



**EFFECTIVE STRATEGY FOR CONSTRUCTION MATERIALS PROCUREMENT  
DURING CONSTRUCTION TOWARDS THE ENHANCEMENT OF SUSTAINABLE  
BUILDING PRODUCTION IN WESTERN CAPE, SOUTH AFRICA**

**BY**

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In the Faculty of Engineering  
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## **DECLARATION**

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## ABSTRACT

Sustainable buildings are structures produced to meet the present housing needs of a society without compromising the ability of the future generation to meet their future needs. Based on the findings derived from the reviewed literature, the production process and the operational lifecycle of sustainable buildings promote a healthy well-being for the inhabitants and environmental balance through the effective management of energy, water, land and materials resources at every stage of construction. However, ineffective construction materials procurement strategy was found in literature as a major factor that constrains the production of sustainable buildings; leading to project failures or production cost and time overrun. Thus, the production cost of sustainable buildings is influenced by the total cost of construction materials acquisition, which amounts to about 65% of the total cost of building production. This factor on cost has over the years been a significant barrier to the adoption of sustainable building principles in the construction industry. This prompted the need to establish an effective strategy for construction materials procurement towards the enhancement of sustainable building production in Western Cape, South Africa.

The research study adopted a mixed methodological approach, which involved the use of semi-structured qualitative interviews and closed-ended quantitative questionnaires administered to construction stakeholders (contractors and consultants) in the Western Cape Province of South Africa. SPSS version 23 software was used to analyse the quantitative data collected and ‘content analysis’ method was used to analyse the information collected through qualitative interview conducted.

The research findings affirmed that for effective materials usage towards the enhancement of sustainable construction the following factors should be considered: enforcing the adoption of the Green Building Council of South Africa (GBCSA) policy, evaluating the Life-cycle analysis (LCA) process of materials proposed for use, adopting the principles of Sustainable Assessment Criteria (SAC) for proper materials analysis and selection. More-so, the research asserted the need for the availability of materials proposed for the sustainable building construction in market; effective strategic planning before procurement at design stage of building construction and to facilitate effective materials usage towards the enhancement of sustainable building production, there is a need for timely delivery of construction materials to site, and adequate project planning at inception of sustainable building designs is also

found to be essential. In addition, the research findings confirmed that, despite the high initial cost of Electronic Materials Procurement Technology strategy (EMPTs), the EMPTs is found to be most effective and cost-efficient for materials procurement as compared with the Traditional Materials Procurement strategy (TMPs). Among the paramount factors that significantly affect the effectiveness of materials procurement strategies implementation are: level of corruption in the government, lack of long term perception on sustainable procurement implementation by the Government and the effect of inadequate flow of finance from the client.

The study concluded that proper consideration of these findings, by construction stakeholders in the private and public sectors of the industry, would enhance the production of sustainable buildings with production cost-efficiency and expected benefits of the building.

This research study recommends, among other issues, the need of ‘comparative cost – benefit analysis of Electronic Materials Procurement Technology strategy (EMPTs) and Traditional Materials Procurement strategy (TMPs) during sustainable building production, in the South African construction industry.

**Keywords:** Construction materials, Construction stakeholders, Electronic materials procurement, Government procurement policies, Materials procurement strategies, Sustainable building production, Traditional materials procurement.

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## **DEDICATION**

I completely without any reservations dedicate this thesis to God Almighty, who saw me through the hurdles of the program and made adequate provisions for my sustenance.

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## LIST OF ABBREVIATIONS AND GLOSSARY OF TERMS

<b>BBBEEA:</b>	Broad-Based Black Economic Empowerment
<b>CIB:</b>	Conseil International du Batiment
<b>CIDB:</b>	Construction Industry Development Board
<b>EICT</b>	Electronic Information and Communication Technology
<b>EIT:</b>	Electronic Internet Technology
<b>EMPTs:</b>	Electronic Materials Procurement Technology Strategy
<b>GBCSA:</b>	Green Building Council of South Africa
<b>GPC:</b>	Government Procurement Cycle
<b>ISO:</b>	International Organisation of Standardization
<b>PFMA:</b>	Public Finance Management Act
<b>PMBOK:</b>	Project Management Body of Knowledge
<b>PPPFA:</b>	Preference Procurement Policy Framework Act
<b>SABS:</b>	South African Bureau of Standards
<b>SAC:</b>	Sustainable Assessment Criteria
<b>SMMEs:</b>	Small, Medium and Micro Enterprises
<b>SPSS:</b>	Statistical Package for Social Science
<b>TBL</b>	Triple Bottom Line
<b>TMPs:</b>	Traditional Materials Procurement Strategy
<b>WCED:</b>	World Commission on Environment and Development
<b>4Ms:</b>	Money, Manpower, Machine and Materials
<b>4Rs:</b>	Renewable, Reusable, Recyclable and Reduction

## LIST OF PUBLICATIONS

Articles published during this research study:

**Fapohunda, J.A., Ganiyu, B.O., Nicholson, A., and Solanke, B.H. 2015,** *Cost and Benefits Analysis of Sustainable Building Production in Western Cape Province, South Africa*, 9<sup>th</sup> Built Environment Conference, Association of Schools of Construction Southern Africa, 31 May-2 June, 2015, Durban, South Africa.

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# CHAPTER ONE

## INTRODUCTION

### 1.1 Chapter Introduction

The concept of sustainability has gained massive attention in the construction industry over the past decades, (Asif, Bruijn, Fisscher & Steenhuis, 2008). Sustainability is aimed at achieving a balance in ecological, social and economic activities, minimizing the impact of construction on the environmental and social aspect of living, and in the process, maximising economic advantages (Hediger, 1999). Similarly, Asif *et al.* (2008) described sustainability as the ability to meet present needs of stakeholders without impelling the future quality of life due to excessive use of environmental resources, social impact and profit losses in a region or country.

However, a sustainable building is a structure whose process of construction and life-cycle of operation promotes healthy well-being of the inhabitants and environmental balance by considering the use of energy, water, land and materials resources at every stage (U.S Green Building Council, 2012; Watermeyer, 2012). Thus, to achieve sustainable building, it is essential to put into consideration the different principles of sustainability from the design stage to ensure adequate use of construction materials through the implementation of effective procurement strategy. The process of achieving sustainable buildings through materials procurement strategies requires appropriate steps in minimising the negative impacts of building production on the environment, society and economy (Miller, Furneaux, Davis, Love & O'Donnell, 2009). Therefore, the construction professionals and technologies required for effective materials acquisition at the lowest possible rate for a sustainable building project delivery is of necessity.

The effective construction materials procurement strategy is a holistic process of purchasing materials at the most satisfactory quality, cost and time (Kong, Li, & Love, 2001). Thus, the effective process of purchasing is essential for contractors to remain competitive in the industry. Kasim, Anumba and Dainty (2006) added that project performance is influenced by improper materials procurement and management on sites, which affects the delivery time of projects to a large extent. Pourrostan and Ismail (2011); Sambasivan and Soon (2007) amongst several other researchers stated that poor project performance and project failures in

both private and public sectors are caused by delayed project financing and payments, ineffective materials procurement strategy, poor contractor and consultant management, as well as, poor technical performance, price fluctuation, labour and equipment availability, change of scope, weather conditions and poor communication system. Failure in managing and organising purchases will significantly result in materials' wastages, profit losses, project delay, time overrun and inadequate administrative procedures (Canter, 1993). Hence, a more integrated materials procurement process is required (Kasim *et al.*, 2006).

Construction Procurement Best Practice Guideline #A2 (CIDB 2007) cited in (Mathonsi, & Thwala, 2012a) noted that procurement in South Africa as a developing country is guided by the utilisation of the procedures and standards set for procurement systems regulated by the government through various legislations. Thus, this research study investigates the practice of materials procurement; possible challenges faced during procurement and seek to establish an effective strategy towards achieving an improved sustainable building in South Africa.

## **1.2 Background of Study**

### **1.2.1 Procurement in the construction industry in context.**

The history of procurement is dated back to the 1800s where it was considered as a clerical function of purchasing (Leenders, Fearon, Flynn & Johnson, 2002). Since the 1970s, research has shown that procurement is an administrative advantage in organisations (Ammer, 1974). Although, procurement was later reviewed and adopted in the 1980s as a strategic function of purchasing and competitive force (Porter, 1980). Various researchers (Stuckhart, 1995; Miller *et al.*, 2009; Cheung, Chan & Kajewski, 2010) notably viewed procurement as a comprehensive process of acquiring materials, equipment and other resources required in delivering a project sustainably. Masterman (1996) further described procurement as organisational strategies put together to identify how a project (depending on the client) can be delivered without glitches, taking into account the risks and constraints of delivering the project.

Therefore, procurement strategy can be seen as a process of commissioning professional services, either within the procuring organisation or externally, to relate with and meet stakeholders' requirements (Pawel *et al.*, 2012). These strategies are steps and choices made

to achieve the value for money invested and at the same time the objectives of the project (Anthony, 2013; Government general procurement guide, 2003).

The construction industry as described by the National Construction Council of Tanzania (NCC) is one of the major sectors that have visible impact on the economy, which in turn, influences the sustainable development of a society and country at large (NCC, 2003). The Brundtland, and Mansour (1987) further explained that the sustainability can be defined as the ability to meet the current needs of humans in a region using the available resources', without jeopardising the ability to meet the needs of future generations. Furthermore, the knowledge of this definition can be applied also in the production of sustainable buildings. Therefore, building sustainability is a process of producing structures which create a balance between environmental, social and economic sustainability by using environment friendly and resource-efficient processes towards achieving set project objectives (Du Plessis, 2002; Florez, Castro, & Irizarry, 2013).

The project objectives are formed from series of choices made with the aim of satisfying stakeholders' needs. Project objectives can be further divided into primary objectives (budget, quality, rate of delivery, user satisfaction, maintenance and operation) and secondary objectives (promotion of construction technologies, environmentally-friendly building materials, sustainable development and reduction of poverty) towards sustainable project delivery (Watermeyer, 2004; Watermeyer, 2012). Berth (2011) stated that the adoption effective materials procurement strategy in gathering and organizing sustainable construction materials, ideas and techniques' from trusted sources at every stage of construction would enhance the possibility of meeting the objectives of the building project, at the same time, this ensures the sustainability of the building.

### **1.2.2 Construction materials procurement**

Construction materials procurement strategy is an array of steps or methods implemented in achieving project objectives and value for money invested, taking into consideration risk and project constraints (Watermeyer, 2012). Kasim *et al.* (2006) stated that depending on the construction project, the cost of construction materials acquisition is assumed to an amount between 40-70% of the total cost of construction. Khyomesh and Vyas (2011) added that the costs of materials procurement are significantly influenced by various factors such as: improper materials handling and management on site during construction production

processes. As a result, materials procurement strategies have been observed to influence the quality, time and socio-economic sustainability of the project. Construction materials procurement as defined by Nogueron, Laestadius, Lawson, MeadWestvaco, McIntyre and Mendiluce (2011) is the process of purchasing materials and services required for construction projects taking into consideration the cost implication, environmental impact, social impact and managerial skills required through the lifecycle of the building.

In a study, Andraw, Roger, George and David (1998) proposed that the utilisation of materials procurement strategies aids in achieving orderliness and avoids materials wastages on construction sites. Literature review states that materials wastages on construction sites are as a result of excessive purchase of materials, prolonged storages, materials abandonment and unclear design specifications during production. Thus, it is of high essence that material resources are managed properly to reduce wastes, achieve timely project delivery at the budgeted cost and quality.

Research has shown that delays in project deliveries have resulted in client and contractor disputes, litigations and project abandonment, cost and time over-run. Kasim *et al.* (2006) in their individual studies, stated that the adoption of effective procurement strategy - especially in acquiring materials - will ensure project success and clients' satisfaction. However, Linden and Josephson (2013) posited that the process of selecting the most appropriate procurement strategy for materials acquisition in a project primarily been a source of concern to the contractor.

In the context of this study, materials procurement strategy is sub-divided into two categories: traditional materials procurement strategy and electronic materials procurement technology strategy. The strategies are used by the contractor or site engineer to estimate and acquire the total value of materials required for the completion of any project.

#### **1.2.2.1 Traditional materials procurement strategy (TMPs)**

The traditional construction materials procurement strategy is the oldest and most commonly used procurement strategy by consultants and contractors in the construction industry. This procurement strategy has shown some advantages and disadvantages over the years during procuring processes such as quotations, purchase ordering and material requisitions. In a study, Kong, Li, Hung, Shi, Lacouture & Skibniewski (2004) highlighted that the traditional system of materials procurement, which is a paper-based system, obligates the contractors to



search for construction materials through paper catalogues provided by the suppliers and to contact the suppliers to place orders. The Construction Industry Development Board (CIDB) in its practice note No.23 stated that the traditional materials procurement approach during construction is most functional when the design and other associated documents are completed adequately before contractors are invited to tender (CIDB, 2010).

Figure 1.1 illustrates the typical process of traditional materials procurement from the receipt of tender document to the delivery of the materials on site. Noteworthy, each phase in theory is separate and distinct in operation (Walker, Hampson & Peters, 2000). However, the major limitations of the traditional materials procurement system are geographical time zones, availability of products and suppliers' information, as well as data computing error, due to the transference of details from paper to digital format (Angeles & Nath, 2007).

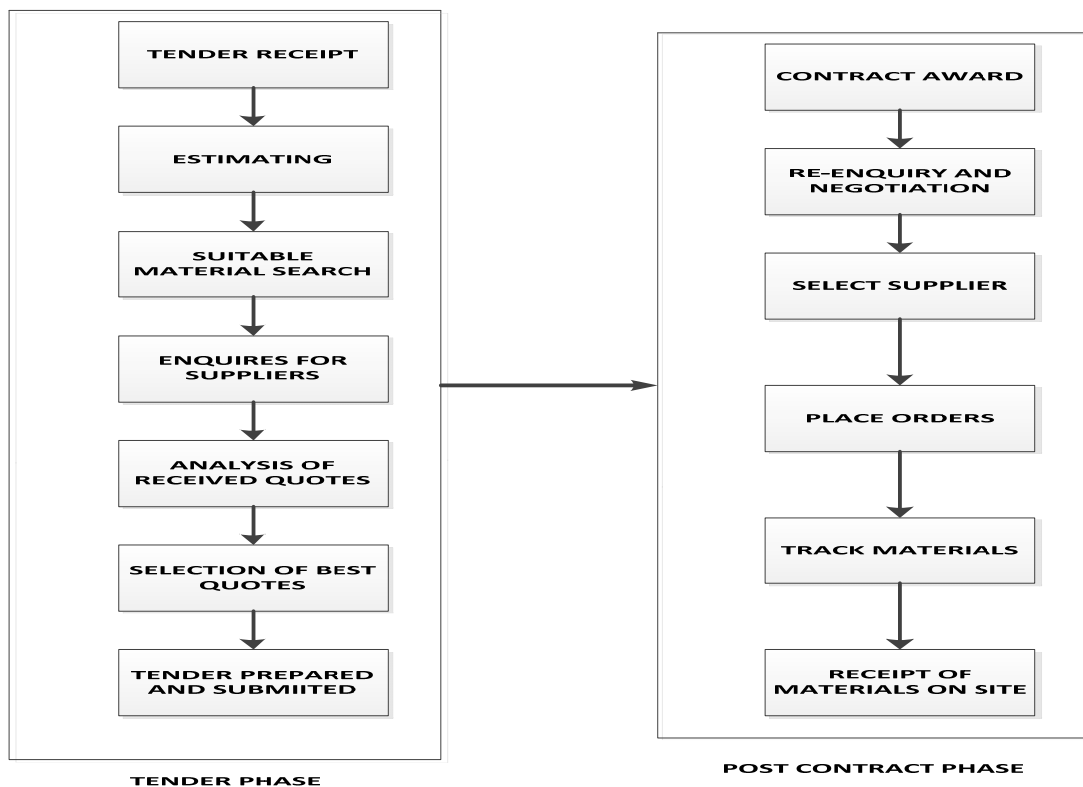


Figure 1.1 Traditional construction materials procurement process (Adzroe & Goulding, 2004)

### 1.2.2.2 Internet based material procurement strategy

In recent times, the construction industry has been confirmed to be in an era of high speed downloads and immediate gratification (Kaelbe, 2001). Contractors and consultants have been reported to be pressured by clients to deliver projects on time, budget and within shorter time

frames to gain quick value on investments (Kasim *et al.*, 2006; Watermeyer, 2012). The tendency for projects to be managed using the fast-track approach in an attempt to reduce project time schedule and production cost has been concealed (Alarcon, Rivas & Serpell, 1999; Ren, 2011). The emergence of internet technology has aided the exchange of materials information electronically, at a relatively low cost and fast-track approach (Kong *et al.*, 2004). As a result, some construction companies have adopted the Internet-based electronic procurement (e-procurement) system to communicate directly with the material manufacturers, suppliers and agents for materials purchase (Ren, 2011).

According to Grilo and Jardim-Goncalves (2011) and Panayiotou *et al.* (2004) e-procurement is described as the use of Internet technologies to enhance the day-to-day business activities of a company in purchasing and payment of goods and services. E-procurement is said to create a solution for materials procurement using non-traditional methods and which is an advantage to construction materials procurement participants (Kong *et al.*, 2001). E-procurement provides an expanded market place where buyers and suppliers can communicate directly. Thus, it gives room for better negotiation of contract price, minimising cost and time-cycle of project production, which gives the contractor a competitive advantage (Cheng, Li, Love & Irani, 2001; Florez, Castro, & Irizarry, 2013).

### **1.2.3 Impact of Government policies on materials procurement implementation**

In recent years, the system of procurement in the South African construction industry is not a new practice; to an extent, it has been implemented and researched on in decades. The industry as reported by Ramabodu (2013) shows that South Africa adopted the traditional procurement system in the early '80s based on the British model which is not effective today due to system overturn. The traditional procurement system was reformed in 1994 and mandated to improve the standard of construction procurement practices in line with the government procurement policy (CIDB, 2005b). Procurement in South Africa, presently, as a policy tool was implemented as a result of the discriminatory and unfair practices during apartheid (Bolton, 2006). Subsequently, Anthony (2013) highlighted Section 217 of the Constitution of the Republic as the standard for government procurement in South Africa.

The government procurement policies were issued by the government as a statement of commitment to standardise construction materials procurement system which directly or indirectly impacts the ecological, economic and social well-being of South Africans now and

the future. Section 217(1) of the 1996 Constitution states that procurement system must be in accordance with a set of standards embedded on 5 pillars: value for money, equity, fair dealing, accountability, open and effective competitions as authorised by the Public Finance Management Act, 1999 for effective sustainable procurement in South Africa.

Sustainable procurement in this context is the process of achieving sustainable development objectives (Walker & Brammer, 2012). Government boards, Acts and councils have been established to enforce these authorised laws, guidelines and promote standardisation of procurement processes in the construction industry (City of Cape Town Smart Building Handbook, 2012). These government bodies include: Green Building Council of South Africa (GBCSA), Sustainable Buildings Industry Council (SBIC), Black Economic Empowerment (BEE), South African National Standards (SANS), Small, Medium and Micro Enterprises (SMMEs) etc. This statement was supported by Bowen, Pearl and Akintoye (2007) who stated that government legislations, policies and Acts were enacted to redefine the social contract between government and its citizens by reconstructing and transforming the construction industry through government established strategies (e.g. Growth, Employment and Redistribution (GEAR) strategy).

Thus, for effective procurement in South Africa, contractors and consultants must be registered and certified by any of the government established councils, boards, organisations and institutions based on their designation and statues for practice eligibility in the industry (Anthony, 2013).

#### **1.2.4 Stakeholders impact on construction materials procurement**

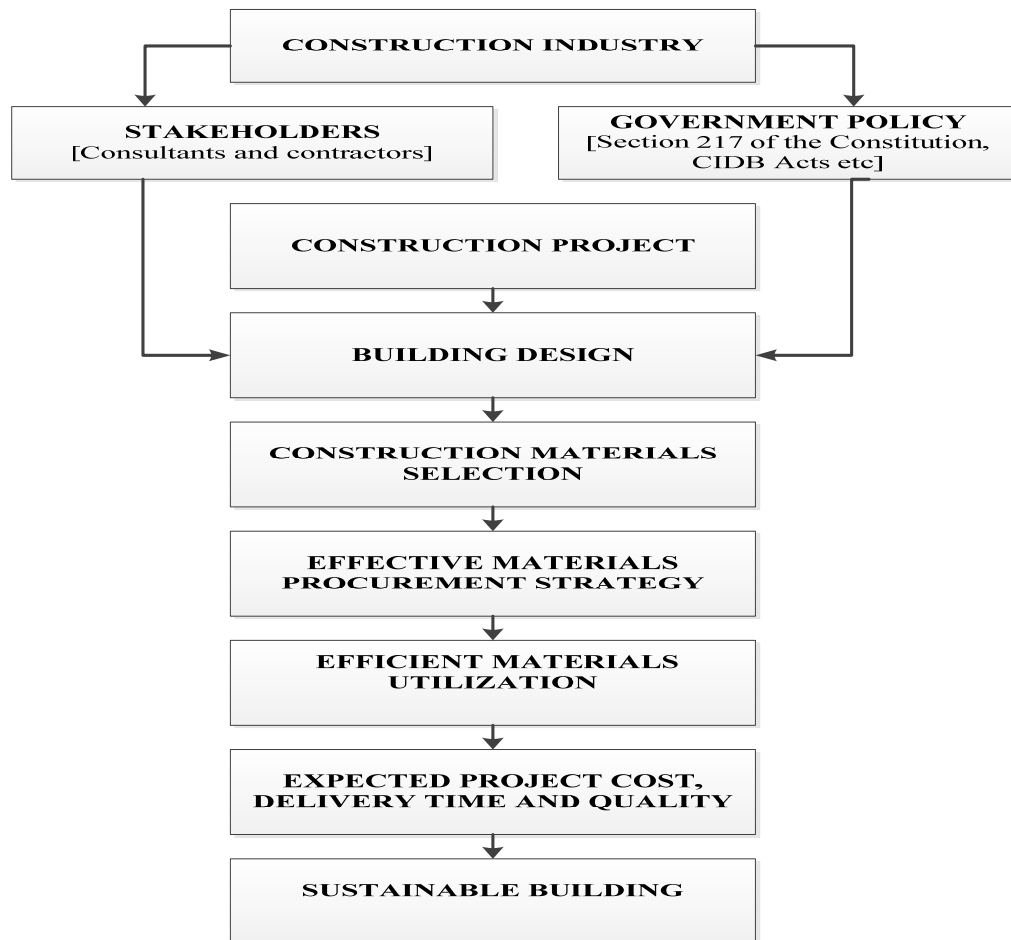
The construction stakeholder(s) is a person or group of persons who has/have acknowledged their interest in the success of a project in the environment where it is being produced (McElroy & Mills, 2000; Khalfan, Maqsood & Noor, 2011). The stakeholders become threats to the project in a long run, if their needs are not met or put into consideration (Gibson, 2000). The views and reactions of the stakeholders (project owner, project management organisation, construction team, design team and many others) in any project from the design stage to the operational stage will affect the materials procurement strategy to be implemented before and during construction (Olander & Landin, 2005). In agreement to this statement, Mensassa and Baer (2014) mentioned that acknowledging the needs and requirements of the stakeholders from the design stage will influence the overall cost, time schedule and usefulness of the

project to a large extent. The project owner(s), in some cases the end-user as described by the Chinese Construction Project Management System (CPMS) is one of the most important stakeholders' in-relation to other stakeholders in the construction project (Chen & Partington, 2004a). Thus, stakeholders have a remarkable impact on materials procurement and project success.

Research shows that providing sustainable building creates a balance in a region environmentally, socially and economically to improve its quality of living (Asif *et al.*, 2008; Khalfan *et al.*, 2011). Procurement strategies implemented influences the building production process and the success of the project at large. The efforts of construction practitioner to improve the production processes to meet high construction demands within time, cost and quality constraints and also contribute to economic growth, depending on the effective ability to manage available resources.

This study considers sustainable construction, materials procurement strategies, project management skills, traditional construction materials procurement method, electronic materials procurement method (e-procurement) and stakeholders' impact on materials procurement, with the aim of establishing the effectiveness of the available procurement strategies for materials acquisition towards the enhancement of producing buildings that meet the needs of the present generation for a reliable future.

The conceptual framework for the study is illustrated in Figure 1.2



**Figure 1.2: Conceptual framework**

Figure 1.2 shows that in order to commence on a construction project, the impact of government policies and construction stakeholders influences the building design and the selection of materials required for construction. From the figure, the delivery of sustainable buildings at expected time, cost and quality is dependent on the effectiveness of the materials procurement system and the utilisation of the available construction materials. The figure also shows that the impact of building design and materials selection influences the effectiveness of the procurement strategy to be implemented.

### **1.3 Background of the Problem**

Sustainable building is a concept of sustainability that has gained global attention over the years. The concept is aimed directly at producing buildings, where the process of construction and life-cycle of operation, promotes a better quality of living for the inhabitants over a long period of time, putting into consideration the use of energy, water, land and material resources

at every stage of construction. However, the construction industry is challenged with the inability to meet these pressing demands effectively due to poor materials procurement/management strategies used on sites during building production (kasim *et al.*, 2006). Arguably, materials selection and procurement challenges are influenced by delays in construction design, production schedules, lack of standardised procurement strategy, fluctuation cost of materials, poor communication network and resource specification based on quantity and quality (Alarcon *et al.*, 1999; Khyomesh & Vyas 2011; Ambe & Weiss, 2012b).

Notably, materials selection significantly impacts on the green certification of any building as it is realised by using the most appropriate materials for construction (Florez, Castro & Irizarry, 2010). However, achieving sustainability during building construction can be jeopardised by selecting and procuring inappropriate construction materials for production (Ljungberg, 2007). Thus, to bridge these production gaps, materials selection and procurement challenges would be evaluated in compliance with South African government procurement policy and bearing in mind clients' satisfaction for an improved materials procurement management technique within construction constraints. Hence, the study seeks to develop an effective materials procurement strategy that aids structured and unstructured materials selection and purchasing methods for construction materials in conformity with the principles of sustainability for an efficient building performance.

## **1.4 Aim and Objectives**

### **1.4.1 Aim**

This study is aimed at establishing an effective materials procurement strategy to enhance the production of sustainable buildings in the Western Cape province of South Africa.

### **1.4.2 Objectives**

The objectives of this study are:

1. To evaluate the concept of sustainability in the South African construction industry as regards materials usage during building construction.
2. To analyse the effectiveness of materials procurement strategies in the construction industry.

3. To identify the impact of government policies on materials procurement strategies implementation.
4. To ascertain the impact of stakeholders on materials procurement before and during construction processes.
5. To establish an effective materials procurement strategy that will enhance sustainable building production processes.

## **1.5 Research Questions**

*How can construction materials procurement be made more effective towards enhancing sustainable building production in the Western Cape Province?*

### **Research investigative sub-questions:**

1. What are the strategies in use as regards materials usage towards attaining sustainable buildings?
2. How effective are the various materials procurement strategies available if explored for successful project delivery in the construction industry?
3. To what extent do government policies influence the implementation of materials procurement strategies in the provision of sustainable building?
4. How does stakeholders' factor facilitate optimum materials procurement towards sustainable construction?
5. What approach can be effectively adopted for materials procurement strategies towards enhancing sustainable building production processes in South Africa?

Table 1.1 illustrates the relationship between research objectives, research questions and the research methodology to be adopted in the course of study.

## **1.6 Significance of Research**

With the aim of developing an effective strategy for construction materials procurement to achieve building sustainability, it is believed that the findings and recommendations of this research, when implemented in the construction industry will enhance the system of sustainable construction materials procurement towards achieving a healthy built environment using resource-efficient based principles all through the life-cycle of buildings.

Literature revealed that effective production of sustainable building depends significantly on efficient materials utilisation which emanates from adequate procurement system. Hence, the need for an improved materials management during production processes cannot be over emphasised. Improved materials procurement strategies have been reported to enhance the sustainable production of buildings which impacts on the value of humans in that region. Noteworthy, the success of every construction project is measured by the rate at which the project is delivered on time, within budgeted cost, in good quality and to clients' satisfaction. Therefore, developing an effective procurement strategy for construction materials is not only necessary to enhance sustainable building production processes, but will enhance the reduction in resource wastages, effective cost estimation, timely project delivery and stakeholders' satisfaction.

The strategy will be useful to construction material suppliers' for product advertisement, categorised and comprehensive detail display of the products or materials (product number, description and product cost) and will create room for supplier-customer interactions. This strategy will also benefit the contractor and project managers by enhancing good and quality materials selections and estimations, fast supplier selection and price negotiation and proper materials tracking to facilitate timely project completion. The research will also add to the body of knowledge in the field of sustainable building production.

**Table 1.1 Relationship between research objectives, research questions and research methods.**

<b>RESEARCH OBJECTIVES.</b>	<b>RESEARCH QUESTIONS.</b>	<b>RESEARCH METHODS.</b>
To evaluate the concept of sustainability in the South African construction industry as regards materials usage during building construction	What are the strategies in use as regards material usage for attaining a sustainable building?	Review of relevant literature and analysis of questionnaires and Interviews.
To analyse the effectiveness of materials procurement strategies in the construction industry.	How effective are the various materials procurement strategies available if explored for successful project delivery in the construction industry?	Review of relevant literature and analysis of questionnaires and Interviews.
To identify the impact of government policies on materials procurement strategies implementation.	To what extent do government policies influence the implementation of materials procurement strategies in the provision of sustainable building?	Review of relevant literature and analysis of questionnaires and Interviews.
To ascertain the impact of stakeholders on materials procurement before and during	How does materials procurement strategies implementation influence user-satisfaction and value for money in a long term?	Review of relevant literature and analysis of questionnaires and



construction processes.

To establish an effective materials procurement strategy that will enhance sustainable building production processes.

What approach can be effectively adopted for materials procurement strategies towards enhancing sustainable building production processes in South Africa?

Interviews.

Review of relevant literature, analysis of questionnaires and Interviews.

## **1.7 Research Methodology and Design**

A preliminary pilot study will be conducted by administering questionnaires to construction practitioners' (target groups) to investigate and identify the present overwhelming procurement challenges in industries in the Western Cape of South Africa. The pilot study focuses on construction materials procurement strategies, construction stakeholders' involvement and the impact of government policies on the system of materials procurement. The pilot study will aid the formulation of the research questions and objectives for a precise and modified questionnaire for a thorough investigation in the main study.

### **1.7.1 Research method and design**

Leedy and Ormrod (2010) indicated that the research method and design adopted in a research determines its originality and eventually the success of the research work. Research methods and designs are patterns by which data collections and analysis will be carried out from a broad span of assumptions (Clark, Creswell, Green, & Shope, 2008). The research design may be qualitative, quantitative or a combination of the two (Creswell, Klassen, Plano Clark, & Smith, 2011). The mixed method research approach combines several research methods within paradigms (for instance, mixed qualitative method) or across paradigms (quantitative and qualitative methods) for data collection (Clark *et al.*, 2008).

This research evaluates the present materials procurement strategies being used in the construction industry and its level of effectiveness for sustainable building production, as well as the impact of construction stakeholders on the strategy to be implemented for materials procurement. The constitution of South Africa will also be evaluated to understand the policies guiding the implementation of procurement in the South African construction industries. This is aimed at establishing a more functional materials procurement strategy to guide and assist procurement participants in quality materials selections and estimations, fast supplier selection, price negotiation and proper material tracking to facilitate timely project completion, as well as achieving the aim of the study. A mixed research design is therefore

deemed appropriate for this research study. The approach will be a “quantitative and qualitative survey”, as this helps in studying a phenomenon through a thorough analysis of randomly selected samples from the target population. The sample may be a group of individuals, community, region or any other strata in the population (Biggam, 2011). Some construction industries in the Western Cape Province will be selected as “samples” for the research study.

### **1.7.2 Data collection and sampling methods**

The triangulation data collection technique will be considered for this research study. This methodology was chosen because the data analysis triangulation technique solves a research problem using various data collection methods rather than one (Clark *et al.*, 2008).

The methodology proposed for data collection will be based on three (3) elements using the following techniques:

1. Literature reviews: the literature review will comprise of exclusive reviews on previous relevant research works, text-books, journals and articles. The data collected are identified as the secondary data.
2. Structured quantitative questionnaire surveys: the primary data will be collected using structured close-ended questionnaires.
3. Qualitative interviews: the qualitative research method emphasises on the in-depth aspect of the findings.

### **1.7.3 Sampling technique**

**Cluster sampling technique:** The principal target population is construction professionals and private clients/end-users within the Western Cape Province. The cluster sampling involves breaking down the target population into clusters or strata from which samples are randomly selected for data collection (Biggam, 2011).

### **1.7.4 Method of data analysis**

Data analysis includes data testing, tabulating, categorising and examination of results to address the purpose of a study (Yin, 2003). Quantitative data will be analysed using a generic

software package, known as the Statistical Package for Social Science (SPSS). The Likert scale is used to determine the range of respondent's agreement or disagreement to statements on a ranking of 1-4. Data gathered from questionnaires will be analysed using the descriptive statistics.

The translational validation test, such as the content analysis, will be used to analyse the qualitative data gathered and each interview will be transcribed and checked for accuracy for respondent validation. Reliability test of the data collected will be tested using the "Cronbach's Alpha" test.

## 1.8 Scope and Limitations



Figure 1.3: Cities and towns in Western Cape, South Africa (Google map, 2014).

This study takes into account the processes and procedures involved in materials procurement in the construction industry. It seeks to identify an effective strategy in achieving an improved sustainable building in South Africa, as well as investigates possible limitations.

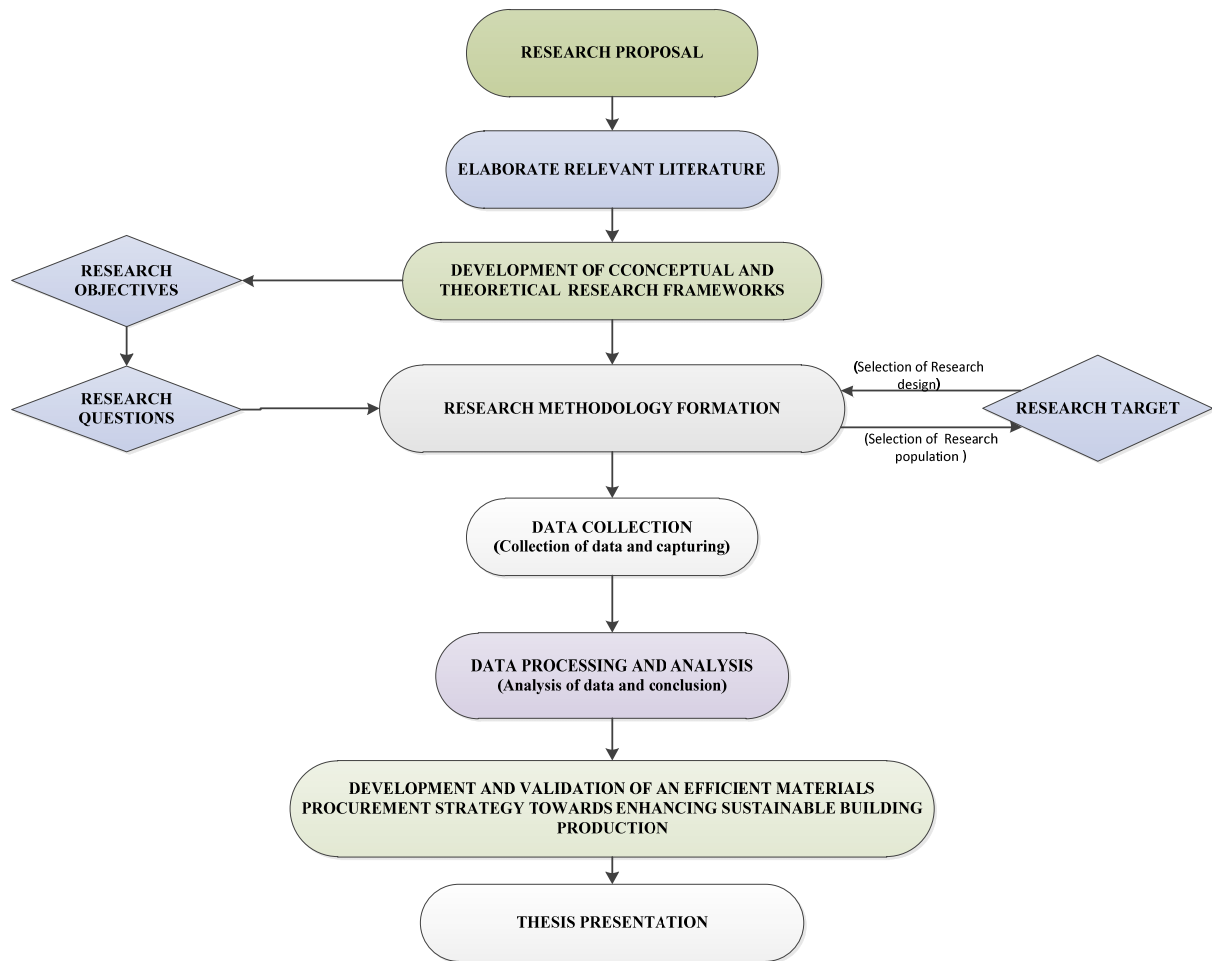
The field survey and data collection is restricted to construction companies in the Western Cape Province.

## **1.9 Key Assumptions for Data Collection**

This study assumes as follows:

- Construction companies selected will allow access to their various sites for the collection of data during the survey.
- Selected construction companies are confronted with challenges in materials procurement on their various sites. This is to show that selected respondents' are qualified and experienced practitioners in construction industry, whose judgments on issues of construction materials procurements can be reliable.
- Questionnaires to be administered are designed to ask the relevant questions in relation to the challenges faced presently in the industry based on the information derived from reviewed literature in correlation with objectives of the study.
- Research targets will provide relevant information to justify the study objectives and research questions. The validity and reliability of the survey tool were tested to significantly determine the probability of obtaining relevant data in drawing meaningful conclusion at the end of the study.

The research is structured as shown in Figure 1.4



**Figure 1.4: Research framework.**

### 1.10 Ethical Considerations

The names of participating organisations and individuals will be left anonymous on research documents; this complies with ethical standards accepted internationally. Research participants will not be paid or compensated for their participation. The quality of research is based on qualitative and quantitative questionnaires and data, general conduct and interviewer’s level of competence.

### 1.11 Definition of Terms

1. **Project Success:** The process of balancing construction constraints of cost, time, quality, as well as satisfying the stakeholders’ expectations.

2. **Procurement Strategy:** These are fundamental procedures by which the objectives including contract and sub-contract arrangements of the project are attained for the design, construction, operation and maintenance phases of the building project.
3. **E-procurement:** This is the use of Internet technologies platforms to facilitate and manage strategic daily business activities of sourcing, selecting and purchasing of goods and services.
4. **Construction materials procurement:** The process of sourcing, purchasing and payment for materials which involves the tendering, contracting and pricing (negotiation) phases required for a complete project delivery and establishing a mutual relationship between suppliers and buyers.
5. **Sustainable buildings:** These are cost effective buildings that have the ability to serve the users for a long time. The process of constructing these buildings from the design phase, construction, operation and maintenance promotes a healthy environment, minimise redesign and materials wastages.

## **1.12 Thesis Organisation**

This thesis will be structured as follows:

### **Chapter One: Introduction**

The introductory chapter will comprise the background of study, statement of problem, research questions and objectives, methodology, limitations, preliminary literature review, key concept, significance of study and chapter outline.

### **Chapter Two: Literature review**

The literature review will emphasise on previous works of different researchers related to this study. The literature will be obtained in textbooks, articles, journals and dissertation affiliated with sustainable development and materials procurement efficiency.

### **Chapter Three: Research methodology.**

This chapter describes the method implemented to achieve the research aim and objectives. It further discusses the research design, target, data collection tools and administration pattern, method of analysis and reliability of the study.

**Chapter Four: Analysis of exploratory study**

The analysis of the pilot study will be presented in this chapter.

**Chapter Five: Analysis and discussion of data gathered for main study**

The analysis and interpretation of data collected will be discussed in this chapter.

**Chapter Six: Summary, Conclusion and Recommendation.**

This chapter presents summary of findings, conclusions and recommendations.

**1.13 Chapter Summary**

This chapter provides an overview of what is to be achieved in the research study. The background, research aim, objectives, research questions, significances, scope and limitations, literature review and methodology of the research study were briefly discussed. The subsequent chapters will elaborate on the literature review, research methodology, analysis and discussion of results, conclusions and recommendations derived from the research.

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

The literature review encompasses the concept and impact of construction materials management on sustainable building construction and the concept of procurement in South Africa. Also, the scope of materials procurement in the construction industry for stakeholders' satisfaction is considered in this chapter.

The roles and impacts of government policy on the implementation of procurement strategies, and the criteria for contractor and supplier selection based on these policies, will be reviewed. Over the years, the construction industry is characterised by its use of complex construction technique, poor materials procurement and management strategies and poor workmanship which has led to the unskillfulness of numerous contractors and consultants in the industry (Mbachu & Nkando, 2007). However, despite these complexities, the construction industry is reported to be a major contributor to the sustainable development of the society, adding to the gross national product (GNP), as it has the capacity to employ a large number of the population (Enshassi, Mohamed & Abushaban, 2009; Osec 2010).

To attain project success, Donyavi and Flanagan (2009) conceded that proper management of construction materials during construction should be made paramount to the project manager. Kasim (2011:31) added that the acquisition of construction materials determines the cost and quality of the construction project, as it claims approximately 40-70% of the total working capital of the project. Conversely, the construction industry in its present state is barely focused on materials management efficiency and effectiveness improvement. Thus, in an effort to improve materials procurement efficiency during sustainable buildings construction, a rigorous review of the basic factors affecting materials procurement, and possible solutions to any problems, will be discussed later in this chapter.

#### **2.2 South African Construction Industry**

The South African construction industry contributes immensely to the economic growth of the country, as it plays a vital role the socio-economic advancement of the society (Statistics South Africa [Stats SA], 2010: Online). The Construction Industry Development Board



(CIDB) shared in a status report in 2004 that construction industry on a global platform accounts for over 15% of the world's economy (CIDB, 2004a: Online). In South Africa, the construction industry approximately accounts for 8.6% of the gross domestic income (GDI) and contributes over 35% to the gross fixed capital formation (GFCF) of the country (CIDB, 2004a: Online). Bowen *et al.*, (2007) affirmed that this was attained through the provision of employment to over 2million skilled workers. To buttress this, the South African Statistics' Quarterly Labour Force Survey (SASQLFS) reported that as a result of creating jobs in both the Building and Civil sector of the construction industry, there has been a drastic increase in the GDI of the industry with over two hundred and sixty-eight million rand (R268 million) between 2007 and 2011 (Statistics,2012). Therefore, this report construes that the construction industry is a dynamic driver of the socio-economic development in South Africa (Windapo & Cattell, 2013).

However, despite the advantages ascribed to the construction sector, Son, Kim, Chong and Chou (2011) stressed that the construction sector is a major contributor to the unsustainable development of most civic societies. This could be attributed to the unplanned rapid population growth, industrialisation, urbanisation and the unruly use of natural resources (Son *et al.* 2011). Thus, the cases of rapid environmental deterioration and gradual socio-economic collapse have been a huge source concern in the construction industry. This resulted to the adoption of sustainability in building construction as a possible solution.

### **2.3 Sustainable Building Construction**

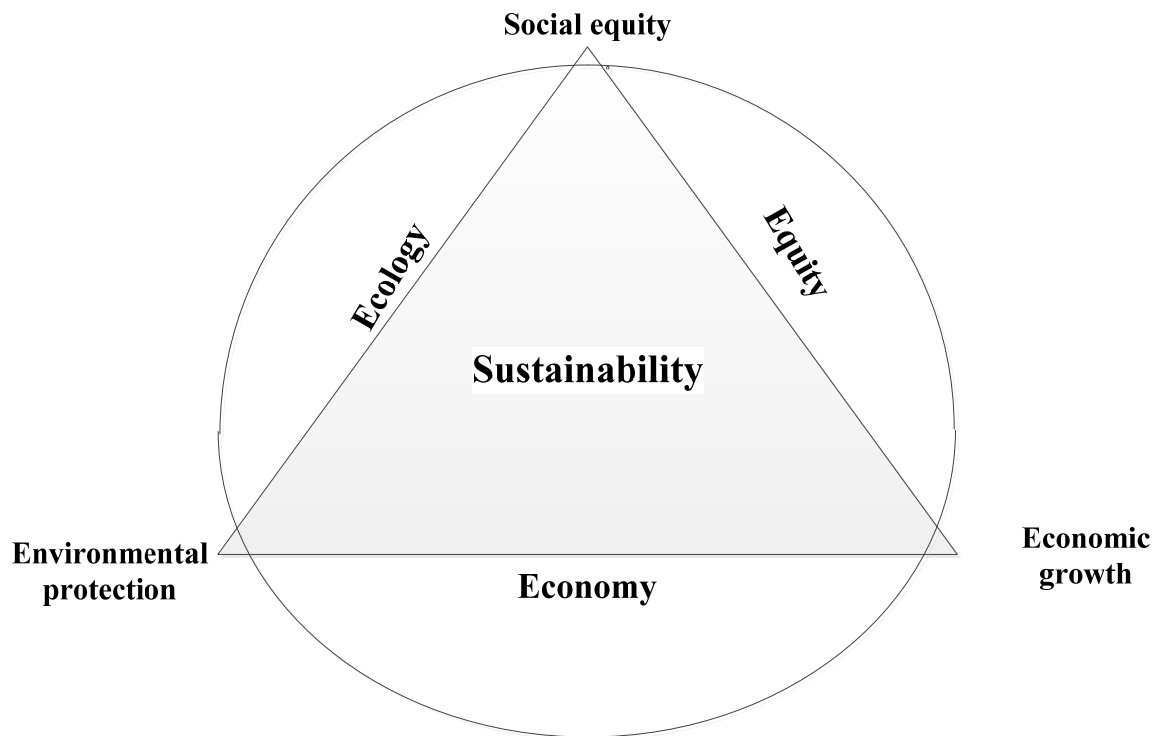
The term sustainable building is a composition of two highly complex concepts - 'sustainable' and 'building'. Thus, it is impossible to simply defined sustainable building as a building that is sustainable without separately defining and understanding the driving concepts (knowing the 'for whom', 'how' and 'why') of sustainable building (Bakhtiar, Shen & Misnan, 2008).

