Journal of Cleaner Production*, Vol.40, No.1, pp.1-5.

Construction Education and Training Authority (2008), *Overview of Construction Sector*, Retrieved 05 May 2013, <http://www.ceta.org.za/Mandate/OverviewConstructionSector.asp>

Construction Industry Development Board (2011), *Standard for the Delivery and Maintenance of Infrastructure using a Gateway System*, CIDB.

Construction Industry Development Board (2013), Retrieved 03 May 2013, <http://www.cidb.org.za/default.aspx>

Construction Industry Development Board, *Infrastructure Delivery Management Guidelines - Module 4 – Project Delivery*, Retrieved 29 January 2014, CIDB: <http://www.cidb.org.za/toolkit06/toolkitpages/module4/10guideline/module4.htm>

Construction Industry Research and Information Association (2011), *Guide to Sustainable Procurement in Construction*, London.

Clayton, J (2007), *Commercial Real Estate Analysis & Investments*, United States of America: Cengage Learning.

## REFERENCES

---

- Crespin-Mazet, F, Dontenwill, E (2012), *Sustainable Procurement: Building Legitimacy in the Supply Network*, Journal of Purchasing & Supply Management, Vol.18, No.1, pp.207-217.
- Daddi, T, Frey, M, Iraldo, F, Testa, F (2012), *What Factors Influence the Uptake of GPP (green public procurement) practices? New Evidence from an Italian Survey*, Ecological Economics, Vol.82, No.1, pp.88-96.
- De Boer, L, Michelsen, O (2009), Green Procurement in Norway; a Survey of Practices at the Municipal and County Level, *Journal of Environmental Management*, Vol.91, No.1, pp.160-167.
- Denzin, MK, & Lincoln YS (2010), *The SAGE Handbook of Qualitative Research: Third Edition*, Pitman Publishing.
- Design Technical Resource Company Services, *Project specifications*, Retrieved 30 January 2014, Dtr consulting services: [http://www.dtrcs.com/Project\\_Specifications.html](http://www.dtrcs.com/Project_Specifications.html)
- Doberstein, B, Geng, Y (2008), Greening Government Procurement in Developing Countries: Building Capacity in China, *Journal of Environmental Management*, Vol.88, No.1, pp.932-938.
- Ekram, HM, Huang, D, Liu, B & Tran, Q (2011), A Construction Enterprise's Readiness Level in Implementing E-Procurement: A System Engineering Assessment Model, *Systems Engineering Procedia*, Vol.2, No.1, pp.131-141.
- Emery, SB, Gaterell, MR, Sammons, G & Smith, DN (2007), Estimation of the Recycled Content of an Existing Construction Project, *Resource Conservation and Recycling*, Vol.52, No.1, pp. 395-409.
- EPROP (2013), *Green Leases Integral to Commercial Property*. Retrieved 19 August 2013, <http://www.eprop.co.za/news/item/15213-green-leases-integral-to-commercial-property.html>
- Eriksson, PE, Pesa"maa, O & Hair, JF (2009), Validating a Model of Cooperative Procurement in the Construction Industry, *International Journal of Project Management*, Vol.27, No.1, pp.552-559.
- Eriksson, PE, Westerberg, M (2011), *Effects of Cooperative Procurement Procedures on Construction Project Performance: A Conceptual Framework*, International Journal of Project Management, Vol.29, No.1, pp.197-208.
- Food and Agriculture Organisation (2013), *3 PHASE II DESIGN*, Retrieved 22 December 2013, FAO Corporate Document Repository: [http://www.fao.org/docrep/s6665e/s6665e04.htm#3.3 cost re evaluation or value engineering](http://www.fao.org/docrep/s6665e/s6665e04.htm#3.3_cost_evaluation_or_value_engineering)
- Gerber, BG & Kent, DC (2012), Understanding Construction Industry Experience and Attitudes toward Integrated Project Delivery, *Journal of Construction Engineering and Management*, Vol.136, No.1, pp.815-825.
- Gibson Jr, GE, Hale, DR, Migliaccio, GC & Shrestha, PP (2009), Empirical Comparison of Design/Build and Design/Bid/Build Project Delivery Methods, *Journal of Construction Engineering and Management*, Vol.135, No.1, pp.579-587.
- Gill, J & Johnson, P (2010), *Research Methods: Course Introduction and Overview*, SOAS: University of London, London.

## REFERENCES

---

- Governor's Green Government Council (2014), *What is a green building? Fundamental Principles of Green Building and Sustainable Site Design*, Pennsylvania.
- Green Building Council South Africa (2013), *Green Building Council South Africa*. Retrieved 14 February 2013, <http://www.gbcsa.org.za/home.php>
- The Green Economy Post (2014), *An Introduction To Green Building Construction Contracts*, Retrieved 11 August 2014, <http://greeneconomypost.com/green-building-construction-contracts-8059.htm>
- Greenpoint - Cape Town (2014), *Green Leases - What You Need to Know*. Retrieved 14 July 2014, <http://greenpoint-capetown.co.za/listing/green-leases-%E2%80%93-what-you-need-to-know/>
- Greenwood, DG & Hughes, WP (1996), The Standardisation of Contracts for Construction, *International Construction Law Review*, Vol.13, No.2, pp.196-206.
- Ha, H, Na, Y & Jun, Z (2012), Elementary Introduction to the Green Management of the Construction in Whole Process, *Physics Procedia*, Vol.24, No.1, pp.1081-1085.
- Horman, M, Korkmaz, S & Riley, D (2009), Key Attributes of a Longitudinal Study of Green Project Delivery, *Construction Research Congress*, Vol.1, No.1, pp.558-567.
- Huang, J, Huang, R, Pullen, S, Shi, Q, & Zuo, J (2013), Identifying the Critical Factors for Green Construction - An Empirical Study in China, *Habitat International*, Vol.40, No.1, pp.1-8.
- Hwang, BG, & Ng, WJ (2013), Project Management Knowledge and Skills For Green Construction: Overcoming Challenges, *International Journal of Project Management*, Vol.31, No.1, pp.272-284.
- Imperial College London (2014), *Estates Projects*, Retrieved 3 January 2014, from Imperial College London:  
<http://www3.imperial.ac.uk/estatesprojects/projectprocedures/processes/dm/3.10/3.10.02>
- Johnsen, T, Miemczyk, J, Spencer, R, Walker, H (2012), Sustainable Procurement: Past, Present and Future, *Journal of Purchasing & Supply Management*, Vol.18, No.1, pp.201-206.
- Jorge, OJ, Qi, GY, Shen, LY & Zeng, SX (2010), The Drivers for Contractors' Green Innovation: An Industry Perspective, *Journal of Cleaner Production*, Vol.18, No.1, pp.1358-1365.
- Kelemen, M & Rumens, N (2008), *An Introduction to Critical Management Research*, SAGE Publications, London.
- Lacouture, DC, Oberle, R & Smith, VR (2009), Effects of the Regulatory Environment on Construction Project Delivery Method Selection, *Construction Research Congress*, Vol.1, No.1, pp.211-218.
- Lewis, P, Saunders, M, Thornhill, A (2012), *Research Methods for Business Students*. Harlow: Pitman Publishing.
- Loprieno, AD, Porta, P, & Tarantini, M (2011), A Life Cycle Approach to Green Public Procurement of Building Materials and Elements: A Case Study on Windows, Energy, Vol.36, No.1, pp 2473-2482.