Brundtland, and Mansour (1987) in a report publication referred to as the "Brundtland report", clearly stated a comprehensive definition of sustainability as 'the ability to meet the present needs without compromising the ability of the future generations to meet their own needs' (cited in Hill & Bowen, 1997:224; Du Plessis 2007:70). Subsequently, in agreement with the "Brundtland report", various authors such as Hediger (1999); Asif *et al.* (2008); Segalas,

Ferrer-balas and Mulder (2010), have defined sustainability in their individual research works in line with this landmark definition. Thus, the Brundtland definition has become the most internationally accepted definition among researchers.

From the late 1980s, till date, the concept of sustainability has been a major research focus as it has a reoccurring impact on the existence of the human race (Kibert, 2007). Thus, the essence of sustainability in every aspect of the human life (economic, social & environmental) cannot be over emphasized as every choice and action made in the present affects the future. This concept is known as the 'Triple Bottom Line' or the 'Three Pillars of Sustainability' (Asif, Brujin, Fisser & Steenhuis, 2008; Khalfan, Maqsood & Noor, 2011; Sourani & Sohali, 2011).

The triple bottom line (TBL) is a framework used in measuring the ecological, equity and economic impact of a product on the quality of human existence as regards product performance, as illustrated in Figure 2.1, (Ljungberg, 2007). From Figure 2.1, it was observed that in attaining sustainability, optimum balance between the environmental, social and economic factors are required during construction operations. Arguably, Hill and Bowen (1997) proposed a 'Four Pillar sustainability model' against the originally formed model by Barbier (1987). The Authors included technological factors as the fourth pillar of sustainable construction principle.



**Figure 2.1: The Triple bottom line Framework (Adapted from Ljungberg, 2007:468).**

Figure 2.2 illustrates the relationship between humans, their environment, economy, society and technology which is well supported in literature by other researchers such as: Du Plessis, (2007); Bakhtiar, Shen and Misnan (2008); Son *et al.* (2011). Hill and Bowen (1997) in figure 2.2 highlighted the acceptability and relevance of each pillar to any construction projects. The Conseil International du Batiment (CIB) cited in (Kibert, 2008) further proposed seven criteria of sustainability as a guide (checklist) to construction stakeholders at every phase of construction and through the lifecycle of the building, they are:

1. Reducing resource consumption;
2. Reusing resources;
3. Recyclable resources usage;
4. Nature protection;
5. Eliminating toxics;
6. Applying life-cycle costing;
7. Quality management.

Significantly, Hill and Bowen (1997) opined that implementing these guiding criteria may seem infeasible to meet the immediate priorities of the contractors but should not be disregarded at any point in time. However, the decision on which criterion or set of criteria to implement in a particular construction project depends on the construction stakeholders. Thus, the adoption of Kibert's proposed criteria in building construction towards the achievement of sustainability is paramount.

## PROCESS-ORIENTED PRINCIPLES OF SUSTAINABLE CONSTRUCTION

Over-arching principles indicating approaches to be followed in evaluating the applicability and importance of each 'pillar' and its associated principles, to a particular project.

- Promote interdisciplinary collaborations and multi-stakeholder partnerships
- Comply with relevant legislation and regulations
- Exercise prudence
- Identify synergies between the environment and development
- Manage activities through the setting of targets, monitoring, evaluation, feedback and self-regulation of progress
- Utilize a system approach

### **PILLAR 1: SOCIAL SUSTAINABILITY**

- Improve the quality of human life, including poverty alleviation
- Promotes and protects human health through a healthy and safe working environment.
- Implement skills training and capacity enhancement of staff members.
- Seeks fair distribution of social costs of construction.
- Seeks equitable distribution of the social benefits of building constructions.
- Seeks intergenerational equality

### **PILLAR 3: ENVIRONMENTAL SUSTAINABILITY**

- Maximize resource reuse, and/or recycling
- Use renewable resources in preference to non-renewable resources
- Create a healthy, non-toxic environment
- Maintain and restore the Earth's vitality and ecological diversity
- Minimize damage to sensitive landscapes, including scenic, cultural, historical and architectural
- Reduce the use of generic resources used during construction

### **PILLAR 2: ECONOMIC SUSTAINABILITY**

- Ensures financial affordability for intended beneficiaries
- Promotes employment creation and labour intensive construction
- Enhance competitiveness in the market place by adopting policies and practices that advance sustainability
- Choose environmentally responsible suppliers and contractors
- Invest some proceeds from the use of non-renewable resources in social and human-made capital, to maintain the capacity to meet the needs of future generations

### **PILLAR 4: TECHNICAL SUSTAINABILITY**

- Humanize larger buildings so that individuals can control the indoor environment
- Construct durable, reliable and functional structures
- Use serviceability to promote sustainable construction
- Pursue quality in creating the built environment
- Infill and revitalize existing urban infrastructure with a focus on rebuilding mixed-use pedestrian neighborhoods

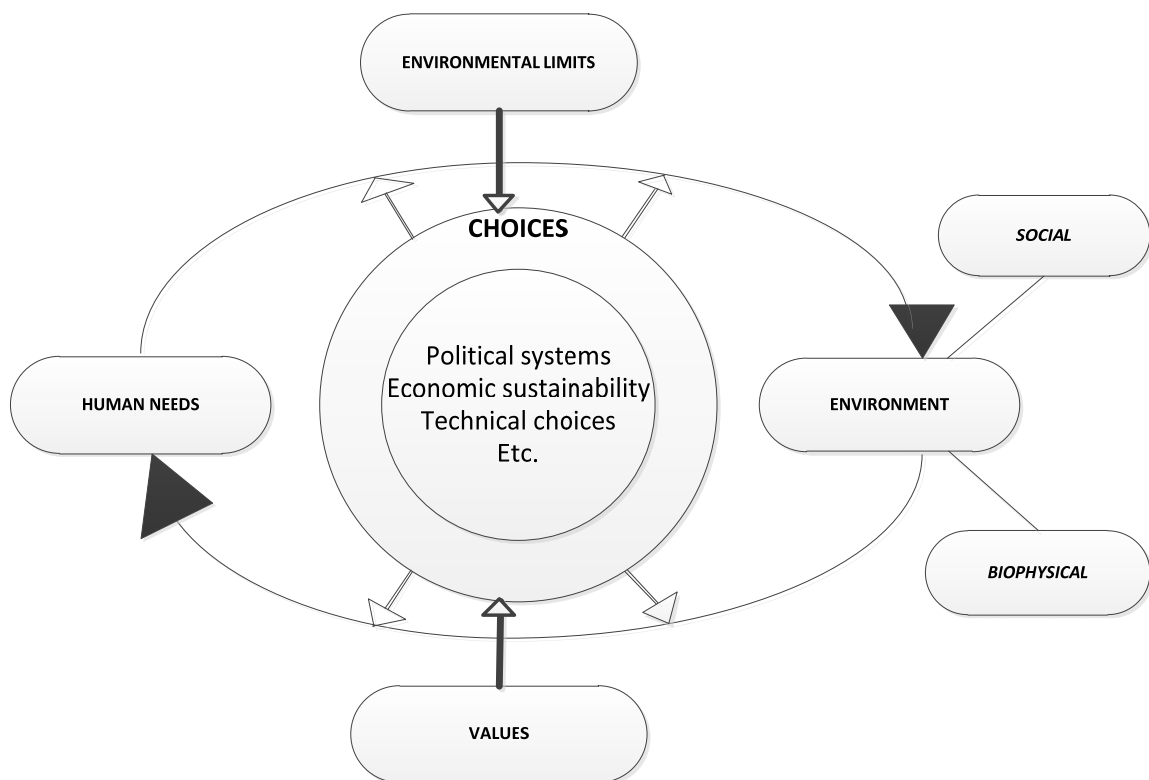
**Figure 2.2: Principles of sustainable construction (Adapted from Hill & Bowen, 1997:228; Ashley *et al* 2003:49)**

In a report by Sourani and Sohali (2011), a few publications reveal that sustainability in building construction is influenced by other dimensions' aside technical, social, economic and environmental sustainability. These dimensions include: cultural sustainability (CIB, 1999); community sustainability and managerial sustainability (Ofori, 1998). However, in the context of the South African construction industry, the 'four pillar model', which focuses on the social, economic, technical and environmental sustainability, is feasibly functional (O'Riordan, 1998). Sustainability in the South African Construction industry is being adopted to socially improve the quality of human existence (seeking for intergenerational equality, implementing skills training and capacity enhancement programs); ensure financial security to the citizens (promote job creation, enhance competitiveness amongst suppliers and constructors and also maintain the capacity to satisfy the needs of the future generation); to environmentally abate air, land and water pollution (maximize construction materials resource reuse, recycling and the use of renewable materials). Technical sustainability was adopted to ensure the construct of durable, reliable and functional structures towards quality built environment establishment and rejuvenation. According to Harman (2007) "*Changing the way we build, produce energy and make technology more efficient must go hand in hand with the changes in behaviour and life style...*" .

Therefore, sustainability in building construction is an integral part of sustainable development and it is holistically aimed at restoring or maintaining a balance between the natural and built environment to create a settlement that adds value to human dignity and enhance economic equity (Du Plessis, 2005; Osec 2010; CIDB 2010). Sustainable buildings according to Yudelson (2010:19) are buildings architected and constructed to reduce negative environmental impacts and improve the health status of the habitat through the rational use of water, land and energy. In essence, sustainability in building construction interprets and manages the needs of humans (Stakeholders) in relation to their social and biophysical environment without exceeding judicious environmental limits (as described in Figure 2.3) to promote the values of the stakeholders (Du Plessis, 2007; Isa, Alias & Abdul Samad, 2014). Furthermore, Sourani and Sohali (2010) comprehensively described sustainable building construction as a process of achieving a balance between the social, economic environmental and technical aspect of construction in order to optimise time, quality and cost benefits during and after construction. Therefore, to improve the possibility of achieving sustainability in buildings, the criterion to be met in compliance with other relevant specifications and

Government policies posited by Maxwell and Van der Vorst (2003) cited in Ljungberg (2007:468) are as follows:

1. Building functionality and structural demands
2. Minimum environmental impact
3. Maximum social and economic impact
4. Technical feasibility
5. Social, economic and environmental impact
6. Market demands
7. Government legislation and policy
8. The building should be of standard quality and should meet stakeholders' requirements.



**Figure 2.3: Relational model for sustainable construction (Adapted from Du Plessis, 2007:70)**

Noteworthy, the criteria highlighted by Ljungberg (2007) can only be achieved if considered at the 'planning phase' of the building project. The planning phase prior to the commencement of any construction project is opined by researchers as the most important phase in managing and organising the life-cycle of a building (Zwikael, 2009; Isa *et al.*,

2014). To buttress this, Reyes, San-José, Cuadrado, and Sancibrian (2014) added that the process of incorporating sustainability into the processes of building production is entirely dependent on the strategic consideration of sustainable factors at the planning phase. Thus, at the conceptual phase of a construction project, stakeholders are mandated to decide on sustainable project goals to attain sustainability standards in building production. Hence, the success ratings of any building are expressively a corollary of the planning process towards project delivery.

In South Africa, the government in past years has shown commitments to developing sustainable buildings in the country as a bid to remedy the problems of the Rural-Urban migration. In 2010, a resolution was made to retrofit over 106,000 buildings and about 100 buildings have already been completed in the Western Cape and Free State Provinces (Osec 2010). To this effect, in an effort to facilitate this dream, various policies, Acts and regulations have been designed and enacted into constitution. These include: Standard for buildings and construction in South Africa (SANS), National Environmental Management Act (NEMA), National Building Regulations and Building Standard Act 103, South African Bureau of Standards (SABS) (Osec 2010; Anthony, 2013).

Literature revealed that there has been a general misconception on the operations of sustainable buildings among researchers. The concept of sustainability in building construction have been constrained to the aspects of energy efficiency, zero net waste on construction sites, earth protection and workforce efficiency improvement (Ahmad & Abdul-Ghani, 2011; Akadiri, Chinyio & Olomolaiye, 2012; Vucicevic, Jovanovic, Afganb & Turanjanin, 2014). Conversely, Ljungberg (2007) stated that the sustainability level of a building, which is measurable using a Life Cycle Assessment tool (LCA), depends on the quality of materials used construction or maintenance. In agreement, Walker-Morison, Grant and McAlister (2007) added that construction sustainability is a system driven by materials utilisation. Walker-morison *et al.* (2007) further stated that sustainability in building production is effectively measured when the available materials are utilized efficiently to reduce construction cost, material wastes and environmental pollution. Thus, achieving sustainability in building construction using the life-cycle assessment as a standard of evaluation proffers an improved quality of living for the inhabitants (Vatalis, Manoliadis, Charalampides, Platias & Savvidis 2013). Consequently, adequate understanding of sustainability, materials management which involves materials selection and procurement



during building construction are focus areas for sustainable building realisation in the Western Cape Province of South Africa.

## **2.4 Construction Materials**

Construction materials are a collection of materials incorporated into buildings or structures at any stage or phase of construction (Samarasinghe, Tookey, Rotimi & Thiruchelvam 2012). In attaining project success and stakeholders' satisfaction, it has been argued by some researchers that the construction workforce is most relevant in reinforcing sustainability in the construction industry (Yankov & Kleiner, 2001; Kilby & McCabe 2008; Fien, & Winfree 2014). However, Donyavi and Flanagan (2011) noted that for reduced construction cost; increased productivity; quality and timely project delivery, materials management efficiency must be a top priority. In affirmation, Karana, Hekkert and Kandachar (2010) stated that adequate use of the construction materials determines the strength, functionality and quality of the building, regardless of the expertise involved in the building construction process. Thus, construction materials play a vital role in workforce and machinery productivity (Song, Haas, & Caldas, 2006). Hence, the importance of construction materials in sustainable building production cannot be underestimated.

### **2.4.1 Role of materials in sustainable building construction**

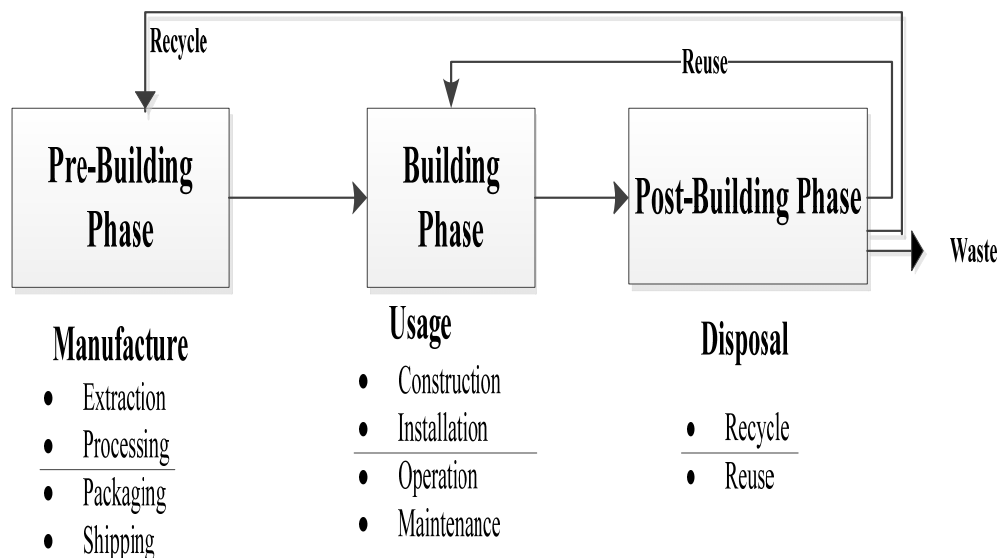
The basic roles of materials in sustainable building production are: safety and functionality (Bhattacharjee, 2010). This infers that the construction materials used in building production influences the performance, durability, reliability and aesthetical values of the building. Harrison (2006:113) buttressed that the choice of materials used construction is a key to sustainability which affects other relevant properties to sustainability, such as: building weight, chemical emissions, thermal comfort and waste management. Economically, the cost of construction materials acquisition directly determines the total value of the building as it claims 40-70% of the production cost (Harrison, 2006; Samarasinghe *et al.*, 2012; Donyavi & Flanagan, 2009; Kasim, Liwan, Shamsuddin, Zainal & Kamaruddin, 2012).

Ljungberg (2007) and Karana *et al.* (2010) stated that the sustainability of a building is dependent on the life-cycle assessment ratings at every phase of building construction. According to Kim and Rigdon (1998), the building construction phases can be categorised as itemised below, (in order to analyse the life-cycle of materials to ensure sustainability):

1. Pre-building phase;

2. Building;
3. Post-building phase

As illustrated in Figure 2.4, the pre-building phase describes the extraction, manufacturing, packaging and the delivery of materials required for construction. In procession, the building and post-building phase are as a result of decisions made in the pre-building phase, which basically comprises of the construction, use/maintenance and waste disposal (recycle or reuse) stage. This implies that construction materials in the second and third phase are likely to be sustainable but the first phase may cause a negative impact to the environment during extraction if not properly managed (Ljungberg, 2007).



**Figure 2.4: The building materials Life-cycle Phases (Adapted from Kim and Rigdon, 1998:8)**

Shakantu, Tookey and Chileshe (2007), further stated that about 50% of the materials used in the construction industry are extracts of the earth's crust which influences the sustenance of the environment. Hence, the process of materials extraction, processing and usage are vital in attaining sustainability as well as client satisfaction (Florez, Castro & Irizarry 2010:2). Consequently, the quality of materials used for construction facilitates the functionality (aesthetics, health enhancement, use of space) and the safety (structure, reliability, durability) of the building (Karana *et.al*, 2010:2933). Thus, the materials selection phase is of essence and should not be approached reluctantly during construction.

#### **2.4.2 Materials Selection System for Sustainable Building Construction.**

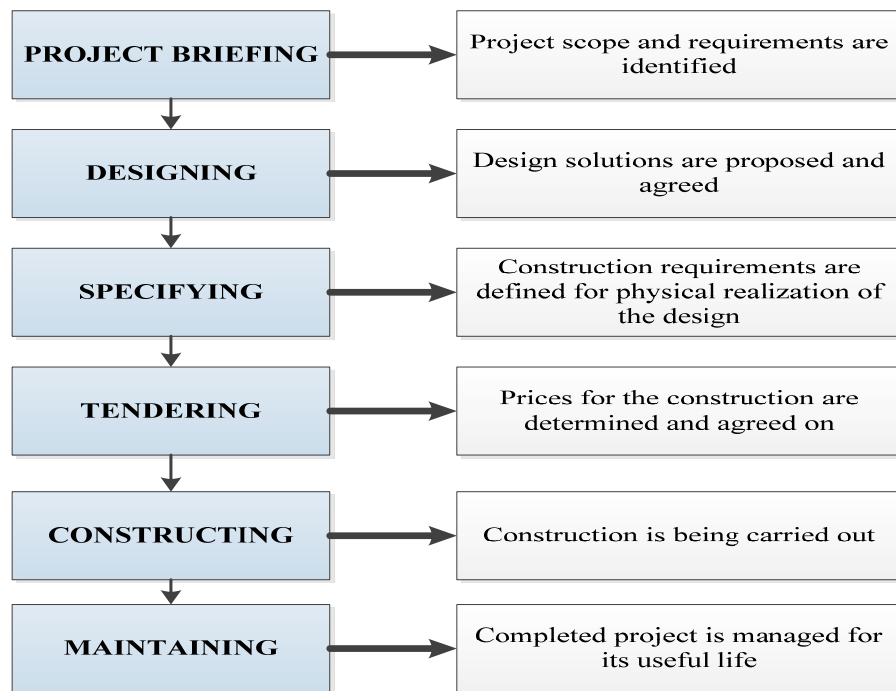
The campaign for sustainable building construction has drastically increased as its impact on the environment with significant social and economic benefits has been generally recognized in the construction industry (Fapohunda, Ogunsanmi, & Fatokun, 2011; Florez *et al.*, 2013). To achieve these benefits, it is essential to note that buildings are characterised by the materials used in its construction and should be selected in conformity with principles of sustainability (Abeysundara, Babel, & Gheewala, 2009). As a result, the practical strategies on how to reduce the impact of building materials usage are a source of concern. Materials selection in sustainable building production is defined as the process of choosing materials that suit the design criteria such as function, shape, cost, cultural aspects of the building (Karana *et.al*, 2010). In addition, careful selection of materials required for construction promotes effortless introduction of sustainable principles during building production by the project team. Hence, materials selection for construction is a vital phase in determining the physical, functional and structural attributes of the building. To buttress this, Kibert (2012:7) posed the following principles as guidelines for materials selection towards achieving sustainability in buildings:

- environmental impact;
- market demands/ trend;
- materials lifecycle cost;
- functional and structural demands;
- dematerialisation in design;
- socio-economic impacts;
- materials efficiency ( use of renewable and recyclable materials);
- building design;
- technological impact;

Abeysundara *et al.* (2009) further highlighted cost, functionality, social issues, aesthetics, density, temperature stability, material strength and durability as attributes considered to influence the selection of materials. Hence, the careful selection of environmentally, socially or economically suitable materials is a swift approach of incorporating the principles of sustainability in buildings. This cannot be done without carefully understanding the processes

of a construction project. Azmy (2012) proposed in Figure 2.5, six (6) possible phases of a construction project for efficient project management and site coordination.

Figure 2.5 illustrates the processes of large construction projects, which commences at the project briefing phase. In this phase of construction, necessary design decisions based on stakeholders' requirements are made. Thereafter, design and construction professionals deemed suitable to meet the requirements of the project are selected. The third, fourth and fifth phases describe the design process from the conceptual design to the working design prepared based on project requirements. Alongside, suitable contractors and materials suppliers are selected and awarded contracts through bids prepared according to design requirements for the construction/finishing phase before it is commission and occupied. The sixth phase signifies the commencement of maintenance works on the completed project to sustain the lifespan of the building.



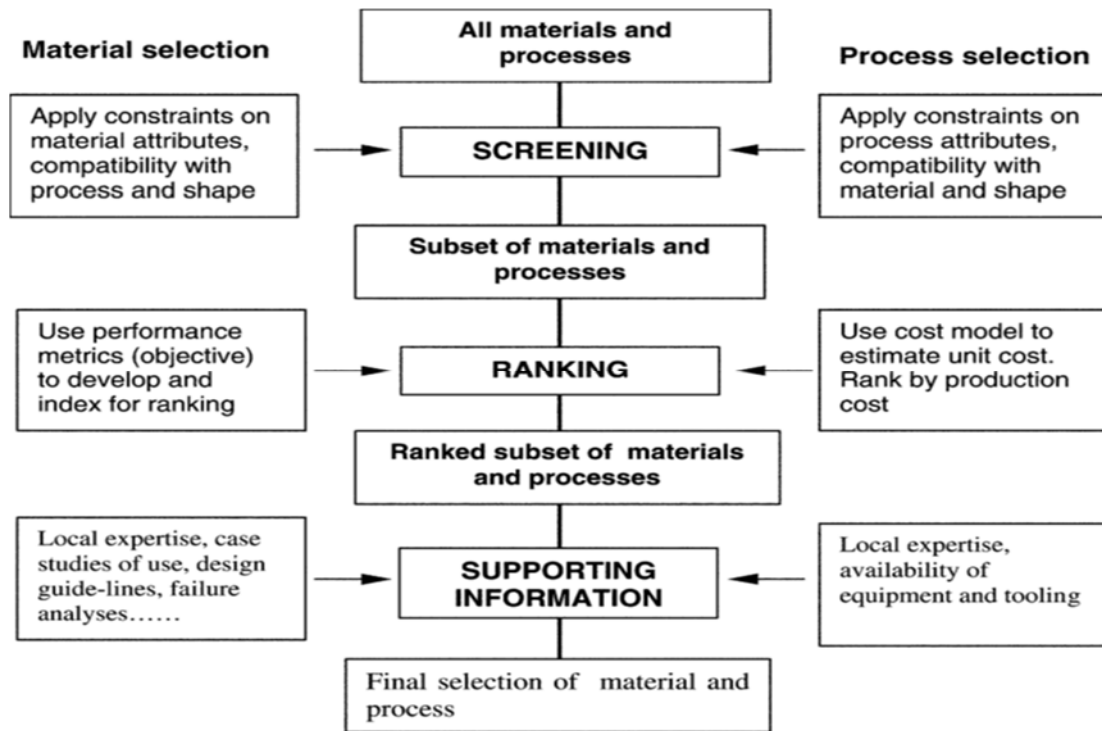
**Figure 2.5: Generic phases in the construction project (Adapted from Azmy, 2012:15).**

The identification and selection of materials at the conceptual design stage enables the designers or engineers develop a feasible plan in achieving the specified design, structural and functional requirements of a building using the best available materials (Deng & Edwards, 2007; Rao, 2008). Thus, selecting materials with specific properties from a set of similar materials to meet design requirements is no negotiable (Karana, Hekkert & Kandachar, 2010).

However, as a result of materials diversity and increasing innovations in construction, designers and engineers are at a high risk of becoming out-dated in the knowledge of available materials and their functional properties (Ramalhete, Senos & Aguar, 2010). According to Ashby, Shercliff and Cebon (2013), the evolution of materials in the last ten (10) decades show the dependent relationship of project initiations on materials and technologies availability. Remarkably, over 200,000 materials are presently available to the engineer for construction, which has made the selection of appropriate and environmentally friendly materials challenging at every phase of construction (Ashby *et al.*, 2013).

In practice, the conventional (traditional) method of materials selection, such as the use of catalogues, paper-based requisitions or the door to doors sourcing of materials, is inadequate for rational decision making. However, an electronic materials search based on a cumulative materials database will be most suitable for the sourcing and acquisition operation. The electronic materials selection method is a more standard and systematic approach, which aids the designers in the search and selection of materials that meet design requirements (Ramalhete *et al.*, 2010). This system poses to be effective in making sustainable choices during materials procurement (Ramalhete *et al.*, 2010).

Ashby, Brechet, Cebon and Saivo (2004) explicitly explained the steps of materials selection in Figure 2.6, highlighting the relevance of design and construction constraints, materials information and the availability of local expertise at every phase of the construction project. The authors buttressed that the process of materials selection is carried out to ensure that design requirements and materials constraints are complied with. Noteworthy, these design requirements or constraints known as “*design metrics*” are often considered at the screening stage of selection to appropriately determine compactable materials based on the design specifications provided.



**Figure 2.6: Stages of materials selection in design and during construction (Adapted from Ashby *et al.*, 2004:56)**

Notably, the design metrics identified in Figure 2.6 are the basic factors for materials ranking to select appropriate materials that best suits design requirements and construction standards (Deng & Edwards, 2007). In agreement, Ashby *et al.* (2004) struck a parallelism between the design concepts, choice of materials selection methods and the properties of the materials required depending on the phase of the construction project. Thereafter, Ashby *et al.* (2007b) developed an improved strategy for materials selection which can be implemented on databases allowing a larger population of materials for selection. This proposed strategy involved 4 basic tasks in making rational decisions:

1. Translating design requirements into prescriptions for materials selection (constraints, functions and objectives).
2. Screening all related materials using the constraints to identify and eliminate materials that are not fit for the job (functional requirement) from materials databases.
3. Ranking the available screened materials based on the ‘Green Star Rating system’ to identify materials that best fit the job description. This is done by using materials indices.
4. Explore the top rated materials by collecting more information about these materials. This helps narrow the shortlist to a final material choice.

Ramalhete *et al.* (2010) buttressed that the effective use of databases and software in enhancing decision-making depends on a proper understanding of the functionality of the search tool. Thus, the knowledge of materials search formats such as: material name; class and subclass of materials; name of suppliers; ecological factors; general classification (keywords) and material properties are significant for optimum use of selection tools (Ramalhete *et al.*, 2010). Due to this drastic change in materials selection and procurement, it is essential for the design team to be well-updated on innovative advancement in materials selection and purchasing.

In addition, Dehn, Mark and Peter (2002:online) and Ashby and Bream (2014:online) postulated that the use of materials software and databases such as ‘EcoSmart materials’, ‘MatWeb’, ‘Cambridge Engineering Selector (CES)’, ‘Materials Connexion’ for materials selection are effective in solving design problems towards sustainable construction. Although, it is often found that some materials whose properties’ are similar have different material names (Ramalhete *et al.*, 2010). This could be as a result of scientific designation or technical dysfunctions, marketing strategies put up by some database companies. Despite all these drawbacks, digital selection tools compared to other selection tools have doubtlessly enhanced the process of materials selection in meeting the design requirements economically with minimal environmental impacts at every phase of construction (Laryea & Ibem, 2014).

### **2.4.3 Materials Utilisation and Wastages**

Materials procurement management is being recognised academically and industrially as an integral section of construction. According to Song *et al.* (2006), materials procurement management in construction projects, especially large and complex project, guarantees proper management of available funds and materials (at the right place, time and quantity). As a result, materials wastages due to excessive purchase of materials, long materials storages and unclear design specifications will be drastically minimised. In addition, the implementation of this management strategy also ensures timely project delivery, environmental protection and proper utilisation of materials towards sustainable construction (Donyavi & Flanagan, 2009).

#### **2.4.3.1 Materials Wastages during Sustainable Building Production**

In construction, the key resources used for construction are: Money, Manpower, Machine and Materials, which is denoted as the four (4)-Ms of construction (Kareem & Pandey, 2013). Construction activities in South Africa and over the world have been proven to generate an

enormous amount of wastes which is a major problem in the construction industry (Kasim 2011). In addition, Baloi (2003) buttressed that construction wastes awfully contribute to the pollution of air and water which poses discomfort and deteriorating health conditions in the society. Weighing the level of resource wastages incurred during construction, Kareem and Pandey (2013) affirmed that materials wastages are outrageously high when compared to other construction resources during construction.

Nagapan, Rahman, Asmi, Memon and Latif (2012) in a study, mentioned that majority of the wastes generated during construction are material wastes, which are as a result of the use of un-reusable materials, leftovers and debris. Unfortunately, these materials waste amounts about 9% of the weight of materials purchased (Azis, Memon, Rahman, Nagapan, and Latif (2012). Kareem and Pandey (2013) also stated that the ratio of incurring high materials wastages during utilisation is directly proportional to the total cost of the project. This implies that the high cost of construction projects can be reduced by adopting waste management techniques. Several researchers and practitioners indicated that construction wastes emanates at the planning, design, procurement and construction stages, which has socio-economic and environmental impact on a society. Hence, construction wastes can be defined as materials or substances generated as a result of unplanned materials utilisation, abandoned surplus materials (processed or unprocessed), demolitions or renovations (Hong Kong Environmental Protection Department, 2010; Nagapan, Abdul Rahman & Asmi, 2011).

In addition, the Waste Disposal Act of Taiwan (2001) defined wastes generally as unwanted materials that may contain toxic and hazardous substances, which pollutes the environment or endangers the well-being of humans. Similarly, the Environmental Conservation Act “ECA” (1989) and the National Water Act “NWA” (1998) cited in the South African legislation define construction wastes in an environmental protection-based approach as unwanted or superfluous materials, which have the potentials to pollute and jeopardise the health of humans. As a result, this study defines construction waste as substances generated throughout the sustainable construction project from the pre-construction phase to the finishing phase of the project which are caused by various construction factors.

In construction practice worldwide, it is no doubt that construction wastes are of great concern which requires immediate attention. Reviewed literatures show that the most effective ways to managing construction wastes is through proactive prevention of wastes by adopting



sustainable wastes management principles. Hence, it is paramount to deliberate on the causes of construction wastages to enhance the application of the appropriate management technique to control wastes (Azis, *et al.*, 2012). To buttress this, Nagapan *et al.* (2012) summarized that sustainable construction wastes are caused basically by 81 factors categorised under seven groups. This is illustrated in Figure 2.7.

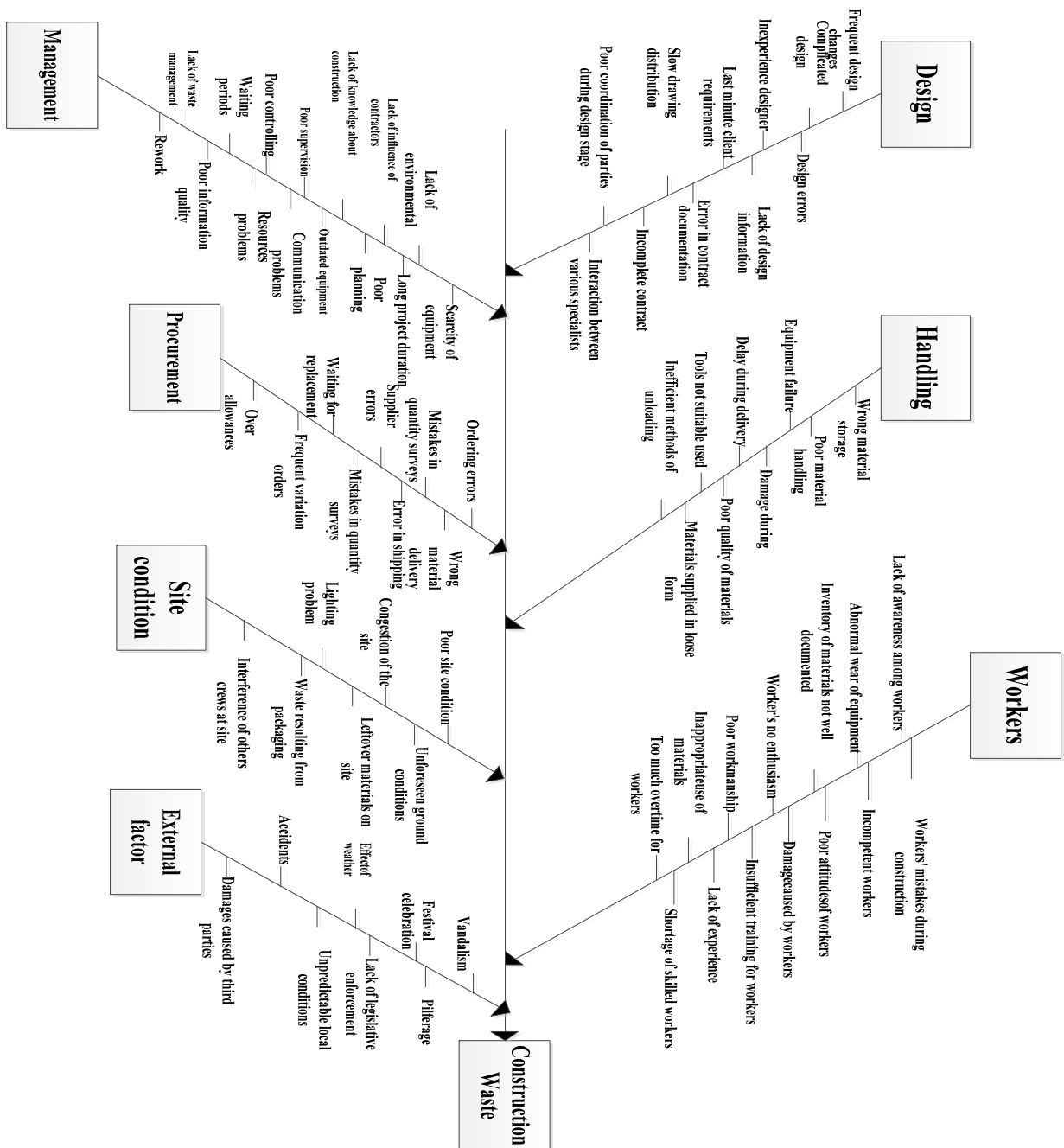
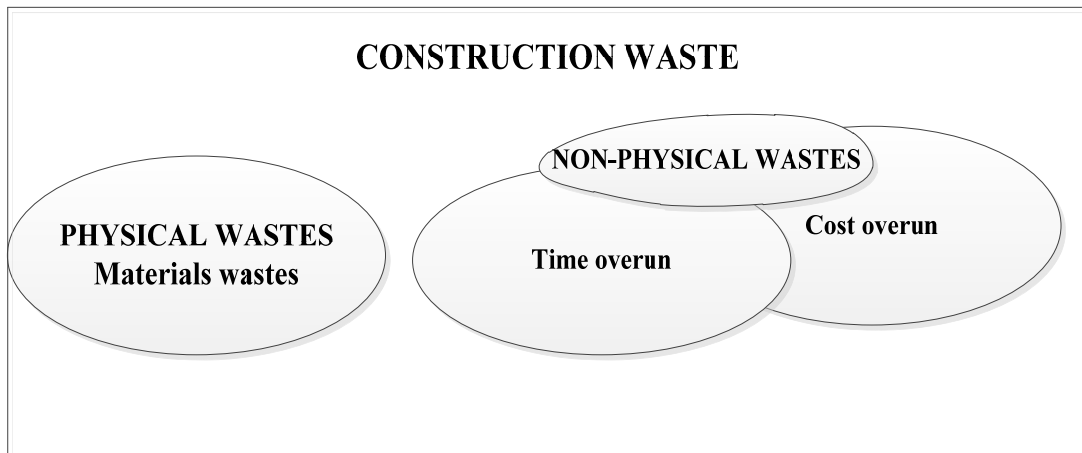


Figure 2.7 Causative factors of construction waste (Adapted from Nagapan *et al.*, 2012:327)

In addition, Nagapan *et al.* (2012) also revealed that for effective waste control, it is logical to understand the cluster groups of construction waste generated during sustainable construction; physical wastes and non-physical wastes as shown in Figure 2.8. The figure indicated that construction wastes occur in form of materials, time and cost, with materials wastes having significant impact on the cost and project delivery time. Hence, wastes management before, during and after construction, remains essential in the attempt to achieve sustainability.



**Figure 2.8 Cluster groups of construction waste generated during sustainable construction (Adapted from Nagapan *et al.*, 2012:327).**

Being fully aware of this, Yahaya and Larsen (2008) and Nagapan *et al.* (2012) highlighted that the major impact of construction wastes results in illegal dumping which influences the ecological and socio-economic aspect of a society. Furthermore, several studies conducted in the past years outlined a summary of the effects of construction wastes on sustainable construction as shown in Table 2.1.

**Table 2.1 Effects of construction wastes on sustainable building construction.**

<i>Principles of sustainability</i>	<i>Effects</i>	<i>References</i>
<b>Environmental</b>	Land Shortages	Gavilan & Bernold (1994); Nagapan <i>et al.</i> (2012)
	Environmental pollutions	Yunpeng (2011); Lu, Nagapan <i>et al.</i> (2012); Lihua <i>et al.</i> (2013).
	Excessive resource consumption	Jayamathan & Rameezdeen (2014);
	Illegal dumping	Gavilan & Bernold (1994); Guerrero <i>et al.</i> (2013); Yeheyis <i>et al.</i> (2013).
<b>Economic</b>	Increased cost of project	Fernández-Solis & Rybkowski, (2015).
	Time overrun	Ndihokubwayo & Haupt, (2009)
	Increased cost of materials	Jayamathan & Rameezdeen (2014)

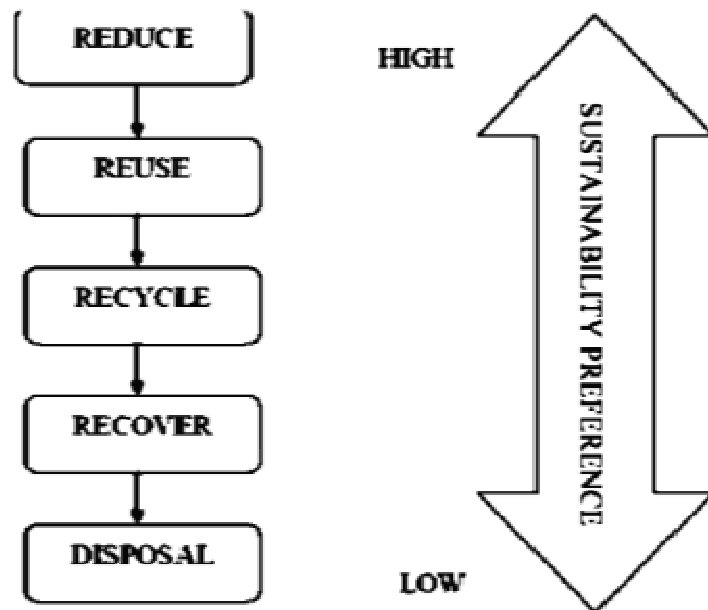
	Increased cost of waste transportation	Nagapan <i>et al.</i> (2012); Fernández-Solis & Rybkowski, (2015).
	Reduction in the Gross Domestic Income (GDI) of the society	Guerrero, Maas, & Hogland (2013); Fernández-Solis & Rybkowski, (2015).
<b>Social</b>	Risk to human health	Nagapan <i>et al.</i> (2012)
	Reduction in the Gross Domestic Production (GDP) of the society	Yunpeng (2011); Ndiokubwayo & Haupt, (2009)

Consequently, Kareem and Pandey, (2013:345) describes waste management as a means of “*eliminating waste wherever possible; minimizing waste wherever feasible, and reusing materials which could become waste*”. Thus, effective management of construction wastes is a vital technique in project management which contributes to the achievement of sustainable developments and sustainable building production.

#### **2.4.3.2 Principles of Materials Utilisation towards Sustainable Construction**

Materials utilisation is an indispensable aspect of building construction which enhances the attainment of sustainable structures. Baloi (2003) stressed that the rate of materials usage in construction has become alarming due to its adverse impact on the environment. Lu and Tam (2013), highlighted that achieving sustainability in construction requires a change in the strategy of materials usage from linear to a cyclic approach.

This approach to materials utilisation emphasises on the 4-Rs’ of sustainable construction: Reducing materials consumption, the use of Renewable, Reusable and Recyclable materials to avert the impact of construction on the environment (USGBC, 2008). The concept of “4R” is a vital rule used in the context of materials utilisation and construction wastes control, which is adoptable in the production cycle of a sustainable building. Studies show that materials utilisation and construction wastes control function coherently, to effectively manage waste. Kareem and Pandey (2013) translated this process as the ‘Golden Rule for Effective Waste Management’ in a hierarchy of operation, as illustrated in figure 2.9, showing an eco-friendly system of disposal.



**Figure 2.9:Golden Rule of Waste Management in a Hierarchy [4Rs] (Adapted from Kareem & Pandey, 2013:349)**

From Figure 2.9 above, Kareem and Pandey (2013) ranked ‘Reduction’ as the top preferable step in managing construction waste; reduction from the start-point of the project minimizes the materials usage and resource transportation which influence the construction cost. Secondly, materials’ ‘Reuse’ followed by ‘Recycle’, ‘Recovery’ and finally ‘Disposal’ was labelled the least step in the process of sustainable wastes management. This process involves the adoption of Eco-friendly system to prevent illegal dumping. Interestingly, Nagapan *et al.* (2012) argued that the ultimate step towards achieving sustainability in construction is ‘Prevention’ as it requires a fine co-ordination of all construction resources (Human, Material and Financial resources).

According to Yates (2013:283), achieving sustainable construction involves the process of constructing buildings using the best-practices and resource-efficient techniques showing the relationship between the raw materials extraction phase, materials utilisation phase and disposal phase which may include recycling or direct reuse (see Figure 2.4). As a result, the extraction and utilisation of materials determines the degree of wastages incurred during construction. Thus, sustainable building construction requires the use of reusable or recyclable materials that have the ability to sustain the lifecycle of the building, and also to reduce excessive materials consumption and wastages are advisable for the construction of

sustainable buildings (Yates, 2013). To this effect, the Los Alamos National Laboratory (LANL) suggested in its Sustainable Design Guide, categories by which suitable materials for sustainable building production are selected by and showing the characteristics they should possess (LANL, 2002). These categories and its properties were expounded on in Table 2.2.

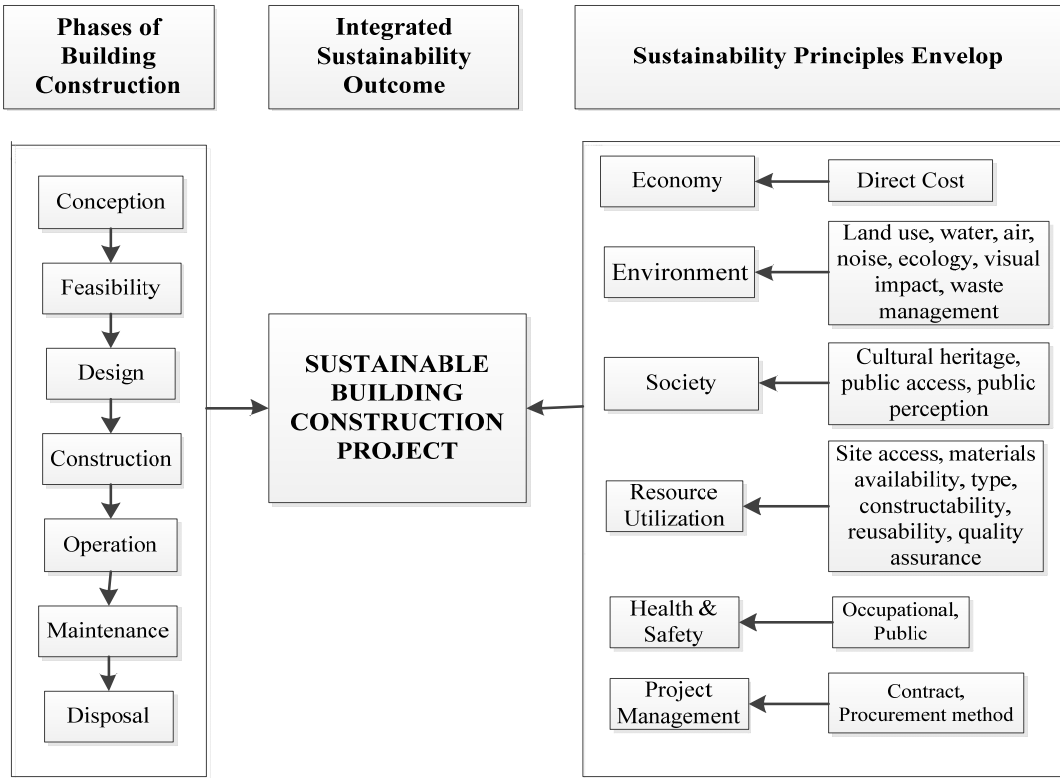
In agreement, the United State Green Building Council’s Leadership in Energy and Environmental Design (LEED) certification system ascertained that these categories are benchmarks for implementing the four (4)-Rs’. Relatively, The Green Building Council of South Africa (GBCSA), using the Green Star rating system awards points to projects based on ‘green measures’ implemented in materials usage during construction (GBCSA, 2014). Akadiri and Olomolaiye (2015) posited that putting into consideration a set of assessment criteria in the process of materials selection by adopting the Sustainable Assessment Criteria (SAC), would also enhance the production of environmentally friendly buildings through the reduction materials waste during production processes. This would also promote the socio-economic and technical sustainability of the building materials assessment and selection (Akadiri & Olomolaiye, 2015).