## REFERENCES

---

Manoliadis, OG, Mavridis, DG & Vatalis, KI (2012), Project Performance Indicators as an Innovative Tool for Identifying Sustainability Perspectives in Green Public Procurement, *Example: Journal of Environmental Management*, Vol.92, No.1, pp.788-795.

Martin CA (2012), *The Development Stages: Property Development Process*, Johannesburg: CMA.

Mathonsi, D & Thwala, WD (2012), Factors Influencing The Selection of Procurement Systems in the South African Construction Industry, *African Journal of Business Management*, Vol.6 No.10, pp.3583-3594.

Mbachu, J & Raymond, N (2007), Factors Constraining Successful Building Project Implementation in South Africa, *Construction Management and Economics*, Vol.25, No.1, pp.39-54.

MediaClubSouthAfrica (2013), *MediaClubSouthAfrica*, Retrieved 15 May 2013, <http://www.medioclubsouthafrica.com/economy/2629-green-building>

Multiproject (2012), *Types of Procurement*, Retrieved 12 October 2012, [http://multiproject.org/multiproject\\_guides/multiproject\\_guides/no\\_4.html](http://multiproject.org/multiproject_guides/multiproject_guides/no_4.html).

Multiproject (2014), *Multiproject*, Retrieved 29 January 2014, Scheduling and planning construction works: [http://www.multiproject.org/multiproject\\_guides/multiproject\\_guides/multiproject\\_guides/no\\_6.html](http://www.multiproject.org/multiproject_guides/multiproject_guides/multiproject_guides/no_6.html)

Myproperty (2013), *Myproperty*, Retrieved 19 August 2013, <http://www.myproperty.co.za/news/3933/Green-Leases-on-the-rise-in-South-Africa.aspx>

National Home Builder Regulation Council, (2014), *National Home Builders Regulation Council*, Retrieved 23 February 2014, from Consumer Info: <http://www.nhbrc.org.za/index.php/consumer-info>

Organisation for Economic Cooperation and Development (2007), *Energy for Sustainable Development*, Paris: OECD Publications.

OGS (2014), OGS Design Procedures Manual, A Guide for Designing Projects for Office of General Services, pp. 1-5.

Professional Consultant Services Agreement Committee (2013), *PROCSA Professional Consultant Services Agreement Committee*. Retrieved 06 January 2013, <http://www.procsa.co.za>

Research Connections (2014), *Research Glossary*. Retrieved 11 March 2014, from Child Care & Early Education Research Connections: <http://www.researchconnections.org/childcare/research-glossary>

Rwelamila, PD, Talukhaba, AA & Ngowi, AB (2000), Project Procurement Systems in the Attainment of Sustainable Construction, *Sustainable Development*, Vol.8, No.1, pp.39-50.

Sev, A (2009), How Can the Construction Industry Contribute to Sustainable Development? A Conceptual Framework, *Sustainable Development*, Vol.16, No.1, pp.161-173.

## REFERENCES

---

South Africa Commercial Property News (2012), *First Refurbished Building in SA to get a Green Star Certification*.

The South African Council for the Architectural Profession (2013), *Annual Report*. Johannesburg: SACAP.

The South African Council for the Quantity Surveying Profession (2013), *Annual Report*. Johannesburg: SACQSP.

Steven, T (2012), Public procurement design: Lessons from the private sector. *International Journal of Industrial Organization*, Vol.30, No.1, pp.297-302.

Sustainable City Team (2006), *Supplementary Planning Document Number 5: Bristol City Council - Bristol Local Development Framework Sustainable Building Design and Construction*, Bristol.

Tashakkori, A & Teddlie, C (2010), *Mixed Methods in Social & Behavioural Research*, SAGE Publications, California.

ThermaGreen (2012), *Thermagreenusa*, Retrieved 26 September 2012, <http://www.thermagreenusa.com/>

WiseGeek (2013), *What is a Turnkey contract?* Retrieved 31 May 2013, <http://www.wisegeek.org/what-is-a-turnkey-contract.htm>

WSP (2013), *Green Lease Toolkit*, Retrieved 19 August 2013, [http://www.gbcsa.org.za/wp-content/uploads/2013/06/5Richard\\_Palmer.pdf](http://www.gbcsa.org.za/wp-content/uploads/2013/06/5Richard_Palmer.pdf)

Yin, RK (2009), *Case Study Research Design and Methods: Fourth Edition*, SAGE Publications, California.

## APPENDICES

## Appendix A: Ethics Clearance Certificate



Research Office

**HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)**

R14/49 Kiggundu

**CLEARANCE CERTIFICATE**

**PROTOCOL NUMBER H103/04/04**

**PROJECT TITLE**

An examination of the relationship between procurement and green rated property development in Gauteng, SA

**INVESTIGATOR(S)**

Mr D Kiggundu

**SCHOOL/DEPARTMENT**

Construction Economics/

**DATE CONSIDERED**

19/04/13

**DECISION OF THE COMMITTEE**

Approved unconditionally

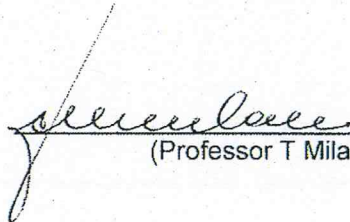
**EXPIRY DATE**

01/05/2015

**DATE**

02/05/2013

**CHAIRPERSON**

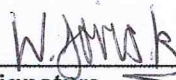
  
(Professor T Milani)

cc: Supervisor : Dr S Laryea

**DECLARATION OF INVESTIGATOR(S)**

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10005, 10th Floor, Senate House, University.

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to completion of a yearly progress report.**

  
Signature

14 / 05 / 2013  
Date

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

## Appendix B: Information Sheet

## Informed Consent for Anonymous Survey

### **A study on the relationship between the design development stage in projects and green buildings in Gauteng, South Africa's construction industry**

**Please read this information/consent document carefully before you decide to participate in this study**

You are invited to participate in a research study concerning the design development stage and green buildings in the construction industry within Gauteng. This research is being conducted by Davis Wasswa Kiggundu, a student from the University of Witwatersrand.

The objective of the questionnaire is to determine the current position of Gauteng's construction industry in terms of the design development stage towards green buildings. This survey is being given to architects and quantity surveyors with knowledge and experience of Gauteng's construction industry.

There are no risks if you decide to participate in this research study, nor are there any associated costs for participating in the study. The information you provide will help gain an understanding to what factors in the construction industry undermines the design development stage from working towards green buildings in Gauteng.