**Table 2.2 Categories and properties of suitable materials for sustainable construction (Adapted from LANL, 2002 cited in Yate, 2013: 289)**

<b>CATEGORY</b>	<b>PROPERTIES</b>
Life cycle cost impact (LCCI)	Relative impact of life cycle cost of building operations (which measures environmental burdens)
Energy efficiency (EE)	Construction materials that directly influence building energy use
Water efficiency	Construction materials that directly influence building water use
Locally manufactured (LM)	Construction materials that are manufactured within a defined distance radius (500 miles for the LEED rating system)
Material reduction (MR)	Self-efficient materials that serve a defined function using less materials
Locally derived raw materials (LRM)	Construction materials that are locally manufactured using raw materials obtained within the defined radius
Non-toxic (NT)	Construction materials that release relatively low levels of emissions of toxic or hazardous substances that could adversely impact human health.
Recycled content (RC)	Amount of reprocessed material contained within a construction product that originated from post-consumer use and/or post-industrial use.
Reuse (RU)	Construction materials that are reused with or without minor refurbishing to change its intended use.
Rapidly renewable (RR)	Construction materials that replenish themselves faster (within ten years) than traditional extraction demand.

Certified wood (CW)	Construction materials manufactures all on in part from wood that has been certified to the standards of the Forest Stewardship Council as originating from a well-managed forest
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Noteworthy, the Green Building Council of South Africa’s Green Star rating system (G.S) is functionally similar to the U.S’s LEED rating system in promoting green building practice in the construction industry. The council regulates the impact of materials consumption on environmental development as one its objectives by certifying projects for environmental leadership (GBCSA, 2014). Therefore, efficient materials utilisation embroils the implementation of sustainable building designs and materials selection as foundational steps in attaining ‘green ratings’. Conclusively, Lim and Yang (2008:336) explained in Figure 2.10 that the sustainability of a building project is collectively attained at every phase of construction project with respect to the principles of sustainability.

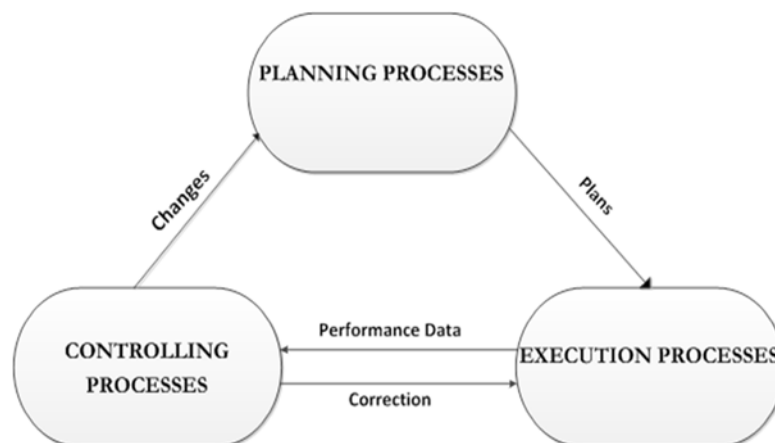


**Figure 2.10 Framework for Developing Sustainable Building Projects (Adapted from Lim and Yang, 2008:336)**

## 2.5 Project Management Techniques

A project is a unique temporary process of ‘start and finish’ which is constrained by time, cost, quality, resources and environmental protection to achieve a set objective. Project management is a systematic process of developing and implementing project plans in ensuring the project maintains its pre-determined critical work path (Kerzner 2013). Kerzner (2013) further highlighted that the process of project management is termed successful when the project objectives are achieved within time, cost and desired technological level. The Project management body of knowledge (2008:37) defines project management as the adoption of specialized knowledge, skills, tools and techniques in construction works to meet the project objectives. Thus, the management of construction projects requires a thorough knowledge and understanding of modern management techniques, designs and construction processes (Koskela & Howell, 2001).

Probable skills required by construction project managers for effective sustainable project management involves the acts of planning, co-ordinating, controlling, organising and forecasting (PMBOK, 2008; Kerzner, 2013). In addition, the management of projects also involves the act of motivating and maintaining an effective communication amongst construction stakeholders (Kerzner 2013; Walker, 2015).



**Figure 2.11 Managerial Processes in Construction Project Management (Adapted from Koskela and Howell (2001:186).**

Figure 2.11, illustrates that the construction project managerial processes are classified in three (3) groups: (a) Planning process, (b) Controlling and (c) Execution phase. Koskela and Howell (2001:186) established that the essence of scheduling at the planning phase of

construction activities include the reduction of work repetition and materials wastages during project execution. Hence, effective project management is attainable by the implementation of various management techniques during construction (PMBOK, 2008:67).

### **2.5.1 Project management techniques for sustainable building production**

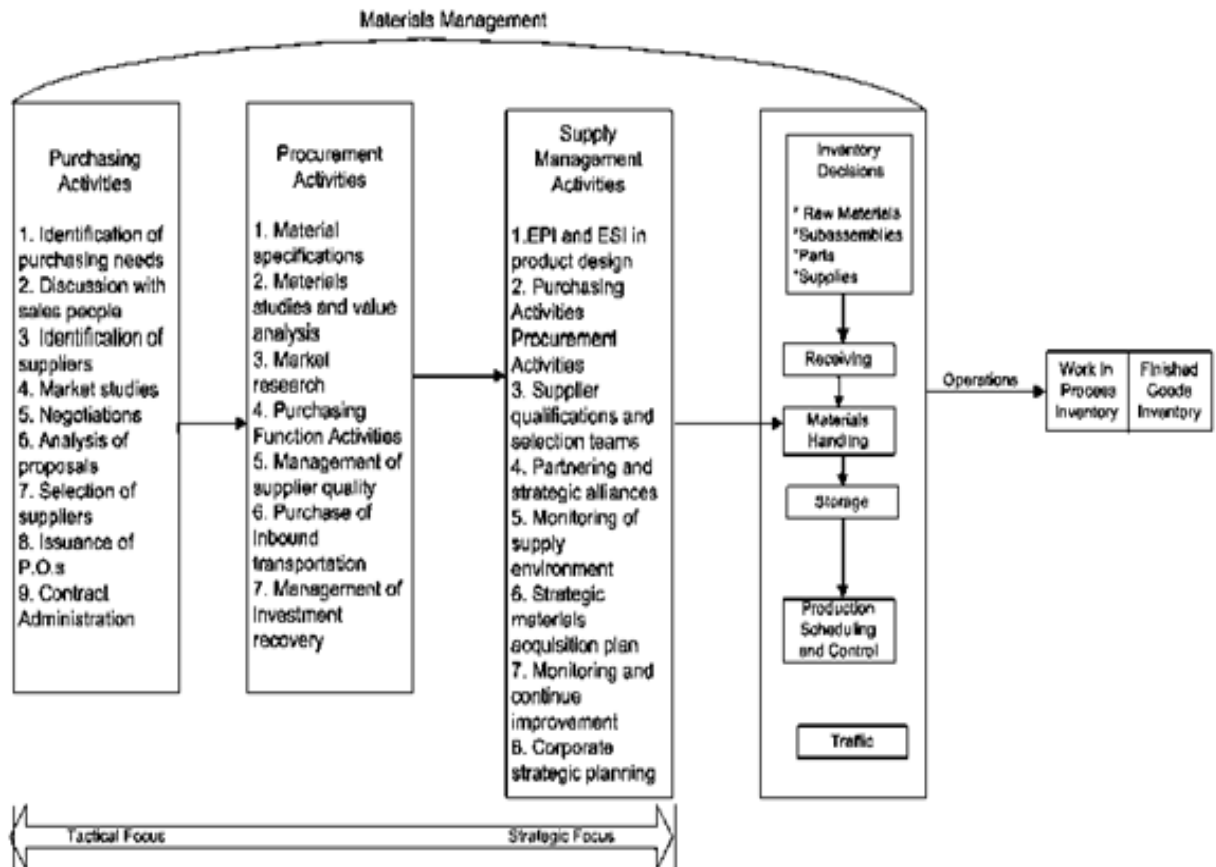
Practically, sustainability in building production through project management is achievable by the effective implementation of various management techniques during construction processes (PMBOK, 2008). Some of the most significant techniques for sustainable building production include: Materials management, Time management, Cost management, Quality management and Procurement management. Thus, in an effort to achieve the production of buildings that meets the clamouring needs of individuals without compromising the ability to meet needs of the future generations, this section evaluates the importance of these techniques to sustainable building production.

#### **2.5.1.1 Materials Management**

Materials management in construction is the process of planning, sourcing, purchasing, transporting, handling and storing of materials, minimising wastage, as well as, optimizing cost profitability (Patel & Vyas, 2011). The process of materials management is characterised by the features of insuring the availability of construction materials when and where needed, and at the right quality and quantity. Consequently, materials management is a planned technique which encompasses purchasing, delivering, handling and waste meeting project requirements (Kasim 2011). Hence, this management technique involves the minimisation of materials handling and controlling of procedures to ensure timely flow of materials at a precise quality, quantity during construction processes (Kasim 2011).

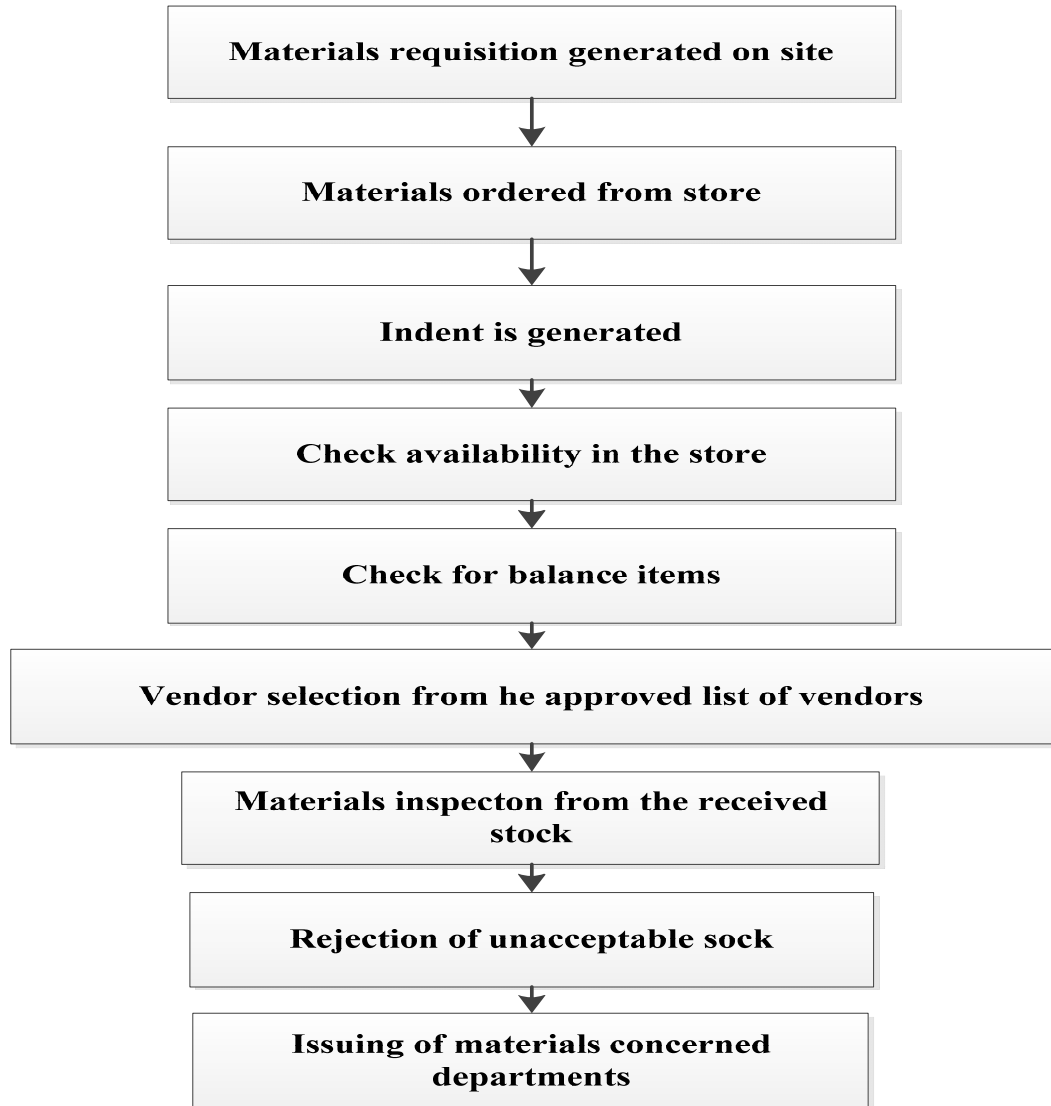
Figure 2.12 illustrates a typical relationship between purchasing, procurement, supply management and materials management. It is equally important to note in the figure that effective communications amongst the project team enhances constructive decision making regarding materials flow and productivity (Haddad, 2006:12). Thus, decisions made at the early stages of the managerial process influences subsequent decisions at later stages of project execution.





**Figure 2.12 Relationship of Purchasing/Procurement/supply management with material management (Adapted from Haddad, 2006:13).**

Effective materials management is significantly relevant in improving the possibilities of reducing the overall project cost noting that construction materials account for about 40-70% of construction cost. In addition, materials purchased too early holds up capital and accrued interest charges, and in most cases, these materials deteriorate or get stolen during storage (Patel & Vyas, 2011:1). However, extra expenses caused by delays may be inevitable where requested materials for a project are not made available when required. Therefore, for effective and sustainable use of materials, project managers must ensure timely flow of materials as illustrated in Fig 2.13.



**Figure 2.13 Process of materials management [Materials flow chat] (Adapted from Patel & Vyas, 2011:2)**

Materials management as an essential project management technique requires additional skills for the assertiveness of project managers (PMBOK, 2008). Patel and Vyas (2011) proposed the following skills as fundamental qualities required to be developed by the project managers for effective materials management during construction:

- Broad knowledge of materials estimation, budgeting and programming.
- Expansive knowledge in materials scheduling, purchasing and procurement.
- Skilful stocks control procedures and technique.
- Good inventory control (purchase costs control, order costs and holding cost)
- Materials utilisation and waste management.

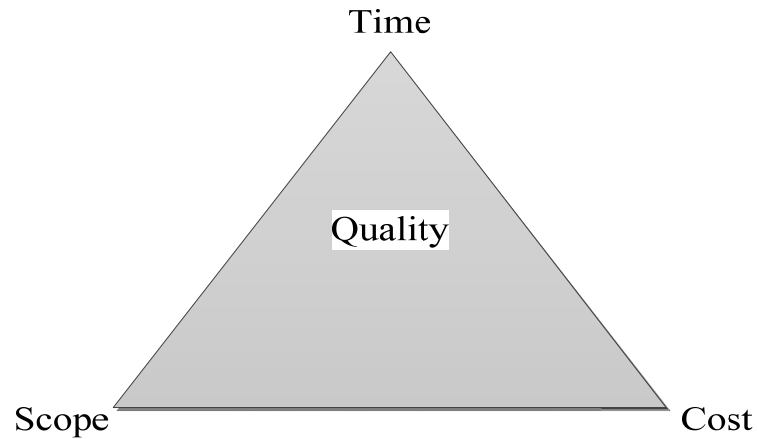
The main benefit of materials management is to ensure the timely availability of materials at the right quality to meet project schedule demands during construction. Nonetheless, attaining these benefits can be compromised by various management problems identified amongst contractors. Kasim (2011) itemized these problems as follows:

- Lack of site storage facilities
- Improper materials handlings.
- Poor general material logistics
- Poor site access points
- Operation limitations due to security consideration.
- Poor materials procurement strategy
- Improper materials deliveries.

#### **2.5.1.2 Project Time Management**

Project time management is technique that involves processes required to ensure timely completion of projects within an estimated time frame (Fapohunda & Omoniyi, 2011; PMBOK 2008:129). Time management is a continuous process preceded by the effort of planning, analysing, estimating, re-analysing and monitoring. Thus, an efficient use of time to manage construction resources utilisation with minimal materials wastages and costs for stakeholders' satisfaction is expedient (Fapohunda & Omoniyi, 2011). Satisfactory project completion and stakeholders' satisfaction in relation to time, quality, scope and cost have been regularly posed to be a yardstick for measuring a successful project (Mallak, Patzak & Kurstedt, 1991; Takim, 2009; Pinder, Schmidt, & Saker, 2013).

However, determining the most paramount factor for measuring project success has proven difficult. Literature reviews that most stakeholders tend to execute quality-based projects at minimum cost without giving the time of completion much consideration, as illustrated in Figure 2.14a. Conversely, every construction project has its predetermined objectives and the ability to realise these objectives depends significantly on the project delivery time (Love, Tse, & Edward, 2005; Fapohunda & Omoniyi, 2011).



**Figure 2.14a: Successful Project Delivery Objectives Triangle (Adapted from Fapohunda & Omoniyi, 2011:309).**

Noteworthy, the construction project completion time is an indispensable factor for project success with other factors (quality, cost, project scope and stakeholders expectation) remaining constant, as illustrated in Fig 2.14b. Thus, a construction project is deemed to be effectively and sustainably implemented when the project is delivered on time, within cost, scope and meets the required quality. These factors contribute to improving the chances for satisfying customers' expectations, as illustrated in Figure 2.14b



**Figure 2.14b Stakeholder's Expectation Diamond (Adapted from Fapohunda & Omoniyi, 2011:309).**

The PMBOK (2008:131), in figure 2.15, buttressed that to achieve an optimum output through time management, the management process is required to adapt the following phases:

- **defined activities** - the tasks and activities required to be executed to produce the project deliverables within a time frame must be identified and included in the project plan;
- **sequenced activities** - the process of relating each construction activity to its immediate subsequent activities, to avoid a break in the flow of works;
- **estimate activity resources** - the process of estimating the quality and quantities of materials, equipment and workforce required for the completion of the project;
- **estimate activity durations:** the process of approximating the specific time frame required to complete each construction activity with allocated resources;
- **develop schedule** - the process of analysing each construction activity, sequences, durations, required resources and constraints to plan a project schedule;
- **control schedule** - the act of coordinating and monitoring the progress of the project based on the developed project schedule.

The benefits to effective time management to the realisation of sustainable building in relation to construction project delivery were as highlighted by Shen, Li Hao, and Yao, (2007), as follows:

- It allows for the effective use of construction materials, thus reducing materials wastages and cost of construction.
- The enhancement of productivity in building construction.
- Improves the possibility for customer satisfaction.
- It creates room for future sustainable planning and long-term solution to the challenges in building production.
- Timely delivery of construction projects.

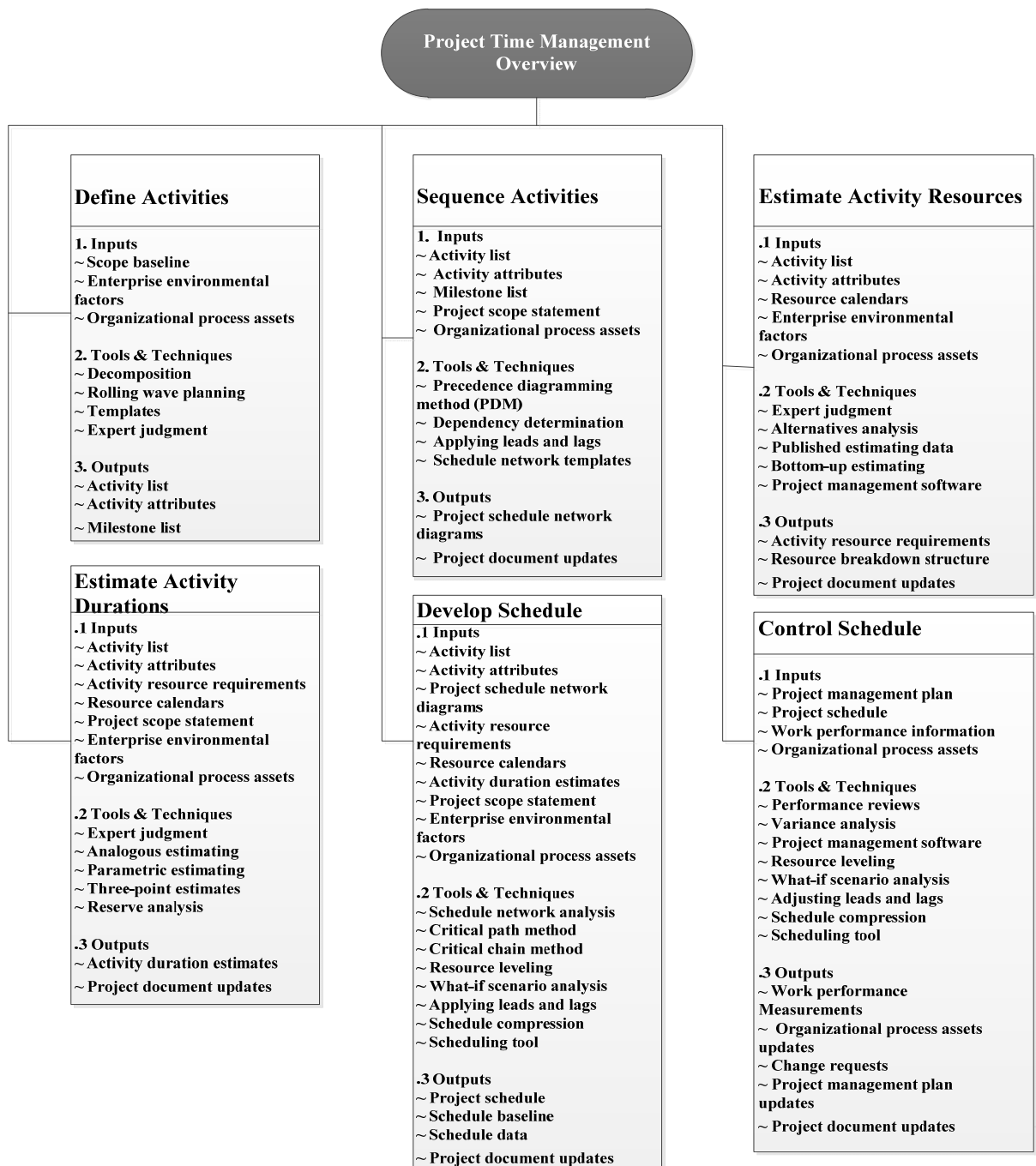


Figure 2.15 Project Time Management Overview (Adapted from PMBOK, 2008:131).

### 2.5.1.3 Project Cost Management

The entity of a construction projects is dependent on the finances budgeted for the commencement of that project. Thus, construction projects cannot commence without knowing the cost implication of completing the project (Atkinson, 1999; Walker, 2015). Furthermore, financial budgets towards the success of a construction project can be referred to

as a 'self-unproductive' input which facilitates production activities on site (Adebowale & Fapohunda, 2014). Therefore, construction cost in relation to quality and time - as earlier stated - are significantly important in any construction project. Although, the order of importance and preference of these three factors are yet to be determined, the level of importance ascribed to each of them can be weighed based on the requirements of the construction stakeholders.

In relation to the production of sustainable buildings, there has been a common understanding that the production of sustainable buildings cost much more than conventional buildings. However, adopting the techniques of cost management during construction will ensure that the projects are completed within the approved budgeted cost. As a result, the PMBOK (2008:167) theorised the following basic techniques for effective cost management during sustainable build construction:

- **Construction Resources Planning:** This process primarily determines the quality resources and specific quantities of each resource required to complete a project activity at the lowest possible cost.
- **Cost Estimating:** This involves process of approximately estimating the total costs of the resources required to complete the construction project.
- **Cost Budgeting:** This process requires the project manager to prepare a cumulative estimated cost of all individual work items to establish a formal working cost. For example a construction Bill of Quantities (BOQ).
- **Cost of Control:** This is the act of monitoring the status of the project budget. Thus, cost control is basically concerned with manipulating factors that may cause changes to the cost baseline of the project to ensure the changes are beneficial to the project.

However, despite the benefits of cost management during sustainable building construction, Kasimu (2012) noted that deficiency on the part of the project manager to ensure cost management efficiency could lead to bankruptcy during construction, delays or project abandonment and construction cost over-run. As a result, Kasimu (2012:776) highlighted the following factors are causes of construction cost over-run of which project managers must be cautious of at the cost planning, controlling and execution phases of management:

- Frequent alteration of project design by clients
- Incomplete design during tendering

- Inadequate cost planning at the design phases of construction
- Logistics due to site conditions
- Lack of monitoring during pre-contract and post-contract phases of construction
- Lack of cost and expenditure documentation during construction.

#### **2.5.1.4 Project Quality Management**

Quality in construction management is simply defined as the act of meeting the expectation of the customer (Knutson, Schexnayder, Fiori, & Mayo, 2009). According to, Harris and McCaffer (2013), the quality of a product or service describes the characteristic value devoted by the project manager to meeting the specified requirements of a customer. Hence, quality management is a management technique which involves all the processes required to determine the quality policy, objectives and responsibilities in order to meet the expectations of the stakeholders. (PMBOK, 2008:189).

In the context of sustainable building production, quality management remains an essentially requirement ultimately for the production of buildings that satisfy client's prospects with reduced subsequent recurring cost related to operation and maintenance (PMBOK, 2008:190). Thus, the ability to sustain the needs of the future generation with the available resources is not compromised. As a result of the effort to promote quality management, the International Organisation for Standards (ISO) was advocated and certified for management standardisation. The ISO was founded in 1947 in Geneva, Switzerland and has since been accepted internationally for quality production legislation (Terlaak & King, 2006). This was because it endorsed the adoption of Total Quality Management (TQM); Six Sigma; Failure Mode & Effect Analysis (FMEA) and Quality Inspection and Management (QIM) as approaches for quality building production. Nonetheless, the process of quality projects management is achievable through the implementation of the following as stressed by Knutson *et al.*, (2009:506):

- Quality planning
- Quality policies and procedures
- Quality assurance
- Quality control



Therefore, the ability to satisfy the stated or implied needs of a customer is determined by the characteristic quality of the product (PMBOK, 2008:190). Thus, the significant aim of project quality management is to transform the implied needs of the customer to stated needs through proper management policies and procedures, as quality assurance is vital in any sustainable building project.

### **2.5.1.5 Procurement Management**

Procurement simply describes the process of resource acquisition (need requisition, locating and selecting of suppliers, price negotiation and delivery). According to Manana, van Waveren and Chan (2012:2117) procurement in the CIDB context is defined as “*a process which creates, manages and fulfils contracts relating to the provision of suppliers services, allotment of grants and concessions*”. Procurement management in sustainable construction involves the processes required to acquire all necessary resources needed for the completion of a project from outside the project construction team (PMBOK, 2008; Van Weele, 2010; Manana *et al.*, 2012). The CIOB (2005b) added that the process of procurement also forms a vital part of a sustainable building construction which precedes any stage in the project construction cycle. Furthermore, Govender and Watermeyer (2000) describe procurement as the process of creating, managing and finalizing contracts. The authors added that procurement in the developing countries has overtime become a tool used by the government to promote sustainable development in the construction industry.

Fundamentally, procurement management is a management process which involves the modalities of purchasing or securing goods and services for all construction activities from external sources (PMBOK, 2008). Thus, these processes includes the following for effective management (PMBOK, 2008:313; Manana *et al.*, 2012:2117):

- Procurement planning
- Solicitation planning
- External source selection
- Procurement contract administration
- Procurement contract completion.

Traditionally, every construction project is unique with respect to requirements, management, challenges and available resources (Walter, 2015:239). Nonetheless, the cost, time and quality are constantly the basic tools required for successful sustainable building delivery. However,

it is paramount to note that effective procurement is essential to determine ‘whether to procure’, ‘what to procure’, ‘how much to procure’, ‘what quality to procure’, and ‘when to procure’ for a particular project. Thus, it is obligatory for the procurement managers to possess advanced knowledge of the various procurement activities and procedures (CIDB 2005b). Consequently, the CIDB (2005b) highlighted these following as guiding principles for effective procurement system:

- **Establish what to procure:** Determine the work scope and estimate the financial consequence of the propose procurement activity.
- **Choosing the procurement strategy to implement:** Deciding and establishing the applicable preferential procurement, pricing strategy, tendering strategy and procurement procedures to adapt.
- **Solicit tender offers:** This involves preparing procurement documents, submission of tender offers by the contractors to show interest and the preparation of reports on the shortlisting process.
- **Evaluation of tender offers:** This involves the process of performing a risk analysis on submitted tender offers to determine their responsiveness. This process also includes the preparation of tender evaluation reports.
- **Awarding of procurement contract:** Compiling and formally accepting competent tender offers.
- **Administering contracts and confirms requirements for total completion of the contract.**

## 2.6 Materials Procurement

Materials procurement (MP) is the primary objective of materials management in a project management system (Patel & Vyas, 2011). MP is the process of purchasing materials from external sources to support the operations of the producing company (Lambert, Stock & Ellram, 1998 cited in Kasim, 2011:32). Furthermore, Hadikusumo, Petchpong, and Charoenngam, (2005) and Mehr and Omran (2013) described MP as a fundamental function of acquiring goods and services based on established terms and conditions mutually acceptable by buyers and sellers to enhance work efficiency.

Materials procurement can also be likened to the process of planning, supply sourcing, negotiation, order placement and co-ordination with suppliers at every phase of a project (Van der Vaart, De-Vries & Wijngaard, 1996). However, construction materials procurement is termed sustainable if the processes of acquiring materials have minimal impact on the socio-environmental status of a region through the lifecycle of the building (Meehan & Bryde, 2011; Musa, Buniamin, Johari, Ahmad, Rauf & Rashid 2013). Hence, based on the definitions and explanations above, materials procurement (MP) could be categorised as a management objective which involves the process of purchasing materials in its right quality, at the right time, in the right quantity, from the right sources (external or internal) and at an affordable price.

In most construction organisations, the activities of materials procurement (MP) are the responsibilities of the procurement department. Practically, procurement officers or buyers performs vital functions to ensure that the materials requirement for a project are provided for timely (Haddad 2006). As a result, Hadikusumo *et.al*, (2005) itemized the following as functions of the procurement officer towards effective materials procurement during construction:

- Identification of materials requirement for the construction project
- Processing and issuance of internal requisition (Request for Quotation 'RFQ')
- Bidding processes with sales representatives
- Identification of pre-qualification of bidders, Bid evaluations and enlisting approved bidders
- Carrying out market surveys for specific materials
- Solicitation of bids and price quotations
- Bid classification and awarding suppliers.
- Issuing of purchase orders (PO), subcontracts or leases.
- Materials tracking and expediting
- Inspection and acceptance of delivered goods.
- Inventory maintenance: preservation of all company purchase records.

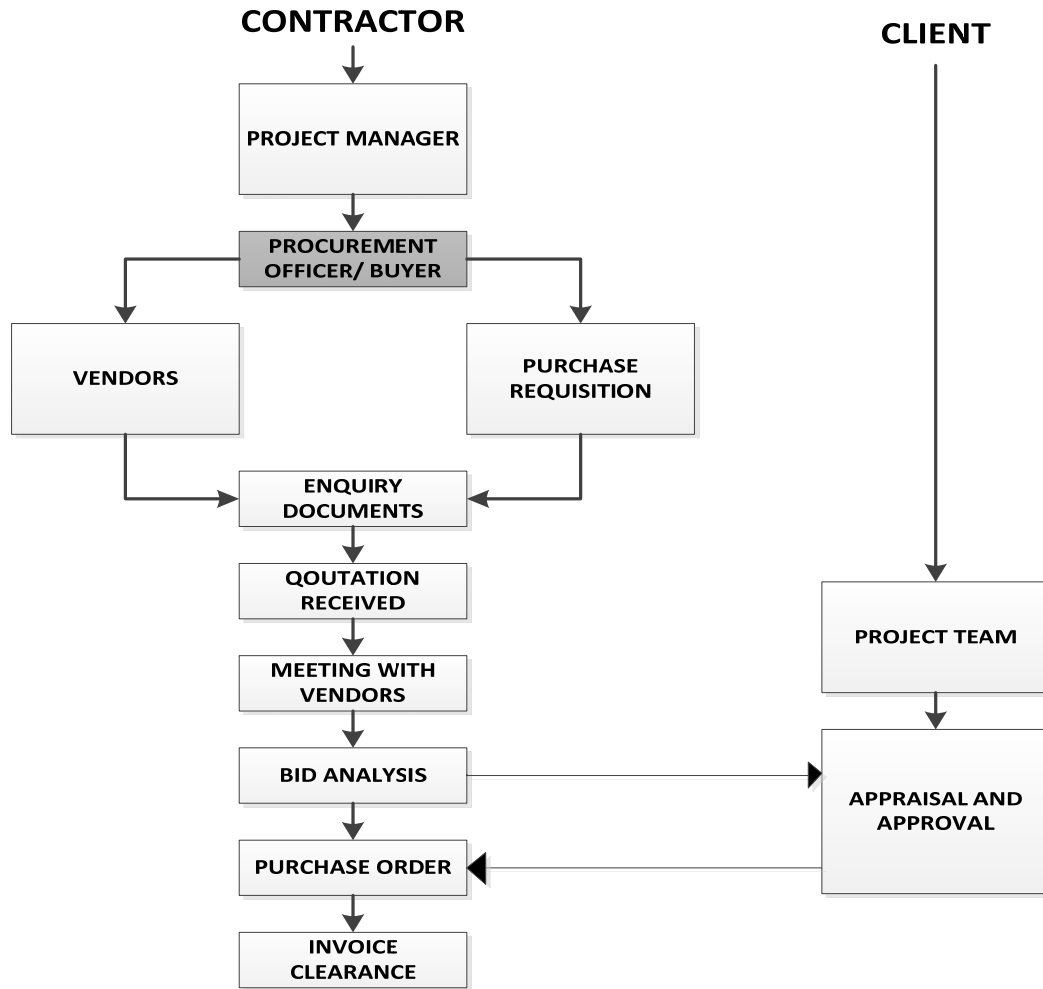


Figure 2.16: Typical function of procurement officers in a materials procurement system (Adapted from Baily *et al.*, 2008:385).

Figure 2.16 illustrates the process of procurement and functions of procurement officers in large construction companies. As seen in Figure 2.16, the client relates directly with the project team on contract appraisals and approvals in terms of tenders analysis and purchase orders. The contractor works directly with the project manager and procurement officers in obtaining quotations from sub-contractors and suppliers to prepare a tender document which is to be presented to the client for analysis and approval. Therefore, in order to optimise construction performance and maximise profitability, procurement officers are advised to adopt the principles of procurement during construction as identified by Baily, Farmer, Jessop and Jones (2008:4) below:

- To ensure the flow materials and services during construction (Supply chain concept)

- To purchase materials wisely and efficiently based on ethical means at the best value for revenue spent (Best practice management)
- To maintain an effective relationship with the existing sources and develop new supply sources to meet emerging needs and to ensure continuity of supply (Relationship management)
- To maintain the correct quality/value balance (Total quality management).
- To adopt environmentally responsible supply management system

### **2.6.1 The Role of Materials Procurement in Supply Chain Management**

The role of materials procurement in supply chain management has received recognition and is still being recognised in the construction industry. Notably, the hackneyed perception of several professionals and researchers is that materials procurement is a routine process based on administrative activities, such as ordering and payments not until the initiation of supply chain management.

The supply chain also known as '*Procurement cycle*', '*Pipeline management*' or '*Value stream*' is a network system which enhances the procurement strategy efficiency adopted by organisations in adding value and reducing cost during construction (Gaosheng, Ge and Hui, 2010) Additionally, the supply chain is strategically a pro-active function which is concerned with the flow of materials from the raw stage to usage and disposal after construction works (Baily *et al.*, 2008). Hence, supply chain can be likened to a pyramid of materials distribution which shows the relationship between suppliers, series of procuring companies and the customers that constitute the chain.

Supply chain management as an operations management discipline examines the upstream and downstream flows of products, services, finances and information from a source to the customers in an organisation(s) (Van Weele & Raaij, 2014). Handfield, Monczka, Giunipero and Patterson (2009) in a study, described supply chain management as an “integration of all the phases of materials flow through an improved supply chain relationships to achieve a sustainable competitive advantage”. It is equally a materials and services management technique, which ensures adequate flow of materials from the raw form through suppliers to the construction company and unto the customers in form of sustainable buildings (Baily *et al.*, 2005; Van Weele, 2010).

The definitions of supply chain management (SCM), as stated above, suggests that the links between suppliers, procuring companies, the customers and other associates of the supply chain should be strongly fused. These links enhances supply/procurement managers in attaining an effective supply end in the supply chains. Thus, Wisner, Tan and Leong (2015) suggested that for effective management of materials flow between the links, a synergistic relation must be established. Wisner *et al.* (2015) further stated that the objective of this management process is to ensure customer satisfaction, enhance supply chain productivity and also its profitability by adding value at each stage of the procurement process.

Materials procurement activities in the supply chain during construction have been acknowledged to have a significant impact on the sustainability statues (environmentally, socially and economically) of the society and productivity of the organisation (Mwikali and Kavale 2012). As a result, procuring organisations are mandated by the British standard (BS7750) and the International Standards Organisation (ISO14001/2) to demand details of the environmental preservation intent of tendering supplier (Baily *et al.*, 2005). Albeit, the value for money is essential for organisational growth and profitability but it is important to note that this should not be achieved at the expense of the sustainable development of the society.

Thus, according to Meehan and Bryde (2011:95), the following factors should be appraised by the procuring organisation to ensure sustainable materials procurement practice in the organisation's supply chain:

- The impact of products materials usage on the environment
- The impact of the bio-degradability of the construction materials on disposal.
- Effective waste management techniques to be adopted during construction.
- Sustainability of the construction materials and the availability of alternative materials usable for construction.
- The impact of government policies on the management of the supply chain.
- The environmental implications of using any of the tendering suppliers, noting their environmental protection intent.

#### **2.6.1.1 Supply Chain Management in the South African Construction Industry**

Supply chain management (SCM) plays a principal role in the financial management of the South African construction industry which is relative to the ongoing financial reformation in the South African public sector (Ambe & Badenhorst-Weiss, 2012a). According to the Office

of Government of Commerce (OGC) (2005), the SCM is an integral part of the pragmatic financial management used for managing the public procurement sector of South African construction industry. Primarily, SCM was introduced into the South African construction industry and other sector in 2003, to revolutionise the procurement system from the 'rule-based' system to an 'integrated SCM system' (Ismay, 2008). As a result, the adoption of SCM in the construction industry sector is aimed at adding value to the process of materials procurement – from the phase of materials requisition to acquisition, usage and finally, disposal.

Legislatively, procurement supply chain management (PSCM) practices in the South African public sector is endorsed by the Preferential Procurement Policy Framework Act No 5 of 2000 (PPPFA) and the Public Finance Management Act No 1 of 1999 (PFMA) of the constitution (Ambe, & Badenhorst-Weiss (2012b). The focus of this Acts by the constitution is to ensure uniformity in contract documentations and also promote a standardised supply chain management practice in the various sectors (National Treasury, 2003; Ambe, & Badenhorst-Weiss 2012b). To this effect, Naude and Badenhorst-Weiss (2011) proposed a framework for effective implementation which comprises of demand management, acquisition management (building relationship), supply chain integration and ultimately sustainability. Conversely, attempts to effectively implement these policies have been interrupted by different factors on the part of both the government and other procurement practitioners in the construction industry.

Ambe and Badenhorst-Weiss (2012a) highlighted that the episodic implementation of the procurement (SCM) policies is as a result of: a). Defiance of the SCM legislated Acts, b). Lack of strategic planning, c). Lack of knowledge and skills on the part of the workforce, amongst others. Consequently, Emuze (2009) conducted a quick survey amongst contracting organisation registered as members of the Master Builders South Africa (MBSA) to appraise the practice of SCM in the industry. Emuze (2009) noted in the study that SCM implementation at the contracting level is challenged by industry's layout fragmentation, inconsistent risk management, communication technique, resistance to technological innovations, and poor adoption of waste management during construction. Thus based on reviewed literatures, it is perceived that SCM implementation in the South African public sector especially the construction industry is still at infancy.

## **2.6.2 Materials Procurement Outsourcing.**

Outsourcing is a collective term used to describe a partnership relationship between an organisation and several selected suppliers for specific purposes. Zenz and Thompson (1994) explains that the SCM process of outsourcing is a strategic technique used by procuring organisations to select eligible suppliers and increase its reliance on the quality of resources delivered by the suppliers. Successively, outsourcing is defined as a process of purchasing materials or services a company requires from an external company at a crucial moment (Wadhwa & Ravindran, 2007).

In a simplified form, outsourcing is an act of transferring some internal procurement duties of a company to an external service or resource provider. Thus, materials procurement outsourcing according to Fernández and Kekale (2007), is described as a managerial practice of completely or partially re-assigning business and resources processes associated with procurement to a third-party service provider to enhance the productivity of the company.

The primary goal of materials procurement outsourcing is not cost reduction as perceived by Schniederjans, Schniederjans and Schniederjans (2005); Wang, Chen, Wang and Su (2010); Irina, Liviu and Ioana, (2012) and other researchers. Wadhwa and Ravindran, (2007) argued that organisations focus on the co-ordination of business functions through procurement outsourcing primarily to improve the performance and productivity of the organisation. Thus, the motives and benefits of procurement outsourcing according to Brewer, Wallin, and Ashenbaum (2014:187) which can be applicable to sustainable building construction are as follows:

- Procurement outsourcing provides opportunity access to specialised technology and services.
- Improves staff disciplinary co-ordination and work activity process organisation.
- Reduces the staffing levels of the organisation, thus curtailing staff salaries range to the minimum.
- Enables the company to concentrate on core competencies.
- Enhances contract compliance and on time project delivery.

Studies reveal that materials procurement outsourcing is equally identified with supplier performance deficiency. Wadhwa and Ravindran, (2007:3726) in agreement buttressed that



the major factors affecting materials procurement outsourcing efficiency are: a). Financial instability b). Technical illiteracy c). Supplier treachery and d). Supply-base invisibility. However, the procuring organisation may lose its control of the performance and reliability of the suppliers leading to materials cost hike, loss of long-term relationships privileges with suppliers and other risks of treason (Brewer, Wallin, & Ashenbaum, 2014; Amaral, Billington & Tsay, 2006). Thus, it is essential to logically select efficient supplier to meet the objectives (Time, Cost and Quality) of a project through effective procurement strategies.

### **2.6.3 Challenges of Materials Procurement.**

Materials procurement (MP) being the most critical stage in a sustainable construction process is faced with numerous challenges. This could be as a result of the rapid change experienced in the industry with regards to the nature of construction processes/products. Lindén and Josephson (2013) asserted that due to the complexity and uniqueness of construction projects, the purchase, delivery and handling of construction materials over the years has been a huge challenge. Thus, the challenges to MP could be attributed to the strategy of materials management and the nature of the construction project at hand. Consequently, Hadikusumo *et.al*, (2005:738) mentioned in a study that the challenges related to ‘MP’ in various organisations are as follows:

- Challenges related to Communication: This challenge is mostly experienced in large construction companies with a sizable number of geographically distributed workers. Dues to the poor communication system found in most companies, procuring materials during construction may consume more time and money as a result of unclear procurement information (such as specifications, delivery date, and purchase orders), rebutted RFQs and POs, unclear criteria for materials selection and poor materials tracking.
- Challenges related to suppliers selection: This challenge may arise as a result of poor or unclear selection criteria, less supplier competition, limited supplier information and undefined materials requirements.
- Supplier evaluation problems: This evaluation problem arises as a result oversight in the evaluation process, lost evaluation information and disorientated evaluation process not based on purchase order.
- The use of outdated materials purchase information

In the new era of information technology in the system of materials procurement, lack of user-friendly materials procurement software packages and lack of competent managers are considered as the challenges of modern materials management (Mehr & Omran, 2013). Furthermore, Eshofonie (2008) highlighted other challenges of materials procurement experienced in developing countries as: a). High cost of indigenous materials; b). Fluctuating price of materials; c). Fluctuating cost of materials importation; d). Insufficient construction materials producing companies; e). Ineffective implementation of materials procurement strategy.

However, considering all the above stated materials procurement challenges, deficiency in the flow of information perceived to be the major contributor to the challenges in materials procurement, decision making and sustainable project delivery. Conclusively, Thomas, Riley, and Messner (2005) added that the effect of these deficiencies in materials information flow results to production and profit degradation. The process of materials information flow is fundamentally between the project team (Procurement officer) and the bidding suppliers through catalogues (paper based or electronic). Hence, based on the catalogue information obtained from the suppliers, the tendering suppliers are compared and the suitable supplier is selected. In addition, Kasim (2011) noted that effective communication in the procurement system of an organisation has the ability to enhance production value, risk management and avert unnecessary construction delays, misunderstanding and high procurement costs.

#### **2.6.4 Strategies of Construction Materials Procurement**

Procurement in sustainable building construction has, over the years, been translated to a strategy for cutting production cost, improving building quality and enhancing procurement efficiency (Sobhani, Malarvizhi, Al-Mamun, & Jeyashree, 2014). The initiation of a viable procurement strategy is a reliable approach to attaining construction project success. Hence, strategic procurement is defined as a systematic process of planning, evaluating, implementing and controlling of activities involved in resource sourcing and acquisition towards building completion (Carr & Smeltzer, 1997; Department of Public Works, 2008). Furthermore, Sourani and Sohail (2011) depicts that the aim of strategic materials procurement is to identify the best way of acquiring materials required to achieve the objectives of a project taking into account the value for money, risks and basic building constraints. Hence, strategic procurement is characterised by the development of a detailed

materials sourcing system which results to a close relationship with suppliers in an effort to sustain value for money.