This survey is anonymous. If you choose to participate, do not write your name on the questionnaire. No one will be able to identify you, nor will anyone be able to determine which company you work for, in short no one will know whether you participated in this study. Your participation in this study is voluntary. If you choose to participate, please state your profession and answer the attached questionnaire where required.

This study is being conducted for academic purposes; information provided by you will be stored anonymously on a computer with analysis of the information obtained undertaken by the researcher. The results from this analysis will be available at the university of Witwatersrand main Library. Furthermore the University of Witwatersrand has given permission for this research to be conducted.

If you have any questions or concerns about completing the questionnaire or about being in this study you may contact the following individuals:

Researcher: Davis Kiggundu; Cell - 079 562 7319, email - [wdkiggs@gmail.com](mailto:wdkiggs@gmail.com)

Supervisor: Samuel Laryea; Tell - 011 717 7657, email - [samuel.laryea@wits.ac.za](mailto:samuel.laryea@wits.ac.za)

## Appendix C: Architect Questionnaire



## ARCHITECTS

Profession: .....

Years of experience:

Please answer the following questions and indicate (tick/cross) the degree to which green building criteria is incorporated into each phase in the *Design Development Stage* in projects in Gauteng, South Africa?

### Design

1. When developing the approved concept, what is looked at?

|           |  |
|-----------|--|
| Very poor |  |
| Poor      |  |
| Fair      |  |
| Good      |  |
| Very good |  |

2. When finalising the design, what is looked at?

|           |  |
|-----------|--|
| Very poor |  |
| Poor      |  |
| Fair      |  |
| Good      |  |
| Very good |  |

3. When providing specifications, what is looked at?

|           |  |
|-----------|--|
| Very poor |  |
| Poor      |  |
| Fair      |  |
| Good      |  |
| Very good |  |



### **Comments on green buildings**

4. What are your thoughts regarding green buildings in Gauteng, South Africa?

## Appendix D: Quantity Surveyor Questionnaire



## QUANTITY SURVEYORS

Profession:.....

Years of experience:

Please answer the following questions and indicate (tick/cross) the degree to which green building criteria is incorporated into each phase in the *Design Development Stage* in projects in Gauteng, South Africa?

### Financial Planning

1. When producing cost plans, what is looked at?

|           |  |
|-----------|--|
| Very poor |  |
| Poor      |  |
| Fair      |  |
| Good      |  |
| Very good |  |

2. When conducting financial viabilities, what is looked at?

|           |  |
|-----------|--|
| Very poor |  |
| Poor      |  |
| Fair      |  |
| Good      |  |
| Very good |  |

### Project Programme

3. When developing programmes for projects, what is looked at?

|           |  |
|-----------|--|
| Very poor |  |
| Poor      |  |
| Fair      |  |
| Good      |  |
| Very good |  |



### **Comments on green buildings**

4. What are your thoughts regarding green buildings in Gauteng, South Africa?

## **Appendix E: Data Collected from Architect Questionnaires**

Initial Report

Last Modified: 01/19/2014

1. Profession:

| Text Response             |       |
|---------------------------|-------|
| Architecture              |       |
| Architect                 |       |
| Architecture              |       |
| Architect Project manager |       |
| Professional Architect    |       |
| architect                 |       |
| Architect                 |       |
| Architect                 |       |
| Architect                 |       |
| architect                 |       |
| Architect                 |       |
| Architect                 |       |
| Architect                 |       |
| Architect                 |       |
| Architect                 |       |
| Architect                 |       |
| Architect                 |       |
| Architect                 |       |
| Architect                 |       |
| Architect                 |       |
| Architect                 |       |
| Statistic                 | Value |
| Total Responses           | 20    |

2. When developing the approved concept, what is looked at?

| Text Response                                                                                                                                                                                              |       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| One would start refining building orientation issues; percentage of glazing area compared to opaque areas; shaping the building footprint more to maximise natural lighting of the building ect.           |       |
| many aspects to do with the construction technology, materials and finishes                                                                                                                                |       |
| issues of cost are usually one of guide as well as client need and compliance to .                                                                                                                         |       |
| Green design criteria looked at is energy efficiency of building, materials used, water consumption and collection, maximising on site and orientation.                                                    |       |
| The genius loci of the site, where the site is and exactly how much impact the concept will make on the site and if the concept seamlessly settles into the site with making as minimum impact as possible |       |
| Client, cost, aesthetics, materials, site                                                                                                                                                                  |       |
| Visually appealing concept, but economical to manage.                                                                                                                                                      |       |
| If the function of the building reflects the needs of the client and if their needs can accomodate sustainable methods.                                                                                    |       |
| Brief Adaption to the surrounding environment                                                                                                                                                              |       |
| Orientation..aesthetics. access and exits. And relation to context                                                                                                                                         |       |
| Client requirements, budget, project constraints.                                                                                                                                                          |       |
| Suitability of concept as the concept is the roadmap to design                                                                                                                                             |       |
| Can the concept be developed into a design that suits the clients objectives.                                                                                                                              |       |
| Concept in line with developed brief, whether from client or self generated, concept is integrated in its site and is viable for further development.                                                      |       |
| Urban context, public relm, sustainability "big idea"                                                                                                                                                      |       |
| Site analysis is done, research on existing site, exisiting vegetation, movement etc.                                                                                                                      |       |
| Has the concept articulated the idea addressing client requirements. Can the concept be developed into a workable design and strategies.                                                                   |       |
| Site, brief, client.                                                                                                                                                                                       |       |
| Project scope, client needs, development strategy.                                                                                                                                                         |       |
| Aesthetics Size of the building The zone in which the building is to be erected The budget of the client Orientation of the building                                                                       |       |
| Statistic                                                                                                                                                                                                  | Value |
| Total Responses                                                                                                                                                                                            | 20    |

3. Incorporation of green building criteria when developing the approved concept.

| # | Answer    | Bar | Response | %   |
|---|-----------|-----|----------|-----|
| 1 | Very Poor |     | 0        | 0%  |
| 2 | Poor      |     | 2        | 10% |
| 3 | Fair      |     | 10       | 50% |
| 4 | Good      |     | 7        | 35% |
| 5 | Very Good |     | 1        | 5%  |
|   | Total     |     | 20       |     |

| Statistic          | Value |
|--------------------|-------|
| Min Value          | 2     |
| Max Value          | 5     |
| Mean               | 3.35  |
| Variance           | 0.56  |
| Standard Deviation | 0.75  |
| Total Responses    | 20    |