Construction materials procurement strategies focuses on the ability of a construction company to satisfy the expectations of its clients without incurring time and cost over-runs during construction. Despite the general conception that the process of materials procurement is time-consuming, it is essential to bear in mind that this process remains the most potent avenue in reducing construction cost (Rajeh, Tookey & Rotimi, 2014). Quayle (1998) buttressed that the process of making decisions on the source of materials supply and how to go about sourcing materials, is one of the most critical decisions the procurement officer makes, which apparently consumes the procurement time. Therefore, to enhance productivity and adding values, to both the clients and the organisation, strategic, tactic and operational decisions occupy a substantial portion of the buyers' attention (Venkataraman & Pinto, 2011; Baily *et al.*, 2008; Faes, & Matthysens, 2009). To this effect, researchers and organisations sought for strategies with the ability to effectively procure the required construction materials and efficiently meet the goal and objectives of the project.

Based on assumptions, cost, quality, time, client, supply chain and project size, are drivers of strategic materials procurement selection, which are usually influenced by the legislations of any country [developed or developing] (Baloi, 2002). In addition, the Department of Public Works (2008) stated that the process of materials procurement strategy selection can also be influenced by: a). the objectives and constrain of the project, b). probable procurement risk and c).the level of project complexity. Consequently, the materials procurement strategy scheduled for a construction project as large as an industrial plant requires a complex and integrated system, which could be determined by considering the above mentioned factors of selection. It is worthy to note that the selection of an unsuitable materials procurement strategy for a project could result in unsatisfactory project outcomes in terms of quality and cost. To buttress this, Quayle (1998:399) credibly postulated that the performance assessment of a procurement strategy is classified effective when the 'Pros and Cons' of that strategy is put into consideration by the procuring organisation. The factors to consider for effective procurement evaluation as cited in Quayle (2005:27) include:

- cost of procuring operation

- quality and profit value of the procurement operation towards enhancing organisational competitiveness
- goals and objectives of the procuring organisation
- strategic planning and progress reports on meeting these set organisational goals
- effective staff development planning towards professional competence
- Function and purpose of the project being procured for.

Hence, it is essential to primitively understand the processes and strategies involved in the process of materials procurement. In the context of this study and based on reviewed literature, materials procurement is broadly classified into two (2) strategic approaches, namely:

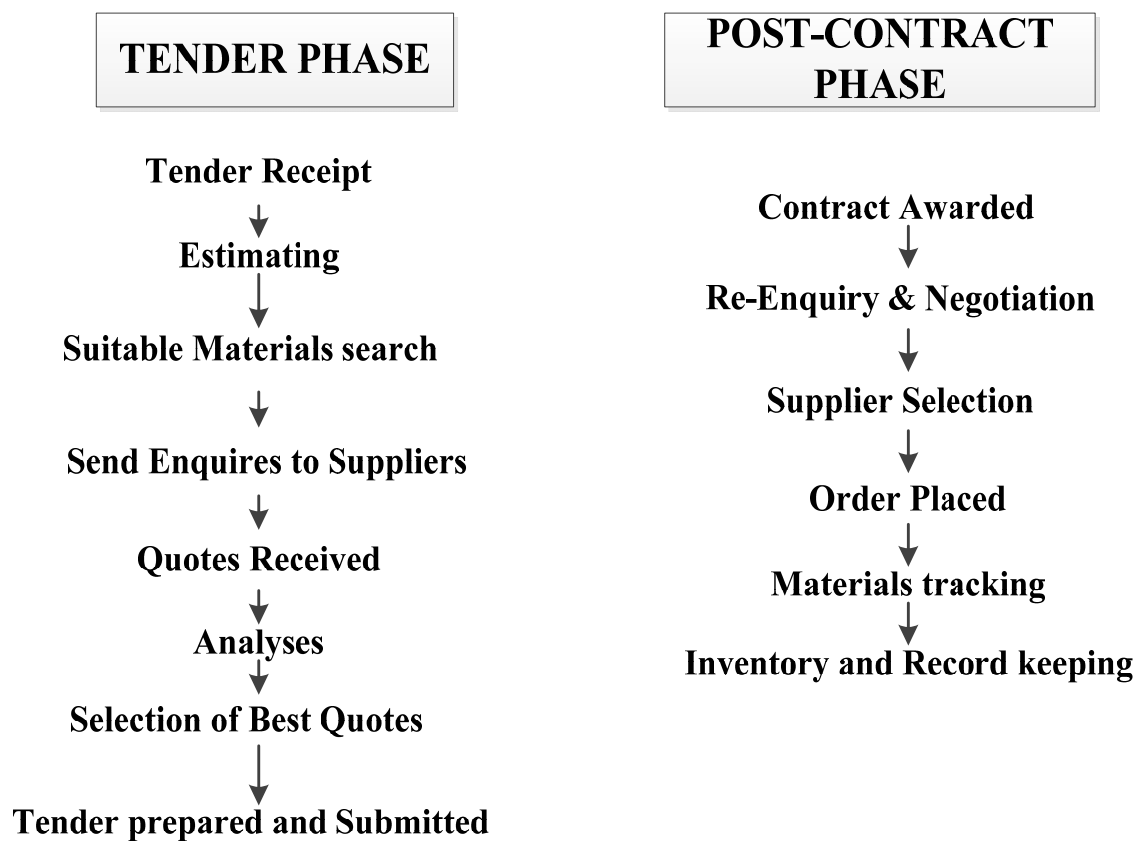
1. Traditional Materials Procurement Strategy(TMPs)
2. Electronic Materials Procurement Technology Strategy (EMPTs)

#### **2.6.4.1 Traditional Materials Procurement Strategy (TMPs)**

The traditional materials procurement strategy is a systematic and specialised procurement process, which is predominantly a paper-based technique for materials acquisition during construction (Kong, Li, Hung, Shi, Castro-Lacouture and Skibniewski, 2004) This procurement strategy is referred to as “traditional” by various researchers because it has virtually been the only procurement choice available to construction companies and their contractors in the past decades. The materials procurement process in TMPs encompasses two (2) phases before and after construction projects. According to Adzroe and Goulding (2004:2), these phases are: a). Tender Phase and b). Post-contract Phase; as illustrated in Figure 2.18.

From the pictorial representation in Figure 2.19 - showing the sequential process of the traditional material procurement - it is noted that this process, which is split up into two phases, starts with the collection of tender documents by contractors at the Tender phase. Tender estimation starts immediately alongside, materials requisitions based on costs, properties, qualities are sent to major supplies and wholesale/manufacturing company to determine suitable materials for construction. Afterwards, quotations are received and analysed by the contractor to select the best quotes in order to prepare his tender documents for contract bidding. As soon as the contractor is awarded the contract, the second phase begins immediately with a re-enquiry and negotiation process between the contractor and a

couple of selected suppliers (with potential suppliers inclusive). Next, a comparison is made by the contractor between the earlier collected quotes and the new ones in order to select the best suitable supplier for the required materials. Once this is done, purchase orders are raised which becomes a binding contract/ legal commitment between the contractor and the selected supplier (s) once the purchase order is accepted. In most instances, these contracts are inscribed on paper for reference purposes stating some agreeable terms and conditions guiding the contract. Thereafter, materials dispatch notification is sent out to the contractor which highlights the speculated time of site delivery. The procurement process is concluded as soon as the materials are delivered on site with inventory and record keeping conducted.



**Figure 2.18 Sequential Stages in Traditional Materials Procurement Strategy (Adapted from Adzroe & Goulding, 2004:2)**

In succession, Figure 2.19 illustrates the typical paper-work cycle in the traditional materials procurement during a construction process. From the figure, it is observed that the process of traditional materials procurement involves the flow materials information in a paper-based system which entails a lot of paper-work archiving. The process is conducted amongst four (4) principal personnel offices, namely: Supplier, Site office, Procurement/ Buying

department and the Accounts department (Calvert, 2012). Adzroe and Goulding (2004) added that the smooth flow of materials information (communication) between these offices is fundamental in order to avert misinterpretations and obscurities in the materials procurement process.

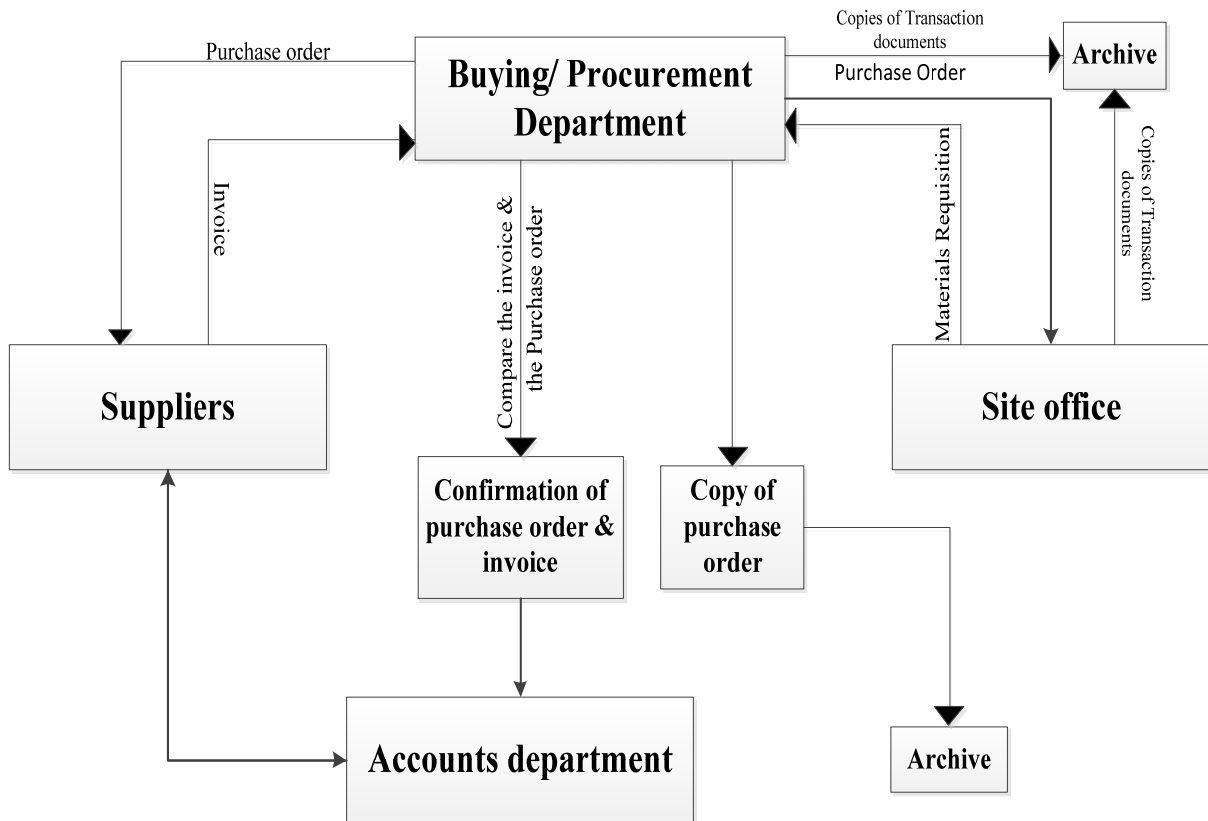


Figure 2.19 Typical Paper-work cycle in Traditional Materials Procurement (Adapted from Adzroe & Goulding, 2004:3)

#### 2.6.4.1.1 Benefits of Traditional Materials Procurement Strategy (TMPs).

The construction sector, just like other economic sectors in both developed and developing countries, comprise of small, medium and micro enterprises (SMME) and large enterprises. Variably, these enterprises have absolutely different goals and needs to satisfy in order to remain successfully competitive in the industry. In developing countries, South Africa inclusive, the benefits of adopting the TMPs are measured by its impact on the throughput of the various enterprises and its level of acceptance in the industry. Table 2.3 shows the benefits of adopting TMPs in the South African construction industry.

From table 2.3, it is observed that the TMPs is exceptionally beneficial to the SMME in the industry compared to the LSE principally because of the size of the enterprise. This could be

because the cost of adopting the TPMs favours the SMME in terms of the supply base, technological advancement and work base of the company.

**Table 2.3: Benefit of Traditional Materials Procurement Strategies (TMPs) in South Africa (Modified from Jooste & Van Schoor, 2003:9)**

<b>Small, Medium and Micro Enterprises (SMME)</b>	<b>Large Scale Enterprises (LSE)</b>
Cost of implementation is affordably low	Cost of implementation is affordably low
Primarily encourages the use of indigenous construction materials	Combines the usage of indigenous and transcontinental construction materials.
Supports the principles and objectives of guiding the SMME (accommodates growing companies)	Requires a streamlined supply base during procurement (accommodates few growing companies)
Materials information are easily accessible by SMME due to its purchasing nature and expenditure.	Materials information are usually accessible to some extent due to its indirect nature of purchases and large scale of expenditure.
Paper-work coping and archiving enhances personnel accountability at every stage of procurement.	Paper-work coping and archiving enhances the accountability of every procurement personnel especially in the LSE

#### **2.6.4.1.2 Criticisms and Barriers of Traditional Materials Procurement Strategy (TMPs).**

Before the inception of information and communication technology (ICT), the typical process materials procurement was systematically paper-based, as seen in Figure 2.18. In the past years, construction organisations have displayed their enthusiasm to remain competitive in the construction environment. Ironically, the TMPs approach in materials procurement has been proven by various researchers to be incapable of satisfying optimum goals of most procuring organisations (Kong, Li, & Love, 2001; Walker & Brammer, 2012). As a result, it was observed by Kong *et al.* (2004) that the TMPs is limited by the following operational factors in developing countries, South Africa inclusive. These factors are considered to be fostered by communication setbacks:

- Geographical limitation: The contractor is confined to working with only the suppliers in that geographical location, which permits little or no room for the exchange of innovative construction ideas and expatriates.
- Stipulated business hours: Purchasing companies can only make business transactions at regulated time and days i.e. Mondays–Fridays between the hours of 08h00 and 16h00 daily. Thus, this method cannot be relied on for emergency or convenience purchasing.
- Limited supplier and product information.
- The use of physical catalogue and other paper-works, makes the procurement process cumbersome and lengthy.
- The adoption of the paper-based system has made the process of materials search and cost/quality comparison a strenuous task.

Kasim (2011) noted that as a result of the ineffective purchasing system of the paper-based procurement strategy, construction companies have experienced various setbacks such as: profit due to time over-run, loss of materials information and high level of process uncertainty. Ren, Skibniewski, and Jiang (2012) further buttressed that the adoption of the traditional procurement system is being observed to reduce the competitive level of the contractors in the business market. This is as a result of the use of out-dated supplier details from catalogues, production time consumption etc.

With reference to figure 2.19, it was noticed that the process of traditional materials procurement involves the transfer of various copies of document between the procurement parties at different phase of construction. Thus, it is worthy of note that there exist a high possibility of documentation errors and data transcription. Furthermore, it is perceived that the likelihood of experiencing a bridge in information transfer in the paper-based system is inevitable due to document mix-ups or lost information. Due to the unending challenges and barriers of TMPs, the implementation of innovative approaches, such as the use of Electronic Information and Communication Technology (EICT), enabled techniques were introduced into the MP system. This approach was initiated to enhance the performance and production processes of MP activities.



#### **2.6.4.2 Electronic Materials Procurement Technology Strategy (EMPTs)**

Electronic materials procurement is simply the process of conducting business electronically. In other words, EMPT is a materials acquisition process that integrates a paperless purchasing strategy. Hence, electronic materials procurement is described as an advanced strategy that tackles the needs of an organisation or consumer at a reduced cost, improved quality and time needed (Anumba & Ruikar, 2002). Worthy of note, the term Electronic Materials Procurement Technology (EMPT) is not synonymous to Internet Materials Procurement (IMP) as represented by various researchers (Weele, 1994; Presutti, 2003; Panayiotou, Gayialis, & Tatsiopoulos, 2004; Panda & Sahu, 2012). Arguably, Ordanini and Rubera (2008) & Ronchi, Brun, Golini and Fan (2010) clarified that the acronym “E” in E-procurement simply represent the adoption of electronic devices such as computers, Tablets etc. in the process of materials procurement with the aid of the internet. The Internet facility serves as a networking technology that links an array of electronic devices to a global platform.

Extensive use of Electronic Information and Communication Technologies in EMPT facilitates effective communication, transactions and information transfer between suppliers and buyers which could either be conducted via public or private internet networks (Quesada *et al.*, 2010). Thus, the Internet is a complementary tool used in sync with most electronic technological devices to provide solutions to the challenges of the Electronic Data Interchange (EDI) and to reduce the cost of information transfer (Ordanini and Rubera, 2008; Tai, Ho & Wu, 2010). Hence, the main concept of e-procurement is to involve the end-users (customers) in the whole process of materials procurement via Internet based electronic mediums in order to close the communication gap in the supply chain.

##### **2.6.4.2.1 Development in Electronic Materials Procurement Technology (EMPT).**

The practice of Electronic Information Communication Technology (EICT) in the construction industry is rapidly gaining recognition and attention, especially with regards to the procurement of construction materials. EICT according to Kasim (2011) is defined as the use of electronic technology and software programmes for the purpose of processing, transferring, storing and presenting information between different parties. Based on the evolution of e-commerce (EC), e-procurement (EP) was initiated to create a platform for buyers and sellers to exchange purchase information. Thus, e-procurement provides a virtual space (e-market place), which permits the exchange of information (specifications and price)

between procurement participants on considerable materials via an ‘inter-organisational’ Internet-based information system (Grilo & Jardim-Goncalves, 2011).

The concept of electronic procurement has very much been in existence since the late 1960s in various forms, such as the Electronic Data Interchange (EDI), Just-in-time (JIT) programs (Rahman, 2004:34; Tai *et al.*, 2010:5398). With the advent of the World Wide Web (WWW) in the early 1990s, online trading and linkages between buyers and suppliers have been easier with lower cost and risks, if compared with the paper-based system (Grilo & Jardim-Goncalves, 2011). Subsequently, construction companies have been reported to experience faster information transfer (communication), paperless transaction documentations, reduced cost and at a defined standard. Despite the advantages incurred in the use of EDI, it is limited from being widely accepted in the industry by various factors such as technological imbalance, cost of utilisation, standardisation and conflicting communication format (Anumba & Ruikar, 2002; Walker & Brammer, 2012). As a result, the quest for other innovative techniques in implementing the EDI in the supply chain commenced.

Literature reveals that the use of the Internet enabled procurement strategy guarantees the dynamic transmission and exchange of materials information in the supply chain (Rahman, 2004; Angeles & Nath, 2007; Luzzini, Brandon-Jones, Brandon-Jones & Spina, 2015). To date, the adoption of Internet-enabled procurement strategies differ from company to company and for this reason, some companies are ahead of others in the industry. Thus, the extent to which the benefits of EMPTs incurred by companies in the construction industry are dependent on the level of innovative technological adopted.

#### **2.6.4.2.2 Benefits of Electronic Materials Procurement Technology strategy (EMPTs).**

Philosophically, the core activity in materials procurement is to search for anticipated construction materials from a wide range of available materials and enormous range of suppliers. This indicates that the process of materials acquisition tends to be time-consuming, cumbersome and expensive if not properly managed. Consequently, Bof and Previtali (2010), professed that the adoption of e-procurement creates avenues to avert the impinging challenges of procurement as a results of project delays, corruption, fraud etc. Tai *et al.*, (2010) added that the overt benefits of electronic materials procurement technology strategy during sustainable construction are to streamline the purchasing processes and reduce costs in order to enhance the company’s competitive advantage. Researchers’ over the years have

reported numerous benefits of adopting the EMPTs during construction from diverse approaches. Table 2.4 presents a cumulative summary of the benefits of EMPTs.

**Table 2.4: Benefits of Electronic Materials Procurement Technology strategy (EMPTs)**

BENEFITS	REFERENCE	INFERENCE
<b>Advanced Global Communication</b>	Kong & Li (2001); Chen, Paulraj & Lado (2004); Grilo & Jardim-Goncalves (2011); Walker & Brammer (2012); Derman <i>et al.</i> , (2012); Eadie <i>et al.</i> , (2007); Quesada <i>et al.</i> (2010); Chang & Wong (2010); Piera <i>et al.</i> (2014); Toktaş-Palut <i>et al.</i> (2014)	Company and Product promotion, Aids Environmental Supply Chain management, Customer Satisfaction, Unlimited & direct communication with suppliers (new & old); Global market place for buyers and suppliers; Wide range of materials to choose from; Standardization of communication network; Increased productivity; increases the speed of returns on investment (ROI)
<b>Reduced Transaction Cost</b>	Croom & Jones (2007); Adebajo (2010); Bot & Previtali (2010); Adebisi <i>et al.</i> , (2010); Khanapuri <i>et al.</i> , (2011); Rahman (2004); Walker & Brammer (2012); Grilo & Jardim-Goncalves (2011); Eadie <i>et al.</i> , (2007); Chang & Wong (2010); Piera <i>et al.</i> (2014); Ronchi <i>et al.</i> , (2010).	Economic benefits, Budgetary control, Materials Procurement Decentralization; Customer Satisfaction; Reduced labour cost/ overhead; Reduced materials cost; Profitability; Eliminates maverick expenditure.
<b>Easier Materials trade process</b>	Adzroes & Goulding (2004); Engstrom <i>et al.</i> , (2009); Rahman (2004); Kong & Li (2001); Eadie <i>et al.</i> , (2007); Eadie <i>et al.</i> , (2011); Chang & Wong (2010); Piera <i>et al.</i> (2014) Toktaş-Palut <i>et al.</i> (2014); Ronchi <i>et al.</i> , (2010).	Wide range of materials to choose from; Materials Procurement Decentralization, Service Standardization; Business process re-engineering; Electronically enabled supplier payment; enhanced inventory management; Global market place for buyers and suppliers; Transaction Error elimination.
<b>Reduced Transaction Time</b>	Bot & Previtali (2010); Khanapuri <i>et al.</i> , (2011); Kong & Li (2001); Eadie <i>et al.</i> , (2011); Piera <i>et al.</i> (2014) ; Toktaş-Palut <i>et al.</i> (2014).	Suppliers management, Business process Re-engineering, Customer Satisfaction, Eliminates the participation of multiple middlemen.
<b>Fraud Prevention</b>	Piotrowicz & Irani (2009); Cimander <i>et al.</i> , (2009); Gunasekaran & Ngai (2008); Chang & Wong (2010); Panda & Sahu (2011); Walker & Brammer (2012); Eadie <i>et al.</i> , (2011)	Improved technical interoperability, Legal harmonisation, Improved ICT Skills and Infrastructure, Security and Authentication integration, Risk management.
<b>Prevalent Corruption Reduction</b>	Panda & Sahu (2010); Parida <i>et al.</i> , (2010); Tatsiopoulos, Gayialis & Panayiotou, (2010); Caniato <i>et al.</i> (2010); Eadie <i>et al.</i> , (2011); Chang & Wong (2010); Neupane <i>et al.</i> (2014); Ronchi <i>et al.</i> , (2010).	Transparency, Legal Framework reformation, Internet Security improvement, efficient & effective public procurement system.
<b>Sustainable Societal Development</b>	Quayle (2005); Walker & Brammer (2012); Grilo & Jardim-Goncalves (2011); Quesada <i>et al.</i> (2010); Piera <i>et al.</i> (2014); Toktaş-Palut <i>et al.</i> (2014)	Employee development, Supports SME development, Environment protection, Waste reduction, Customer Satisfaction, Environmental purchase opportunities.

In addition to the benefits e-procurement cited above, Panda and Sahu (2012:5) illustrated in Figure 2.20 the possible drivers of e-procurement in both developed and developing countries, the impacts of these drivers on the productivity of the construction industry and its expected benefits. To buttress this, Kaliannan, Awang and Raman (2010) opined that the adoption of e-procurement in the Government system possesses the ability to deliver a cost-effective system with innovative ideas and strategies to improve the quality of public services, increase the access to information in the public sector. This process is widely known as Electronic Government Procurement (e-GP). According to Adebisi, Ayo and Adebisi (2010), e-GP is defined as the online application of EICT to procurement management in conducting the operations of activities of the government procurement cycle (GPC) which involves the acquisition of consultancy services, materials and workforces.

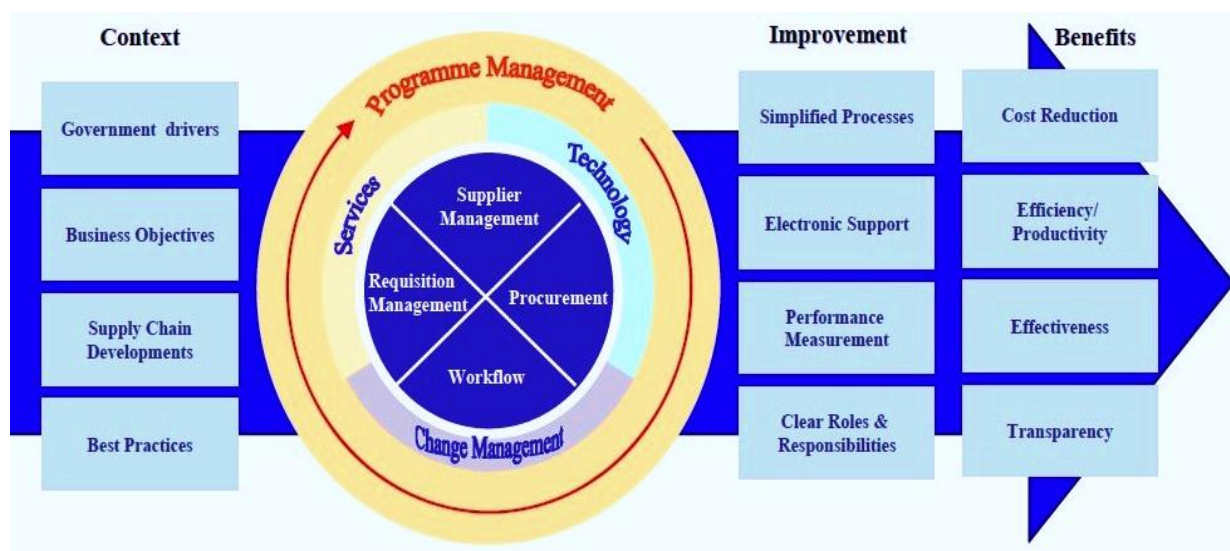


Figure 2.20: Expected Benefits of E-procurement (Adapted from Panda & Sahu, 2012:5)

#### 2.6.4.2.3 Criticisms and Barriers of Electronic Materials Procurement Technology Strategy (EMPTs)

Regardless of the numerous outstanding benefits of e-Procurement in the socio-economic sectors of a country (developed or developing), with the construction sector inclusive, there are major issues that require adequate attention in order to earn public loyalty with regards to adopting electronic procurement. In the past years to date, scholars have ‘searched’ and ‘researched’ on the challenges and barriers of encountered by construction companies since

the advent of e-procurement strategies. Eadie *et al.* (2011), in a study titled “Analysis of the use of e-procurement in the Public and Private Sectors of the UK Construction Industry”, identified that most construction companies - especially the SMEs- are financially unstable to implement the EMPT to support their building production processes.

The studies undertaken by other researchers such as: Anumba and Ruikar, (2002); Perera and Karunasena (2004); Angeles and Nath (2007); Deraman, Salleh, Beksin, Alashwal and Chafe (2012); Toktaş-Palut, Baylav, Teoman and Altunbey (2014) coincided that the following factors are immensely responsible for the protracted adoption of e-procurement in the construction industry:

- Poor Electronic information technology literacy of construction professionals
- Pitiabile state of the telecommunication infrastructures in most developing countries
- Incompliance with company’s culture due to fragmentation in the systems and principles of the construction industry.
- Porous data transfer security technologies, transaction data are prone to ‘eavesdropper’ visibility in the electronic environment.
- Lack of managerial commitment to the adoption of e-procurement
- Recurrent government regulatory issues such as ethical issues, legal issues, taxation
- Lack of standardized information transfer process
- Trust and commitment fickleness between procuring partners (suppliers and buyers)
- Tenacious resistance to transaction process modification in the construction industry (lack of e-readiness)
- Constant financial commitment in hardware, software and personnel upgrade on e-procurement usage
- Integration concerns with other systems used due to software interoperability concerns and lack of software/hardware compatibility
- Bureaucratic process dysfunctionality issues due to the nature of the governmental regulatory bodies
- Monopolization of the electronic materials procurement system
- The size of the procuring company, this mostly does not favour the Small Medium and Micro Enterprises (SMMEs).

Based on reviewed literatures, the pitiable state of telecommunication infrastructures, system integration concerns, system transaction security/authentication and unsatisfactory level of electronic information technology literacy amongst construction professionals were identified as the major barriers of e-procurement implementation in construction industries. According to Jooste and Schoor (2003) & Laryea and Ibem (2014), the impact of the Black Economic Empowerment (BEE) policies, bandwidth limitation, supply base monopolisation and the SMME policies significantly complicate the feasible adoption of e-Procurement in the South African construction industry. To this end, in order to relatively envision the impediments of implementing EMPT in the construction industry, it is expedient to understand the scope of electronic procurement technology.

#### **2.6.4.2.4 Forms of Electronic Materials Procurement Technology Strategy (EMPTs) Implementation**

The implementation process of e-procurement during materials procurement in the construction industry has revealed various merits and demerits during sustainable building production. However, maximising these merits require optimum understanding of the various forms of EMPT in order to establish suitable approaches in addressing diverse purchasing scenarios (De Boer, Harink, & Heijboer, 2002). Remarkably, each form of EMPT is engineered for specific operational purposes during procurement based on process functionality (Neupane, Soar & Vaidya, 2014).

Table 2.5 illustrates the brief description of the basic forms of EMPT as postulated by various researchers. Based on these reviews, it is believed that proper implementation of these electronic internet technology based forms during materials procurement may facilitate positive and corrective transformation in either the Cultural, Financial, Organisational, Information technological and Environmental aspects of the construction industry.

**Table 2.5: Forms of EMPT in building construction**

Form of EMPT	Description	References
<i>e-Informing</i>	The process of gathering or distributing materials and purchasing information by an organization both internally and externally, using Electronic Internet Technology (EIT)	De Boer <i>et al.</i> (2002); Essg & Arniod (2001); Boer <i>et al.</i> (2001); Neupane <i>et al.</i> (2014); Knudsen (2003); Ronchi <i>et al.</i> , (2010).
<i>e-Sourcing</i>	The process of identifying new suppliers via EIT of specifically using a B2B marketplace, for specific purchasing purposes in order to enhance competitiveness amongst suppliers. Hence, problems associated with supply delivery risks are solved.	De Boer <i>et al.</i> (2002); Boer <i>et al.</i> (2001); Chang <i>et al.</i> (2013); Neupane <i>et al.</i> (2014); Fuks, Kawa & Wiczerzycki (2013); Knudsen (2003); Panda & Sahu (2012); Ronchi <i>et al.</i> , (2010).
<i>e-Tendering</i>	This is the process of sending request for information (RFP), request for price (RFP) and other request information to suppliers and receiving responses using the EIT.	Knudsen (2003); Neupane <i>et al.</i> (2014); De Boer <i>et al.</i> (2002); Betts <i>et al.</i> (2010); Robie (2014); Grilo & Jardim-Goncalves (2011); Ronchi <i>et al.</i> , (2010).
<i>e-Reverse auction</i>	This process enables the procuring company to purchase materials at the possible lowest prices and best condition via EIT. The auction takes place in real time and closes with a bid between the buyer and supplier.	Carter <i>et al.</i> , (2004); Knudsen (2003); Neupane <i>et al.</i> (2014); De Boer <i>et al.</i> (2002); Ehr Gott <i>et al.</i> (2011); Kersten <i>et al.</i> (2012); Kong <i>et al.</i> (2001); Panda & Sahu (2012); Ronchi <i>et al.</i> , (2010).
<i>e-MRO and Web-based ERP</i>	These processes are involved in creating and approving purchase orders, placing purchase orders and receiving materials ordered via electronic internet technology supported software. The e-MRO basically focuses on materials and services required for Maintenance, Repair & Operation while the Web based ERP (Entrepreneur Resource Planning) focuses on product related items.	Bruno <i>et al.</i> (2005); Gunasekaran <i>et al.</i> (2009); Neupane <i>et al.</i> (2014); De Boer <i>et al.</i> (2002); Knudsen (2003); Yu <i>et al.</i> (2015); Panda & Sahu (2012); Ronchi <i>et al.</i> , (2010).
<i>e-Payment</i>	This form in-cooperates both the process of invoicing purchase orders and payment of suppliers for materials delivered using internet enabled electronic technologies (Electronic purchase cards, Electronic fund transfer "EFT", Electronic invoice machines etc.)	Gunasekaran <i>et al.</i> (2009); Kim <i>et al.</i> (2004); Turban <i>et al.</i> (2015); Wan <i>et al.</i> (2012); Grilo & Jardim-Goncalves (2011); Ronchi <i>et al.</i> , (2010).
<i>e-Ordering</i>	This facilitates the operational process of materials acquisition which includes requisitions, order approval and order receipt using an e- catalogue via the EIT	Grilo & Jardim-Goncalves (2011); Neupane <i>et al.</i> (2014); De Boer <i>et al.</i> (2002); Reunis <i>et al.</i> (2006); Panda & Sahu (2012) Ronchi <i>et al.</i> , (2010).
<i>e-Market</i>	This is an electronic Internet technology enabled meeting platform for suppliers and buyers for materials procurement purposes.	Kersten <i>et al.</i> (2012); Gunasekaran <i>et al.</i> (2009); Neupane <i>et al.</i> (2014); Block & Neumann (2008); Kong <i>et al.</i> (2001); Panda & Sahu (2012)

## **2.7 Construction Stakeholders**

The construction industry in its holistic nature is made up of individuals or groups of people who have the singular power/ resources at their disposal to either facilitate the furtherance of a construction project or to frustrate the success of the project. Takim (2009:168) describes construction stakeholders “*as a group of people who have the ability to influence production process and final products of a construction project, whose quality of living and environmental statues are affected by positively or negatively by the project*”. To buttress this, Smith, Love and Wyatt (2001) & Lim and Yang (2008), noted that stakeholders are direct or indirect representatives of a group of individuals who have collective interests in the benefits of a project at the end of the project and sometimes they incur huge losses during construction.

Despite the variance in the definitions ascribed to the construction stakeholder by numerous researchers, it was concluded that proper management of the needs and expectations of construction stakeholders towards satisfaction is a major factor to be considered for project success. However, Takim (2009) and Azny (2012) stated that lapses in the management of stakeholder’s requirement may result in dissatisfaction, and subsequently, project failure. Thus, it is essential to identify the classification of project stakeholders; the role of the construction stakeholder in achieving sustainability during construction, and the management principles of project stakeholders and their associated stakes.

### **2.7.1 Classification of Construction Project Stakeholders**

According to Isa, Alisa and Samad (2014), the construction project stakeholders are a team of core intellect, integrated at the planning/development phase of a building project to accomplish cross-functional construction tasks. Takim (2009) and Yudelson (2010) added that for construction efficiency and effective management during construction, an integrated project team is made up of a wide range of professionals such as: Users (owners’), general contractors, architects, project managers, consultants, engineers and government agents/commissioning authorities depending on the complexity of the project. These identified stakeholders in a project (before, during or after construction) are recognised through signed-off official agreement documents and development plans; community meetings and via media.



Literature reveals that the functionalities of stakeholders in any construction project is relevant for attaining success and sustainability during construction (Takim, 2009:167; Menassa & Baer, 2014:208). Winch (2010:13) and Manowong & Ogunlana (2010:122) reckoning with this statement added that for a smooth and organised construction process, it is essential to understand the broad classification of construction stakeholders in order to manage their interest and better relate with them. Manowong & Ogunlana (2009:122) opined that construction stakeholders can be classified into:

1. Internal or Primary stakeholders
2. External or Secondary stakeholders

The internal stakeholders in construction comprise of a group of people who have legal contact or associated with the client, project owners or core project team. Examples are end-users, project managers, project financiers, architects, engineers, contractors and materials suppliers. Whilst, external stakeholders comprise of regulatory bodies/agents, local and national authorities, community groups, land-owners and other independent groups with special interest in a project. Relatively, collective decisions made by these stakeholders have the ability to enforce the implementation of sustainable principles in building construction (Menassa & Baer, 2014; Isa *et al.* 2014).

### **2.7.2 Role of the construction stakeholders in achieving sustainability in construction**

The ultimate role of construction stakeholders in producing buildings that have the ability to meet the pressing needs of the stakeholders without compromising the satisfaction of the future generation, is making ‘imperative decisions’ on sustainability implementation (Isa *et al.*, 2014). Hence, a collective decision by a team of project stakeholders to produce sustainable building requires the initiation of a strategic planning process at the conceptual stage of the project. Storvang and Clake (2014) added that the planning process creates an opportunity for the participation of the stakeholders’ involved in a project to contribute relevant insight to the construction process. Correspondingly, Menassa and Baer (2014) proposed a guiding principle for the planning process based on ‘4-E’ (Early, Everything, Everyone, Engaging) in order to depict the values, ideas and expectation of each stakeholder and arrive at a consensus before focusing on other technical aspects of the project. Thus, the roles played by the stakeholders’ in a construction project are determined by their level of

investment and interest, and the level of stakeholders' functionality at every stage of construction is strongly related to the cost and quality of the building.

According to exploratory studies, the construction industry in both developing and developed countries accounts for four (4) key construction project stakeholders who are responsible for the sustainability performance and success of the project, regardless of the size and nature of the project (Azmy 2012; Bal, Bryde, Fearon & Ochieng, 2013; Wang & Huang, 2006). These stakeholders are:

- Project owners'
- Construction contractors
- Project manager
- Government stakeholders.

The project owners as a construction project stakeholder can either exist in form of public or private entities, such as real estate developers, clients, project land owners etc. Logically, the project owners are individuals or organisations primarily responsible for initiating construction ideas, defining project scopes and specifications (Doloi, 2013; Azmy, 2012). Wang and Huang (2006) & Robichaud and Anantatmula (2011) added that the project owners also have the responsibility of procuring construction contractors and consultants with professional capability on sustainable building production so that they can gauge the value of their investment and purchases.

The construction contractors and consultants include architects, engineers, materials suppliers who are basically responsible for generating construction documentations and physically representing on ground the building plan as in the design documents' through subcontracted and sub-subcontracted labour (Robichaud & Anantatmula, 2011). This phase of construction requires the commitment and collaborative effort of the consultants' and contractors in integrating the principles of sustainability throughout the stages of the construction project.

The construction project manager has the role and responsibility of managing the construction schedule plan, communication amongst workers and the management of construction risks during construction for critical sustainable project planning based on quality (Isa *et al.*, 2014). Consequently, the construction project manager ensures that the project owners understands the process of sustainable construction, probable challenges and balanced opinion on the

construction strategy before and during project construction. Thus, the major attribute of a successful project manager is the ability to understand the roles, power and influence of the various stakeholders' involved in a project which is usually obscure (Manowong & Ogunlana, 2010).

The government agencies assume the role as custodians of building regulatory policies and codes that promote the scopes and objectives of sustainable building practices. Perkins *et al.* (2011) added that having the local government as a stakeholder involved in the planning phase will ensure that the project design plans comply with regulations and are approved in time for construction. Thus, government stakeholders are organisations or agencies who offer exclusive information on a particular project to ensure that the needs of the local communities are met, as well as financially supporting the project.

### **2.7.3 Construction Stakeholders' Management (CSM)**

The theory of stakeholders' management was first hypothesized by Freeman in 1984. Freeman stated that the framework of co-operate organisations constitutes of various groups with diverse interests and the act of creating and maintaining the supports of these groups by considering and balancing their interests is known as 'Stakeholder Management' (Freeman, 1984:246; Freeman, 2010). According to Nash, Gameson and Suresh (2010), stakeholder management is entrenched in the concept of business management where the ideology of ethical factors are accentuated and facilitated by economic, social, legal and environmental factors during implementation. To buttress this, Yang, Shen, Ho, Drew and Xue (2011) highlighted that the process of stakeholders' management affiliated with the concept of 'Cooperate Social Responsibility' sustainable building construction.

Comprehensively, Construction Stakeholders' Management (CSM) is a project management strategy, which aims at analysing and managing the differing interests of stakeholders throughout the entire period construction without inflicting any harm on the stakeholders (Chinyio & Olomolaiye, 2010). Thus, CSM is simply the process of identifying project stakeholders at the early stage of a project and earning their support throughout. Research shows that effective management of construction stakeholders' is an essential factor considered for project success (Manowong & Ogunlana, 2010; Atkin & Skitmore 2008; Newcombe, 2010). Otherwise, the construction project will be resolved, usually during construction, due to mismanagement and misunderstandings amongst stakeholders.

Chinyio and Olomolaiye, (2010) suggested that in managing the diverse interests of stakeholders' towards satisfaction, a proactive management approach is considered appropriate in order to off-set the reactive nature of construction stakeholders (CS). Worthy of note, the management approach adopted during sustainable construction could be direct or indirect, detailed or sketchy, formal or informal depending on the nature, size and requirements of the construction project (Manowong & Ogunlana, 2010). Clarkson (1999), a patriot of the stakeholders' management theory, illustrated in Table 2.6 seven (7) principles guiding the stakeholders' management approach.

**Table 2.6 Principles of Construction Stakeholders' Management (Adapted from Clarkson 1999).**

<b>PRINCIPLES</b>	<b>PREREQUISITES FOR PROJECT MANAGERS</b>
<i>P 1</i>	Prompt recognition and appropriate consideration of legitimate stakeholders' requirements at the planning stage of a project.
<i>P 2</i>	Maintain a transparent and efficient communication strategy with stakeholders to relate on their concerns and contributions.
<i>P 3</i>	Relate with each stakeholder in a uniquely based on their concerns and capabilities
<i>P 4</i>	Acknowledge the co-operate efforts the stakeholders and fairly justify the distribution of profits and losses based on the risks incurred by each stakeholder
<i>P 5</i>	The engagement of external stakeholders should be encouraged to reduce the risks result from internal cooperate activities.
<i>P 6</i>	Activities involving the stakeholders' must promote the inalienable human rite of the stakeholder (Right to life, sustainable environment, good health etc.) at minimal risk level.
<i>P 7</i>	Divergence in stakeholders interest as a result of conflicts based on co-operate roles and legal/moral responsibilities should be addressed through open communication and report documentation.

According to Manowong and Ogunlana, (2010) & Menassa and Baer (2014), the implementation of stakeholders' management principles in project management are made effective through the adoption of the following strategies:

- **Engagement:** This strategy involves the close participation of stakeholders in all activities and decision-making processes to ensure that their needs and concerns are duly considered during construction.

- **Consult:** This strategy attracts the commitment of influential secondary stakeholders during project execution. The stakeholders are consulted to seek their opinion regarding important issues to ensure satisfaction.
- **Inform:** This strategy ensures that stakeholders are updated on the progress and decisions made throughout the construction process. To an extent, the stakeholders may not necessary partake in the decision making.

The prime merit of construction stakeholder management is to enable construction organisations' secure business continuity and satisfaction with its stakeholders to gain competitive advantages in the industry. However, the size of participating companies could be a major disadvantage to the economy of the country if its stakeholders are not properly managed. This statement was supported by Olander and Atkin (2010) who stated that about 95% of construction companies in developing countries are small or medium scaled companies which have an impact on the productivity of the county. Thus, to flawlessly manage the categories of construction stakeholders in the industry despite the size of participating companies, it is expedient for the project manager to be acquainted with the following management factors:

- **Stakeholders' Analysis:** This is a strategy implemented by managers to identify and describe stakeholders based on their attributes, interrelationships and interests regarding a project (Grimble & Wellard, 1997:173; Manowong & Ogunlana, 2010:122; Atkin & Skitmore 2008:550)
- **Stakeholders' Power:** This is the actual ability of a stakeholder to influence the progressive statues of a project, positively or negatively (Manowong & Ogunlana, 2010:122; Chinyio & Akintoye, 2008:592; Nash *et al.*, 2010:473). Thus, the power allocated to a stakeholder is commensurate to the involvement and level of expected contribution to the project.
- **Stakeholders' Interest:** This is simply the stakeholder's desire to influence the process construction to satisfy his needs (Chinyio & Akintoye, 2008:597; Nash *et al.*, 2010:473).
- **Stakeholders' Influence:** This refers to a group of stakeholder who have both high power and interest is considered to have a great influence on the project (Manowong & Ogunlana, 2010:123; Atkin & Skitmore 2008:550). Thus, stakeholders' influence is

described as the extent to which stakeholders can effect changes in the sustainability statuses of a project, dependent on the power and interests of the stakeholders’.

- **Stakeholders’ Importance:** This is described as the influence of construction project operations and products on the needs, objectives and requirements of construction stakeholders’ (Manowong & Ogunlana, 2010:123). This enables the project manager to know who the target groups are in any sustainable building project and how to satisfy their needs to attain project success.

Conclusively, based on these definitions, the primary stakeholders are deemed important and influential in every aspect of a construction project, especially in making decisions on integrating sustainable principles during construction. Furthermore, decisions to produce sustainable buildings begin first with the demand for facilities that support the stable “socio-economic, ecological and technological” prestige of the stakeholders. This phase is followed by putting into consideration the best strategies for achieving sustainability such as strategic materials procurement, sustainable planning and design processes and premeditated Government policy implementations. Comparatively, the roles and position of secondary stakeholders are either important or influential in terms of decision making towards sustainability, for example, government regulatory bodies.

## **2.8 Government Procurement Policy**

The activities of the construction industry are recognized for contributing immensely to the national socio-economic status of a country, which directly or indirectly have adverse effects on the environment. Consequently, these factors have attracted the attention of the government to the essence of regulating and controlling the process of construction in a country towards sustainable development. In an attempt to balance the effects of construction activities sustainably, the government in recent years have intensified the use of procurement powers as a regulatory tool (Bolton 2008:1). The government - being the custodian of any country - has assumed the responsibility of the principal purchaser of good and services for development projects.

Dlungwana, Nxumalo, Van Huyssteen, Rwelamila and Noyana (2002) reported in a study that the government is singly the biggest client in the construction industry, contributing over 40% to the gross domestic construction expenditure. As a result, the procurement activities by the government in both developed and developing countries claim the largest proportion of the

total budget of expenditure for sustainable development achievement (National Treasury, 2004). To buttress this point, Musa *et al.*, (2013) affirmed that the fundamental role of government procurement in sustainable construction is to induce the demand for economic and social friendly building with minimal impact on the environment. According to Lim and Yang (2008), in some project, the government is regarded as a primary stakeholder and otherwise as a secondary stakeholder. Thus, the government's participation in procurement is a vital strategy in achieving ecological, socioeconomic and technological advancement in the society.

Ambe and Badenhorst-Weiss (2012b:244) defines government procurement as *the process of acquiring goods, services and construction project development from suppliers in the local and international market, subject to the general principles of fairness, equitability, transparency, competitiveness and cost-effectiveness for successful project and service delivery*. Therefore, sustainable government procurement, in the context of materials procurement, is defined as the process of securing construction materials through specific legal frameworks and policies to manage the implementation of sustainable principles in order to protect the environment and the socio-economic well-being of the citizens during building production. Furthermore, Son *et al.*, (2011). & Govender and Watermeyer (2001) highlighted that the adoption of legal procurement frameworks and policies by the government will enhance the promotion of socio-economic objectives and construction industry efficiency through controlled materials acquisition.

Literature reviews that the adoption of electronic technologies can improve the procurement activities of the government through reduced transaction costs, better quality and prompt decision making towards effective project delivery (Isa *et al.* 2014; Panayiotou *et al.*, 2004). This indicates that the efficiency of sustainable building practices in the industry can be improved through strategic construction knowledge and policies adoption into construction (Son *et al.*, 2011). Correspondingly, Musa *et al.* (2013) & Yang and Zhang (2012) added that successful implementation of sustainable building principles necessitates the familiarity of construction organisations and actors with policies, legal frameworks and regulations related to the concept of sustainability. Thus, the government (in its diversity) is best liable to deal with financial, regulatory, policy and guidance impediments related to materials procurement in sustainable building construction.

## **2.8.1 South African Government Procurement Policies**

In the past decades, precisely the early 1980s and late 1990s, Mathonsi and Thwala (2012a) accounted that the procurement system in South Africa was based on the British model established by the British colony was during the apartheid period. However, due to the variance in the political and institutional set-up of South African and Britain, the founded model was ineffectively adopted into the South African construction industry. This led to a focal change in the professional practices orientation from the first-world construction model to a developing world construction model of operation (Bolton, 2006).

The Department of Public Works (DPW) (1999), attested that the reformation in the procurement system focused on the adoption of congenial construction polices, is aimed at fostering socio-economic and environmental development governance in the Republic. Ramabodu (2013) indicated that these frameworks and Acts include: the Preference Procurement Policy Framework Act (PPPFA) of 2000; Act No. 108 of the 1996 South African Constitution; Public Finance Management Acts (PFMA), Broad-Based Black Economic Empowerment Act (BBBEEA), Electronic Communication and Transaction Act No 25 of 2002. Thus, the South African construction industry is a vital sector of the economy which enhances the furtherance of government policies towards economic and social benefits (CIDB, 2004; Ambe & Badenhorst-Weiss, 2012b).

Generally, the participation of the South African government in procurement is basically a tool to correct past unruly and discriminatory policies and procurement practices. According to Bolton (2006), the South African procurement Act is aimed at enhancing the participation of Historically Disadvantaged Individuals (HDI) and Small Medium and Micro Enterprises (SMMEs) in procurement to ensure work efficiency, effectiveness, accountability and transparency during construction. Thus, it is essential to have a focal understanding of the Acts and Regulations of Procurement in South Africa.

### **2.8.1.1 Section 217 of the 1996 Constitution of the Republic of South Africa.**

The constitution of a country defines the right and obligations of its citizens and also provides a framework or mechanism to keep the legislators in check (South African Constitutional Court, 2009). The South African constitution is extensively recognised as one of the most developed constitution worldwide. Prior to the establishment of the 1996 Constitution (Section 217) Act No.108, the 1993 Constitution (Section 187) was promulgated with the aim



of instituting government procurement as constitutional principles of sustainability. As an upgrade to the 1993 Constitution (Section 187), the 1996 Constitution was recognised to facilitate the use of procurement as a policy tool in any organ of state (national and provincial department, municipalities and public entities). Table 2.7 indicates a conclusive description of the objectives of Section 217 as contained in the Constitution. Section 217, sub-section 3 of the Constitution necessitates “the provision of a prescribed framework by the national legislation within which the policy in subsection (2) must be implemented” (Ambe & Badenhorst-Weiss, 2012b).

This indicates that Section 217 of the 1996 postulates the use of procurement as a policy tool to provide opportunities to Historically Disadvantaged Individuals’ (HDIs) in the society.

**Table 2.7: Government Procurement Objectives with respect to Materials Procurement in South Africa as set out in the Constitution (Adapted from Ambe & Badenhorst-Weiss, 2012b:247; Watermeyer, 2011b:3)**

Objective		Reference
<b>Primary</b>	Procurement system to be fair, equitable, transparent, competitive and cost-effective	Section 217(1)
<b>Secondary</b>	Procurement policy may provide for: 1. Categories of preference in the allocation of contracts. 2. The protection or advancement of persons or categories of persons, disadvantaged by unfair discrimination.	Section 217(2)

### **2.8.1.2 Preferential Procurement Policy Framework Act No 5 of 2000 (PPPFA)**

The preferential procurement policy framework Act (PPPFA) was established in response to the imperative nature of the Section 217 (2) of the Constitution which gives effect to the framework formation of section 217 (3). To buttress this, Hlakudi (2012) added that the framework formed in Section 217(3) permits the implementation of preferential procurement in government. According to Bowen, Pearl, and Akintoye (2007), PPPFA was promulgated by the government to allow preference in the allocation of contracts to advance the interests of the HDIs in the society with the intention of meeting the Reconstruction and Development Programme (RDP) goals. To buttress this, Section 2(1) (d) stipulates that every organ of state in the country must have in place the PPPFA.

In order to properly adopt the PPPFA into the procurement system, the government introduced a strategy referred to as the “Target procurement strategy” or “Affirmative procurement strategy”. According to Bolton (2008), this strategy is aimed at providing opportunities to a ‘target group’ to participate in public procurement with or without adequate resources, expertise and capacity to execute contracts independently. The strategy as postulated by the government in an attempt to achieve socio-economic goals led to the creation of jobs, poverty alleviation, use of indigenous materials etc (Bolton 2008).

#### **2.8.1.3 Public Finance Management Act No 1 of 1999 (PFMA)**

Finance management in the public sector is aimed at controlling and accounting for the use of funds to achieve optimum output in government development operations. Thus, Public Finance management is described as an integrated government activity which influences the allocations of funds and resources (Evans, 2014). Evans (2014) further highlighted that this management activity encompasses every aspect of the government’s budgetary policy such as budget preparation, accounting, internal and external audit, procurement and financial resource monitoring to ensure a long-term socio-economic success.

In South Africa, Section 76 subsection 4 of the Public Finance Management Act (PFMA), Act 1 of 1999 was enacted as a standardised framework for appropriate procurement system to ensure which is fair, equitable, transparent, competitive and cost-effective (Watermeyer 2011b). Subsequently, Section 122 of the PFMA was endorsed by the government to permit the issuance of regulatory frameworks by the ministry of Finance to provide guidance for specific SCM setbacks (Ambe & Badenhorst-Weiss, 2012b). Furthermore, Section 38 of the PFMA Act 1 of 1999 of the constitution provides a framework for fraud and corruption prevention to both National and Provincial Treasury departments (Mafunisa, 2014). Thus, effective adoption of the public finance management acts serves as a major platform for government policies implementation with regards to materials procurement.

#### **2.8.1.4 Broad-Based Black Economic Empowerment Act 53 of 2003 (BBBEEA)**

The Broad-Based Black Economic Empowerment Act (BBBEEA) is government initiative programme enacted towards the even distribution of economic benefits with a broad base of ‘historically disadvantaged individuals’. Consequently, the BBBEEA was endorsed into the constitution to enable the government adopt procurement contract policies which promotes the empowerment of HDIs in the society (Bowen *et al.*, 2007). Hlakudi (2012) further

highlighted that the HDIs are basically Black people, youths and women who have interests in increasing their participation in the economy in both private and public sector. Also in terms of South African citizenship, the term ‘Black-People’ is a generic term used to identify Africans, Indians and Coloured population of South Africa from the apartheid era till date (Republic of South Africa, 2003; Mparadzi, 2014). Thus, the BBBEE Act supports the legislative framework for the endorsement of the Black Economic Empowerment programme to promote constitutional and social equality amongst citizen (Hlakudi, 2012; Mparadzi, 2014).

Worthy of note, the PPPFA and the BBBEEA have been enacted to achieve similar objective of promoting socio-economic equality in the society especially with SMMEs (Ambe & Badenhorst-Weiss, 2012b; Hlakudi, 2012). Hence, this depicts the importance of conceptualising an affirmative action on the part of the government to directly or indirectly support SMMEs materials suppliers and contractors. Table 2.8 summarises various Procurement Acts and Policies in practice in the South African Construction industry.

**Table 2.8 Primary Acts and Policies that regulate Government procurement in South Africa (Watermeyer 2011:3)**

ACTS AND POLICIES	INFERENCE
Public Finance Management Act 1 of 1999 (PFMA)	Establishes a regulatory framework for SCM, which includes procurement in national and provincial departments and state-owned enterprises.
The Promotion of Equality and the Prevention of Unfair Discrimination Act 4 of 2000	Prohibits the state or any person from discriminating unfairly against any person on the grounds of race or gender through the denial of access to contractual opportunities for rendering services or by failing to take steps to reasonably accommodate the needs of such persons.
Preferential Procurement Policy Framework Act 5 of 2000 (PPPFA)	Establishes the manner in which preferential procurement policies are to be implemented.
Construction Industry Development Board Act (CIDB) 38 of 2000	<p>Establishes the means by which the Board can promote and implement policies, programmes and projects, including those aimed at procurement reform, standardisation and uniformity in procurement documentation, practices and procedures within the framework of the procurement policy of government, through the establishment of:</p> <ul style="list-style-type: none"> <li>• A national register of contractors (and if required, consultants and suppliers) to manage public sector procurement risk and facilitate public procurement;</li> <li>• A register of projects above a financial value with data relating to contracts awarded and completed and a best practice project assessment scheme;</li> <li>• Best practices</li> </ul> <p>Establishes a code of conduct for the parties engaged in construction</p>

	procurement.
Broad-based Black Economic Empowerment Act 53 of 2003 (BBBEEA)	Establishes a code of good practice to inform the: <ul style="list-style-type: none"> <li>• Development of qualification criteria for the issuing of licences or concessions, the sale of state-owned enterprises and for entering into partnerships with the private sector; and</li> <li>• Development and implementation of a preferential procurement policy.</li> </ul>
Local government: Municipal Finance Management Act 56 of 2003	Establishes a regulatory framework for SCM which includes procurement in municipalities and municipal entities.
Prevention and Combating of Corrupt Activities Act 12 of 2004	Makes corruption and related activities an offence; establishes a Register in order to place certain restrictions on persons and enterprises convicted of corrupt activities relating to tenders and contracts; and places a duty on certain persons holding a position of authority to report certain corrupt transactions.

### **2.8.2 Impact of Government Procurement Regulatory Legislation and Acts on materials procurement during Sustainable Building Production**

The composite function of government procurement regulatory bodies and acts during sustainable building production is basically focused on human rights, economic growth and the environment protection. Gibberd (2011) buttressed that enacted legislations and acts are hands-on measures established to ensure sustainable ecological development and tenable socio-economic growth through the use of natural resources for construction. Thus, the South African Government's procurement Acts and constitution infers the following for the process of sustainable building construction as postulated by Gibberd (2010:4):

- The process of sustainable building construction should ensure a favourable environment is created for the development of the social, physical and mental well-being of the inhabitants.
- The process of construction should take into consideration the traditional rights, values, present and future demands of the indigenes.

A review of the South African Constitution indicated that the objectives of sustainable development are definite requirements to endorse sustainable building production in the country. It was proposed in clause 4.27 of Section 217 (2) cited in Bolton (2008:2) that to achieve the goals of sustainability in the organs of state, it should: *buy only from vendors who are in compliance with all environmentally-related legislation; promote environmental awareness amongst suppliers, government officials, service providers and contractors; favour procurement of less environmentally damaging products; develop and maintain a database of vendors in which information relating to their environmental conduct is retained; develop and*

*promote a code of conduct for vendors; develop a policy with respect to the use of construction materials and waste treatment to manage the total life cost of sustainable construction.* As a result, the key legislations implemented in procurement for controlled sustainable building development in South Africa includes the South African Bureau of Standards (SABS 1990b), Section 217 & 24 of the constitution and the National Environmental Management Acts (NEMA). Adshead (2011:144) buttressed that these Acts and legislations were enacted to encourage the procurement of alternative and indigenous materials for production of affordable and sustainable buildings. Thus, this implies that procurement can be adopted as a tool of environmental policy, social policy and economic policy in-terms of materials acquisition, construction cost and job creation during sustainable building production.

## **2.9 Chapter Summary**

This chapter presents reviewed literature established a broad foundation of factors that influence the effectiveness and efficiency of materials procurement strategies during sustainable building production. Literature revealed that the impact of factors, such as materials management, stakeholder's management and government policies on materials procurement strategies, possess the capability to either promote or relegate its adoption. This factors significantly vary depending on the construction project, country and the foundational circumstances of the project. However, previous studies revealed that the South African construction industry as a major contributor to the gradual environmental degradation and socio-economic collapse of most civic societies as a result of the unruly acquisition of construction materials by contractors. This is known to directly or indirectly affect the well-being of the stakeholders. Thus, the government and construction professionals in every organ of state are challenged with producing environmental friendly and cost-effective buildings, in terms of materials procurement, within budgeted time.

Materials procurement is described as the most critical stage in the process of sustainable building construction. Literature revealed that the activities of materials procurement have significant impacts on the sustainability statues (environmentally, socially and economically) of the society and productivity of the organisation. The communication system, supplier selection, outdated materials information, fluctuating cost of materials, insufficient supply base and technical illiteracy were revealed as the main challenges of materials procurement. Consequently, these factors affect the cost, quality and time of building delivery. Thus, it is

imperative to effectively manage the materials procurement process to insure sustainability in the production of buildings.

In an attempt to proffer solutions to these challenges, literature revealed that as regards legal policy associated to effective materials procurement adoption in the industry, there is need for appropriate policy legislation by the government. Therefore, the effectiveness of the materials procurement strategy in securing reduced procurement cost at optimum quality and time towards clients' satisfaction is considered as the major focus of construction industry.

## CHAPTER THREE

### RESEARCH METHODOLOGY AND DESIGN

#### 3.1 Introduction

Based on the preceding research objectives, the previous chapter provided a review of theoretical and empirical literature towards achieving the aim of the study. This chapter presents the methodology adopted for data collection and analysis processes. Relatively, Leedy and Ormrod (2010) described research methodology as a section in a study that illustrates and dictates the step-by-step process on conducting a research. That is from phase of data acquisition to data analysis and conclusion. Thus, the research methodology section is a platform for researchers to justify their research method decisions in achieving the research objectives by way of answering the research questions.

This chapter begins with a general overview of various types of research methods, followed by the specific research design adopted for this study. Prior to the adoption of a research design, the research problem and questions are considered ultimate in selecting an appropriate methodology for the research. Therefore, this chapter encompasses design, sampling techniques, data collection strategy, process of analysis, the rationale for these selection and importantly the test of validity and reliability of the research tool.

#### 3.2 Research Methodologies

Research methodology as earlier stated is a holistic process of acquiring, analysing and interpreting data with the soul aim of reaching a conclusion that expands the knowledge of a phenomenon or study (Leedy & Ormrod, 2010). According to Fapohunda (2014), research methodology is the process of weighing merits and demerits of various research methods, so as to identify the best appropriate methods for research. Leedy and Ormrod (2010) further stated the primary functions of the research methodology are:

- To set a standard for data acquisition
- To collate the data after their acquisition and give interpretations to them.

Research is cyclic process of study in nature; it entails several tentative and logical steps in reaching a comprehensive solution to the research questions. These steps are clearly

illustrated in Fig 3.1 In agreement, Collis and Hussey (2009) and Biggam (2011) highlighted the relevance of relationships between the research methodologies, methods of data collection and the techniques of data analysis. The authors' stated that principal concerns of a researcher in methodology designs in order to solve research problems are:

- What are data to be collected (Research concept);
- Why those specific data being are collected (Significance);
- Where the data will be collected (target population);
- When the data collection will be coordinated;
- How the data will be collected and analysed.

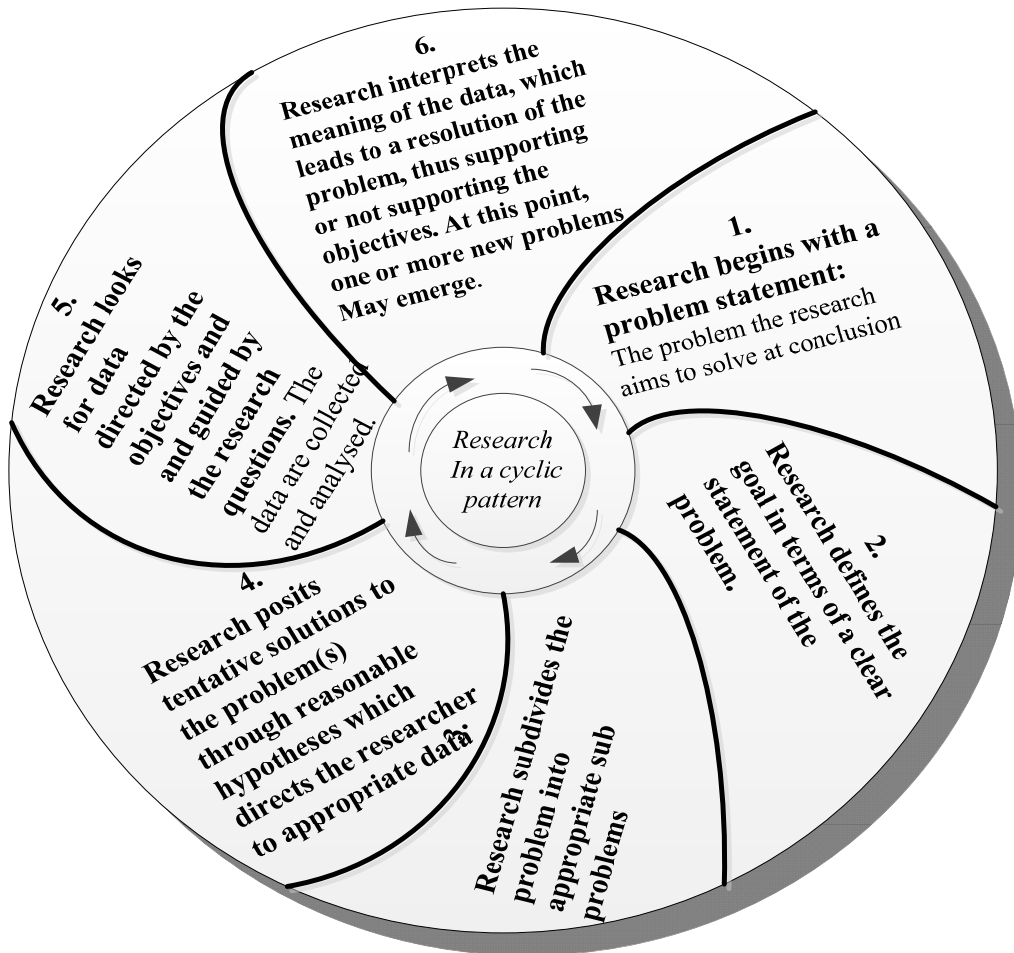


Figure 3.1 The research cycle (Adopted from Leedy & Ormrod, 2010:7)



### **3.2.1 Quantitative research method**

The quantitative research is basically the measurement of quantities, numbers and amounts (Kothari, 2004). The quantitative research is a systematic process of using numerical data from a selected sample group of a population to generalise the findings to the population of study (Maree & Pieterse 2007). Thus, this method is said to use the statistical method of analysis and presenting the results numerically (O’leary, 2010). According to Thomas (2003:2), the quantitative research method allows the researchers to obtain generalizable and predictable results from a large population within a short time and at low cost. In addition, Maree and Pieterse (2007) and Flick (2011) buttressed that this research method is characterised by these three (3) elements:

- Objectivity
- Numerical results(data)
- Generalizability

Quantitative research method is a goal-oriented procedure of research, which postulates inter-subjective realities as a standard for quality assurance (Kromre, 2006). As a result the collection of a qualitative data often time involves the use of a close-ended questionnaire or checklist (Creswell & Clark 2007). Notably, various methods have been identified for conducting a quantitative research, they include: theoretical studies, descriptive research, developmental studies (case studies & surveys) and correlational studies (Leedy & Ormrod, 2005).

### **3.2.2 Qualitative research**

Leedy and Ormrod (2005) expressed that the qualitative research is a broad method to research which encompasses several approaches, techniques and philosophies. The qualitative research method involves the use and collection of various empirical data, for example: observational, interview, life story and historical studies (Creswell & Clark 2007). In addition, the qualitative research method is involved is an attempt of collecting in-depth descriptive data concerning a particular phenomenon with the aim of improving knowledge (O’leary, 2010). Similarly, Flick (2011) posited that this method is basically concerned with acquiring an intent understanding of the social, cultural and behavioural patterns of people in an environment by observing or interacting with the participants of the study.

Noteworthy, the qualitative research methodology is an ‘umbrella term’ which houses and shows the relationship between ranges of research paradigm (Nieuwenhuis, 2007). These paradigms include ontology, epistemology, nomothetic, positivism, and ethnography (Nieuwenhuis, 2007:76).

**Table 3.1: Characteristics summary of qualitative and quantitative research methods (Macdonald and Headlam, 2008:9)**

	<b>Quantitative</b>	<b>Qualitative</b>
<b>Aim</b>	The aim is to count things in an attempt to explain what is observed	The aim is a complete, detailed description of what is observed.
<b>Purpose</b>	Generalizability, prediction, causal explanations	Contextualization, interpretation, understanding perspectives
<b>Tools</b>	Researcher uses tools, such as surveys, to collect numerical data.	Researcher is the data gathering instrument.
<b>Data collection</b>	Structured	Unstructured
<b>Output</b>	Data is in the form of numbers and statistics	Data is in the form of words, pictures or objects
<b>Sample</b>	Usually a large number of cases representing the population of interest. Randomly selected respondents	Usually a small number of non-representative cases. Respondents selected on their experience.
<b>Objective/Subjective</b>	Objective – seeks precise measurement & analysis	Subjective - individuals’ interpretation of events is important
<b>Researcher role</b>	Researcher tends to remain objectively separated from the subject matter.	Researcher tends to become subjectively immersed in the subject matter.
<b>Analysis</b>	Statistical	Interpretive

### 3.2.3 Mixed method research

Mixed method research involves the adoption of philosophical assumptions in the collection and analysis of both quantitative and qualitative data in a single research work (Creswell & Clark 2007). In addition, implementation of this combined state of qualitative and quantitative provides a better understanding of the research focus (Creswell & Clark 2007). The mixed research approach gives the researcher an opportunity increase the validity of the research where one method covers-up for the lapses of the other leaving no room for personal bias (Henn, Weinstein & Foard, 2006). Thus, the mixed method enhances the integration of a variety of pragmatic and theoretical perspectives, which has been seen as a challenge of the qualitative and quantitative method separately (Creswell, Klassen, Plano-Clark and Smith

(2011). The merits of integrating the qualitative and quantitative method postulated by Creswell and Clark (2007:9) are as follows:

1. The mixed method of research provides solutions to questions the qualitative or quantitative approach cannot answer unaided.
2. The mixed method research provides the researcher a broader and more comprehensive perspective on the area of study.
3. The mixed method researcher is encouraged to utilise various paradigms associated to both research methods (qualitative and quantitative method).

Conversely, despite the advantages of the mixed method research, researchers are faced with some challenges in the course of their research. These challenges according to Creswell and Clark (2011:8) include:

1. The process of collecting and analysing of multiple data is time and resource consuming.
2. It complicates the process of data collection in research
3. It requires multidisciplinary and specialised team work for data interpretation
4. Sampling size involved the design and data collection

### **3.3 Research Philosophies**

Research philosophy is a term used to describe the evolution and nature of a specific knowledge (Bandaranay, 2012). The philosophical stance of a research guides and justifies the researchers' decisions (philosophical or theoretical) (Greene, 2006). According to Biggam (2011:136), the pillars of the philosophical stance of research include:

- Positivism (Realist)
- Interpretivism

#### **3.3.1 Positivism**

Positivism is a terminology used to describe the quantitative nature of a research (Biggam 2011). The positivist research is characterised by the ability of researcher to test hypothesis derived from existing theories by observations or measurements of social realities (Flowers, 2009). Lawrence (2000) defined positivism as a research paradigm based on scientific knowledge or experimental testings' without the influence of human participation. Arguably,

Biggam (2009) highlighted that a positivist research in the sociology and history is influenced by human participation and observation based on the concept of obtaining quantifiable data for research. Therefore, this concept involves the use of quantitative methods – questionnaires, experiments and interviews - and statistical analysis which dependent on the human responses and experience. Thus, human participation is inevitable (Kumar, 2011; Eriksson & Kovalainen, 2008). Eriksson and Kovalainen (2008) posed the basic philosophical positions of a positivist research include that:

- Knowledge is derived based on results obtained from the application of scientific methods to test observations and hypothesis.
- The research aims at finding explanations and regularities on the causes and effect of a given phenomenon.

### **3.3.2 Interpretivism and Constructionism**

The Interpretivism paradigm of research is described as a philosophical position aimed at interpreting and understanding the theoretical content of a data by adopting the principles of social sciences (Eriksson & Kovalainen, 2008). The authors also stated that the philosophical background of an Interpretivism research is based on hermeneutic and phenomenology to give subjective meanings to an objective phenomenon. The interpretivist is concerned with the adoption of unstructured qualitative approach in data collection, which may include in-depth interviews with the participants (Henn *et al.*, 2006). In addition, the primary focus of the researcher is to understand, interpret and give meanings to social realities from their perspective (Flowers, 2009). Thus, the Interpretivism philosophy of research is based on four (4) assumptions as identified by Burr (2003) as:

- It presents a critical stance and scrutiny on hidden, forgotten or undiscovered knowledge (objective information).
- The knowledge derived is sustained by qualitative methods and social relations with participants.
- Subjective knowledge and social processes and actions are relative.
- The languages used for data interpretation are derived from social interaction with the participants in a particular place and time.

### **3.4 Research Approach**

#### **3.4.1 Deductive approach**

The deductive approach to research was first orchestrated by the Ancient Greeks and later modified by Aristotle through the use of deductive syllogisms (Walliman, 2012). A deductive approach to research comprises of logical arguments which begins with general statements with the aim of reaching a specific conclusion (Walliman, 2005). According to Dahlberg and McCaig (2010), deductive research approach involves the process of generating hypotheses from a general truth or statement to reach a definite conclusion. The results reached in deductive research are obtained by testing these hypotheses empirically (Dahlberg & McCaig 2010). Thus, the principles of this research approach can be adapted in a qualitative research (Bryman, 2012).

#### **3.4.2 Inductive approach**

The inductive approach to research is the most frequently used approach in most scientific research. It involves the process which begins with a specific observation or survey and thereafter general conclusions are derived as results (Walliman, 2012). The inductive research approach compared to the deductive approach, contributes to a general known truth about a theory. The validity of the conclusions is dependent on the strength of the supporting evidences; i.e. the stronger the supporting evidences are, the more likely the conclusions are proven valid (Mouton, 1996; Walliman, 2005). However, Walliman, (2005) further stated that an inductive (generalized) result can only be regarded legit if it satisfies the following conditions for inductive research approach.

- A large size of population for survey or observation is required.
- The observation or survey must be coordinated repeatedly under different conditions.
- The derived observed empirical data must correspond with the generalized result.

#### **3.4.3 Inductive/deductive approach**

The Inductive/deductive approach is a combination of observatory reasoning and logical argument in research. It involves the process of developing and testing hypotheses to form a foundation for potent additional knowledge, mostly scientifically based (Walliman, 2012). Noteworthy, this derived knowledge, after being tested, can either be accepted or rejected based on the aim of the research. The application of this combined approach to research

denotes the process of seeking valid statements (truth) from opposite school of thoughts (Walliman, 2005). Henn *et al.* (2009) identified that, in a scientific research, researchers can be required to begin the research process with an inductive exploratory approach to generate hypotheses, which will be tested using the deductive explanatory approach to reach a valid conclusion. Thus it adopts the principles of quantitative and qualitative methodology for research.

### **3.5 Research Strategies**

Literature has reviled numerous research strategies for the usage of qualitative, quantitative and mixed research methods (Walliman, 2012; Leedy & Ormrod, 2010; Walliman, 2005). These research strategies include case studies, structured interviews, phenomenological study, historical research, action research, experimental studies, quasi-experimental studies and also theoretical research studies (Bryman, 2012; Biggam, 2009; Walliman, 2012; Leedy & Ormrod, 2010; Creswell *et al.*, 2007).

#### **3.5.1 Survey research**

Survey research according to McMillan and Schumacher, (2001) and Crowther, Smits and Herbst (1994) cited in Maree and Pieterse, (2007:155) is a systematic process which requires the selection of respondent samples by the researchers before the survey tools are administered (questionnaires) or conducted (interviews) for data collection on their values, beliefs and views.

Similarly, O’leary (2010:181) defined survey research “*as the process of data collection by asking a selected set of individuals the same questions based on their characteristics, attitude and ways of living by administering questionnaires*”. Cohen, Manion and Morrison (2001) and Henn *et al.*, (2006:126) expressed that the basic aim of the survey research is to “*explore, understand and interpret phenomenon(s) which exists presently*”. Dahlberg and McCaig, (2010) added that the proportion of information derived from the survey participants is vital in determining the validity and reliability of the study. This infers that generalisation of research results in any study is dependent on the response rate of the research population. Thus, survey research according to Maree and Pieterse (2007) is characterised by the following:

- Large sample size
- Numerous variables are measured to generate related hypothesis for testing
- The result can be generalised

### 3.5.2 Historical research

The historical research is defined as an effort undertaken by a researcher to interpret historic events through the collection and analysing of relevant historic documents or oral histories (Leedy & Ormrod, 2010). According to Borge (1963) cited in Walliman, (2005:113), a historical research is a systematic and objective process of locating, evaluating and integrating research findings to reach a factual conclusion derived from past events. Similarly, Maree and Pieterse (2007) defined the historic research as a systematic holistic process of describing, analysing and interpreting past scenarios based on information derived from a selected population. Hill and Kerber (1967) cited in Walliman, (2005:113), categorized the importance of a historic research to the researcher as follows:

- It helps provide solutions to contemporary problems that occurred in the past.
- It stresses the relevancies and defects of interfaces in the culture of a selected population (asking “*why*” and “*how*” things happened).
- It creates room for the reappraisal of past collated data supporting theories, hypothesis or generalised conclusion to give further insight to present and future trends

The historic research requires the researcher to give critical, analytical scrutiny of minutes, reports or documents about events or incidents (Nieuwenhuis, 2007). The author broadly enumerated four types of historic research, which are useful in general research and they are:

- The primary source ( achieved documents or other original sources)
- Secondary source ( works of other scholars on the focus of study)
- Running records ( documentaries maintained by organisations)
- Recollection (includes Oral histories autobiographies etc.)

### 3.5.3 Comparative research

Comparative research is often used concurrently with the historical research (Walliman, 2005). The comparative research is a systematic process of searching for the similarities and differences between phenomena over a specific period of time (Nieuwenhuis, 2007). Comparative research involves the process of defining the research concepts, itemising them as operational variable, and generating the hypothetical relationships between the variables before carrying out a test on hypothesis (Yanow, 2013). Thus, a comparative researcher is required to compare the experiences of different people - of different backgrounds - based on

situations at a particular time. Notably, Nieuwenhuis (2007) claims that a comparative research proffers first-hand accounts of events which are usually reported by the observers. The author further buttressed that the content of information derived from this strategy of research is validated if is not forgery or exaggerated facts.

#### **3.5.4 Action research**

An action research is denoted as an applied research which is aimed at finding solutions to the indigenous problems of a specific group of people by using communal resources (Leedy & Ormrod, 2010). McNiff and Whitehead (2011:8) defined action research as *“a form of analysis conducted by professional practitioners to evaluate and improve the existing work practices by resolving issues relating to their job”*.

The fundamental aim of an action researcher as a mediator is to assist in planning and implementing effective solutions to problems suffered by the participants (Nieuwenhuis, 2007). However, to successfully conduct an action research, it is required of the research to possess the ability to understand and interpret the problems faced to proffer possible solutions (Kumar, 2011). Conclusively, Ebersöhn, Eloff, and Ferreira (2007:124), enumerated the following as characteristics of an action research:

- It seeks to derive solutions to practical issues
- It is aimed at effecting a change
- It is an interactive strategy to knowledge development
- It is a cyclic research process of planning, solution implementing and reasoning
- It requires the participation of the research sample and the researcher(s)

#### **3.6 Questionnaire Design**

Questionnaires are tools used for data collection containing questions and statements organized to acquire information from research respondent without actually having to talk to them (Adler & Clark, 2008). Although questionnaires are designed as flexible as possible, they must be utilised appropriately to address relevant issues of the research (Walliman, 2005; Flick, 2011). The questionnaire design phase is an extremely important phase of a research because it aids the realization of the research objectives (Maree & Pieterse, 2007). Thus, the process of questionnaire design requires the researcher (s) to put into consideration the type of data to collect and the method of data analysis to be implemented. Dahlberg and McCaig



(2010) further buttressed that the effect of inadequately designed questionnaires results in obtaining irrelevant or insufficient information in a research. Therefore, designing an adequate questionnaire requires the following to be given more attention by the researcher (s), as enumerated by Maree and Pieterse (2007):

- The total appearance of the questionnaire (quality of paper used, font size etc.)
- The question sequence (easy to answer questions)
- Response categories
- Wordings of question (carefully selected clear words)

Bell (2005) cited in Maree and Pieterse (2007:160) stated that questionnaires are of various forms which are mainly divided into two categories, namely:

- Open-ended questions
- Closed-ended questions

### **3.6.1 Open-ended Questions**

Open-ended questions are questions asked without a specific guide on the patterns to answer the questions. These forms of questions are usually designed with the participant's undiluted opinions in mind (Maree & Pieterse, 2007). Thus the respondents are allowed to give comments and express their opinions (Kumar, 2011). Nevertheless, Hopkins (2008) affirms that although the closed-ended questions are usually used to test research hypothesis, the open-ended questions are most appropriate in generating these research hypothesis. The author added that open-ended questions tend to explore and discover validity and reliability of the questionnaire. The following according to Maree and Pieterse (2007) and Leedy and Ormrod (2010) are advantages and disadvantages of open-ended questions:

#### **Advantages**

- The participants respond to questions honestly with the assurance of being anonymous.
- The respondent's opinions are revealed
- Complex question are duly answered with detailed justifications

#### **Disadvantages**

- Data coding poses to be difficult
- It requires a lot of time for the respondents to complete (thinking and writing).

- The answers are variably different in content as a result of the unstructured nature of the question.
- The use of statistical analysis in this design has proven abortive.

### **3.6.2 Closed-ended Questions**

Closed-ended questions are structured questions asked to obtain unified responses from participants. The closed-ended questionnaires provide a set of sequential questions, requesting the respondents to choose the most appropriate answers (Maree & Pieterse, 2007). Kumar (2011) affirmed that the use of closed-ended questions in research gives the researchers the benefits of obtaining sufficient information to reach a more generalizable conclusion. Leedy and Ormrod (2010) further buttressed that applying a closed-ended question in research has the following advantages:

#### **Advantages**

- The questions are short, precise and easy to answer
- Coding and statistical analysis are easily done

However, despite the numerous advantages of closed-ended questions, Maree and Pieterse (2007) stated the following as disadvantages of closed-ended questions:

#### **Disadvantages**

- The answers are very simple with no background details
- The respondent's may be cajoled to give answers they would never have given.
- Answering the questions are too easy, answers given may mislead the researcher (s)
- The respondent's opinion might not an option to choose from.
- The questionnaires are always too lengthy

### **3.7 Research Methods**

The process of research design involves the planning and strategizing of approaches required in conducting a research (Henn *et.al*, 2006). According to Leedy and Ormrod (2010), research design is a holistic process which describes the general procedure of solving a research problem within a specified period of time (data collection, analysis and selection of relevant empirical materials). In addition Leedy and Ormrod (2010) and Henn *et al.* (2006), identified the following as characteristics of a reliable research design:

- The design must aim at obtaining a measurable data, that is, data derived should be statistically based.
- The design must be replicable by other researchers within the same parameters.
- The research design must state the appropriate data analysis to be used and why

Notably, the selection of a research design relevant to the existent study is dependent on the phenomenon being studied, study participants, location of the survey and the researcher's survey experience (Kumar, 2011).

### **3.7.1 Research design for this study**

Various researches have been conducted over the years to evaluate the availability and assess the relevance of these strategies to materials procurement in the construction industry. Notably, majority of the research studies were conducted to evaluate and improve the efficiency of materials procurement strategies; concentrating on aligning the materials procurement strategy requirements with the project objectives (Watermeyer, 2011). Similarly, this process enables site engineers determine how and when the project will be delivered. Thwala and Mathonsi (2012a) highlighted the relevance of exploring the perception of the architects, quantity surveyors, project managers and engineers in an effort to modify the effectiveness of the strategies in meeting project requirements. However, the industry is yet to reach a consentient on the most appropriate strategy for materials procurement during construction. Thus, a comparative analysis of the identified materials procurement strategy in the industry must be conducted (Thwala & Mathonsi, 2012a).

The research adopted a mixed method research approach to evaluate and compare the effectiveness of materials procurement towards achieving sustainable building production. The mixed approach was adopted for this study because it provides a comprehensive perceptive of a phenomenon than either approach separately (Leedy & Ormrod, 2010). Additionally, the mixed research approach aided the exploration of government policies and the perceptions of construction professionals on factors affecting the effective implementation of materials procurement. This research method was adopted specifically because it allows the opportunity to validate the data derived by using two or more research methods without bias.

The qualitative method was applied to evaluate the practice of sustainable construction, explore the relationship between the identified materials strategies, and evaluate the impact of

stakeholders on the choice of materials procurement in the construction industry. The quantitative method, on the other hand, was used to collect data from professional consultants (architects, quantity surveyors, engineers, construction managers and project managers) and contractors to enhance in ranking and comparing the effectiveness of these procurement strategies based on their level of efficiency, benefits, barriers and the factors influencing the choice of materials procurement strategy towards optimum usage. The research data was obtained with the aid of a structured questionnaire survey (quantitative method), which was validated by conducting a semi-structured interview (qualitative method) shortly after the questionnaire survey. The quantitative method was adopted purposely to enable the researcher quantify and identify the effectiveness of materials procurement strategies adopted in the construction industry. The results and conclusion of this study is thus reliable and generalizable.

### **3.7.2 Exploratory study**

An exploratory study is essential part of research questionnaire design to gain more insight of the research problem and to provide solutions to them (Dahlberg & McCaig, 2010). The major purpose for conducting an exploratory survey determines the relevance of the study to the target population (Struwig & Stead, 2001). The questionnaire was the major data collection technique used for the exploratory study. Prior to the exploratory study, the research tool (questionnaire) was piloted amongst construction professionals and research post graduate students department of Construction Management and Quantity Surveying to certify the relevance of the tool to the research. Piloting the research tool helped in determining the possibility of answering the research questions using the data generated from the administering the questionnaires before proceeding to the main study. The questionnaires which were obtained from the sample population during the exploratory study were analysed using the content analysis technique of the Statistical Package for Social Science (SPSS) package.

### **3.7.3 Approach for this study**

Researchers in the past decades practiced the use of various research approaches. The approach adopted for a research is dependent on the nature of the research, information prerequisite, study participants and study area. Considering the nature of this study,

information required and the participants (construction professionals), the online research approach and the traditional paper approach were adopted.

The online research platform is a solution to the numerous challenges faced by researchers in the realm of conducting research traditionally (Gaiser & Schreiner, 2009). The online research platform offers to the researcher innovative ways of conducting research and to create generalizable conclusions (Gibson, Aldrich & Prensky 2007). The online research approach adopts the use of both quantitative and qualitative techniques in data collection (Gaiser & Schreiner, 2009; Nieuwenhuis, 2007). Thus, this approach aided the collection of quantitative data in the course of this study. The online research technique is a sub-set of the social science research which offers an expanded possibility to conduct a research with various individuals and communities based on the nature of information required (Domínguez, Beaulieu, Estalella, Gómez, Schnettler, & Read, 2007). Hence, this approach facilitates the comprehensive study of the social world of the participants. In terms of cost, the online research poses to be a lot cheaper than the traditional research method (James & Busher, 2009). Gaiser (2008) added that the adoption of online research aids easy access to respondents in different geographical areas almost at the same time. In addition, the online research sample creates an environment that cannot be easily influenced by the researcher by using standardized research procedures (Russell & Purcell, 2009).

Conducting an online research promotes anonymity and confidentiality of the participants, especially in answering sensitive questions (James & Busher, 2009). Gaiser and Schreiner, (2009) posed that the anonymity of the participants can be maintained by the use of IP addresses, avatars and anonymous usernames in place of their real names. However, developing an online survey at the initially stage has proven to be difficult; it requires the collective effort and time of the researchers and web-designers (Buchanan, 2002). Literature revealed that the web-designers' efforts in developing user-friendly software programs facilitates the adoption of the internet research survey (Russell & Purcell, 2009). These software and programs include: Survey-Monkey, Google Docx etc.

The major disadvantage of the online research survey is the ability control the category of populace to participate in the survey (Russell & Purcell, 2009). The Internet comprises of a web of different people from different professions and works of life. Thus, obtaining data from a random population without configuring the survey tool to screen

out unsuitable respondents results to a time-consuming and challenging data analysis phase (Russell & Purcell, 2009; Gaiser & Schreiner, 2009). As a result, to address this challenge, the data collection technique for the online survey was designed to navigate the questionnaires links directly to the email address of the participants. The Email addresses were obtained from construction professional bodies such as the Chartered Institute of Builders ‘CIOB’, the South African Council for Quantity Surveying Professionals ‘SACQSP’, South African Institute of Civil Engineering ‘SAICE’, the South African Institute of Architects ‘SAIA’, South African Council for Project and Construction Management professionals ‘SACPCMP’ etc. This decision was made to avoid getting responses from random Internet users and also to have total control of the research online, from the questionnaire administration phase to the data analysis. Thus, the validity and reliability of the data is assured.

### **3.7.4 Population and Sampling size**

Population is defined as the total unit of a particular class or group from which a sample is selected from (O’leary 2010). A population can also be defined as a collection of people, items or animals considered for a research study (Bryman 2004). It is of worthy note that the term ‘population’ in a research does not out-rightly refer to a group of people being considered for study but varies and depends on the nature and field of the study. For the purpose of this study, the population considered are professional consultants (architects, quantity surveyors, engineers, the government, construction managers and project managers) and contractors in the South African construction industry. Considering the large size of the population, a sampling technique was used to select respondents for the study.

Flick (2011) explained that the sample of any population in a research is a minimised depiction of the population. However, for the purpose of result validity and generalisation in qualitative research, it is considered that the larger the sample size, the better the possibility of achieving the aim of the research unbiased (O’leary, 2010). The construction professionals and contractors that constitute the research sample as earlier stated, directly or indirectly contribute to factors that influence the effective selection and usage of construction materials procurement strategies on site. Therefore, the study sample is unarguably a suitable representation of construction stakeholders in South Africa.

### 3.7.5 Sampling technique

Sampling theory is the process of developing ways of obtaining scientific samples (Maree & Pieterse, 2007). Maree and Pieterse (2007) stated that sampling is the process of making random selections from a population to derive a generalised finding of the whole population. O'leary (2010) further described sampling as the process of breaking a large group of respondents into sections with the purpose of deriving results concerning the large group. When conducting sampling, it is necessary to note that how well the sample represents a population is dependent on the sampling design, sample size and sample frame (Floyd & Fowler, 2009; Leedy & Ormrod, 2010). Floyd and Fowler (2009) added that a sample frame is set of people that are likely to be selected depending on the sampling technique adopted.

Considering the complex nature of the construction industry in terms of operations, management, and geographical distribution, projects professionals have been observed to operate on very busy schedule. As a result, construction professionals and contractors in Cape Town and Stellenbosch were selected as samples for the research population (Western Cape Province). The samples were selected by the use 'cluster sampling and purposive sampling technique'.

Biggam, (2008) & Maree and Pieterse (2007) define cluster sampling as a process of redistributing a target population into smaller groups (clusters), from which samples are randomly selected for data collection and result generalisation. The common aim of adopting this sampling technique is to reduce the total number of the target population, cost and accuracy of the desired results. Noteworthy, cluster sampling technique in data collection is most effective if the clusters formed are heterogeneous in nature as a representative of the population. The questionnaires were administered to construction professionals and contractors in Cape Town (CBD) and Stellenbosch, as earlier stated, based on how the accessibility of the construction sites, and availability of the construction professionals as a result of their busy schedules. Thus, the cluster sampling technique was adopted in the phase, questionnaire administration (quantitative data collection), for easy and fast generalisation of findings. For the quantitative data collection, Construction and consulting companies in Cape Town, CBD were grouped into clusters of ten (10) in which respondents were randomly selected using a 'simple random sampling method'. A total of thirty-two (32) companies were randomly selected with at least seven (7) representatives of each company. Construction and consulting companies in Stellenbosch were grouped into five (5) clusters; fifteen (15)

companies were randomly selected with at least four (4) representatives from each company as respondents.

To validate the data obtained from the questionnaires, contractors and company buyers majorly from construction companies earlier selected for the quantitative data collection phase of the survey were randomly interviewed. These participants were selected for interviews using the convenience sampling method. The interviews were conducted with the aim of determining the most effective materials procurement strategy that best facilitates sustainable building production. Biggam, (2008) defined convenience sampling as a technique implemented in a research to derive ideas and insights based on facts which are conveniently available to the researcher. As the name implies, convenience sampling method is a quick and cheap approach in research to validate information obtained in the course of the study (Maree & Pieterse, 2007). According to Bornstein, Jager and Putnick (2013), convenience sampling is a non-probability approach to sampling which selects study participants based on their juxtaposition to the research. However, the only disadvantage of the convenience sampling is that results derived by using this technique lack generalizability in relation to the target population.