4. When finalising the design, what is looked at?

| Text Response                                                                                                                                                                                                       |       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Optimal use of natural elements to benefit the building and reduce dependency of building on man made power sources.                                                                                                |       |
| Its the cost of construction versus the use of green technologies as a whole                                                                                                                                        |       |
| Client requirements, building type and function, building industry regulations as well as cost/budget                                                                                                               |       |
| Same criteria as above                                                                                                                                                                                              |       |
| When d finalising the design first thing looked at is the budget, you can have the most award winnning design but if it is not within budget (most times concepts are always over budget) it will never be realized |       |
| Practicalities of structure, materials and source, feasibility, special construction techniques and consequently the contractors and sub contractors , passive solar design                                         |       |
| A building that is sustainable for future development and environmentally friendly.                                                                                                                                 |       |
| Confirm methods and make sure that the methods can indeed save money.                                                                                                                                               |       |
| Cost implications Environmental aspects Timline of construction                                                                                                                                                     |       |
| Aesthetics, design                                                                                                                                                                                                  |       |
| Design functionality.                                                                                                                                                                                               |       |
| Consider if the idea's essence is captured through design.                                                                                                                                                          |       |
| A balance between different aspects that influence the deliverables to acheive the clients objectives.                                                                                                              |       |
| In line with the approved concept and allows for green building concepts to be successfully integrated.                                                                                                             |       |
| Construction details, materiality                                                                                                                                                                                   |       |
| Have opportunities been addressed, have constraints been dealt with.                                                                                                                                                |       |
| Does the design satisfy the concept by implementation.                                                                                                                                                              |       |
| Metting the clients requirements, meeting building regulations e.g. Sans                                                                                                                                            |       |
| Client satisfaction, cost, value for money.                                                                                                                                                                         |       |
| Cost of the project The budget of the client Materials to be used Professional team to be involved                                                                                                                  |       |
| Statistic                                                                                                                                                                                                           | Value |
| Total Responses                                                                                                                                                                                                     | 20    |

5. Incorporation of green building criteria when finalising the design.

| # | Answer    | Bar | Response | %   |
|---|-----------|-----|----------|-----|
| 1 | Very Poor |     | 0        | 0%  |
| 2 | Poor      |     | 5        | 25% |
| 3 | Fair      |     | 9        | 45% |
| 4 | Good      |     | 4        | 20% |
| 5 | Very Good |     | 2        | 10% |
|   | Total     |     | 20       |     |

| Statistic          | Value |
|--------------------|-------|
| Min Value          | 2     |
| Max Value          | 5     |
| Mean               | 3.15  |
| Variance           | 0.87  |
| Standard Deviation | 0.93  |
| Total Responses    | 20    |

6. When providing specifications, what is looked at?

| Text Response                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Specifications are basically detailed instructions to the contractor on what and how to use any given material or building component(s). In terms of green building technology, one would specify exactly which technologies to incorporate into the building for example what make and model solar panels to put on the roof, at what angle and so forth.                                                                                                                                          |       |
| Providing cost effective solutions that are consistent with energy saving                                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| The National Building standards as we specifically clauses that may compliment eg energy regulations. Client need is also considered as well as building use.                                                                                                                                                                                                                                                                                                                                       |       |
| Performance of specification materials and their procurement.                                                                                                                                                                                                                                                                                                                                                                                                                                       |       |
| Budget and the performance of the project undertaken, but budget will always take priority. With the somewhat new regulations where in Gauten you have to submit fenestration calculations in order for your project to get approved, most people in the industry try to post rationalise and adjust the design in order to make the building pass the fenestration calculations. This means the local authorities in Gauteng regulate the performance of building subitted in their juristriction. |       |
| Quality control, source of materials for specs, durability, ease of a access to materials                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| Sustainable materials and methods that don't waste energy                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| Look at the viability of materials and methods.                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       |
| Building regulations Materials                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       |
| Cost and aesthetics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |
| Suitability to design.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |
| Current building trends and aesthetics.                                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| Quality, safety, maintenance, aesthetics.                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| The green building theme is relatively new and requires extensive research in precedents, globally and internationally.                                                                                                                                                                                                                                                                                                                                                                             |       |
| Materiality                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |
| Minimum requirements for specific specifications, reference national building regulations.                                                                                                                                                                                                                                                                                                                                                                                                          |       |
| Affordability, implementationt, appeal to design.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |
| Desired finishes, availability of materials, sustainable materials.                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |
| Client satisfaction.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |
| Where to get the materials Cost of the project The budget of the client Materials to be used Professional team to be involved Sans regulations                                                                                                                                                                                                                                                                                                                                                      |       |
| Statistic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Value |
| Total Responses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 20    |

7. Incorporation of green building criteria when providing specifications.

| # | Answer    | Bar         | Response | %   |
|---|-----------|-------------|----------|-----|
| 1 | Very Poor | <div></div> | 1        | 5%  |
| 2 | Poor      | <div></div> | 3        | 15% |
| 3 | Fair      | <div></div> | 7        | 35% |
| 4 | Good      | <div></div> | 6        | 30% |
| 5 | Very Good | <div></div> | 3        | 15% |
|   | Total     |             | 20       |     |

| Statistic          | Value |
|--------------------|-------|
| Min Value          | 1     |
| Max Value          | 5     |
| Mean               | 3.35  |
| Variance           | 1.19  |
| Standard Deviation | 1.09  |
| Total Responses    | 20    |

8. What are your thoughts regarding green buildings in Gauteng, South Africa?

| Text Response                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| My thoughts regarding green buildings generally are that they are nonsensical and pretentious. There is a lot of hoo haa about green stars and all that when in truth the buildings are not really practical or sustainable. Until "green" technology becomes affordable, it is not practical                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |       |
| More can be done and the information should be readily made available to as many people as possible and raising awareness of importance of green building                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |
| The design and implementation of green building is still at an early stage within the industry. A lot of the time this is hampered by budgetary factors as green building design has high initial costs (though long term benefits), something the clients do not understand as yet.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |       |
| The built environment is embracing the development of green buildings. Strides are being made to design green efficient buildings across the private and public sector.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       |
| I think its an affordability thing, it is still expensive for a person to really produce a green building big corporations with big budgets are mostly the ones who afford to bring up a good and optimal green building on larger scales, but when it comes to middle and lower scale building being small offices, small industrial building, residential building and the likes seem to end up performing the bare minimal. Its all about who has the most money to intergrate the best technologies and pay the best and experience people in the industry. In turn the people who really need these green buildings being the lower income level in Gauteng cannot afford this service. This means producing a green building becomes a specialized skill exclusive to the ellipse. I believe if green building could service the mid to lower income level group in Gauteng it will give some sort of relief to their economic situation and at the same time contribute to the environment in numbers which i think is bigger than few corporates can do, to me green design needs to work on both a social and environmental level in order for it to be efficient. |       |
| The building industry is dominated by an older generation. They are adapting to new green design concepts. The good architects and developers have these incorporated in their designs. Technology as a form of sustainability is dominant which reads to the general public as the same buildings that's are negatively impacting the environment. There is a lack of public / social awareness which I believe is not being communicated well by designers and developers. There is a need for an ethical responsibility from developers, architects and technologies as buildings contribute to 50% of pollution. It's an imperative social right.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       |
| Green architecture exists at an aim to use environmentally friendly materials and techniques that save energy, prevents waste through using clean and renewable material avoiding damage to the environment.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |
| -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| There is greater consideration for green buildings amongst new designers. The elder generation hinders the diffusion of green buildings within the industry.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |
| Its a good idea that does really work. The Sans calculations that have been introduced are a headache as the are just a good idea but have no use really. There is more to it than just maths. It doeant work but just modularises the profession and I dont think people in council even have the time to go thru them..                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |
| A growing phenomenon, however not adequately incorporated in projects.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       |
| -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| Still requires good implementation, council standards limit design at this stage and requires additional support/translation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |       |
| -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| If not in the relevant field, not enough information is distributed to the general public.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |       |
| Through proper understanding, the concept can be well implemented and beneficial. My feel is that most developers do not thoroughly understand its benefit making implementation difficult.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |
| -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| Not fully administered in the market of homes, largely applied to commercial projects because of the cost-benefit ratio.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |       |
| In Gauteng, green building is now at an advanced stage. Though there are some loopholes here and there but we are moving towards the mark. We still need to educate the local people the importance of green architecture and its benefits to the environment around them. Also the technical team needs to be honest in conducting there duties.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| Statistic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Value |
| Total Responses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 20    |