### **3.7.6 Data collection techniques**

Data collection entails the process of exploring a range of data sources to gather information for a research work. The choice of data collection technique selected for a research work is directly dependent on the sample frame, nature of the sample, research topic and the facilities available for data collection (Floyd & Fowler, 2009). Noteworthy, there are variably two types of data collected in a research work: secondary data and primary data (Struwig & Stead, 2007; Biggam, 2008).

A triangulation data collection technique was adopted for this research; that is, data was not collected only through questionnaires, but also through interview and literature reviews. Thomas, (2011) opined that, the process of triangulation views a research problem from different perspectives by using various data collection methods rather than one. Literature reviews, questionnaires and interviews were used to obtain data for this study as subsets of secondary and primary data collection.



### **3.7.6.1 Secondary data collection**

Secondary data are basically referred to as literature review in a research. The secondary data is an overview study of data generated and concluded on by other authors. Struwig and Stead, (2007) noted that secondary data are readily accessible data obtained from research works conducted by other researchers. Relatively, Dahlberg and McCaig (2010) added that the review of literature enables a researcher to have an in-depth knowledge of information relative studies which reveals the flaws of these studies. The secondary data collection for this study was obtained from the reviews of past literature. Melville and Goddard (2004) further buttressed the secondary data (literature review) is obtainable in two distinct forms: preliminary review and a comprehensive review of other research works. The preliminary review was adopted in the chapter one of this study to develop a framework for the study. While the comprehensive review of literatures was conducted in the chapter two of this study to evaluate and magnify the views of other researcher on relatively relevant topics. In addition O'leary (2010) highlighted that for new knowledge to be generated, it is essential to consult past innovations.

Considering past researches conducted, the data obtained revealed the significance of materials procurement to the process of sustainable construction and the factors affecting its effective implementation in the industry. Comparatively, most researches were conducted on the process of materials management, selection of materials procurement, materials usage and variably very little researches have considered the effectiveness of materials procurement towards the enhancement of sustainable building production. This research study poises to consider these lapses. The sources of information for the review of literature included textbooks, journals, articles, conference proceedings, dissertations and theses.

### **3.7.6.2 Primary data collection**

The primary data are the most valid information obtained in a research (Leedy & Ormrod, 2010). The primary data collection entails the collection of information directly from a survey sample by a researcher. Thus, the researchers are required to design the questions in clear and easily understandable formats in order to obtain appropriate information form the respondents (Kumar, 2011). The primary data for the study were collected through the administration of quantitative questionnaires to survey respondents and through interviews. The interviews were conducted with face-to-face with the site supervisors, while the questionnaires were administered to respondents by hand and via the internet (survey monkey).

### **3.7.6.2.1 Interview**

This method of data collection is qualitative in nature and usually open ended. Interviews in a survey are designed in two forms: structured and semi-structured, depending on the purpose of the survey (Leedy & Ormrod, 2010). However, due to the flexibility of the semi-structured qualitative interview, it was implemented to probe the perspectives and philosophies of the interviewees (Flick, 2011). Kumar, (2011) highlighted that interviews give the researcher a level of spontaneity, flexibility and power to dialogue and interact with the survey respondents. As a result, this method was used to explore in depth the background knowledge of materials procurement in South Africa and significantly to validate the quantitative data obtained on effectiveness of materials procurement in building construction.

The respondents were informed prior to the meeting of the focus of the interview and the relevance of the research study. This gave the respondents ample time to prepare for the interview in advance. The interview was tape-recorded with permission from the respondents. A total of three (3) construction sites were selected for data validation (interview).

The contractors and company buyers were selected for data validation because they were directly involved in the construction of the buildings on site. Noteworthy, site supervisors are in the most appropriate position to disclose the effectiveness of the procurement strategy implemented for materials purchase. The interview also explores the efficiency of these strategies in the enhancement of sustainable construction operation.

### **3.7.6.2.2 Questionnaire design**

The research questionnaire was designed using close-ended questions. The close-ended questions adopted the use of a four point Likert scale to restrict the answers to be provided by the survey respondents. The questionnaire is designed based on the information derived from reviewed literature in correlation with objectives of the study.

The questionnaire was structured in sections, where each section addresses a particular objective or objectives. Table 3.2 illustrates the relationship between sections and the study objectives. The first section of the questionnaire inquires the biographical information of the survey participants. Second section comprises of three sub-sections which addresses the first objective of the study, with the aim of evaluating the concept of effective materials usage during sustainable building production. The sub-sections considered the impact of materials management on materials usage, strategies and factors to consider for effective materials

usage. The third section of the questionnaire gives a comparative analysis of a number of materials procurement strategies, which is aimed at addressing objective two and five. In this section, the benefits and barriers, effectiveness of materials procurement during procurement was analysed. The fourth section inquires on the extent to which governments policies impact the implementation of materials procurement. The final section, section five, elaborated on stakeholders' factors that affect materials procurement efficiency during construction aimed at addressing objective 4.

**Table 3.2: Questionnaire design**

Section	Section title	Objective to be addressed
1	Biographical information	
2	Effectiveness materials usage during sustainable construction	Objective 1
3	Comparative analysis of a number of materials procurement strategies	Objective 2 and 5
4	Impact of governments policies on the implementation of materials procurement	Objective 3
5	stakeholders' factors affecting materials procurement efficiency during construction	Objective 4

### 3.7.7 Data analysis for the study

Data analysis includes data testing, tabulating, categorising and examination of results to address the purpose of a study (Yin, 2003). The quantitative and qualitative data gathered were analysed using the Statistical Package for Social Sciences (SPSS) software. The quantitative data, which were obtained by questionnaires, were analysed with descriptive statistics. Conversely, the qualitative data were analysed technically by content analysis.

#### 3.7.7.1 Descriptive statistics

Descriptive statistical analysis in an exploratory research can be defined a process of illustrating or summarising a set of quantitative data in easily understandable formats (tables, charts etc.) (Quartaroli, 2009). The descriptive statistics presents a basic overview of each data variable by using descriptive statistical tools (O'leary, 2010). Stead and Struwig, (2007) opined that the purpose for the use of statistical tools in data analysis is to present a straightforward and pictorial representation of a large data set. Henn *et al.* (2006) and Leedy and Ormrod (2010) identified that central tendency measurement, dispersion measurements

and frequency distributions are the three prescribed terms predominately used in descriptive statistical data analysis. Thus, this study adopted the use of frequency distribution and central tendency measurement technique (mean and standard deviations) in analysing the quantitative data obtained in the survey.

#### **3.7.7.2 Content analysis**

Content analysis is a detailed and systematic process of analysing the content of a body of knowledge with the aim of accessing the significance, theme, pattern and flaws (Leedy & Ormrod, 2010). Content analysis basically involves the coding and transcribing of human communication (written or oral) or other means of communication: videotapes and Internet blogs (Babbie, 2007; Leedy & Ormrod, 2010). Flick (2011) added that this approach enables the researcher to omit irrelevant words and terms by paraphrasing and giving a summary of accounts. Notably, the content analysis is an effective method in simplifying a large set of question with few lines of statements. Conversely, when compared to the use of questionnaires, content analysis is more time consuming in terms of data processing and transcribing (Thomas, 2003). The approach to data analysis is usually not designed as a stand-alone method; it adopts the principles of other methods to discover new theories (Leedy & Ormrod, 2010). Therefore, the content analysis adopts the inductive approach in exploring the pros and cons of a text or statement in order to support or oppose a theory. In context, this study reported a summary of the relevant contents in the transcribed data obtained from the interviewees, as well as irrelevant omitted information in the course of reporting the research findings.

### **3.8 Validity and Reliability of the Data**

The validity and reliability of the research tool influences the originality of the research work. Testing the validity and reliability of the survey tool significantly determines the probability of obtaining relevant data in drawing meaningful conclusion at the end of the study (Leedy & Ormrod, 2010). Struwig & Stead (2007) highlighted that the validity of a research tool denotes the extent to which the tool measures what it is designed for, while the reliability denotes the consistency of the results produced by the tool used with consistency over a period of time. Notably, the principles validity and reliability varies depending on the nature of the research conducted.

### **3.8.1 Validity**

The validity of a research refers to the credibility of the survey tool, thus, the research findings (Struwig & Stead, 2007). Similarly, Leedy and Ormrod (2010) otherwise stated that the validity of a research is the extent to which the instrument used measures what it is supposed to measure. Biggam (2008) also highlighted that the validity of a research relates to how the empirical data is collected and analysed (from strategy design to analysis). Denscombe, (2010) noted that the validity of a research can be addressed by the use of respondent validation, grounded data and triangulation. For the purpose of this study, the triangulation method was applied for data collection, as earlier stated. The quantitative data obtained by questionnaire administration was validated by interviews (respondent validation). Also, a pilot study was conducted to test the validity questionnaires for content validity.

### **3.8.2 Reliability**

Research reliability refers to the consistency of a research result under the same circumstances (Leedy & Ormrod, 2010). In other word, a research is denoted as reliable if the findings of the study remain constant when conducted by another researcher in a steady condition. Biggam (2008) opined that the reliability of a research forces on the record of evidences. Thus, a great measure of result consistency indicates a great level of research reliability assurance (Kumar, 2011). The purpose for conducting a reliability test is to minimise the errors and biases in a survey (Yin, 2003). In the context of this study, the reliability of the questionnaire was ensured by testing the tool using the Cronbach's co-efficient alpha. It was noted that the closer the co-efficient is to 1, the more reliable the survey instrument is. Thus, the optimal Cronbach's co-efficient alpha value should be above 0.7.

## **3.9 Chapter Summary**

This chapter provided a comprehensive overview of the research methodology adopted in the study. A mixed research method (quantitative and qualitative) was adopted to achieve the aim and objectives of the research. The quantitative research questionnaire was structured and designed to obtain the perceptions of construction professionals and stakeholders on the characteristic functions of identified materials procurement strategies based on their relevance to sustainable construction in the Western Cape Province. Literature reviews, interviews and

questionnaires were used in collecting the primary and secondary data for the study. The approach used for questionnaire administration was the ‘online’ and ‘hand-in’ approach. Thereafter, the reliability of the findings and result were tested using the Cronbach’s alpha coefficient reliability test.

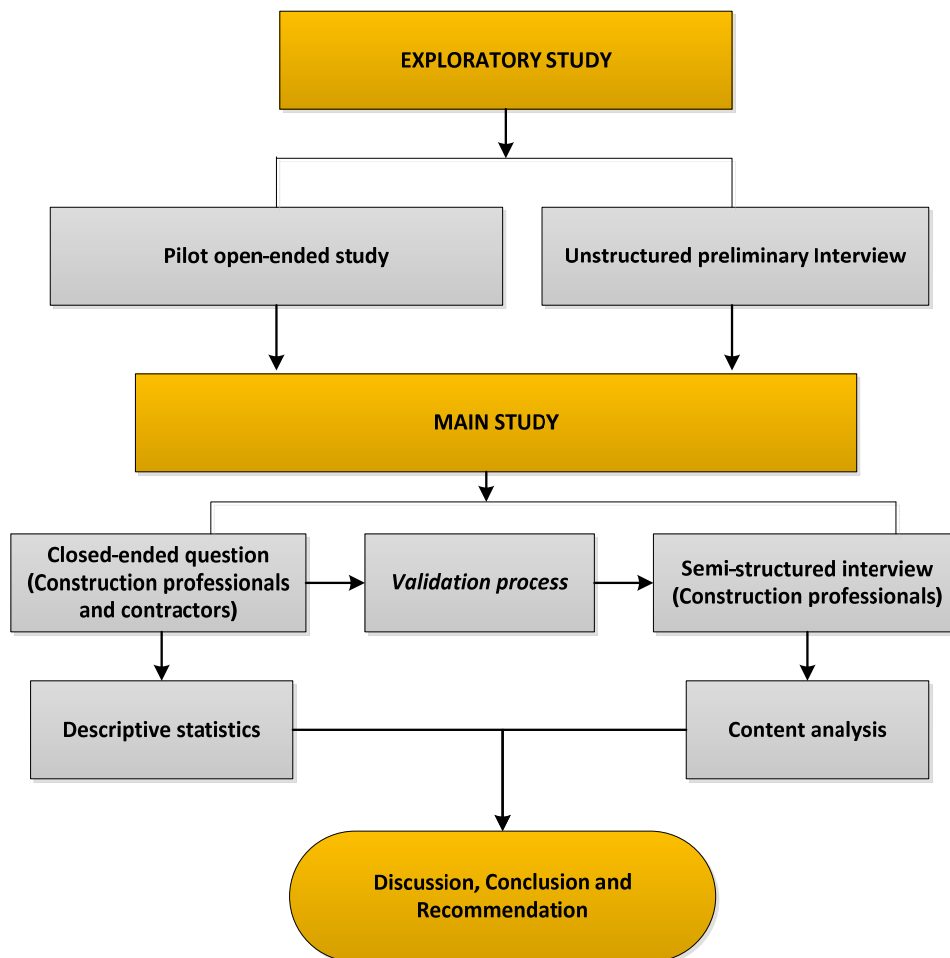


Figure 3.2: Research methodology

## **CHAPTER FOUR**

### **DATA ANALYSIS AND DISCUSSION OF FINDINGS**

#### **4.1 Introduction**

This chapter presents the analysis of the data collected through closed-ended questionnaires survey and interviews conducted with construction professionals. The results of quantitative data analysis conducted using both descriptive and inferential statistical techniques are reported in this chapter. Detail account of participant responses during the qualitative interview conducted in this research were reported and tabulated under appropriate section. The results of statistical analysis were interpreted; inferences were drawn from the results and exhaustively discussed to bring the research outcomes into focus.

#### **4.2 Exploratory Study**

The exploratory study was conducted in Cape Town, Western Province of South Africa. The study was conducted to identify the existence of these materials procurement issues such as barriers to materials procurement, effectiveness of the materials procurement strategy currently in use and stakeholders factors that affect the effective use of materials procurement strategies during construction. The exploratory study was also conducted to ascertain questionnaire clarity for the main study in the industry. The study population were architects, site engineers, project managers, quantity surveyors, contractors and government workers. The population sampling technique adopted for the exploratory study was the ‘Simple random sampling method’.

Quantitative questionnaire survey was conducted and a total of 40 questionnaires were administered out of which 30 were retrieved after numerous follow-up calls and emails. Twenty-four (24) copies were satisfactorily completed while six (6) copies were incomplete. The respondents were required to complete the questionnaire and make constructive comments where necessary. Successively, comments and inputs from the respondents were considered and slight changes were made in the questionnaire design for the main study.

### **4.3 Questionnaire Survey for the Main Study**

Quantitative data collection for this study was conducted through the use of questionnaire survey. A total of two hundred and eighty-seven (287) questionnaires were administered to construction professionals (architects, site engineers, project managers, quantity surveyors, contractors and government workers) in the Western Cape Province, specifically in Cape Town and Stellenbosch. One hundred and thirty-seven (137) questionnaires were administered in person to the respondents, of which sixty (60) questionnaires were adequately completed and retrieved. Subsequently, one hundred and fifty (150) were administered online via electronic mails; thirty-three (33) questions were completed and sent back electronically. The total of ninety-three (93) questionnaires were retrieved which represents 32.40% of the administered questionnaires.

### **4.4 Biographical Information of Respondents**

The results in Table 4.1 present the characteristics of the respondents from different work divisions, profession and companies. The information obtained was from both private and public sector of the construction industry. 55.9% of the respondents were from contracting firms, 33.4% were from government establishments', 10.7% are materials suppliers. Furthermore, the results indicates that 48.4% of the respondents were quantity surveyors, 24.7% were project managers, 18.3% were construction managers and 8.6% were Architects by professional affiliation. The highest numbers of respondents in this study were quantity surveyors. The current positions occupied by the respondents were managers' (46.3%), senior managers' (27.9%) and as junior managers' (25.8%). Table 4.1 also shows the work experiences of the respondents in their current position. Majority (90.3%) of the respondents have 6-20 years' work experience and 9.7% have 1-5 years' work experience. Nonetheless, this inference doesn't suggest that the inputs and work experiences of the respondents between 1-5 years is not significantly reliable for this research study. The study shows that 65% of the respondents hold diploma degrees as the highest qualification, 32% hold bachelor's degrees and 3% hold masters. The results of analysis on respondents demographic and background information have shown that the respondents sampled were qualified and experienced practitioners in construction industry, whose judgments on issues of construction materials procurements can be reliable.

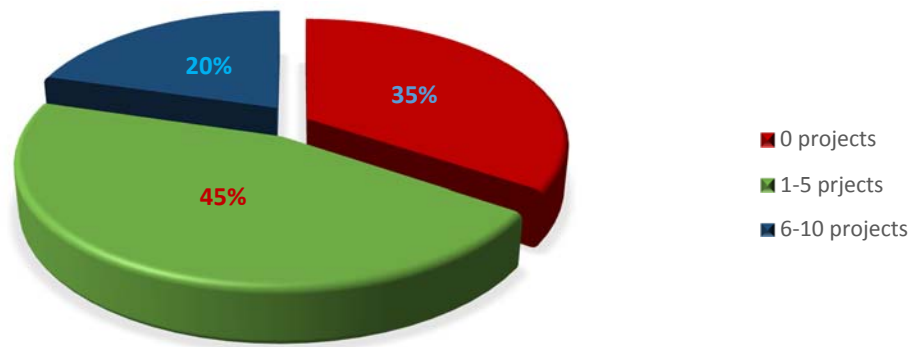


**Table 4.1 Respondents' details**

Categories		Percentage %	Cumulative percentage %	Frequency
<b>Participating company</b>	Contracting firms	55.9	55.9	52
	Materials suppliers	10.7	66.6	10
	Government establishments	33.4	<b>100.0</b>	31
<b>Professional affiliation</b>	SACQSP (QS)	48.4	48.4	8
	SACPMP (PM)	24.7	73.1	17
	SACPCMP (CM)	18.3	91.4	23
	SACAP (Arc)	8.6	<b>100.0</b>	45
<b>Current position</b>	Manager	46.3	46.3	26
	Senior manager	27.9	74.2	43
	Junior manager	25.8	<b>100.0</b>	24
<b>Working experience</b>	6-10years	41.9	41.9	9
	16-20years	19.4	61.3	39
	11-15years	18.3	79.6	17
	Above 20years	10.7	90.3	18
	1-5years	9.7	<b>100.0</b>	10
<b>Highest qualification</b>	National Diploma	64.5	64.5	60
	Bachelor	32.3	96.8	30
	Masters	3.2	<b>100.0</b>	3
	Doctorate	0.0	0.0	0

#### **4.5 Sustainable Building Production Experience**

Information was sought from respondents on how often they participate in the adoption of sustainable principles based on the number of projects managed and produced. The responses of the respondents are presented in Figure 4.1. Figure 4.1 reveals that 45% of the participating companies have been involved in the construction of 1-5 projects and 20% were involved in 6-10 projects. In contrast, 35% of the respondents indicated that the principles of sustainable constructions are yet to be adopted in their individual organisations. These findings indicate that a significant amount of the respondents are aware of the practice of sustainability in building construction with respect to materials procurement in the construction industry.



**Figure 4.1 Frequency of sustainable building projects managed**

#### 4.6 Testing the Reliability of the Research Instrument

The reliability of the questions used in the study was tested with the Cronbach's alpha test using a Statistical Package for Social Sciences (SPSS) version 23 to ensure the reliability of the research questions. Cronbach's alpha reliability test is an estimate of the internal consistency associated with the scores that can be derived from a scale or composite score (Allen, 2004). From Table 4.2, it is observed that the Cronbach's alpha coefficient values are greater than 0.70 (>0.70). Tavakol and Dennick (2011) endorsed that the score values between 0.70-0.95 are standardized values for the reliability of a test to be proven.

**Table 4.2 Reliability of research instrument**

Questions No.	Headings	No. of items	Cronbach's alpha coefficient
Section 2A	Policies for effective materials usage towards the enhancement of sustainable construction	7	0.8
Section 2B	Impact of construction materials management on materials selection during building production	11	0.7
Section 2C	Facilitators for effective materials usage towards the enhancement of sustainability in building production	9	0.8
Section 3A	Comparative analysis of materials procurement strategies towards enhancing sustainable building construction	17	0.9
Section 3B	Benefits of materials procurement strategy	12	0.8
Section 3C	Barriers of materials procurement strategy	12	0.8
Section 4A	Impacts of government policies on the efficiency of materials procurement strategies implementation	5	0.9
Section 4B	Objectives of government policies in materials procurement	9	0.9
Section 4C	Barriers to the influence government policies in materials procurement	9	0.9
Section 5	Construction stakeholders related factors affecting materials procurement efficiency towards sustainable building construction.	15	0.9
	<b>Sum total of all questions used</b>	<b>107</b>	<b>0.8</b>

#### 4.7 Policies for Effective Materials Usage towards the Enhancement of Sustainable Construction

Table 4.3 presents the effectiveness of construction approaches in materials usage towards sustainable building production. These policies were evaluated by the respondents based on a four (4) point Likert scale: Strongly disagree =1, Disagree =2, Agree =3, strongly agree = 4. Majority of the respondents (87.1%), agreed that the Green Building Council of South Africa (GBCSA) policy on selection and usage of building materials should be enforced in every construction projects towards the enhancement of sustainable building production. 80.7% of the respondents also indicated that frequent evaluation of the Life-Cycle Analysis (LCA) of construction materials proposed for use as important, 82.7 % indicated that adopting the principles of Sustainable Assessment Criteria (SAC) in materials selection and 79.6% agreed that imbibing the principles of construction wastes recycling to reducing environmental pollution as effective policies that must be considered in enhancing sustainability during construction materials procurement in building production. These policies were ranked based on the mean value of 3.27, 3.17, 3.16, and 3.08 respectively.

**Table 4.3 Polices for effective materials usage towards the enhancement of sustainable construction**

<b>Policies</b>	<b>No.</b>	<b>Strongly disagree (%)</b>	<b>Disagree (%)</b>	<b>Agree (%)</b>	<b>Strongly agree (%)</b>	<b>Mean value (mv)</b>	<b>Std. D</b>	<b>Rank(r)</b>
Enforcing the adoption of the Green Building Council of South Africa (GBCSA) policy.	93	1.1	11.8	46.2	40.9	3.27	0.71	1
Evaluating the Life-cycle analysis (LCA) process of materials proposed for use	93	4.3	15.1	39.8	40.9	3.17	0.84	2
Adopting the principles of Sustainable Assessment Criteria (SAC) for proper materials analysis and selection.	93	2.2	15.1	47.2	35.5	3.16	0.76	3
Imbibing the principles of construction wastes recycling to reduce environmental pollution.	93	0.0	20.4	51.6	28.0	3.08	0.70	4
Adapting the process of dematerialisation at every phase of construction.	93	3.2	31.2	34.4	31.2	2.94	0.87	5
Using renewable and reusable materials for construction.	93	2.2	28.0	48.4	21.5	2.89	0.76	6
The use of Eco-friendly technologies during construction	93	4.3	39.8	30.1	25.8	2.77	0.89	7

#### 4.8 Impact of Construction Materials Management on Materials Selection During Building Production.

Table 4.4 presents findings on the impact of construction materials management factors often considered during materials selection to enhance optimum materials usage. The respondents were asked to rank the strategies based on their level of importance towards optimum materials usage during sustainable building production. A four (4) point Likert scale: extremely unimportant=1, less important=2, important=3, very important=4 was adopted. Findings reveal that majority of the respondents (91.4%) agree that in attaining sustainability during building construction, the availability of materials proposed for construction in market (mv=3.45) is an important purchasing function of materials management to consider for optimum materials usage. A significant percentage (93.6%) of the respondents also agreed that strategic planning before procurement at design stage of building construction (mv=3.42) is important in enhancing the availability of materials when needed for adequate usage during construction. Most of the respondents (92.5%) agree that in selecting materials for optimum usage in sustainable building production, it is important to consider the environmental impact of the available materials (mv=3.35). 89.2 % of the respondent also perceived that it is important to put into consideration the requirements of South African National Standards (SANS) policies during selection (mv=3.33), in order to ensure quality consistency and building sustainability. These findings imply that effective consideration of materials availability, strategic planning before procurement and the environmental impact, will enhance effective materials selection for optimum use during sustainable building production.

**Table 4.4 Impact of construction materials management on materials selection during building production**

Factors	No.	Extremely unimportant (%)	Less important (%)	Important (%)	Very important (%)	Mean value (mv)	Std. D	Rank (r)
Availability of materials proposed for construction in market	93	0.0	8.6	37.6	53.8	3.45	0.65	1
Strategic planning before procurement at design stage of building construction.	93	0.0	6.5	45.2	48.4	3.42	0.61	2
The environmental impact of the materials	93	0.0	7.5	49.5	43.0	3.35	0.62	3
The requirements of South African National Standards (SANS) policies on materials selection	93	1.1	9.7	44.0	45.2	3.33	0.70	4

Procurement strategy considered for materials purchase	93	0.0	5.4	62.4	32.3	3.27	0.55	5
Work experience of construction workforce	93	0.0	18.3	44.1	37.6	3.19	0.73	6
Materials specifications required for construction	93	3.2	14.0	44.1	38.7	3.18	0.79	7
Communication level between the workforce during construction	93	1.1	13.9	57.0	28.0	3.12	0.67	8
Sustainable nature of materials (recyclable or renewable materials)	93	1.1	11.8	67.7	19.4	3.05	0.60	9
General site organization which may affect the flow of materials on site	93	0.0	31.2	43.0	25.8	2.95	0.76	10
Effects of the fluctuating cost materials on the total cost of construction	93	1.1	35.5	44.1	19.4	2.82	0.75	11

#### **4.9 Facilitators for Effective Materials Usage towards the Enhancement of Sustainability in Building Production**

The perceptions of the respondents were explored on factors that facilitate proper usage of materials during construction as presented in Table 4.5. The respondents were required to rank the extent to which they agree with the identified facilitators. A four (4) point Likert scale: strongly disagree =1, disagree =2, agree =3, strongly agree = 4, were adopted. Timely delivery of construction materials to site was ranked as the top facilitator of effective materials usage by the respondents. Majority of the respondents (92%) agreed that timely delivery of materials (mv=3.47) enhances the availability of materials on site and improve the productivity of the workforce, 6.5% of the respondent disagreed while 1.1% of the respondent strongly disagreed with the proposition that timely delivery of construction materials facilitates optimum usage of materials during sustainable building production. Proper project planning at inception using sustainable building designs (mv=3.38), proper understanding of clients' ideas at the conceptual phase of design (mv=3.38), and the implementation of waste reduction techniques during construction (mv=3.23) were also identified to significantly facilitate the effective usage of materials to enhance the building sustainability.

**Table 4.5 Facilitators for effective materials usage towards the enhancement of sustainability in building production**

Facilitators	No.	Strongly disagree (%)	Disagree (%)	Agree (%)	Strongly agree (%)	Mean value (mv)	Std. D	Rank (r)
Timely delivery of construction materials to site	93	1.1	6.5	36.6	55.9	3.47	0.67	1
Proper project planning at inception using sustainable building designs	93	1.1	5.4	48.4	45.4	3.38	0.64	2
Proper understanding of clients ideas at the conceptual phase of design	93	1.1	10.8	37.6	50.5	3.38	0.72	2
Implementing waste reduction techniques during construction	93	0.0	10.8	46.2	43.0	3.32	0.66	3
Effective communication amongst workers during construction.	93	0.0	14.0	41.9	44.1	3.30	0.70	4
Efficiency of the materials procurement strategy in place during construction	93	0.0	15.1	53.7	31.2	3.16	0.66	5
Government policies related to materials usage and disposal	93	0.0	19.4	61.3	19.3	3.00	0.63	6
Early learning on sustainable building practices in institutes' and universities'	93	4.3	24.7	52.7	18.3	2.85	0.77	7
Staff innovations on materials usage for effective materials utilization	93	3.2	29.0	50.5	17.2	2.82	0.75	8

#### 4.10 Effectiveness of Materials Procurement Strategies in the Industry

A comparative analysis was conducted in this section. The respondents were required to indicate how often the traditional materials procurement strategy (TMPs), and the electronic materials procurement technology strategy (EMPTs) is being adopted in the process of materials acquisition and how effective these strategies are in the procurement phases in their individual companies.

##### 4.10.1 Materials sourcing phase

Table 4.6 and Table 4.7 present the perception of respondents on the frequency and effectiveness of materials procurement strategies in the materials sourcing phase for a construction project. In Table 4.6, the respondents were required to indicate the materials procurement strategy most often used in sourcing for materials during construction in their individual companies. Majority of the respondents (71%), agreed that the utilisation EMPTs in sourcing for materials specifications. The results of the analysis show that 62.4 % of the respondents also adopt the use of EMPTs in sourcing for appropriate materials for on-going project. However, it was noticed that a significant percentage of the respondent (61.3%)

indicated that the TMPs is most often adopted in evaluating the lifecycle (installation, servicing and maintenance requirements) of the materials to be purchased. 57% of the respondents indicated that the EMPTs is most often used in investigating the quality certification, work credibility and financial statuses of selected suppliers and 53.8% also adopted the use of EMPT in sourcing for potential suppliers for tendering and contract purposes.

**Table 4.6 Frequency of materials procurement strategies adopted in the materials' sourcing phase.**

Materials' Sourcing Phase	N	Frequency of materials procurement strategy usage (%)		Mean value (mv)	Rank(r)
		TMPs	EMPTs		
Sourcing for potential suppliers for tendering and contract purposes.	93	46.2	53.8	1.54	5
Sourcing for appropriate materials for the on-going project	93	37.6	62.4	1.62	2
Evaluating the lifecycle (installation, servicing and maintenance requirements) of the materials to be purchased.	93	61.3	38.7	1.39	3
Sourcing for materials specifications	93	29.0	71.0	1.71	1
Investigating the quality certification, work credibility and financial statuses of selected suppliers.	93	43.0	57.0	1.57	4

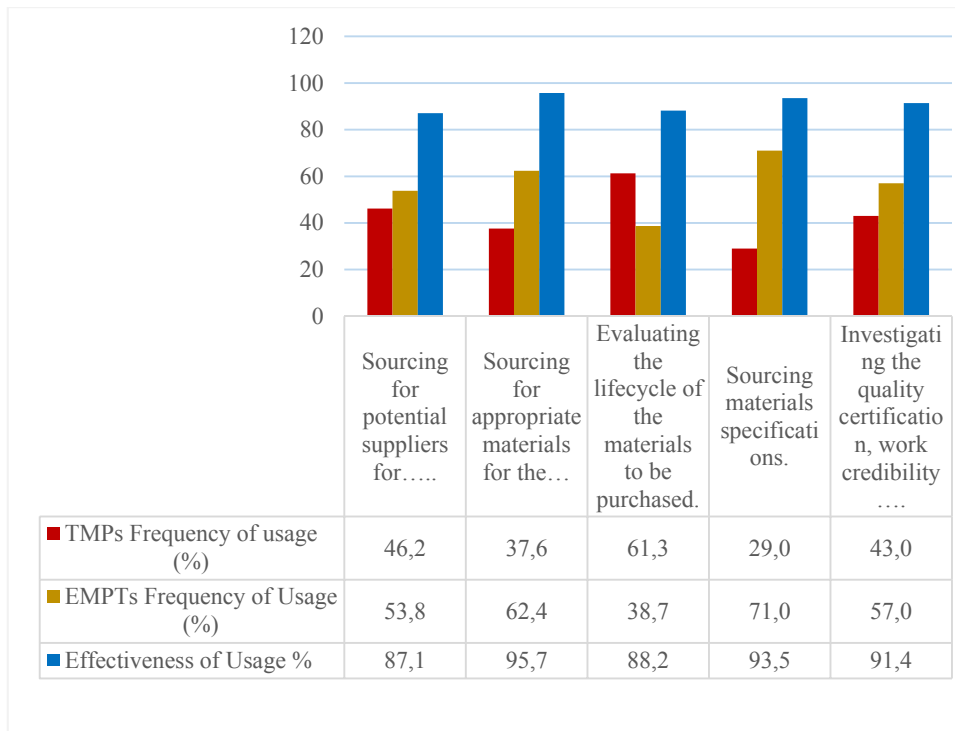
In Table 4.7, the respondents were required to rate the effectiveness of the strategies using a Likert scale: Ineffective effective = 1, Less Effective = 2, Effective = 3 Very effective = 4. Majority of the respondents indicated that the adoption of EMPTs is 95.7% effective in sourcing for appropriate materials for on-going projects in anticipation for an on-time and accurate materials delivery. In investigating the quality certification, work credibility and financial statuses of suppliers to be considered for the contract phase, the usage of EMPTs was perceived to be 91.4% effective. Likewise, respondents indicated that the utilisation of TMPs is 88.2% effective in the process of evaluating the lifecycle of the materials considered for purchase. It can be generally inferred from the findings in table 4.6 & 4.7 that both procurement strategy (TMPs and EMPTs) are most frequently and effectively used in materials acquisition depending on the 'materials sourcing' task it is adopted for.

**Table 4.7 Effectiveness of materials procurement strategies adopted in the materials' sourcing phase**

Materials Sourcing Phase	N	Effectiveness of materials procurement strategy (%)				Mean value (mv)	Rank (r)
		Ineffective	Less effective	Effective	Very effective		
Sourcing for potential suppliers for tendering and contract purposes.	93	0.0	12.9	66.7	20.4	3.08	5
Sourcing for appropriate materials for the on-going project	93	0.0	4.3	74.2	21.5	3.17	1
Evaluating the lifecycle (installation, servicing and maintenance requirements) of the materials to be purchased.	93	1.1	10.8	65.6	22.6	3.10	3
Sourcing materials specifications	93	0.0	6.5	78.4	15.1	3.09	4
Investigating the quality certification, work credibility and financial statuses information about selected suppliers.	93	0.0	8.6	68.8	22.6	3.14	2

In relation to the frequency of usage (TMPs and EMPTs) and the effectiveness of usage, figure 4.2 illustrates a comparison of the effectiveness and frequency of usage in the phase of materials sourcing, based on percentage value of the factors (effectiveness & frequency) in table 4.6 and table 4.7. It was observed from the analysis in figure 4.2 that the EMPTs is most often used (71%) in sourcing for materials specifications with 93.5% effectiveness while the TMPs is frequently used in evaluating the lifecycle of the materials to be purchased for construction with 88.2% effectiveness. It can be inferred from the figure revealed that the high frequency of usage of the procurement strategies (EMPTs & TMPs) is directly proportional to the effectiveness in the processes of materials sourcing. However, the EMPTs tends to be the most frequently and effectively strategy used in sourcing for materials information.





**Figure 4.2 Comparative analysis of materials procurement strategies based on the frequency and effectiveness of adoption during the materials sourcing phase**

#### 4.10.2 Contracting phase

Table 4.8 and Table 4.9 presents the perception of respondents on the effectiveness and frequency of materials procurement strategies utilised at contracting phase in the acquisition of materials for a construction project. In Table 4.8, the respondents were required to indicate the materials procurement strategy most often used in the contracting phase of materials procurement in their individual companies. Table 4.8 shows that 74.2% of the respondents indicated that the EMPTs is most often used in requesting for information on materials specifications by contractors (RFIs). 55.9% of the respondents also indicated the use of EMPTs in receiving request for quotes (RFQs) from suppliers and responding to request for proposals (RFPs) from suppliers. While 52.7 % of the respondents indicated that the TMPs is most often used in selecting qualified suppliers for negotiation and further contract processes, as compared to 47.3% of the respondents who adopt the use of EMPTs.

**Table 4.8 Frequency of materials procurement strategies adopted in the contracting phase**

Contracting phase	N	Frequency of materials procurement strategy used (%)		Mean value (mv)	Rank (r)
		TMPs	EMPTs		
Sending request for information on materials specifications by contractors (RFIs)	93	25.8	74.2	1.74	1
Receiving quotes (RFQs) from suppliers	93	44.1	55.9	1.56	2
Responding to request for proposal (RFPs) from suppliers.	93	48.4	51.6	1.48	4
Selecting qualified suppliers for negotiation and further contract processes	93	52.7	47.3	1.47	3

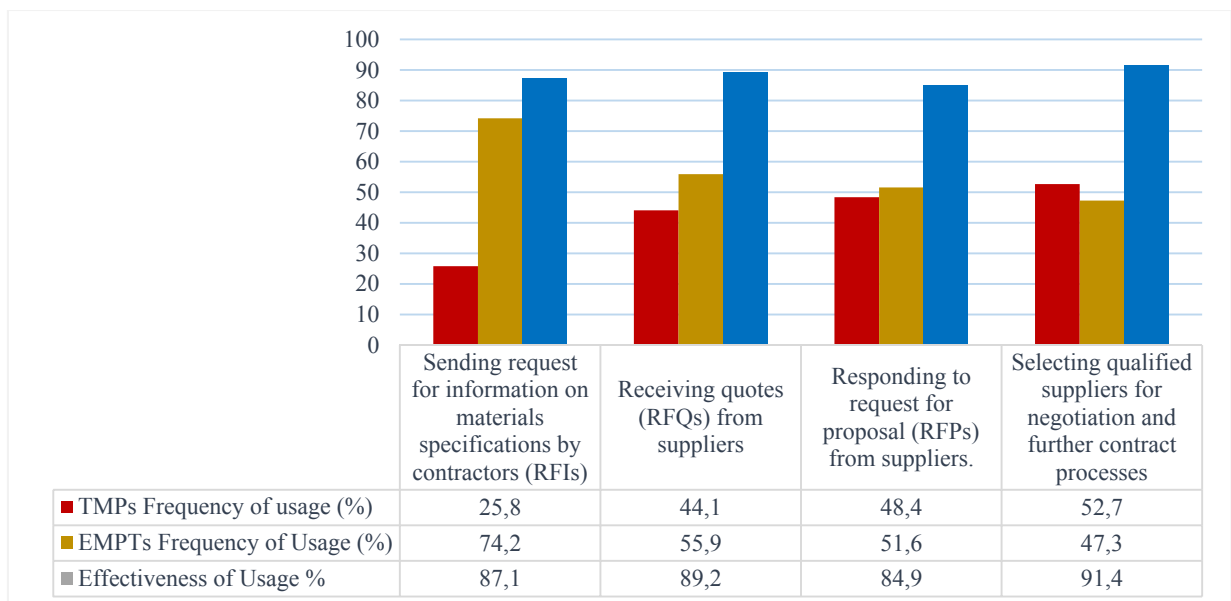
In Table 4.9, the respondents were required to rate the effectiveness of the materials procurement strategies adopted using a Likert scale: Ineffective effective = 1, Less Effective = 2, Effective = 3 Very effective = 4. Table 4.9 presents the findings on the effectiveness of the materials procurement strategy used in the contracting phase. Findings reveal that the adoption of TMPs in the process of selecting qualified suppliers for contract negotiations was 91.4%, effective, as agreed by majority of the respondents. The respondents also agree that adopting the use of EMPTs in raising requisitions' for information on materials specifications by contractors (RFIs) is 87.1% effective, as compared to the indication of 12.9% ineffectiveness by other respondents. It was generally inferred from the findings in Table 4.9 that the procurement strategy (TMPs &EMPTs) adopted by respondents in the processes of the contracting phase are significantly effective in selecting and contracting the supply of materials required for a construction project.

**Table 4.9 Effectiveness of materials procurement strategies adopted in the contracting phase**

Contracting phase	N	Effectiveness of materials procurement strategy (%)				Mean value (mv)	Rank (r)
		Ineffective	Less effective	Effective	Very effective		
Sending request for information on materials specifications by contractors (RFIs)	93	3.2	9.7	65.6	21.5	3.05	2
Receiving quotes (RFQs) from suppliers	93	1.1	9.7	73.1	16.1	3.04	3

Responding to request for proposal (RFPs) from suppliers.	93	1.1	14.0	67.7	17.2	3.01	4
Selecting qualified suppliers for negotiation and further contract processes	93	1.1	7.5	62.4	29.0	3.19	1

Figure 4.3 presents the comparative analysis of the effectiveness and frequency of materials procurement strategy usage in the contracting phase of procurement, as illustrated in Table 4.8 and Table 4.9. The analysis was based on the percentage value of the frequency and effectiveness of the procurement strategy adopted for use in the industry. It was observed that the procurement strategy (EMPTs) is effectively and frequently adopted in sending requisition for information (RFI) on materials specification by contractors. The figure also revealed that the TMPs is most suitable in selecting qualified suppliers for negotiations and further contract processes. Nonetheless, in responding to requests for proposal from suppliers (RFPs), both EMPTs and TMPs have been indicated to be effective as the frequencies of usage are not significantly different



**Figure 4.3 Comparative analyses of materials procurement strategies based on the frequency and effectiveness of adoption during the contracting phase**

### 4.10.3 Negotiation Phase

Table 4.10 and Table 4.11 presents the perception of respondents on the frequency and effectiveness of materials procurement strategies adopted for use in the negotiation phase during materials procurement. In Table 4.10, the respondents were required to indicate the procurement strategy most frequently used the negotiating phase of materials procurement in their individual companies. From Table 4.10, 77.4 % of the respondents indicated that the EMPTs is in making payments to suppliers (mv=1.77), while 22.6 % of the respondent use TMPs in the payment of company suppliers. In addition, Table 4.10 shows that EMPT is being used in the process of specifying the properties of materials required (mv=1.70), comparing the properties of available materials based on catalogue information (mv=1.69) and creating requisition order based on catalogue information (mv=1.61) with the respondent percentage of 69.9%, 68.8% and 61.3% respectively. However, 50.5% and 57% of the respondent indicated that in negotiating the cost and quality of materials required respectively, the TMPs is most conveniently used in this procurement phase.

**Table 4.10 Frequency of adoption and effectiveness of materials procurement strategies in the negotiation phase**

Negotiation phase	N	Frequency of materials procurement strategy used (%)		Mean value (mv)	Rank (r)
		TMPs	EMPTs		
Payments to supplier(s)	93	22.6	77.4	1.77	1
Materials specification	93	30.1	69.9	1.70	2
Comparison of available materials properties based on catalogue information	93	31.2	68.8	1.69	3
Creating requisition orders based catalogue information	93	38.7	61.3	1.61	4
Tracking of new and pending transactions	93	43.0	57.0	1.57	5
Negotiation of materials qualities	93	57.0	43.0	1.43	5
Materials tracking (from suppliers to site).	93	49.5	50.5	1.51	6
Materials cost negotiations	93	50.5	49.5	1.49	6

In Table 4.11, the respondents were required to rate the effectiveness of the strategies adopted using a Likert scale: Ineffective effective = 1, Less Effective = 2, Effective = 3 Very effective

= 4. In relation to the frequency of materials procurement strategy usage presented in Table 4.10, Table 4.11 presents the effectiveness of the procurement strategies used in the processes of the negotiation phase. Findings show that the use of EMPTs in the payment of suppliers was ranked the most effective.

The table shows that majority of the respondents agreed that the effectiveness of using EMPTs in suppliers payments is perceived as 87.1%, as against 12.9% of ineffectiveness (mv=3.20). The respondents' also indicated that the use of EMPTs in materials specification is 92.5% effective in the operations of materials procurement. Likewise, TMPs was agreed by the respondents to effectively (88.5%) enhance the process of negotiating the cost of materials required for construction with suppliers.

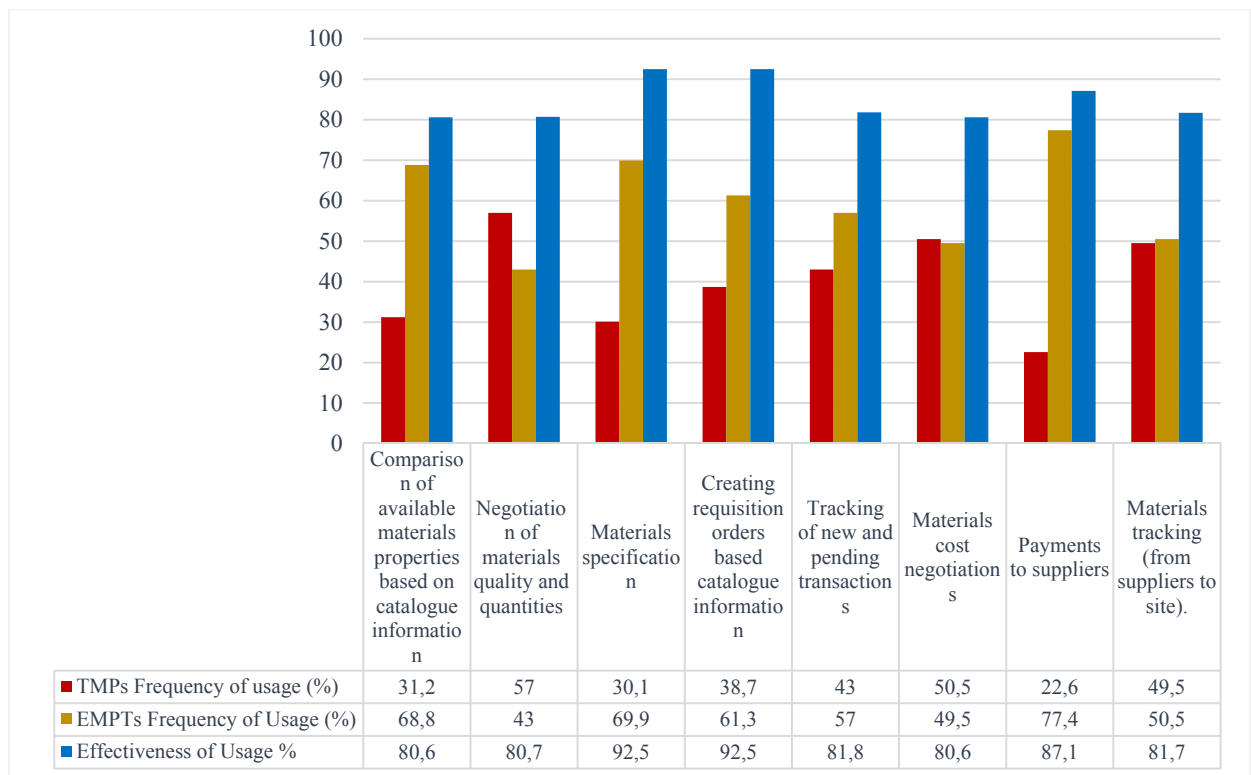
It can be inferred from Table 4.11 that the procurement strategies (EMPTs &TMPs) adopted by the respondents are significantly effective. However, the use of EMPTs is most effective in the materials negotiation and delivery phase.