9. Years of Experience:

| Text Response       |  |
|---------------------|--|
| 3                   |  |
| 5                   |  |
| 4                   |  |
| 6                   |  |
| 4                   |  |
| 1 year and 2 months |  |
| 5 years             |  |
| 4 years             |  |
| 3                   |  |
| 2                   |  |
| 5 years             |  |
| 1                   |  |
| 3 years             |  |
| 6 years             |  |
| 3 years             |  |
| 1                   |  |
| 8 years             |  |
| 4 years             |  |
| 3.5                 |  |
| 7                   |  |

| Statistic       | Value |
|-----------------|-------|
| Total Responses | 20    |

## **Appendix F: Data Collected from Quantity Surveyor Questionnaires**

Initial Report

Last Modified: 01/09/2014

1. Profession:

| Text Response     |
|-------------------|
| Quantity Surveyor |
| Quantity Surveyor |
| Quantity Surveyor |
| Quantity Surveyor |
| Quantity Surveyor |
| Junior Q.S.       |
| Quantity Surveyor |
| Quantity Surveyor |
| Quantity Surveyor |
| Quantity Surveyor |
| Quantity Surveyor |
| Quantity Surveyor |
| Quantity Surveyor |
| Quantity Surveyor |
| Quantity Surveyor |

| Statistic       | Value |
|-----------------|-------|
| Total Responses | 15    |

## 2. When producing cost plans, what is looked at?

| Text Response                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Use, cost, quality and time                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |       |
| Cost Quality Resource availability                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       |
| Design of building                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       |
| Viability Value Engineering                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |       |
| <p>When you boil down all of the cost related activities on a project, there are really four key components: 1. Estimating costs – accurately determining what costs will be before the project work is started 2. Tracking costs – keeping track of all costs on a project, and being able to review cost information in a timely fashion 3. Controlling costs – being able to influence the spend on a project while it is in progress 4. Maintaining cost data – archiving cost information in such a way that it can be used for future projects</p> <p>The way that our organisation operates is highly based on the clients budget. We work mostly with the interior renovation and revamping of existing buildings, from interior space design to the total refurbishment of the interior spaced to the clients requirements. With regards to green technology implementation into building it is always the case that this not allowed for by the clients budget therefor it is not catered for in the service we provide.</p> |       |
| Labour, material, overheads.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| Duration of project, scope of works, trades,, materials, labour, distance of project, profit margins, client budget.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |
| The scope of works specified, the design, location of the works and the budget are looked at to produce a cost plan.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |
| Cost plans differ depending on the nature of the works and design provided, the required quality and current market rates are used to produce cost plans.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |
| Design and the required quality.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       |
| <p>When producing cost plans building elements are measured as per the standard measuring system from the designs provided, the cost of each element/trade/bill is calculated and totalled to determine the total cost of construction.</p> <p>The cost of construction and professional fees is measured based on the drawing provided. Materials, labour and profit are all considered.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |
| Designs, specifications, material, labour, economy                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       |
| The cost of the proposed works is established based on the designs given, if over budget, cost engineering is conducted as far as possible to reduce costs.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |       |
| Statistic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Value |
| Total Responses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 15    |

3. Incorporation of green building criteria when producing cost plans.

| # | Answer    | Bar         | Response | %   |
|---|-----------|-------------|----------|-----|
| 1 | Very Poor | <div></div> | 1        | 7%  |
| 2 | Poor      | <div></div> | 6        | 40% |
| 3 | Fair      | <div></div> | 7        | 47% |
| 4 | Good      | <div></div> | 1        | 7%  |
| 5 | Very Good |             | 0        | 0%  |
|   | Total     |             | 15       |     |

| Statistic          | Value |
|--------------------|-------|
| Min Value          | 1     |
| Max Value          | 4     |
| Mean               | 2.53  |
| Variance           | 0.55  |
| Standard Deviation | 0.74  |
| Total Responses    | 15    |

#### 4. When conducting financial viabilities, what is looked at?

| Text Response                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Use, cost, quality, functionality and time                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |
| NPV IRR Rate of return                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |       |
| Return on investment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       |
| Return on investment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       |
| Financial viability is one of a range of measures designed to reduce risk. Financial viability can rapidly deteriorate or improve with changes to the economic and operating environment. As such it should be recognised that a point in time of viability can only screen out high risk tenderers, and is not substitute for the sound project planning and contract management.                                                                                                                                                        |       |
| Green building technology is expensive in regards to the work we provide to our clients. The financial viability for them to transform their buildings into green buildings is not there. Also considering that most of our clients are government departments that's often just require upgraded office spaces, green building technology is not considered. Although the initial implementation of green technologies into building may be expensive, the long term expense of having a green building will prove to be cost efficient. |       |
| Escalation, time constraints.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| Capital cost, return on investment, detailed cashflow, sustainability of development, residual value of property                                                                                                                                                                                                                                                                                                                                                                                                                          |       |
| Will the project be profitable enough to go ahead with the scope of works.                                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |
| Anticipated cost versus the anticipated returns are used to investigate financial viabilities.                                                                                                                                                                                                                                                                                                                                                                                                                                            |       |
| ROI, ROE, NPV and cash flow                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |       |
| When conducting financial viabilities the profit and cash flow against expenses to be incurred is used to determine the financial viability of a project.                                                                                                                                                                                                                                                                                                                                                                                 |       |
| The highest possible return is calculated, different scenarios are looked at. If the return is not high enough projects are not pursued.                                                                                                                                                                                                                                                                                                                                                                                                  |       |
| Profitability, is the project worth doing or should the money be invested somewhere else.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |
| The return is analysed and compared to all the anticipated costs, if the returns are suitable the project is given the green light.                                                                                                                                                                                                                                                                                                                                                                                                       |       |
| Statistic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Value |
| Total Responses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 15    |

5. Incorporation of green building criteria when conducting financial viabilities.

| # | Answer    | Bar         | Response | %   |
|---|-----------|-------------|----------|-----|
| 1 | Very Poor | <div></div> | 1        | 7%  |
| 2 | Poor      | <div></div> | 7        | 47% |
| 3 | Fair      | <div></div> | 6        | 40% |
| 4 | Good      | <div></div> | 1        | 7%  |
| 5 | Very Good |             | 0        | 0%  |
|   | Total     |             | 15       |     |

| Statistic          | Value |
|--------------------|-------|
| Min Value          | 1     |
| Max Value          | 4     |
| Mean               | 2.47  |
| Variance           | 0.55  |
| Standard Deviation | 0.74  |
| Total Responses    | 15    |

6. When developing programmes for projects, what is looked at?

| Text Response                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Completion in the specified time, resources availability                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| Activities Resources Costs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |
| Timeline of construction                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| Client requirements Weather Costs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |       |
| We look at the activities schedule, how long it will take to complete the project, the critical path of the project.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |       |
| <p>The are three important phases one will go through when compiling a project programme. Pre-Tender Phase, Pre-Contract Phase, and your Contract phase. the development of an adequate project programme needs to be developed at each of these phases fully understand the complexity and requirements one will need to fulfil to successfully undertake a project. During your Pre Tendering phase one will be able to identify if they will be able to undertake to proposed project. do you have the necessary resources, finance, labour force, plant, etc. to undertake the project. identifying this will help you determine what provisions need to be made if a decision is made to pursue the project. Your Pre-Contract phase will now require you to develop a plane of action of undertaking the proposed work. identifying all the different phases of the project and scheduling events accordingly to maximize efficiency. Plant scheduling, Material scheduling, Labour requirements, are any subcontractors to be involved in this projects. A programme looking at the projects entirety is developed considering all the listed factors. Your Contract phase is where you now adopt the programme developed at the pervious phase and explode it to give as much detail as possible for an accurate and effective project plan. Exploding it to show the entirety of the project, monthly, weekly and daily scheduling of work is essential in keeping track with the projects progress. a more detailed project programme helps for a more efficient project management. with respect to Green building criteria being incorporated into projects, through my experience, this is always at the clients discretion. at this stage of my career I have not worked on a project where Green construction processes have been incorporated.</p> |       |
| Needs (client), resources available                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |
| Lead times on items and the client requirements. Usually clients don't give enough time before tender, or enough time for construction, so everything can be fast-tracked and that can result in more cost (as more slip-up occur)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |
| Required activities in relation with when the project has to be completed                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |
| The critical path is determined and worked around to ensure programme is realistic and effective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |
| Each bill is mapped out across the specified time of the project.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |       |
| When developing programmes the scope of the works is mapped out against the specified peroid of construction/ the project.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |
| Time frame of the project is used to develop a programme.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |
| Time constraints against what needs to be done                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       |
| The project is broken down into the required activities and plotted against calander dates that work will take place.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |
| Statistic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Value |
| Total Responses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 15    |

7. Incorporation of green building criteria when developing programmes for projects.

| # | Answer    | Bar         | Response | %   |
|---|-----------|-------------|----------|-----|
| 1 | Very Poor | <div></div> | 1        | 7%  |
| 2 | Poor      | <div></div> | 9        | 60% |
| 3 | Fair      | <div></div> | 4        | 27% |
| 4 | Good      | <div></div> | 1        | 7%  |
| 5 | Very Good |             | 0        | 0%  |
|   | Total     |             | 15       |     |

| Statistic          | Value |
|--------------------|-------|
| Min Value          | 1     |
| Max Value          | 4     |
| Mean               | 2.33  |
| Variance           | 0.52  |
| Standard Deviation | 0.72  |
| Total Responses    | 15    |

8. What are your thoughts regarding green buildings in Gauteng, South Africa?

| Text Response                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Green building has still not been fully incorporated in the Gauteng, more needs to be done to raise awareness and highlight benefits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       |
| In my opinion it is slowly improving but there is not a major incentive for clients to have green buildings as the costs initial are seen to be high. Consultants need to persuade their clients of the benefits of green buildings as opposed to conventional buildings.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |       |
| Green building method have been considered                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |
| They are few and far between                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |       |
| Green building has become part of the compliance for the construction industry in south africa.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |       |
| In my opinion, South Africa is a 3rd world country with a 1st world façade. With regard to steps being taken to move toward buildings leaning to falling under The Green criteria, plans have been developed and some initiated in order to achieve. thought as small as these steps are they don't go unnoticed. the cost factor of the total transformation is a big factors that contributes to the slow process. Unlike leading 1st world counties where transformation towards green building is taking place faster, South Africa is still growing as an economic contender with the rest of the world but the rate of growth does not allow for the required rate of transformation that we would like to see. (opinion, not fact.) |       |
| Should be implemented pre-design                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| Any project that has the words "heritage" and "green" in it – results in more cost automatically. I think geen buildings are beneficial, but its iniyial capital costs are to high.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |       |
| -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |
| -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |
| Green building are expensive innitialy and thus provides little incentive to clients.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       |
| -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |
| The benefits of green buildings are not widely known in the industry, their extra cost thus putting off clients.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| I feel it will take sometime before green buildings become the norm in South Africa                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |       |
| People in the industry do not fully understand green buildings and what thet are about.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |       |
| Statistic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Value |
| Total Responses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 15    |

9. Years of Experience:

| Text Response   |       |
|-----------------|-------|
| 3               |       |
| 3               |       |
| 2               |       |
| 6 years         |       |
| 6 years         |       |
| 1               |       |
| 2               |       |
| 2               |       |
| 4 years         |       |
| 3               |       |
| 2               |       |
| 3 years         |       |
| 2               |       |
| 3               |       |
| 3               |       |
| Statistic       | Value |
| Total Responses | 15    |

## Appendix G: Architect Interviews



## ARCHITECTS

**Profession: Architect**

**Years of experience: 4**

Please answer the following questions and indicate (tick/cross) the degree to which green building criteria is incorporated into each phase in the *Design Development Stage* in projects in Gauteng, South Africa?

### Design

1. When developing the approved concept, what is looked at?

The design should be within the cost estimate (parameters), back and forth.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      | X |
| Fair      |   |
| Good      |   |
| Very good |   |

2. When finalising the design, what is looked at?

All disciplines come together, ensuring building works for what it is intended to be used for. Architect dictates what materials are to be used. What u present to client, whether you go further or not, not into detail that's where your documentation stage comes into play. Final design is just the pretty picture.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      |   |
| Fair      | X |
| Good      |   |
| Very good |   |

3. When providing specifications, what is looked at?

Aesthetics, functionality, workability, cost, testing out products, testing out new ideas, availability of materials, delivery times.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      |   |
| Fair      | X |
| Good      |   |
| Very good |   |



#### **Comments on green buildings**

- 4. What are your thoughts regarding green buildings in Gauteng, South Africa?**

**A lot of the time it's an afterthought, however there is a push, industry is knowledgeable in terms of green buildings but cost is a barrier. Introducing foreign concepts and high start-up costs are barriers. Stakeholders need to educate themselves. It's a lot of effort to design green. Architects design should consider the fact buildings get hot, air-conditioning is an afterthought. No integration between different disciplines.**



## ARCHITECTS

**Profession: Architect**

**Years of experience: 3**

Please answer the following questions and indicate (tick/cross) the degree to which green building criteria is incorporated into each phase in the *Design Development Stage* in projects in Gauteng, South Africa?