**Table 4.11 Effectiveness of materials procurement strategies adopted during the negotiation phase**

Negotiation phase	N	Effectiveness of materials procurement strategy (%)				Mean value (mv)	Rank (r)
		Ineffective (%)	Less effective (%)	Effective (%)	Very effective (%)		
Payments to supplier(s)	93	1.1	11.8	52.7	34.4	3.20	1
Materials specification	93	0.0	7.5	65.6	26.9	3.19	2
Creating requisition orders based catalogue information	93	0.0	7.5	73.1	19.4	3.12	3
Comparison of available materials properties based on catalogue information	93	3.2	16.1	59.1	21.5	3.08	4
Materials cost negotiations	93	2.2	9.7	66.7	21.5	3.01	5
Materials tracking (from suppliers to site).	93	2.2	16.1	60.2	21.5	3.00	6
Tracking of new and pending transactions	93	1.1	17.2	62.4	19.4	2.99	7
Negotiation of materials qualities	93	3.2	16.1	65.6	15.1	2.92	8

Figure 4.4 illustrates a comparison of the effectiveness and frequency of materials strategy usage in the negotiation phase of procurement as presented in Table 4.10 and 4.11.

The analysis was based on the usage frequency and effectiveness of the materials procurement strategy adopted for use during construction. From Figure 4.4, it was observed that the procurement strategy (EMPTs) adopted for use in the process of paying materials suppliers is ranked first in terms of effectiveness and frequency of usage respectively. This implies that EMPTs is most suitable for the process of paying suppliers during materials procurement in terms of efficiency. The figure 4.4 also shows that the TMPs is most frequently used in negotiating the quality and quantity of materials required for construction. In negotiation materials cost and tracking pre-ordered materials, figure 4.4 illustrates that the procurement strategies (EMPTs & TMPs) are most frequently used with the effectiveness of 80.6% and 81.7% respectively.



**Figure 4.4 Comparative analyses of materials procurement strategies based on the frequency of adoption and effectiveness during negotiation**

Figure 4.5 presents a pictorial comparison of the effectiveness of the materials procurement strategies based on the task at-hand. The findings presented in Figure 4.5 reveal that in all the phases of the materials procurement, an average of about 65% of the respondents agreed that the adoption of EMPTs is the most effective strategy towards materials procurement time and cost reduction during sustainable building production. This infers that the EMPTs is most

often used in most materials acquisition activities when compared to the TMPs in terms of effectiveness and efficiency.

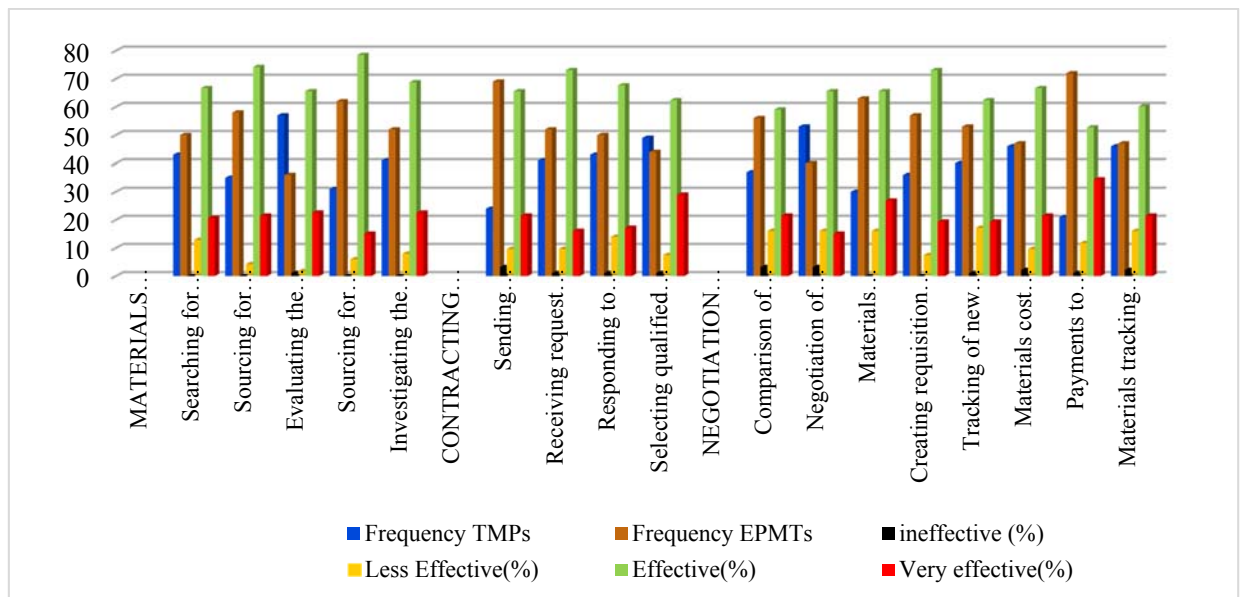


Figure 4.5 Cumulative representation of materials procurement strategies usage frequency and effectiveness in procurement processes

#### 4.11 Benefits of Materials Procurement Strategies

Table 4.12, 4.13 and figure 4.6 presents the findings on the comparison of the benefits of materials procurement strategies (the traditional materials procurement strategy or the electronic materials procurement technology strategy) based on construction and materials acquisition factors. The perceptions of the respondents was evaluated using a four (4) point Likert scale: 1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree which was ranked to further analyse respondents' opinions. From the findings in Table 4.12, 78.5% of the respondents agreed that the adoption of TMPs supports the operations of the Small, Micro and Medium scale Enterprises (SMME) in the construction industry (mv=3.10), 20.4% of respondents disagreed, while 1.1% strongly disagreed with the proposition that the TMPs supports the operations of the SMMEs. Low cost of installation and strategy operation (mv=3.05) was also identified as a benefit of adopting the use of TMPs in materials procurement. The respondents also identified that the use of TMPs creates a forum for mass employment and reduces the cost of materials procurement with mean values of 3.01 and 2.75 respectively.

**Table 4.12 Benefits of Traditional Materials Procurement Strategy (TMPs)**

Benefits	TMPs					
	Strongly disagree (%)	Disagree (%)	Agree (%)	Strongly agree (%)	Mean value (mv)	Ranks
Supports the operations of the Small Micro and Medium scale Enterprises (S.M M.E) in the industry	1.1	20.4	46.2	32.3	3.10	<b>1</b>
Low cost of installation and usage	1.1	20.4	50.5	28.0	3.05	<b>2</b>
Creates forum for mass employment (Creates a large staff-base)	0.0	19.4	60.2	20.4	3.01	<b>3</b>
Reduces materials procurement cost	2.2	37.6	43.0	17.2	2.75	<b>4</b>
Serves as a preferred tool for sustainable procurement	2.2	37.6	44.1	16.1	2.74	<b>5</b>
Facilitates government participation in sustainable procurement	5.4	30.1	53.8	10.8	2.70	<b>6</b>
Requires additional workforce training for effective implementation	2.2	47.3	31.2	19.4	2.68	<b>7</b>
Decentralizes materials procurement activities	4.3	40.2	39.4	16.1	2.62	<b>8</b>
Aids speedy project delivery	3.2	49.5	30.1	17.2	2.61	<b>9</b>
Promotes easy access to updated construction materials information	3.2	47.3	35.5	14.0	2.60	<b>10</b>
Promotes quicker and easier materials comparison in-terms of cost and quality	1.1	50	40.9	8.6	2.57	<b>11</b>
Promotes technical skills improvement of the company's procurement staffs	7.5	45.2	41.9	5.4	2.45	<b>12</b>

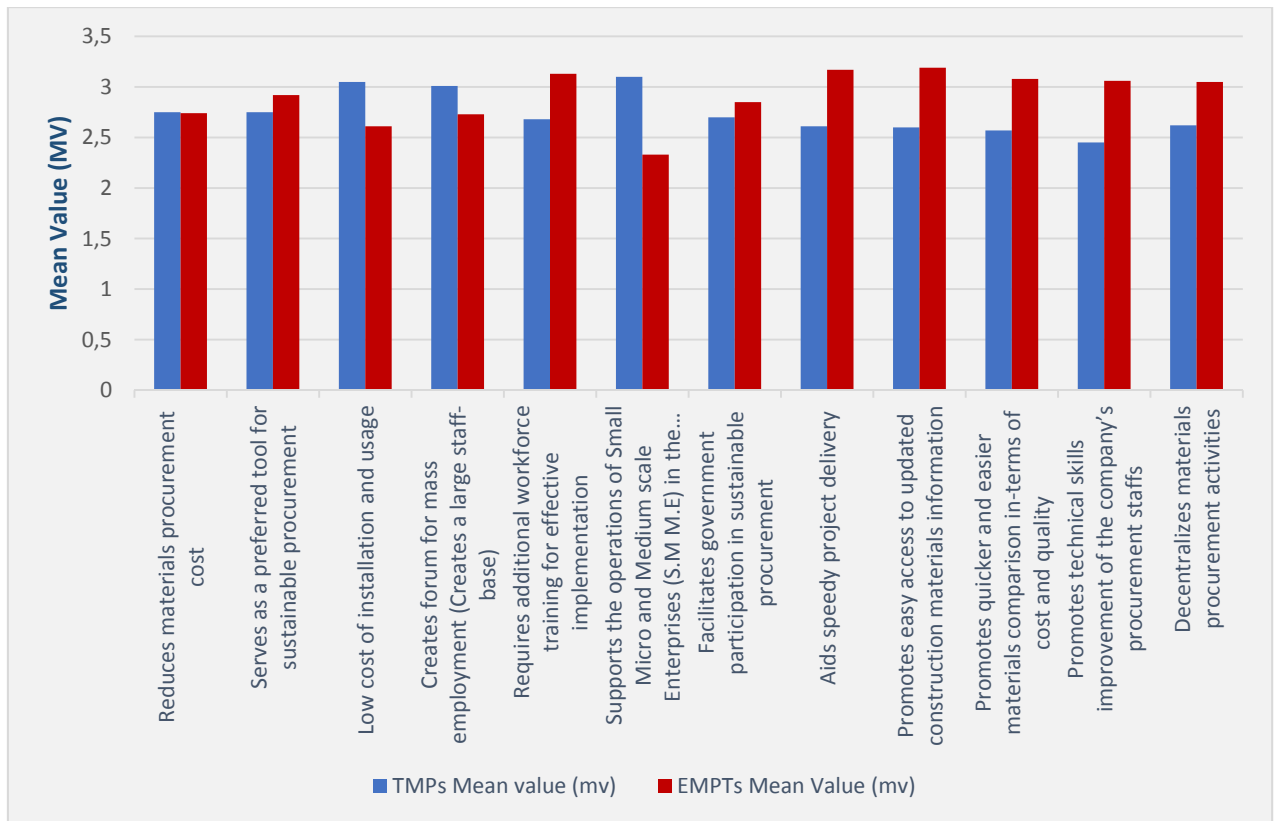
Table 4.13 presents the benefits of electronic materials' procurement strategy (EMPTs). From the table, promoting easy access to updated construction materials information (mv=3.19), aiding speedy project delivery (mv=3.17) and requirement of additional workforce training for effective implementation (mv=3.13) were identified as top benefits of EMPTs in attaining the economic sustainability of the building. 71% of the respondents agreed that adopting the use of EMPTs promotes easy access to updated construction materials information in the process procurement (mv=3.19). A significant percentage of the respondents (84.9%) also agree that the adoption of EMPTs in materials procurement for construction projects aids speedy delivery of the project (mv=3.17). Most respondents (82.8%) indicated that fully attain the benefits of EMPTs, additional workforce training is required for effective implementation.



**Table 4.13 Benefits of the Electronic Materials Procurement Technology Strategy (EMPTs)**

Benefits	EMPTs					
	Strongly disagree (%)	Disagree (%)	Agree (%)	Strongly agree (%)	Mean value (mv)	Rank (r)
Promotes easy access to updated construction materials information	1.1	14.0	49.4	35.5	3.19	<b>1</b>
Aids speedy project delivery	1.1	14.0	51.6	33.3	3.17	<b>2</b>
Requires additional workforce training for effective implementation	1.1	16.1	51.6	31.2	3.13	<b>3</b>
Promotes quicker and easier materials comparison in-terms of cost and quality	0.0	26.9	38.7	34.4	3.08	<b>4</b>
Promotes technical skills improvement of the company's procurement staffs	1.1	21.5	47.3	30.1	3.06	<b>5</b>
Decentralizes materials procurement activities	7.7	22.6	46.2	22.4	3.05	<b>6</b>
Serves as a preferred tool for sustainable procurement	0.0	26.9	53.8	19.4	2.92	<b>7</b>
Facilitates government participation in sustainable procurement	5.4	22.6	53.8	18.3	2.85	<b>8</b>
Reduces materials procurement cost	6.5	32.3	41.9	19.4	2.74	<b>9</b>
Creates forum for mass employment (Creates a large staff-base)	5.4	31.2	48.4	15.1	2.73	<b>10</b>
Low cost of installation and usage	3.0	43.0	43.0	10.8	2.61	<b>11</b>
Supports the principles guiding the implementation of Small Micro and Medium scale Enterprises (S.M M.E) in the industry	14.0	44.1	36.6	5.4	2.33	<b>12</b>

Figure 4.6 illustrates the variance in the responses of the respondents based on the results (mean value) presented in Table 4.12 and Table 4.13. The TMPs is observed to significantly support the principles guiding the implementation of Small Micro and Medium scale Enterprises (S.M M.E) in the industry. Other top benefits of TMPs as illustrated by the figure 4.6 include creating employment for the masses and 'low cost of installation and usage'. The EMPTs, on the other hand, significantly aids speedy project delivery, promotes easy access to updated materials information and support the intellectual improvement of construction worker - especially in the use of electronic gadgets - to improve the system of materials procurement. However, comparing the benefits of the procurement strategies (EMPTs & TMPs) in materials procurement, the EMPTs is most beneficial towards the enhancement of sustainable production.



**Figure 4.6 Comparative analyses of the benefits of TMPs and EMPTs**

#### 4.12 Barriers' of Materials Procurement Strategies

The respondents were requested to appraise the barriers to the adoption of the traditional materials procurement and electronic materials procurement strategies during sustainable building production. Table 4.14 and Table 4.15 present findings from the respondents based on a four (4) point Likert scale: 1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree used in the appraisal. From Table 4.14, the results show that the cumbersome nature of materials selection and acquisition (mv=3.26), risk of information error or duplication during information transfer (mv=3.17), ineffective system of communication between contractors and suppliers (mv=3.12) and size and fragmentation of the construction industry (mv=3.10) were identified as top barriers to the use of TMPs in the construction industry. 91.4% of the respondents consider the cumbersome nature of materials selection and acquisition as a barrier to the adoption of the paper-based TMP system. This is due to the volume of paperwork produced during procurement. 78.5% of the respondents also stated that the adoption of TMPs exhibits a high risk of information error in record keeping and information transfer (from paper to electronic), while 21.5 % of the respondents disagree with this

preposition on the risk of information error. However, findings indicated that 60.2% of the respondents believe that the lack of general awareness of TMPs (mv=2.33) is not a barrier to the adoption and efficiency of TMPs in the construction industry. Most of the respondents (68.2%) also indicated that resistance to change is not a barrier to the adoption of TMPs in materials procurement in the construction industry. It is inferred that this could be because the TMPs is a trusted procurement system, which has been in existence for decades in the construction industry.

**Table 4.14 Barriers of traditional materials procurement strategy (TMPs)**

Barriers	TMPs					Ranks
	Strongly disagree (%)	Disagree (%)	Agree (%)	Strongly agree (%)	Mean value	
Cumbersome nature of materials selection and acquisition	0.0	8.6	57.0	34.4	3.26	<b>1</b>
Risk of information error or duplication during information transfer	0.0	21.5	39.8	38.7	3.17	<b>2</b>
Ineffective system of communication between contractors and suppliers.	4.3	23.7	44.1	28.0	3.12	<b>3</b>
Size and fragmentation of the construction industry	1.1	18.3	50.5	30.1	3.10	<b>4</b>
High fear of fraud	2.2	20.4	45.2	32.3	3.08	<b>5</b>
Permits unplanned purchases from random suppliers at a higher price (Maverick buying)	2.2	21.5	45.2	31.2	3.05	<b>6</b>
Size of procuring company (size of available manpower)	4.3	23.7	44.1	28.0	2.96	<b>7</b>
Lacks standardised documentations for materials requisition and procurement	0.0	33.3	43.0	23.7	2.90	<b>8</b>
High cost of materials procurement	2.2	20.4	45.2	32.3	2.74	<b>9</b>
Ineffective Government policy on materials procurement	9.7	31.2	46.2	12.9	2.62	<b>10</b>
Resistance to change in the construction industry	18.3	40.9	25.8	15.1	2.53	<b>11</b>
Lack of general awareness in the industry	17.2	43.0	29.0	10.8	2.33	<b>12</b>

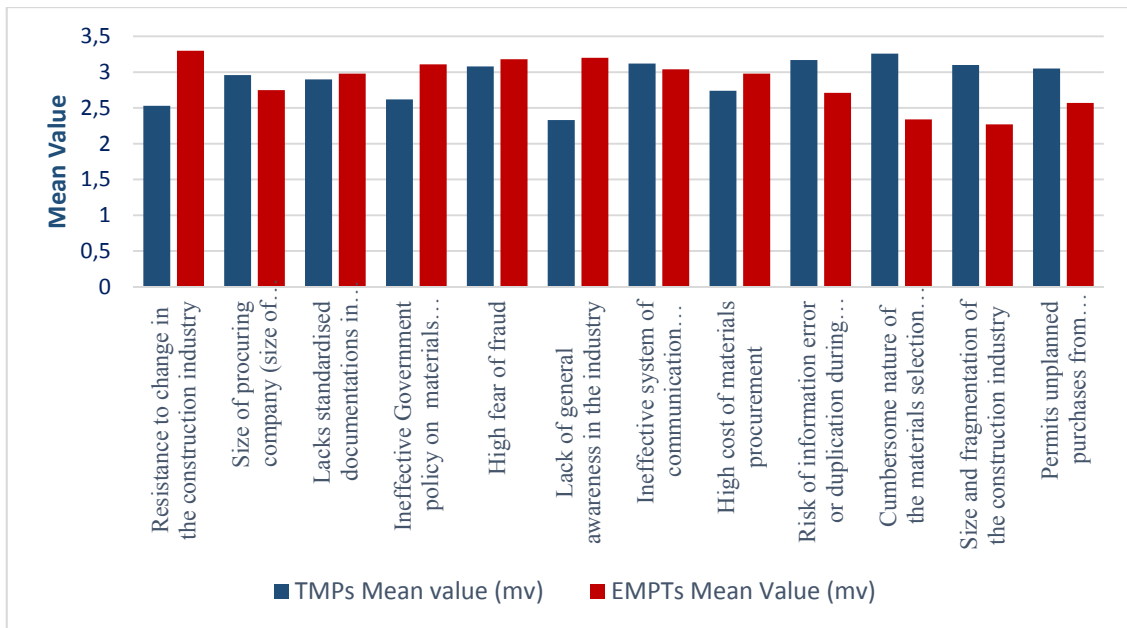
Table 4.15 presents findings on the barriers' to the adoption of EMPTs in the construction industry. Majority of the respondents (90.4%) agree that resistance to change (mv=3.30) is a top barrier to the adoption of EMPTs by construction professionals. Most of the respondents (69.9%) indicated that lack of general awareness in the industry (mv=3.20) is also a notable factor that stands as a barrier to the adoption of EMPTs. High fear of fraud (mv=3.18), ineffective government policy on materials procurement (mv=3.11) and ineffective system of communication between contractors and supplies (mv=3.04) were also identified as barriers to the adoption of EMPTs during sustainable building production. The findings also revealed

that ‘Permits unplanned purchases from random suppliers at a higher price (Maverick buying)’ (59.8% of the respondents), ‘size and fragmentation of the construction industry’ (71% of the respondents) and ‘cumbersome nature of the materials selection and acquisition’ (67.7% of the respondents) were disagreed by respondents as barriers’ to the adoption of EMPTs in the industry, especially during sustainable building production.

**Table 4.15 Barriers of Electronic Materials Procurement Strategies (EMPTs)**

Barriers	EMPTs					
	Strongly disagree (%)	Disagree (%)	Agree (%)	Strongly agree (%)	Mean value	Ranks
Resistance to change in the construction industry	1.1	8.6	49.5	40.9	3.30	<b>1</b>
Lack of general awareness in the industry	2.2	38.7	50.5	19.4	3.20	<b>2</b>
High fear of fraud	2.2	22.1	43.0	32.7	3.18	<b>3</b>
Ineffective Government policy on materials procurement	1.1	23.7	64.5	10.8	3.11	<b>4</b>
Ineffective system of communication between contractors and supplies.	2.2	28.0	50.5	19.4	3.04	<b>5</b>
Lacks standardised documentations for materials requisition and procurement	3.2	20.4	51.6	24.7	2.98	<b>6</b>
High cost of materials procurement	1.1	24.4	58.1	16.4	2.98	<b>7</b>
Size of procuring company (size of available manpower)	8.6	62.4	22.6	6.5	2.75	<b>8</b>
Risk of information error during information transfer or duplication	1.1	43.0	39.8	16.1	2.71	<b>9</b>
Permits unplanned purchases from random suppliers at a higher price (Maverick buying)	7.5	52.3	35.9	4.3	2.57	<b>10</b>
Cumbersome nature of the materials selection and acquisition	5.4	67.7	14.0	12.9	2.34	<b>11</b>
Size and fragmentation of the construction industry	8.6	62.4	22.5	6.5	2.27	<b>12</b>

Figure 4.7 is a graphical representation of the variance in the responses of the respondents based on the ranking presented in Table 4.14 and Table 4.15. It was observed in the analysis that the resistance to change in the construction industry is the most influential barrier to the adoption of EMPTs while the cumbersome nature of the materials procurement system is the most outstanding barrier to the adoption of TMPs. However, from the finding, it was observed that the ineffective system of communication between contractors and supplies, and fear of fraud are common barriers to the adoption of both TMPs and EMPTs during materials procurement.



**Figure 4.7 Comparative analyses of the barriers of TMs and EMPTs in materials procurement.**

### **4.13 Impacts of Government Policies on the Efficiency of Materials Procurement Strategies Implementation**

The respondents were required to quantify the efficiency of government procurement policies in facilitating the implementation of materials procurement strategies in the construction industry. A four (4) point Likert scale: 1=less effective, 2=effective, 3=very effective, 4=extremely effective. Table 4.16 shows that the principles of Section 217(1) Act of the constitution for effective materials procurement system with mean value 2.89 is identified as the most effective policy that facilitates the implementation of materials procurement strategies. 89.3% of the respondents indicated that the principles of Section 217(1) Act of the constitution for effective materials procurement system are effective while 10.8% of the respondents indicated that the policy is less effective. The findings also show that the Construction Industry Development Board Act (CIDB Act 2000) on sustainable procurement prescripts for best practices in the industry (mv=2.80) and the 'Public Finance Management Act in establishing a regulatory framework for SCM at national departments, provincial departments and state-owned enterprises (PFMA)' (mv=2.66) were also considered effective polices in the implementation of materials procurement in the construction industry.

**Table 4.16 Effectiveness of Government policies in materials procurement implementation**

<b>Policies</b>	<b>No.</b>	<b>Less effective (%)</b>	<b>Effective (%)</b>	<b>Very effective (%)</b>	<b>Extremely effective (%)</b>	<b>Mean value (mv)</b>	<b>Rank</b>
Section 217 of the constitution for effective materials procurement system (Fairness, transparency, equity etc.)	93	10.8	23.7	31.2	34.4	2.89	1
The Construction Industry Development Board Act (CIDB Act 2000) on sustainable procurement prescripts for Best practices in the industry	93	9.7	32.3	26.9	31.2	2.80	2
The Public Finance Management Act (PFMA) in establishing a regulatory framework for SCM at national departments, provincial departments and state-owned enterprises	93	14.0	33.3	25.9	26.9	2.66	3
The impact of Preferential Procurement Policy Framework Act (PPPFA) towards the Reconstruction and Development Programme (RDP) in the industry	93	18.3	37.6	31.2	12.9	2.39	4
The Broad-based black economic empowerment towards Protecting disadvantaged citizens (B-BBEE)	93	39.6	23.8	23.4	12.9	2.33	5

**4.14 Objectives of Government Policies in Materials Procurement Strategies Implementation.**

The survey requested that the respondents appraise the extent to which the objectives of government policies facilitates the implementation of materials procurement strategies during construction processes using a four (4) point Likert scale: to a small extent =1, moderate extent =2, large extent =3, extremely large extent= 4. Table 4.17 shows that the main objectives of government policies with regards to materials procurement are to promote the participation of small and medium enterprises in the growth of economy (mv=3.40), register contractors based on CIDB Acts for effective procurement practices (mv=3.35), protecting individuals disadvantaged by discrimination (Preferential procurement policy) (mv=3.20) and Improving the economic statue of the country (GDP) (mv=3.10). The findings also shows that creating job opportunities for local contractors to meet the aim of the B-BBEE policy (mv=2.96), Promoting the use of indigenous resources (mv=2.81) were also indicated as the objectives of government policies in materials procurement implementation. None of the respondents’ indicated any of the objectives as irrelevant in facilitating the implementation the strategies materials procurement.

**Table 4.17 Objectives of government policies in materials procurement implementation**

Objectives	N	Small extent (%)	Moderate extent (%)	Large extent (%)	Extremely large extent (%)	Mean value (mv)	Std. D	Rank
To promote the participation of small and medium enterprises in the growth of economy	93	0.0	36.6	49.5	14.0	3.40	0.74	1
Registration of contractors based on CIDB Acts for effective procurement practices	93	1.1	37.6	40.9	2.9	3.35	0.66	2
Protecting individuals disadvantaged by discrimination (Preferential procurement policy)	93	0.0	26.9	47.3	25.8	3.20	0.73	3
Improving the economic statue of the country (GDP)	93	0.0	29.0	46.2	24.7	3.10	0.74	4
Creating job opportunities for local contractors to meet the aim of the B-BBEE policy	93	0.0	22.6	45.2	32.3	2.96	0.73	5
To remedy the effect of apartheid and inequalities (Black empowerment)	93	0.0	36.6	45.2	18.3	2.85	0.72	6
Promoting the use of indigenous resources (limiting materials importation)	93	0.0	29.0	47.3	23.7	2.81	0.77	7
Standardizing the construction materials mark of approval (SABS mark of approval)	93	0.0	20.4	57.0	22.6	2.77	0.68	8
Enforcing the use of Eco-labelling standards for construction materials	93	1.1	39.8	49.5	9.7	2.68	0.66	9

#### 4.14 Barriers to the Influence of Government Policies in Materials Procurement

Table 4.18 presents the perception of respondents on the barriers to the implementation of materials procurement strategies based on government policies. A four (4) point Likert scale: 1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree adopted to evaluate the perception of the respondents. The finding in Table 4.18 revealed that the level of corruption in the government (mv=3.33), lack of long term perception on sustainable procurement implementation by the government (mv=3.24), lack of materials procurement supportive structures in the government (mv=3.16), resistance to sustainable change by government officials (mv=3.14) and the lack of accountability and supportive government structure (mv=3.11) were indicated by the respondents as barriers to the adoption of government policies in materials procurement towards sustainable building production especially in the public sector. The respondents also agreed that inconsistency in policy implementation by construction managers (mv=2.99), political interference in general decision and policy making (mv=2.97) and the high growing rate of corruption in the construction industry

(mv=3.05) are factors that could also hinder the implementation of materials procurement strategies especially in the public sector.

**Table 4.18 Barriers to the influence of government policies in materials procurement implementation**

Factors	N	Strongly disagree (%)	Disagree (%)	Agree (%)	Strongly agree (%)	Mean Value (mv)	Std. D	Rank
Level of corruption in the government	93	1.1	8.6	46.2	44.1	3.33	0.68	1
Lack of long term perception on sustainable procurement implementation by the Government	93	0.0	9.7	57.0	33.3	3.24	0.62	2
Lack of materials procurement supportive structures in the government	93	1.1	6.5	67.7	24.7	3.16	0.58	3
Resistance to sustainable change by government officials	92	0.0	15.1	54.8	29.0	3.14	0.66	4
Lack of accountability and supportive government structure	93	0.0	6.5	76.3	17.2	3.11	0.48	5
High growing rate of corruption in the construction industry	93	1.1	17.2	57.0	24.7	3.05	0.68	6
Inconsistency in policy implementation by construction managers	93	0.0	18.3	64.5	17.2	2.99	0.60	7
Political interference in general decision and policy making	93	0.0	23.7	55.9	20.4	2.97	0.67	8
Inefficient guidance or best practice Acts for sustainable materials procurement	93	1.1	30.1	52.7	16.1	2.84	0.70	9

#### **4.15 Construction Stakeholders Related Factors Affecting Materials Procurement Efficiency Towards Sustainable Building Construction Enhancement.**

Table 4.19 presents the perception of the respondents on stakeholders' related factors affecting materials procurement efficiency towards sustainable construction enhancement. The respondents were required to use a four (4) point Likert scale: 1=strongly disagree, 2=disagree, 3=agree, 4=strongly disagree. The findings from the table shows that slow or inadequate flow of finance from the client (mv=3.17) and lack of communication with client on basic construction process from the conceptual phase (mv=3.08) are significant client related factors that affect materials procurement efficiency. While obscure design specifications (mv=3.12), scarcity of specified materials in the market (mv=3.09) and missing details in quality and quantity specifications (mv=3.08) were identified as top consultant related factors. The table also shows that the profit-driven intentions of contractors



(mv=3.20), contractors inability to translate designs and understand materials specifications produced by the consultants (mv=3.18) and the contractor s' relationship with sub-contractors (mv=3.08) as contractors' related factors affect the process of materials procurement efficiency towards sustainable building construction.

**Table 4.19 Construction stakeholders related factors affecting materials procurement efficiency towards sustainable building construction.**

<b>Stakeholders' Factors</b>	<b>No.</b>	<b>Strongly disagree (%)</b>	<b>Disagree (%)</b>	<b>Agree (%)</b>	<b>Strongly agree (%)</b>	<b>Mean value (mv)</b>	<b>Std. D</b>	<b>Rank</b>
<b>Clients related factors</b>								
Slow or inadequate flow of finance from the client	93	0.0	23.7	35.5	40.9	3.17	0.79	1
lack of communication with client on basic construction process from the conceptual phase	93	0.0	24.7	43.0	32.3	3.08	0.76	2
Choice of design approved by the client	93	0.0	22.6	48.4	29.0	3.06	0.72	4
Changes in orders and requirements stated by client	93	0.0	26.9	44.1	29.0	3.02	0.75	5
<b>Consultant related factors</b>								
Obscure design specifications	93	0.0	25.8	36.6	37.6	3.12	0.79	1
Scarcity of specified materials in the market	93	0.0	24.7	41.9	33.3	3.09	0.76	2
Missing details in quality and quantity specifications	93	0.0	20.4	51.6	28.0	3.08	0.70	3
Lack of communication between the architect and other stakeholders	93	0.0	22.6	53.8	23.7	3.01	0.68	4
Reluctance of engineers and architects to work	93	0.0	31.2	38.7	30.1	2.99	0.79	5
Errors / omission in the bill of quantities given to the client	93	0.0	33.3	39.8	26.9	2.94	0.78	6
Delay in temporary valuation preparation	93	0.0	35.5	36.6	28.0	2.92	0.80	7
<b>Contractors related factors</b>								
Profit-driven motives of contractors	93	0.0	3.2	19.4	41.9	3.20	0.73	1
Contractors inability to translate designs and understand materials specifications	93	0.0	26.9	48.4	24.7	3.18	0.69	2
Contractor s' relationship with sub-contractors	93	4.3	11.8	67.7	16.1	3.08	0.71	3
Absence of contractor participation in the design stage	93	2.2	17.2	55.9	24.7	2.97	0.71	4

## 4.16 Discussion of Findings

### 4.16.1 The concept of materials usage towards sustainable building production

In this section, the findings on the schemes that facilitate effective materials usage during sustainable building production are discussed. The impact of construction materials

management on materials selection for optimum materials usage and facilitators of optimum materials usage during production process, were also considered.

#### **4.16.1.1 Policies for effective materials usage towards sustainable building production enhancement.**

Construction materials usage has been proven to be an integral constituent of building production. Hence, optimum materials usage is a driving force for labour efficiency and productivity toward a successful sustainable building delivery. Literature affirms that the process of construction materials usage during building production influences the functionality, economic and environmental sustainability of the building. Literature on sustainable building design and construction also revealed that in creating healthier and more productive environments for inhabitants, the effectiveness of regulatory control in materials usage is essential. This is to reduce the level of materials wastages, environmental pollution and total construction cost.

Based on this information, this study evaluated the concept of materials usage towards sustainable building production enhancement in the South African construction industry. The results obtained from findings shown in Table 4.3 revealed that the adoption of the Green Building Council of South Africa (GBCSA) policy is the most effective policy adopted in appraising the usage of materials during building production processes. Since the usage of building materials is observed to have considerable impact on the environment and cost of building production, the GBCSA was established in 2007 (September) is primarily to promote economically and environmentally sustainable practices within the South African commercial property sector. Sebake (2008) posited that a well-planned and effective adoption of the GBCSA's green star rating system in evaluating the suitability of the materials, enhances the sustainability of the building. The materials evaluation proposed are based on sustainable assessment criteria for selection such as performance capability, energy efficiency and environment responsibility of the materials. Van Reenen (2014) further supported the notion that enforcing the adoption of the green star rating system during materials selection and usage is a means of using the Green Star SA rating system developed by the GBCSA in assessing and scoring a building's level of transformation from the conventional (traditional) way of building construction and management to a more economically and environmentally responsible solution" in terms of sustainability. This infers that the impact of construction materials selection and usage at any phase of the building construction based on the policies

of GBCSA can reduce the cost of production and adverse environmental impacts. The finding also indicated that adopting the use of a life-cycle analysis (LCA) system is another effectual scheme for effective materials usage during sustainable construction (Table 4.3). The adoption of the LCA system provides a standardized analysis of the impact of every material used in the production process based on the International Organization for Standardization (ISO) codes. In enhancing the sustainability of a building during production, the LCA is one of the most effective tools available to the contractors to holistically evaluate the environmental impact of the materials, processes or activities adopted at every phase of construction. This finding was supported by Bribián, Usón, and Scarpellini (2009), who stated that analysing the life-cycle of a building – in terms of the use of recyclable materials, bioclimatic ecodesign and energy efficiency - promotes sustainability in building construction.

Other major findings were adoption of the principles of Sustainable Assessment Criteria (SAC) principles, imbibing the principles of construction wastes recycling to reduce environmental pollution and adapting the process of dematerialisation at every phase of construction. Majority of the respondents indicated that the use of Eco-friendly technologies during construction is significantly ineffective in the construction industry of present.

#### **4.16.1.2 Impact of construction materials management on materials selection during building production**

Literature reveals that the process of materials management is an integral feature of construction project activities, which improves labour productivity. This construction function has also been observed to have an influence on project completion time and company profitability. Effective use of materials is dependent on materials management processes adopted at the time of production. The availability of a construction materials in the market when required have been identified by respondents as the most important factor to consider during materials selection for optimum materials usage during building production (Table 4.4). This finding was supported by Ameh and Osegbo (2011) who stated that the shortage or unavailability of construction materials when needed is major factor affecting project success. Kasim (2011) further noted that the availability of suitable construction materials in the market would significantly allow contractors/ engineers produce buildings with improved sustainable values and minimal cost. This approach is achievable through strategic planning at the conceptual phase toward the purchase of materials at the required quantity, cost and time.

This was identified by the respondents as the second most relevant factor to put into consideration during materials selection. Strategic planning before procurement at design stage allows the engineers/contractors time to develop a feasible plan in meeting building specifications with the available materials in the market. The planning phase of a building at the design phase involves materials selection, ordering and scheduling. A lapse in this process will negatively affect the materials usage and workforce productivity. Supporting this finding, Kasim (2011) stated that effective planning at the early phase of building production significantly ensures the availability of construction materials when required and reduces resources wastage, which directly improves the economic sustainability of the building. The environmental impact of the materials to be considered for construction was also indicated as a relevant factor to consider during materials selection. Literature reveals that the sustainability level of a building is characterised by the materials used at any stage of construction. However, the life cycle of building materials from the extraction phase to the disposal phase has a significant impact on the environment. Thus, Karana *et al.* (2010) stated that the selection and usage of materials that cause low harm to the environment or the habitats during and after construction should be encouraged in the industry. This statement was supported by Van Reenen (2014) who posited that this sustainable principle can only be achieved by the use of renewable, reusable and recyclable materials during construction. Other major factors to consider for effective materials management include: the requirements of the South African National Standards (SANS) policies, procurement strategy considered for materials purchase, work experience of construction workforce and the communication level between workers during construction.

#### **4.16.1.3 Facilitators of effective materials usage towards building sustainability**

Exploring the usage of materials on construction sites in the Western Cape Province, delay of materials delivery to construction sites was identified as a significant contributor to construction time and cost overrun. Findings reveal that for effective materials usage in a construction project for economic sustainability, timely materials delivery must be ensured (Table 4.5). Economically, prompt delivery and usage of construction materials leads to timely project completion and profit remuneration. This statement was supported by Haseeb, Bibi & Rabbani. (2011) who stated that timely project completion contributes to the economic statuses of a country especially in large building projects. Environmentally, timely materials delivery prevents materials depletion during the process of sustainable building production on

site. This is as a result of adopting the concept of renewable/reusable materials strategy in construction which serves as a means of mitigating materials wastages and environmental pollution. Van Reenen (2014) opined that the use of local material sources within the proximity of the site reduces the time and cost for materials delivery to site. This approach was observed to encourage the use of locally produced materials as it is stated as a Green Star SA requirement for sustainability (Van Reenen, 2014). Proper understanding of clients' ideas at the conceptual phase of design was also indicated as a relevant factor to consider for materials selection and optimum usage. To support this finding, Storvang and Clake (2014) stated that the conceptual phase provides the client with the opportunity to contribute relevant insights to the construction project. Haseeb *et al.* (2011) added that incompetency on the part of the contractors at this construction phase may result in resource wastages and construction cost over-run.

Other major findings discovered in this study include: implementing waste reduction techniques during construction, effective communication amongst workers during construction and, efficiency of the materials procurement strategy (Table 4.4 & 4.5) which are common productivity factors during construction.

#### **4.16.2 Effectiveness of functional materials procurement strategies in the industry**

The study conducted a comparative analysis of functional materials procurement strategies presently in use in the construction industry. The materials procurement strategies considered for the study were the traditional materials procurement strategy (TMPs) and electronic materials procurement technology strategy (EMPTs). The analysis was based how often these strategies are used and how effective the strategies are in meeting the procurement objectives the companies represented. Table 4.6, 4.7, 4.8, 4.9, 4.10 & 4.11 present a comprehensive report on the perception of the respondents with regards of materials information sourcing, tendering, negotiation and delivery.

##### **4.16.2.1 Frequency and effectiveness of materials procurement strategies adoption**

The findings reveal that majority of the respondent frequently adopted the use of EMPTs most phases of materials procurement in their individual companies (Table 4.6, 4.7, 4.8, 4.9, 4.10 & 4.11). The study on the materials' sourcing phase (Table 4.6 & 4.7) show that the EMPTs is most often used in sourcing for appropriate materials for on-going projects which is 74.2% effective. One of the advantages of the EMPTs is the reduction of procurement time. The

EMPTs gives the contractors the opportunity to search for the required materials from a wide range of suppliers within a short period of time. This finding is supported in literature by researchers. Tai *et al.* (2010) stated that the adoption of the EMPTs streamlines the cost and process of materials procurement towards operational efficiency. The process of investigating the quality certification, work credibility and financial status information about selected suppliers; sourcing materials properties and information and sourcing for potential suppliers were indicated as activities conducted using the EMPTs. The findings also show that a majority of the companies adopted the TMPs in analysing the lifecycle (installation, servicing and maintenance requirements) of the materials to be purchased. This could be because the TMPs provides the contractors/ procurement officers the opportunity to physically enquire from the suppliers the lifecycle properties before making the purchase.

During the Contracting phase (Table 4.8 & 4.9), the EMPTs is most often used in requesting for materials information (RFIs) from suppliers (65.6% effective), receiving request for quotes (RFQs) from procuring firm (73.1% effective), and responding to request for proposal (RFPs) from suppliers (67.7% effective). The findings reveal that majority of the respondents have significantly adopted the concept of e-tendering in their materials procurement system (Table 4.8 & Figure 4.3). This infers that the transfers of requisition documents between contractors and suppliers are carried out electronically to reduce work overload and associated cost. This finding was supported by Oyediran and Akintola (2011) who claimed that the process of e-tendering reduces the tender period and the overhead cost of manually transferring the tender and contract documents (e.g. Postal service). However, the finding also revealed that about 53% of the respondents adopt the use TMPs in selecting qualified suppliers for negotiation with 62.4% effectiveness. The selection of qualified suppliers is an important stage the post contract phase when contract is being award to both large companies and SMEs. Economically, the TMPs gives the contractor the opportunity to select the most competent suppliers for the contract; as most viable and cost efficient suppliers have not readily incorporated the use of Internet in their work culture (Lavelle & Bardon, 2009). Relatively, the adoption of TMPs is a means of patronising local suppliers towards a sustainable socio-economic development during construction.

In the negotiation phase (Table 4.10 & 4.11), the finding reveal that the TMPs are most often being used in tracking materials from suppliers to site, negotiations of materials cost and quality with 60.2, 66.7 and 65.6 % effectiveness respectively. This gives the contractors a

'first hand' contact with the suppliers in negotiating the cost and quality of the materials to be purchased. Lavelle and Bardon (2009) claimed this could be as a result of the reliability and standard concerns of using the EMPTs in the industry. Jooste and Van Schoor (2003) suggested the adoption of TMPs for this activities as it entails paper-work coping and archiving for personnel accountability enhancement at every stage of procurement. The findings also shows that the EMPTs is most often adopted in the payments to supplier(s), making materials order specification, materials comparison, creating requisition orders based catalogue information and tracking of new and pending transactions. The percentages of effectiveness as indicated in Table 4.11 are 87.1%, 92.4%, 80.6 % and 81.8 % respectively. These findings were supported by Chang & Wong (2010) who claimed that the adoption of e-procurement in the process of materials acquisition possess the ability to prevent fraud, create a global market place for suppliers and effectively manage transactions with suppliers. These findings infer that the concept of EMPTs has gained a significant level of awareness in the South African construction.

#### **4.16.3 Benefits of materials procurement strategies**

The analysis of quantitative data collected for this research and literature reviewed clarified that the type of materials procurement strategy adopted in materials purchase for a sustainable building project, is significantly dependent on the benefits of strategy chosen over the other and the construction companies involved. This insinuated the need to evaluate the perceptions of construction stakeholders' on the benefits of materials procurement strategies (TMPs and EMPTs) in the South African industry. Table 4.12, 4.13 and Figure 4.6 show the results obtained from the study.

##### **4.16.3.1 Benefits of the traditional materials procurement strategy (TMPs)**

The findings from the study reveal that supporting the operations of Small Micro and Medium scale Enterprises (S.M M.E) in the industry, lower cost of installation and usage and creating a large staff-base possession (creates forum for mass employment) are the major benefits of the TMPs. The identified factors rated above a mean value of 3.0, indicating that these factors are outstanding benefits of the TMPs which should be considered during the process of sustainable building production towards socio-economic development in the society.

Supporting the operations of the SMME in the industry is the primary benefit of the TMPs identified by the respondents. The size, capital base and fixed assets are factor to consider in

classifying the operations of any enterprise. This statement was confirmed by Esselaar, Stork, Ndiwalana and Deen-Swarray (2006) who claimed that South Africa records an approximate of 219 SMMEs out of which 112 are micro enterprises with less than 50 employees and no robust financial base. Noting that the impact of high financial, regulatory and technical requirements are perceived as binding constraints in the SMMEs, 76% of the respondents agreed to the adoption of TMPs as means of empowering the financially disadvantaged suppliers. To support this finding, McDermotti and Khalfan, (2012) noted that the TMPs poses to be ideal for the SMMEs as a result of the low cost of operation. Another major benefit of the TMPs is the ability to create mass employment for Historically Disadvantaged Individuals (HDI) towards the economic growth of the country especially through the SMMEs.

#### **4.16.3.2 Benefits of the electronic materials procurement technology strategy (EMPTs)**

Promoting the easy access to updated construction materials information was ranked as the primary benefit of adopting the EMPTs during the production process of a sustainable building (Table 4.13). Table 4.13 shows that 85% of the respondents agree that the use of EMPTs allows the contractors easy access to new updated construction materials information. Timely evolution of materials and the diversity of material properties available in the industry, construction engineers are at a high risk of becoming outdated in the knowledge of materials available for sustainable building production. This statement was supported by Ashby *et al.* (2013) who stated that the adoption of EMPTs aids the search and selection of materials based on design requirements. Delivering a building project on time is one of the top objectives of a project contractor. Speedy project delivery which is ranked as the second major benefit of adopting the EMPTs during building production processes. Delays in project delivery may be as a result of time overrun, cost overrun, bad planning, dispute between stakeholders' and total abandonment. Other major benefits of the EMPTs included: additional workforce training for effective implementation, quicker and easier materials comparison in-terms of cost and quality, technical skills improvement of the company's procurement staffs and decentralizes materials procurement activities during sustainable building construction.

#### **4.16.4 Barriers of materials procurement strategies**

Procurement in terms of materials acquisition towards enhancing sustainable building production has demonstrated substantial benefits over the years. These benefits may include: effective materials purchase process and discounted procurement cost from key supplies.



However the adoption of any materials procurement strategy is dependent on the barriers in existence. This prompted the need to identify the barriers of materials procurement strategies in the South African Construction industry. Table 4.14, 4.15 and Figure 4.7 shows the results obtained from the study.

#### **4.16.4.1 Barriers of traditional materials procurement strategy (TMPs)**

Findings from the study show that the cumbersome nature of materials selection and acquisition, risk of information error during information transfer or duplication; ineffective communication system and size and fragmentation of the construction industry are major barriers to the adoption of TMPs in the construction industry. These identified are ranked by mean values 3.26, 3.17, 3.12 and 3.10 respectively.