### Design

1. When developing the approved concept, what is looked at?

**Greater detail to the preliminary design is given within the parameters stipulated. Aesthetics, the materials and quality of finishes to be used for the building are looked at.**

|           |   |
|-----------|---|
| Very poor |   |
| Poor      | X |
| Fair      |   |
| Good      |   |
| Very good |   |

2. When finalising the design, what is looked at?

**Design should suffice for an accurate cost estimate and should be able to articulate the required building methodology to be used by the contractor.**

|           |   |
|-----------|---|
| Very poor |   |
| Poor      | X |
| Fair      |   |
| Good      |   |
| Very good |   |

3. When providing specifications, what is looked at?

**NHBRC standards and specifications are to be adhered to as a basis. Further to that the nature of the building governs the specifications given.**

|           |   |
|-----------|---|
| Very poor |   |
| Poor      | X |
| Fair      |   |
| Good      |   |
| Very good |   |



#### **Comments on green buildings**

4. What are your thoughts regarding green buildings in Gauteng, South Africa?

**Clients do not strive towards green buildings because of cost and lack of knowledge of green buildings. The concept is slowly diffusing into the industry but not at a rate that one would expect the majority of future developments to be predominantly "green". There is not enough pressure in the industry for buildings to be green.**



## ARCHITECTS

**Profession: Architect**

**Years of experience: 4**

Please answer the following questions and indicate (tick/cross) the degree to which green building criteria is incorporated into each phase in the *Design Development Stage* in projects in Gauteng, South Africa?

### Design

1. When developing the approved concept, what is looked at?

Sun angles, position on site, views, volume of spaces, use of rooms and duration (life of building).

|           |   |
|-----------|---|
| Very poor |   |
| Poor      |   |
| Fair      | X |
| Good      |   |
| Very good |   |

2. When finalising the design, what is looked at?

Cost parameters play a major role, subsequent to that the material to be used and other components of the building are looked at such as the window sizes.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      |   |
| Fair      |   |
| Good      | X |
| Very good |   |

3. When providing specifications, what is looked at?

Cost is looked at in order not to go over budget, thereafter the availability of products, past experience is used to provide specifications. Input from engineers where required is received to provide specifications.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      |   |
| Fair      |   |
| Good      | X |
| Very good |   |



#### **Comments on green buildings**

- 4. What are your thoughts regarding green buildings in Gauteng, South Africa?**

**Green elements seem to be added on after the building is designed, very few buildings are designed around green systems, the systems have to be forced into the building. -The initial cost of erective systems stop clients from enforcing sustainable green buildings**



## ARCHITECTS

**Profession: Architect**

**Years of experience: 4**

Please answer the following questions and indicate (tick/cross) the degree to which green building criteria is incorporated into each phase in the *Design Development Stage* in projects in Gauteng, South Africa?

### Design

1. When developing the approved concept, what is looked at?

Maximize commercial returns/rentals, efficient planning, which is flexible to allow for different tenant requirements. Low maintenance and reduced electrical and water consumption. Green technologies only incorporated if the client requests elements or green star ratings. Subcontractors and consultants approached if required.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      |   |
| Fair      | X |
| Good      |   |
| Very good |   |

2. When finalising the design, what is looked at?

As specific tenant and project requirements become clear/finalized, additional items get considered. Normally green principles incorporated at this stage are system based and implemented in the hope of reducing planning costs.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      |   |
| Fair      | X |
| Good      |   |
| Very good |   |

3. When providing specifications, what is looked at?

Reliability, value for money, project budget and comparative performance and cost to industry standard specifications. The advantages of the green specification must be convincing and not to create additional design problems or hinder how the development is utilized by the user. Certain systems can be unconventional and misunderstood by the end user resulting in wasteful utilization of a particular product or system.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      |   |
| Fair      | X |
| Good      |   |
| Very good |   |



#### **Comments on green buildings**

- 4. What are your thoughts regarding green buildings in Gauteng, South Africa?**

**There is greater consideration for green buildings amongst new designers. The elder generation hinders the diffusion of green buildings within the industry.**



## ARCHITECTS

**Profession: Architect**

**Years of experience: 5**

Please answer the following questions and indicate (tick/cross) the degree to which green building criteria is incorporated into each phase in the *Design Development Stage* in projects in Gauteng, South Africa?

### Design

1. When developing the approved concept, what is looked at?

Identifying the problem and strategizing how the concept - herewith interpreted as an idea can be used to solve the problem.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      |   |
| Fair      | X |
| Good      |   |
| Very good |   |

2. When finalising the design, what is looked at?

Stakeholder satisfaction, does the design answer the problem.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      |   |
| Fair      |   |
| Good      | X |
| Very good |   |

3. When providing specifications, what is looked at?

An understanding of the product, whether the properties thereof are beneficial to the operation of the design.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      |   |
| Fair      | X |
| Good      |   |
| Very good |   |



#### **Comments on green buildings**

4. What are your thoughts regarding green buildings in Gauteng, South Africa?

**A growing phenomenon, however not adequately incorporated in projects.**

## **Appendix H: Quantity Surveyor Interviews**



## QUANTITY SURVEYORS

**Profession: Quantity Surveyor**

**Years of experience: 5**

Please answer the following questions and indicate (tick/cross) the degree to which green building criteria is incorporated into each phase in the *Design Development Stage* in projects in Gauteng, South Africa?

### Financial Planning

1. When producing cost plans, what is looked at?

You look at what the client wants in terms of design, layout, location, materials etc. Cost of materials, labour, inflation, considering how long the project will be as it influences cost, pre and post construction escalation, escalating project costs in relation to how long the project will be, contingencies, preliminaries, professional fees.

|           |   |
|-----------|---|
| Very poor | X |
| Poor      |   |
| Fair      |   |
| Good      |   |
| Very good |   |

2. When conducting financial viabilities, what is looked at?

The development cost, operating costs, income over the life of a property, debt and equity, the cash flow and thus the total capital outlay. The IRR, NPV, cap rate and return on investment is all looked at when determining the financial viability of a project.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      | X |
| Fair      |   |
| Good      |   |
| Very good |   |

### Project Programme

3. When developing programmes for projects, what is looked at?

Consideration of occupants e.g. Lecture hall, time constraint, availability of finance, at respondents place of work, 2 weeks minimum time frame given for tenders to be opened. Tender committee meetings, that ensure fraud, they have meetings every second week, have to make sure all documentation is signed by relevant stakeholders i.e. finance director, senior project manager and client. Public holidays need to be considered. Consultant gives time frame for duration of project. Main thing that affects project is getting approval, going to tender committee and when it's needed by.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      | X |
| Fair      |   |
| Good      |   |
| Very good |   |



#### **Comments on green buildings**

4. What are your thoughts regarding green buildings in Gauteng, South Africa?

**Respondent feels green buildings can only be implemented by large corporations as it is too expensive. It requires time and a paper trail, being able to recycle, small construction sites don't make enough waste to recycle e.g. painting walls for small projects. Benefits from green buildings are not worth it for small companies. Respondent feels knowledge in terms of implementation is limited in Gauteng. Misconception of what green buildings are, forget about economic factors. Its more long term and people want quick fixes, cheap now and think about it later. Respondent feels environment in Gauteng is conducive for green buildings as it is competitive, competition between companies pushes towards green buildings but only big companies. Large corporations benefit.**



## QUANTITY SURVEYORS

**Profession: Quantity Surveyor**

**Years of experience: 5**

Please answer the following questions and indicate (tick/cross) the degree to which green building criteria is incorporated into each phase in the *Design Development Stage* in projects in Gauteng, South Africa?

### Financial Planning

1. When producing cost plans, what is looked at?

The scope of work versus the budget is looked at to align with each other. Cost engineering where possible is implemented to provide value for projects. Alternative materials at lower cost that provide the same value is looked at and used where possible. Costs outside construction such as professional fees and preliminaries are taken into consideration.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      | X |
| Fair      |   |
| Good      |   |
| Very good |   |

2. When conducting financial viabilities, what is looked at?

The total capital outlay and revenue is looked at from the beginning of a project to operation to the disposal of the asset. The investment period, ROI, ROE, NPV, IRR, WACC and cap rate are all looked at to make a decision on the financial viability of a project.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      | X |
| Fair      |   |
| Good      |   |
| Very good |   |

### Project Programme

3. When developing programmes for projects, what is looked at?

The requirements to be adhered to such as health and safety are considered, the total anticipated duration of the project and milestone dates are broken down into activities. The surrounding works and the people that may be affected by the project is considered to mitigate inconvenience.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      | X |
| Fair      |   |
| Good      |   |
| Very good |   |



#### **Comments on green buildings**

4. What are your thoughts regarding green buildings in Gauteng, South Africa?

**The environment in Gauteng's construction industry does not stimulate "green" practices; consultants are aware of green buildings but not fully knowledgeable about how to integrate it into their services offered. Green buildings are still somewhat of a novelty in Gauteng, more initiatives are required to stimulate its diffusion into the construction industry. The extra cost of being "green" deters clients from wanting to go green, whereas the extra effort and services required to go "green" deters consultants from such practices.**



## QUANTITY SURVEYORS

**Profession: Quantity Surveyor**

**Years of experience: 4**

Please answer the following questions and indicate (tick/cross) the degree to which green building criteria is incorporated into each phase in the *Design Development Stage* in projects in Gauteng, South Africa?

### Financial Planning

1. When producing cost plans, what is looked at?

Detailed designs specifications, productivity output, sundry/ items, plants required, materials of items and labour costs are looked at when producing cost plans.

|           |   |
|-----------|---|
| Very poor | X |
| Poor      |   |
| Fair      |   |
| Good      |   |
| Very good |   |

2. When conducting financial viabilities, what is looked at?

Return on investment, project internal rate of return, weighted average cost of capital, positive net present value of the project, internal rate of return and the profitability index is all looked at when conducting financial viabilities.

|           |   |
|-----------|---|
| Very poor | X |
| Poor      |   |
| Fair      |   |
| Good      |   |
| Very good |   |

### Project Programme

3. When developing programmes for projects, what is looked at?

The critical path, procurement plan, the activity schedule, lead times, cash flows and network node are all looked at when developing programmes.

|           |   |
|-----------|---|
| Very poor | X |
| Poor      |   |
| Fair      |   |
| Good      |   |
| Very good |   |



#### **Comments on green buildings**

4. What are your thoughts regarding green buildings in Gauteng, South Africa?

**Green buildings are barely promoted in small construction practices which make it even more difficult for people (employees) to spend more time advancing their knowledge on green build projects. South Africa's construction industry has to address green buildings towards small-medium construction companies since the industry is comprised mostly of such practices. Until that happens, green buildings will only make sense to big companies whom their clients wants to meet green build criteria infrastructure and to score green build points.**



## QUANTITY SURVEYORS

**Profession: Quantity Surveyor**

**Years of experience: 6**

Please answer the following questions and indicate (tick/cross) the degree to which green building criteria is incorporated into each phase in the *Design Development Stage* in projects in Gauteng, South Africa?

### Financial Planning

1. When producing cost plans, what is looked at?

Drawings provided by designers are used to determine anticipated construction costs. Costs outside construction are then determined to develop the anticipated costs to be incurred on the project as a whole.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      | X |
| Fair      |   |
| Good      |   |
| Very good |   |

2. When conducting financial viabilities, what is looked at?

Life cycle cost versus the income returns is used as a basis to determine the viability of a project.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      | X |
| Fair      |   |
| Good      |   |
| Very good |   |

### Project Programme

3. When developing programmes for projects, what is looked at?

The time frame given for the project to be completed provides the framework in which to fit the project programme.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      | X |
| Fair      |   |
| Good      |   |
| Very good |   |



#### **Comments on green buildings**

4. What are your thoughts regarding green buildings in Gauteng, South Africa?

**Green buildings are still new in the industry and require time to become the standard for buildings constructed in Gauteng.**



## QUANTITY SURVEYORS

**Profession: Quantity Surveyor**

**Years of experience: 3**

Please answer the following questions and indicate (tick/cross) the degree to which green building criteria is incorporated into each phase in the *Design Development Stage* in projects in Gauteng, South Africa?

### Financial Planning

1. When producing cost plans, what is looked at?

When producing cost plans one looks at the designs and its subsequent systems and components, the cost of each component is priced, costs are built based on the required material, labour, normal waste and the contractors profit in line with the current state of the economy i.e. in a recession profit margins are low where as in an economic boom profit is high.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      | X |
| Fair      |   |
| Good      |   |
| Very good |   |

2. When conducting financial viabilities, what is looked at?

When conducting financial viabilities, all costs are built up and investigated from a micro -level to a macro -level to determine total capital outlay over the course of a development, depending on the nature of the development i.e. will the building be sold upon completion or will it be kept by the client with the intention to receive an income stream, the return on investment is calculated.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      | X |
| Fair      |   |
| Good      |   |
| Very good |   |

### Project Programme

3. When developing programmes for projects, what is looked at?

When developing programmes time constraints and required resources to complete a project are looked and planned accordingly to fit the scope of the project.

|           |   |
|-----------|---|
| Very poor |   |
| Poor      | X |
| Fair      |   |
| Good      |   |
| Very good |   |



#### **Comments on green buildings**

4. What are your thoughts regarding green buildings in Gauteng, South Africa?

**Green buildings are still a novelty in South Africa and implemented more so by larger organizations.**