The traditional materials' procurement strategy, being a paper-based process, involves the use of papers catalogues in collecting information about the suppliers and their products. In a large construction projects, where sizable amounts of materials are required, the process of procurement becomes cumbersome due to the large paper works involved in the process. Kong *et al.* (2004) posited that due to the nature of this procurement strategy, contractors/procurement officers have limited access to updated suppliers' and materials information. The adoption of the paper-based strategy of materials procurement is a tedious process, which is characterised by the risk of information error during information transfer or duplication (Kong *et al.* 2004). The findings ranked this barrier second in Table 4.14. Literature reveal that the system of TMP being paper-based requires piles of documents necessary to carry out a job, where a little percentage of error in a documents creates a bridge in the procurement process. The findings also show that another barrier to the adoption of TMPs is the size and fragmentation of the construction industry. This factor has resulted to the ineffective system of communication between suppliers and contractors in the industry. The construction industry is a national economic sector made up of a sum of geographically dispersed construction organisations, construction professionals and suppliers. Baiden, Price and Dainty (2005) in support of this statement, noted that the construction project delivery process is a collaborative effort of professionals and organisations selected: to meet the objectives of the project. To attain the objectives of the projects, it is essential to maintain an effective communication medium between involved in the production process to achieve timely project delivery. Literature reveal that effective communication in the procurement process ensures that most suitable materials for a project is acquired in the right quantity,

affordable cost and at the time required. From literature and the results of the study, the adoption of TMPs appeared significantly unsuitable for complex projects.

#### **4.16.4.2 Barriers of electronic materials procurement strategy (EMPTs)**

Despite of benefits of the EMPTs in the South African construction industry, literatures shows that a selected number of construction organisations have been able to effectively conduct their procurement processes electronically. Results from the study on the barriers of EMPTs show that resistance to change in the construction industry, lack of general awareness in the industry and high fear of fraud as major barriers to the adoption of EMPTs in the construction industry (Table 4.15)

The attitude of construction stakeholders especially the contractor, towards the adoption of EMPTs during building production process is a major concern. Literature reveals that the attitude of construction stakeholders' (for or against) tremendously influences the success level of adopting the EMPTs in the construction industry. The exploratory study and reviewed literature show that, although most construction companies claimed to have adequate experiences in using the EMPTs, a sparse level of EMPTs implementation was observed during materials procurement. This Finding shows that this could be as a result of the resistance to change in the construction industry. Gunasekaran and Ngai (2008) claimed that this resistance to the EMPTs is caused by the fear to change to new system of operation. From the findings, high level of fraud is another major barrier of adopting the EMPTs in the construction. To support this finding, Eadie *et al.* (2007) claimed that the "World Wide Web (www)" is not secured enough to protect the transaction of the users. Rankin, Chen and Christian (2006) added this is one of the technical issues yet unravelled in the use of e-commerce.

#### **4.16.5 Impacts of Government policies on the efficiency of materials procurement strategies implementation**

The analysis of quantitative data collected for this research and reviewed literature depicts that the participation of the South African government in the process of procurement is aimed at ensuring work efficiency, accountability and transparency in the construction industry. With regards to materials procurement, the government as the principal stakeholder of any sustainable development as the responsibility to ensure materials are procured contributes to the socio-economic, ecological and technical advancement of the country. This instigated the

need to evaluate the impact of the Government on the process of materials procurement during building production processes. The findings from the study (Table 4.16) show that Section 217 of the constitution for effective materials procurement system as the most effective policy enacted into law to regulate the process of procurement in the country. Section 217 of the constitution facilitates the use of procurement as a policy tool in any organ of state. Gibberd (2011) supporting this finding, stated that the policy is most effective because it ensures that in implementing the strategies of materials procurement, the process is fair, equitable, transparent, competitive and cost effective. Bolton (2008) posited that Section 217 was also enacted to achieve sustainability during materials procurement by ensuring supplier comply with all environment-related regulations regarding the effect of materials wastage.

#### **4.16.5 Objectives of Government policies in materials procurement strategies implementation.**

The findings reveal that the top-most objective of government policy enactment, with regards materials procurement, is to promote the participation of the small and medium enterprises towards the growth of the economy (Table 4.17). Literature revealed that the SMEs are the major contributors to the economic development of a county. Smit and Watkins (2012) noted that the activities of the SMMEs promote job creation, economic expansion and also eradicates poverty in the society. The United Nations Report on Human Development in South Africa (UNDP, 2003) further showed that the SMMEs contribute vitally to the economy by focusing on the benefits of sustainable development. The South African Government has recognised that SMME sector as a means to achieving an accelerated economic growth. Smit and Watkins (2012) claim that this government goal is achievable by ensuring quality production, client satisfaction and increased innovative ideas would boost the competitiveness and performance of the enterprise. Cumby and Conrod (2001) added that a sustainable long-term financial performance of the SMMEs is attainable by maintaining client loyalty, employee satisfaction and other non-financial factor. Other major objectives include: registration of contractors based on CIDB Acts for effective procurement practices and protecting individuals disadvantaged by discrimination based on implementation of preferential procurement policies.

#### **4.16.7 Barriers to the influence of government policies in materials procurement**

The findings show that the level of corruption in the government sector is significant barrier to the influence of government policies on materials procurement in the South African construction industry (Table 4.18). Literature reveals that corruption is the '*misuse of publicly entrusted power for selfish benefits through bribery, extortion, fraud, price inflation and embezzlement*' by government officials (Bowen, Edwards and Cattell, 2012:886). Corruption is known to kill the movement towards long term development in any organisation or country. In South Africa, corruption is a major impediment to a sustainable development. Pillay (2004) stated that corruption, overtime, has become a threat to good governance in the form of: antiquated laws, undesirable social controls, entrepreneurial politics and bureaucratisation in government institutions. Bowen *et al.* (2012) posited that corruption as a barrier to socio-economic development is a feature in every sector of the construction industry, especially the contracting phase of construction projects, where consultants and contractors engage in collusive tendering for contract awards. This is as a result of the susceptible nature of the construction industry in developing countries with regards to corruption in the procurement system (Shakantu and Chiocha, 2009) The finding also indicated that lack of long term perception on sustainable procurement implementation by the government, lack of materials procurement supportive structures and resistance to sustainable change by government officials are also barriers to the influence of government policies on materials procurement strategies implementation.

#### **4.16.8 Stakeholders' related factors affecting materials procurement strategy efficiency**

The study explores the perception of the respondents concerning stakeholders' related factors affecting materials procurement efficiency toward sustainable building production in the South African construction industry. The study evaluated the client related factors, consultant related factors and the contractor related factors.

##### **4.16.8.1 Client related factors**

In a building construction scenario, the clients are key participates in bringing innovative construction ideas into reality. They have the ability to influence every phase of building production process, especially in terms of finances. This statement concurs with the finding in Pitt, Tucker, Riley and Longden (2009) who stated that the availability of financial incentives is a vital requirement that supports the practice of sustainability in building production.

Noting that the availability of funds for a project is the responsibility of the client, the findings from this study revealed that slow or inadequate flow of finances from the client is a significant factor affecting the efficiency of materials procurement (Table 4.19). The factor has a mean value of 3.17. To support this finding, Doloi (2013) stated that construction clients significantly influences the factors related to delivering a project within time and budget. It can also be inferred from this statement that the efficiency of the consultant and contractors towards project delivery depends on consistent financial and intellectual inputs from the client. The findings also indicated that lack of communication with client on basic construction process from the conceptual phase is another major factor that affects the efficiency of the materials procurement strategy adopted during construction. The conceptual phase is the most important phase in the construction process. A breach in the communication system between the client, contractors and designer at this stage could result in unforeseen project delays on the contractor's part. Tkinm (2009) suggested that an appropriate communication proficiency should be encouraged especially at the conceptual phase in order to achieve uniformity in decision making. Other factor indicated by the findings include: choice of design approved by the client and changes in orders and requirements stated by clients.

#### **4.16.8.2 Consultant related factors**

The optimum responsibility of the consultant is to ensure the clients get value for money by understanding the client's sustainability ambition of the project. This is achievable through constant exchange of ideals between the consultant and client. The findings show that obscure design specifications at the design phase is the major factor that hinders the efficient materials procurement. This could be as result of breached communication between the client and consultant during the construction phase.

The ability for consultants to understand and conceptualise the client's expectations into a clear and workable design at the pre-tender phase is essential for client satisfaction. Doloi (2013) posited that design clarity at the pre-tender phase allows the contractor plan the purchase and cost estimate of materials required for construction. The findings also indicated scarcity of specified materials in the market and missing details in quality and quantity specifications as notable consultant-related factors triggering materials procurement strategy inefficiency during sustainable building production.

#### **4.16.8.3 Contractor related factors**

The finding reveals that the profit-driven motives of contractors during construction are a major contractor related factor affecting materials procurement efficiency. Given that the primary motive of most construction contractors' is to maximize profit at the expense of the client's satisfaction (Mahamid, 2012). Hence, contractors tend to award the purchase of required materials to the least cost tender as long as the materials are available for the work continuity and considerable incentive from suppliers. Sambasivan and Soon (2007) suggested that to avert the reoccurrence of this factor in a project, clients and consultants must monitor closely the activities done on site by making inspections at appropriate times. The authors also suggested that the consultants must ensure contractors have a fortified financial backing and conduct construction activities according to the work schedule presented to the client to reduce the possibility of contractors collecting bribes from suppliers. Mahamid (2012) added that to facilitate optimum materials procurement system, it is the responsibility of the contractor to ensure that tenders are awarded based on accurate cost estimates and not necessarily to the lowest bidder.

The finding identified the ability for the contractor to translate designs and understand materials specifications produced by the consultants as another major contractor factor. This refers to the expertise of the contractor, in terms of relevant project experience based on proactive planning and decision making competence, materials allocation and technical cost estimation proficiency. This is supported by the findings of Doloi (2013) who claimed that the contractors' inability to understand the requirements and specification of a project at the tender stage significantly influences the effectiveness of the materials procurement strategy, resource allocation and general management control at the construction phase. Sambasivan and Soon (2007) suggested that since the onus of selecting competent contractors for a sustainable building project is laid on the client through the consultants, consultants must ensure that selected contractors have adequate relevant experiences, technical, financial and sufficient workforce to execute the project. The respondents agreed that contractor's relationship with sub-contractors' and the participation of the contractors in decision making at the design stage of the project is also an important factor to consider in increasing the efficiency of the materials procurement strategy adopted during building production processes. This was supported by Mosey (2009) in his research. Son *et al.* (2009) further claimed that the participation of the contractor at the design stage gives the contractor the

responsibility of facilitating the adoption of sustainable principles at the construction phase. Son *et al.* (2009) added that the contractor has the responsibility of determining: a) where and how to procure sustainable materials, b) where and when to recycle construction materials, c) practicality of a design in a particular region, d) the effectiveness of the supply chain involved in materials delivery process and e) construction processes that produce less pollution on site with minimal impact on society.

#### **4.17 validity assurance of the quantitative research results**

This section was conducted to assess the validity of the quantitative data obtained by the questionnaire survey. Basically, the validity assurance of a research result shows the possibility of how applicable the obtained results are in the field of study. Thomas and Magilvy (2011) confirmed that the validity of a research is the level to which the data obtained evaluates accurately the intended. To ensure that the research results are valid and reliable, the following steps were considered:

- a. Research population: The population sampled for this study were construction stakeholders' (basically contractors and consultants) in the construction industry in the Western Cape Province of South Africa. This population was considered in order to achieve reliable results. (Section 4.3)
- b. Expected participants: Experienced construction stakeholders'' within the industry are the targets (Section 4.3 & Table 4.1).
- c. Sampling technique: The cluster sampling method was adopted for data collection in this study. The use of the cluster sampling method redistributes the target population (with high concentration of construction companies and experienced professionals) into smaller groups (clusters) from which samples randomly selected for data collection and result generalization. (Section 3..7.5)
- d. Time: The data were collected with a considerable time limit of six months.
- e. Data collection instrument: The most accurate data collection tool was adopted for each phase of collection (Section 3.7.1, Section 3.7.3 and 4.1)
- f. Exploratory/pilot study: The exploratory study was conducted to determine the reliability and accuracy of the data collection method to be adopted for the main study (Section 3.7.2 and 4.2).

- g. Cronbach's alpha co-efficiency analysis: The Cronbach's alpha co-efficient analysis was conducted to test the reliability of the quantitative research question in this study (Section 4.6)
- h. Interview sessions: The interview sessions with the respondents were recorded using a Philip smart recorder and was analysed using the statistical package software (SPSS, version 23).

#### **4.18 Validation of findings**

The qualitative collection phase adopted the construct validity technique. Construct validity is a technique adopted to ensure that the findings obtained in this research measures what it is claims to measure. The findings from the quantitative data analysis were framed into interview question to confirm if the quantitative results answered what it portrays to answer as regards the research aim and objectives. Four (4) construction organisations selected for the interview. The researcher scheduled appointments for each interview with the respondents to ensure efficient research time management. Four (4) constructional professionals' were interviewed on construction sites A, B, C, D. The interview session conducted with each interviewee started with an introduction research title and the underlying purpose of the study.

##### **4.18.1 Interview with respondent A**

The first interview was conducted on September 23, 2015 at 16h00mins. An experienced project manager who is presently working in the public sector of the construction industry was interviewed. The project manager interviewed had ten (10) years' work experience in the construction industry. The interview lasted for 50 minutes as the interviewee responded to each interview question with all enthusiasm. The interview discussion was recorded using a 'Smart recorder app' installed on an Apple iPad mini. A copy of the interview guideline is found in [Appendix B](#).

The project manager stated that the adoption of the GBCSA policies is a consideration of the impact of construction materials usage on the environment. The respondent further stated that the adoption of the GBCSA policies at the materials selection and procurement phase of construction is dependent on the design specification of consultants based on the clients' requirements. To encourage the adoption of GBCSA policies, construction stakeholders should be enlightened on the benefits of the GBCSA policies in promoting the practice of sustainable building production in the industry. The respondent stated that timely availability



of construction materials on site is an important factor that influences the usage of materials towards sustainable building production and must be prioritised during construction. The respondents noted that *“the delivery time of materials to site must be synchronised with the pace of building production to avoid time wastage, materials deterioration, cost overruns and profit losses ... which are as a result of materials mismanagement during construction”*. The respondent further explained that timely delivery of materials to site could be achievable through strategic planning of the construction process from the inception to the completion of the project. This is to determine the cost and availability of the materials required for the construction process at the inception of the project. The interviewee stated that reducing the cost of sustainable building production commences at the phase of materials procurement. The project manager explained that adopting the use of locally produced materials would increase competitions amongst materials manufacturers to reduce costs associated with sustainable building production. The adoption of cost efficient materials procurement was suggested as another approach to construction cost reduction. The respondent reported that the use of electronic materials procurement technology strategy (EMPTs) in materials acquisition is more effective compared to the traditional material procurement strategy in terms of procurement speed and accuracy. The respondent added that the use of EMPTs promotes effective communication between suppliers and procurement officer which reduces costs associated with materials acquisition at the materials sourcing phase. The project manager further stated that the major challenge experienced with the adoption of the TMPs in materials acquisition is prolonged time consumption. The provision of adequate storage space for overdue and outdated procurement documents, as mentioned by the respondent, has also been a top challenge in adopting the paper based system (TMPs) in the past years. Nonetheless, the respondents explained that the slow pace in the adoption of EMPTs is as a result of the fear of Internet fraud, work culture of companies, high cost of EMPT software installation and information technology literacy of the procurement team. To this effect, the respondent stated that the use of the TMPs is most suitable to promote the operations of the SMME. The respondent explained that *“considering the fact that majority of the SMME in South Africa have less than 200 workforce capacity with minimal technological intellect to run the business electronically, the cost of software installation and workforce usage training would be a huge challenge to the SMMEs if the EMPTs is adopted”*. The respondent indicated that the raise of corruption in the South African construction industry is not dependent on the sector (public or private). However, the respondent emphasized that the traits of corruption is

more evident in the public sector. This was explained to be due to greed and unethical practices on the part of the officials' in-charge of procurement. This according to the respondent, results in the inflation of materials costs and the use of substandard materials by contractors in order to win contract awards for personal financial gains. Nevertheless, despite the raise of corrupt practices during procurement, the respondent stated that the procurement as policy tool (Section 217 of the 1996 constitution) was endorsed by the government to effectively promote fairness, equality, transparency and eradicate corruption in procurement transactions.

The respondents added that the objectives of government procurement policies (such as PFMA, BBBE, CIDB and SCM policy) are to protect the interests and ensure that disadvantaged citizens are given equal opportunities to participate in the process of procurement. The project manager stated that the consultant in a sustainable building project is the principal participating stakeholder in ensuring that the principles of sustainability are adopted during construction from the stage of materials procurement. The respondent explained that the consultant is in a position to make decisions on the concept and process of construction (from the inception to the completion of the project) based on the clients requirements. The respondent further stated that the consultants (architect, construction manager or quantity surveyor) determine the materials specification, procurement strategy to adopt and when it must be purchased in order to meet these client requirements' efficiently in terms of cost, time, materials usage and building quality.

The respondent opined - based on personal experience - that to improve the materials procurement system in the Western Cape construction industry towards the enhancement of sustainable building construction, the adoption of the EMPTs should be encouraged especially in the public sector (through the organisation of training workshops and provision of upgraded technology) as most government officials are resistant to the use of the EMPTs due to the fear of the "unknown".

#### **4.18.2 Interview with respondent B**

The second interview was conducted on September 24, 2015 at 13h05mins. The interview was conducted with an experienced quantity surveyor (QS) who is presently working in the public sector of the construction industry with a working experience of fifteen (15) years. The interview lasted for about 56, minutes as the interviewee responded to each interview question

after being readout by the interviewer from the interview guideline. The interview discussion was recorded using a ‘Smart recorder app’ installed on an Apple iPad mini. A copy of the interview outline is found in [Appendix B](#).

The quantity surveyor (QS) stated that *“based on the policies of the GBCSA, the QS has the responsibility of preparing contract documents which states the materials’ specifications, labour and materials cost estimates required for construction in compliance with the Green Star SA credit criteria”*. The respondent further explained that the adoption of the GBCSA policies at the design and materials selection phase of construction avails the construction team the opportunity to improve socio-economic sustainability of the building in terms of job creation, improved health condition and reduced cost of construction. Timely availability of construction materials, as stated by the respondent, significantly influences the efficient usage of construction materials for sustainable building production. The QS explained that the availability of materials on site determines the speed at which the work is completed with reduced materials wastage and cost towards economic sustainability. The respondent further noted that late delivery of materials to site is the major cause of construction cost and time over-run. The quantity surveyor stated that construction over-run during sustainable construction could be moderated by adopting the use of cost-efficient materials procurement system. The respondent explained from a quantity surveyor’s point of view that ensuring economic sustainability during materials procurement can be effectively achieved by enhancing the communication system between construction professionals, contractors and suppliers. The electronic materials procurement strategy (EMPTs) as stated by the respondent is an upgrade of the traditional materials procurement strategy (TMPs) for materials acquisition. The QS further explained that the use EMPTs for materials acquisition over the years has effectively reduced the time of procurement cost of communication between contractors and suppliers and has also reduced the biased traits in the process of materials supplier selection as compared to the TMPs. The respondent however added that in achieving accuracy during procurement, the use of TMPs is still being adopted in conjunction with the EMPTs in the public sector. This is because of the distrust in the operations of EMPTs the public sector. The respondent stated that the challenges currently faced with the use of TMPs are associated with procurement time consumption, unavailability of storage space for procurement documents and the increasing traits of corruption (document manipulation).

According to the interviewee, the adoption of EMPTs has not been fully implemented in the operations of the construction industry due to the resistance to change by construction professionals' (being comfortable with the old system of operation) and the negligent attitude of public officials to procurement policy implementation towards increased productivity. The respondent stated that the TMPs best promotes the procurement of the SMME. It was explained that this is because majority of the SMME owners are not information technology literate and have no proper background in the use of the electronic system. Reduced operations cost and increased patronage of indigenous materials manufacturers are added advantages of TMPs to SMMEs. The respondent stated that the objective of government policies enacted into the constitution as regards materials procurement (such as the section 217 of the constitution, PFMA etc.) are to promote transparency through the adoption of the open tendering system to eliminate the possibility of corruption at the tendering phase. The respondent explained that in ensuring building sustainability during materials procurement, the consultants determines the specification of materials. Whilst, the contractor on the other hand, determines how materials required for a project can be acquired towards clients' satisfaction, operates according to the specifications of the consultants and sometimes gives inputs on the construction work where the design specifications are not practically feasible on site.

The collaborative effort of both consultants and contractors is highly recommended in achieving the production of sustainable buildings. With regards to improving the process of materials procurement in the construction industry, the respondent commented "*I am very happy with the present materials procurement strategy (TMPs) implemented in this department. I don't think there is a better way of procuring materials during construction especially in the public sector. However, I believe the use of EMPTs can enhance the process of procurement and should be encouraged in the construction industry by making the use of electronic and internet facilities more accessible*". The respondent further added that information technology workshops, electronic equipment and Internet facilities should be made available at every government levels associated with the construction industry.

#### **4.18.3 Interview with respondent C**

The third interview was conducted on October 13, 2015 at 10h05mins. The interview was conducted with a construction site supervisor who has a working experience of about seven (7) years. The interview lasted for about 35 minutes as the interviewee responded to each

interview question after being readout by the interviewer from the interview guideline. The interview discussion was recorded using a ‘Smart recorder app’ installed on an Apple iPad mini. A copy of the interview outline is found in [Appendix B](#).

The respondent stated that the GBCSA policies can be effectively adopted during construction at the conceptual phase if the policies are enacted into the building construction law as a requirement for contract tendering. The respondent explained that enforcing the GBCSA policy as a contract requirement would enhance the production of sustainable buildings at every organ of state. Adopting this approach according to the interviewee would significantly increase the competition amongst building contractors in order to reduce the production cost of sustainable buildings. Timely availability of construction materials on site according to the respondent influences the effective usage of materials in terms of labour productivity, materials wastes reduction and on-time project completion. The site supervisor explained that late delivery or unavailability of construction materials at required time is as a result of poor planning procedure. This building production lapse may result in the interruption of construction work flow, increased risk of materials damages on site and cost overrun. The respondent indicated that the use of electronic materials procurement technology strategy (EMPTs) in materials sourcing is not absolutely effective considering the fact that majority of the materials vendors are yet to adopt the electronic system of trading. The site surveyor explained that this is due to the high cost of adopting the EMPTs. However, considering the ‘pros’ and ‘cons’ of the EMPTs and TMPs, the EMPTs is more effective. The respondent added that the use of EMPTs speeds up the materials delivery process increases the rate of productivity and reduces the advent of materials shortages during construction as a time and cost saving tool.

The respondent stated that corruption which is related to the high level of nepotism is a significant challenge in the usage of TMPs. The bureaucratic system of operations according to the respondent is another problem encountered in the usage of TMPs in the construction industry. Nonetheless, the slow adoption of EMPTs in the building construction industry are due to factors such as socio-economic issues, procurement culture (the interphase of cost of training workshops, computer software and maintenance) and age barrier. The respondent explained that the age variance amongst construction professionals and contractors (New and Old generation) affects the adoption of EMPTs due to the distrust in the new procurement strategy by the older generations. In promoting the operations of the SMMEs, although the

TMPs is most preferred for implementation in the SMMEs, it is advisable that the principles of the EMPTs are adopted as this strategy facilitates the procurement process of the SMMEs and also help to resolve the challenges faced with the use of TMPs. The advent of the EMPTs in SMMEs would create opportunities for social and economic growth in the industry.

The section 217 of the constitution as stated by the respondent is effective considering that there have been no reasons for a constitutional review as regards procurement. The respondent added that government procurement policies are major tools for transformation which gives citizens equal rights during procurement. This approach, as stated by the respondent, is a drive by the government to eradicate the practice of corruption in the construction industry both in the private and public sector. In ensuring sustainability during materials procurement, the respondent affirmed that the role of the consultant is key. This is because the consultants prepare the specifications for the contractors to abide by for procurement. However, the contractors should be given the opportunity to make suggestions on the most appropriate procurement strategy to adopt towards the enhancement of sustainable building production. To improve the process of materials procurement, the site supervisor opined that the EMPTs should be adopted which in the respondent's words "*...is an advancement in the use of TMPs ...*". The respondent added that "*enhanced trainings and awareness are required to ensure that government policies are complied with*".

#### **4.18.4 Interview with respondent D**

The third interview was conducted on October 29, 2015 at 11h15mins. The interview was conducted with a quantity surveyor (QS) with a working experience of about six (6) years. The interview lasted for about 45 minutes as the interviewee responded to each interview question after being readout by the interviewer. The interview discussion was recorded using a 'Smart recorder app' installed on an Apple iPad mini. A copy of the interview outline is found in Appendix B.

The respondent states that the adoption of the GBCSA policies is not a sole responsibility of developers or contractors. The respondent explained that the clients should be educated on the benefits of sustainable building production, because the clients determine the type of building to be constructed by the contractors or developers. The respondent further opined that to optimise the benefits of GBCSA policies during materials selection, it is essential that the government enacts policies that enforce the practice of sustainable construction. The QS

stated that *“timely availability of materials on site ensures smooth work progression”*. The respondent further explained that timely availability of materials on site would ensure the completion of building projects within schedule time and budget. It was also mentioned that the timely availability of materials during sustainable building production reduces the possibilities of materials wastages and construction cost overrun. The high cost of sustainable building production compared to the conventional building production as posited by the respondent is a significant cause for the slow adoption of the sustainable building practice in the South African Construction Industry. The respondent further explained that sustainable building production costs more due to the initial capital cost (short-term cost) incurred at the early stage of construction which involves the acquisition of materials and construction expertise. To reduce the short term cost of sustainable building production, the respondent suggested that *“(a) the contractor should develop a long term business relationship with its suppliers in order to secure reduced business rates, (b) construction materials should be procured long before the commencement of the project on site and (c) appropriate planning must be done before the commencement of any building project (WORK SMART AND NOT HARD)”*. To support this statements the respondent stated that the use of the EMPTs in the acquisition of construction materials is a “smart” way of getting construction work done fast and timely. The EMPTs as explained by the respondent is an effective materials procurement strategy that ensures work efficiency, reduced procurement time and paper works.

The QS affirmed that the current challenges experienced with the use of TMPs include: easy loss of documented paper works, filling and storage of outdated procurement documents. The respondent stated that the pace at which EMPTS is adopted in the construction industry is relatively slow compared to other industries. The respondent mentioned that this is due to the repulse of some construction professionals’ to the adoption of EMPTs, fear of fraud and the high initial cost of implementing this strategy during materials procurement. The respondent stated that although the TMPs is presently being adopted in the SMMEs due to the financial statuses of the enterprises, it is advisable to adopt the use of EMPTs in the process of materials procurement to improve the operations of SMMEs in the construction industry. It was explained that the EMPTs gives the SMMEs a platform to transact with companies outside their geographical location in a short period of time. The respondent added that *“...besides the adoption of the EMPT as a strategy for improvement, big suppliers should partner with SMMEs to encourage and build the financial strength of the enterprises”*.

On issues of the raise of corruption in government as regards materials procurement, the respondent stated that the system is being controlled by politicians with egotistic agendas and not construction professionals due to their legislative powers. The respondent explained further that corruption is experienced in different forms and levels of the procurement process especially at the tendering phase due to the degree of inequality in the industry. However, as indicated by the interviewee “...*there are exceptions to this generalizable statement ...*” .In order to remedy this lapse, the respondent suggested that construction stakeholders - the government inclusive - should ensure implementation of ethical guidelines and policies, an awareness on government Acts such as the PFMA and the Section 217 of the constitution should be created to the reduce level of ignorance in the industry and also lawbreakers should be convicted regardless of their social status. On this note, the respondent stated that the Section 217 of the 1996 constitution is not as effective as it was enacted to be. It was explained that despite this Act being enacted into the Constitution, implementing this Act or policy tends to be a challenge as most of these organisations - especially in the private sector of the construction industry - operate based on their own organisational policies. Nonetheless, the QS stated that government policies were enacted primarily to promote and develop SMMEs, acknowledging that the growth of the SMMEs significantly improves the productivity of the industry. In ensuring building sustainability during materials production, the respondent stated adequate planning of the production process should be put into consideration by the consultants and contractors. According to the respondent, once the design specifications have been completed by the consultant and approved by the clients, the contractor is obliged to ensure the right materials are purchased and arrive on site just-in-time when required at every phase of construction to reduce materials wastages and other costs. The respondent stated that improving the materials procurement system in the construction industry in order to enhance the production of sustainable building within scheduled time and cost is dependent on the speed at which materials are procured. The QS conclusively stated that “...*considering the merits and demerits of TMPs and EMPTs, the EMPTs should be adopted as a benchmark for the improvement of materials procurement system... and considerable supports should also be given to the SMMEs in order to encourage them in the adoption of this strategy*”.



**Table 4.20 Summary of qualitative interviews**

<b>Factors</b>	<b>Respondent A</b>	<b>Respondent B</b>	<b>Respondent C</b>	<b>Respondent D</b>
Encouraging the adoption of GBCSA policy	Construction stakeholders should be enlightened on the benefits of the GBCSA policies.	The GBCSA policy should be enacted as a requirement for contract documentation	Enforcing the GBCSA policy into the building construction law as a contract requirement.	Construction stakeholders should be enlightened on the benefits of the GBCSA policies
Effect of timely availability of materials	Reduces construction time wastage, materials deterioration and cost overruns.	Speeds up project completion time with reduced materials wastage and construction cost.	Increased labour productivity, materials wastes reduction and on-time project completion.	Smooth work progression and completion of building project within budgeted cost and time.
Cost reduction of sustainable building production	Adopting the use of locally produced materials.	Adopting the use of cost-efficient materials procurement system	Increasing competitions amongst materials manufacturers and suppliers.	Appropriate planning before project commences.
Effectiveness of Electronic Materials Procurement Strategy (EMPTs)	Effective in-terms of procurement speed and reduces materials shortages	Reduces procurement time, cost of communication and biased traits in supplier selection.	Speeds up the materials delivery process, increases labour productivity	Ensures work efficiency, reduced procurement time and paper works.
Challenges of Traditional Materials Procurement Strategy (TMPs)	Inadequate storage space for overdue and outdated procurement documents	Time consuming, unavailability of storage space and increasing traits of corruption.	The bureaucratic system of operations and the high possibility of corruption.	Procurement time consumption and unavailability of storage space.
Factors barring the adoption of EMPTs	Fear of internet fraud, work culture of companies, cost of software installation and workers IT illiteracy	Resistance to change by construction professionals' and EMPTs operations of distrust	Cost of training workshops, software maintenance and age variance amongst construction professionals	Resistance to change, fear of fraud and the high initial cost of implementing EMPTs
Promoting the operations of the Small Micro and Medium Enterprise (SMME)	The use of TMPs is most suitable to promote the operations of the SMME.	TMPs is most suitable for the operations of the SMME.	The adoption of EMPTs should be encouraged.	EMPTs exposes the SMMEs to a platform of large numbers of customers
Effectiveness of Section 217 of the Constitution of South Africa.	Remedies the raise of corruption during procurement through fairness, equality and transparency	Eliminate the possibility of corruption at the tendering phase	Empowers the citizens with equal rights to participate in procurement.	The Section 217 of the 1996 constitution is not as effective as it was expected to.
Objectives of Government policies	Protect the interests of the disadvantaged citizens in the process of procurement	Promotes transparency through the open tendering system to eliminate possibility of corruption	To eliminate the practice of corruption in the construction industry	Promotes the SMMEs towards the improvement of productivity
Ensuring sustainability during materials procurement	Principles of sustainability are adopted at the design phase	Adoption of sustainable Principles at the design stage.	Adopting cost effective procurement strategy	Effective materials management strategy
Improving the process of materials procurement	The adoption of the EMPTs should be encouraged especially in the public sector	The use of electronic and internet facilities made more accessible to the SMMEs	The EMPTs should be adopted as it's an upgrade to the use of TMPs	Considerable supports should also be given to the SMMEs

#### **4.19 Achieving the objectives of the research study.**

*Objective One* of this study was to evaluate the concept of sustainability in the South African construction industry as regards materials usage during building construction. In achieving the objective, the data collected were analysed and the major findings were centred on the policies for effective materials usage towards the enhancement of sustainable construction, impact of construction materials management on materials selection during building production and facilitators for effective materials usage towards the enhancement of sustainability in building production.

The findings show that the Green Building Council of South Africa (GBCSA) policy on selection and usage of building materials should be enforced in every construction projects towards the enhancement of sustainable building production, evaluating the life-cycle analysis (LCA) of materials proposed for use, and adopting the principles of recycling materials wastes to reduce environmental pollution are important in achieving sustainability in the South African Construction industry. Other major findings also show availability of materials proposed for construction in market, strategic planning before procurement at design stage of building construction, environmental impact of the materials, the requirements of South African National Standards (SANS) policies on materials selection, timely delivery of construction materials to site, proper project planning at inception using sustainable building designs, proper understanding of clients ideas at the conceptual phase of design, effective communication amongst workers during construction, efficiency of the materials procurement strategy in place, and waste reduction techniques implementation during construction as factors to consider in achieving sustainability with regards to materials' usage.

*Objective Two* of this study is to analyse the effectiveness of materials procurement strategies in the construction industry and this objective as achieved. Findings derived from the analysed data shows that materials can either be procured using the Traditional Materials Procurement strategy (TMPs) or Electronic Materials Procurement Technology strategy (EMPTs). The findings obtained are as follows: In the materials sourcing phase, EMPTs is most frequently used in sourcing for materials specifications, sourcing for appropriate materials for the on-going project, investigating the quality certification, work credibility & financial statuses of selected suppliers and sourcing for potential

suppliers for tendering and contract purposes with an average of 90% effectiveness, while the TMPs was most frequently adopted in evaluating the lifecycle (installation, servicing and maintenance requirements) of the materials to be purchased with an average of 88% effectiveness. In contracting phase, EMPTs is most effective and frequently adopted in sending request for information on materials specifications by contractors (RFIs), receiving quotes (RFQs) from suppliers and responding to request for proposal (RFPs) from suppliers. Whilst, TMPs is most suitable in selecting qualified suppliers for negotiations and further contract processes. Nonetheless, in responding to requests for proposal from suppliers (RFPs), both EMPTs and TMPs have been indicated to be effective as the frequencies of usage are not significantly different. In the negotiating phase, EMPTs was most effective and frequently used in the payments to supplier(s), materials specification, comparing available materials properties based on catalogue information and in creating requisition orders based catalogue information. Whilst, TMPs is most of frequently and effectively used in negotiating the quality and quantity of materials required for construction.

The findings also show the benefits of TMPs as supporting the operations of the Small Micro and Medium scale Enterprises (S.M.M.E) in the industry, low cost of installation and usage, creating a large staff-base, reduced materials procurement cost and facilitates government participation in sustainable procurement while the barriers are the cumbersome nature of materials selection and acquisition, risk of information error or duplication during information transfer, ineffective system of communication between contractors and suppliers, size and fragmentation of the construction industry, high fear of fraud and permitting unplanned purchases from random suppliers at a higher price. The benefits of EMPTs are as follows: easy access to updated construction materials information, speedy project delivery, additional workforce training for effective implementation, quicker and easier materials comparison in-terms of cost and quality and while the barriers are resistance to change in the construction industry, lack of general awareness in the industry, high fear of fraud, ineffective Government policy on materials procurement and Ineffective system of communication between contractors and supplies.

Objective Three of this study evaluates the impact of government policies on materials procurement strategies. The objective was achieved and the findings obtained are as follows: Section 217 of the constitution for effective materials procurement system

(Fairness, transparency, equity etc.), Construction Industry Development Board Act (CIDB Act 2000) on sustainable procurement prescribes for Best practices in the industry, Public Finance Management Act (PFMA) in establishing a regulatory framework for SCM at national departments, provincial departments and state-owned enterprises are effective government policies in the implementation of materials procurement. It was found that the objectives of government policies in materials procurement strategies implementation are: to promote the participation of small and medium enterprises in the growth of economy, register contractors based on CIDB Acts for effective procurement practices, protect individuals disadvantaged by discrimination, improving the economic status of the country (GDP), creating job opportunities for local contractors to meet the aim of the B-BBEE policy, to remedy the effect of apartheid and inequalities (Black empowerment), promote the use of indigenous resources (limiting materials importation), standardise the construction materials mark of approval (SABS mark of approval) and enforcing the use of Eco-labelling standards for construction materials.

However, the findings show that the barriers to the influence of government policies in materials procurement includes: Level of corruption in the government, lack of long term perception on sustainable procurement implementation by the government, lack of materials procurement supportive structures in the government, resistance to sustainable change by government officials, lack of accountability and supportive government structure, high growing rate of corruption in the construction industry, inconsistency in policy implementation by construction managers, political interference in general decision and policy making, and inefficient guidance or best practice Acts for sustainable materials procurement.

*Objective four* of this study to assess the impact of stakeholders on materials procurement before and during construction processes. This comprised of three sub-questions on construction stakeholders related factors affecting materials procurement efficiency towards sustainable building construction. The objective was achieved through the investigation of client related factors, consultant related factor and contractor-related factors. The findings obtained from analysed data on client-related factors affecting materials procurement efficiency towards sustainable building construction include the following: slow or inadequate flow of finance from the client, lack of communication with client on basic construction process from the conceptual phase, choice of design

approved by the client, and changes in orders and requirements stated by client are client related factors that facilitate optimum materials procurement before and during sustainable building production.

This study investigated the consultant related factors affecting materials procurement efficiency towards sustainable building construction. Achieving the objective, the finding obtained after data analysis are as follows: obscure design specifications, scarcity of specified materials in the market, missing details in quality and quantity specifications and lack of communication between the architect and other stakeholders are significant consultant related factors that influences the effectiveness of materials procurement strategy adopted towards the enhancement sustainable building production.

The impact of contractor related factors affecting the effectiveness of materials procurement towards sustainable building construction was also investigated. Findings show that profit-driven motives of contractors, contractors' inability to translate designs and understand materials specifications, contractors' relationship with sub-contractors and absence of contractor participation in the design stage, are factors contractor related factors that determine the effectiveness of materials procurement strategy adopted towards the enhancement sustainable building production.

*Objective five* of this study is to establish an effective materials procurement strategy that will enhance sustainable building production processes. The objective was achieved through the evaluation of policies that enhance effective materials usage towards the enhancement of sustainable construction, impact of construction materials management on materials selection during building production and facilitators for effective materials usage towards the enhancement of sustainability in building production; through the analysis of the effectiveness of materials procurement strategies, considering the benefits and barriers of these materials procurement strategies; through the evaluation of the impact of government policies on the effectiveness of materials procurement strategies implementation, considering the objectives of government policies in materials procurement strategies implementation and barriers to the influence of government policies in materials procurement. Finally, construction stakeholders related factors affecting materials procurement efficiency towards the enhancement of sustainable building construction was assessed. The findings derived from the analysed data are

illustrated in Tables 4.3, 4.4, 4.5, 4.12, 4.13, 4.14, 4.15, 4.16, 4.17, 4.18, 4.19 and Figures 4.2, 4.3, 4.4 and 4.5. The findings were used to establish an effective materials procurement strategy that will enhance sustainable building production processes. A summary of the key findings in this research is shown in Figure 4.8.

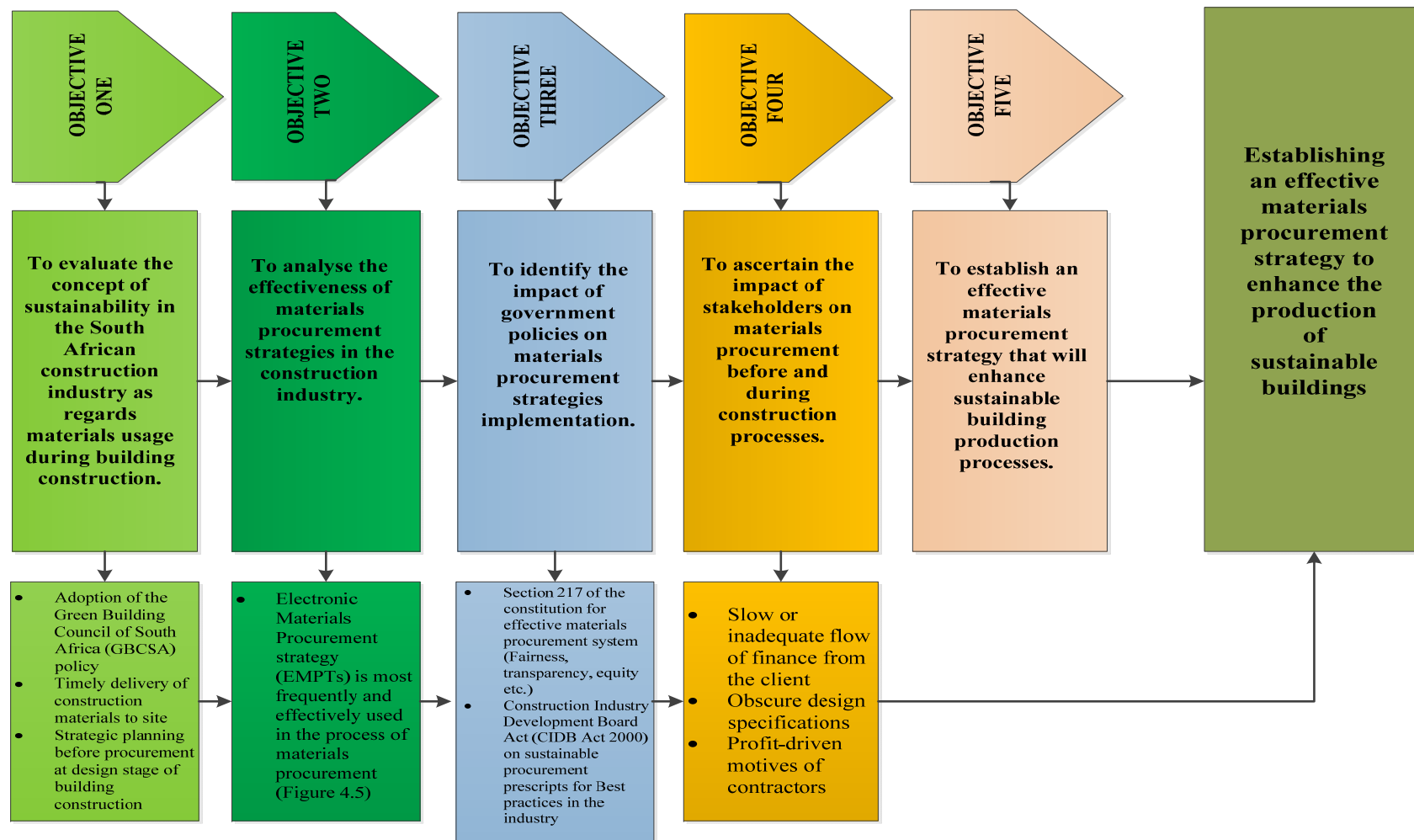


Figure 4.8 Summary of key findings

## 4.20 Chapter Summary

This chapter presents analysis of data, presentation of findings and discussion of findings. The data collected was analysed using the Statistical Package for Social Sciences (SPSS) software, version 23. Descriptive statistics were used in the study. The survey questions were scaled and were tested for reliability using Cronbach's alpha. The average Cronbach's alpha coefficient of the questions was 0.8, indicating that the questions are reliable.

The result obtained from the findings show that the Green Building Council of South Africa (GBCSA) policy on selection and usage of building materials should be enforced in every construction projects towards the enhancement of sustainable building production. This signifies that the GBCSA construction policy is not being implemented in most building construction projects, as it's not a contract requirement. Majority of the respondents agreed that enforcing the adoption of the GBCSA policy would encourage the production of sustainable buildings. From the qualitative interview, an interviewee opined that enforcing the GBCSA policy as a contract requirement would enhance the production of sustainable buildings at every organ of state. According to the interviewee, this would significantly increase the competition amongst building contractors in order to reduce the production cost of sustainable buildings. Timely delivery of construction materials to site is confirmed by the finding as a facilitator of effective materials usage towards sustainable building production. Findings reveal that for effective materials usage in a construction project towards economic sustainability, timely materials delivery must be ensured. The interview respondents opined that this can be achieved through strategic planning at the inception of the project putting into consideration the principles of sustainability especially at the design stage.

The effectiveness of materials procurement strategies in the industry was investigated. Respondents indicated that the Electronic Materials Procurement Technology strategy (EMPTs) is most frequently and effectively used in the process of materials procurement when compared to the Traditional Materials Procurement strategy (TMPs) in terms of efficiency. Majority of the respondents agreed that the EMPTs is the most effective strategy towards materials procurement time and cost reduction during sustainable building production. The interview respondents opined that the



adoption of EMPTs should be encouraged in the construction industry as it affords the SMMEs the opportunity to transact with customers on a global platform at a lower operating cost. However, the initial cost of adopting the system of EMPTs has been a significant barrier to its adoption in the SMMEs.

Majority of the respondents indicated that in the construction industry as a whole, resistance to proposed change in the process of materials procurement is the major barrier to the adoption of EMPTs. Findings show that creating awareness on the benefits of EMPTs and the availability of electronic and internet facilities would make the adoption process easier. The findings indicated that Section 217 of the 1996 constitution as a policy tool ensures that in implementing the strategies of materials procurement, the process is fair, equitable, transparent, competitive and cost effective. This indicates that the major objective of government policy enactment with regards to materials procurement in promoting the participation of the small and medium enterprises towards the growth of the economy. Slow or inadequate flow of finance from the client, obscure design specifications and profit-driven motives of contractors were found to be significant stakeholders' related factors affecting the effectiveness of materials procurement strategy adopted towards the enhancement sustainable building production.

## **CHAPTER FIVE**

### **CONCLUSIONS AND RECOMMENDATIONS**

#### **5.1 Introduction**

The data derived from the quantitative and qualitative survey on this ‘effective strategy for construction materials procurement during construction towards the enhancement of sustainable building production in Western Cape, South Africa’ were analysed and discussed. Conclusions and recommendations were made based on the results obtained in this study. This study is aimed at establishing an effective materials procurement strategy to enhance the production of sustainable buildings in the Western Cape Province of South Africa

#### **5.2 Conclusion**

The adoption of these findings by construction professionals in the South African construction industry during sustainable building production would enhance the delivery of structures whose process of construction and life-cycle of operation promotes healthy well-being of the inhabitants and environmental balance at reduced cost, stipulated time and expected quality. Considering the objectives of this study, these factors were discussed and achieved.

##### **5.2.1 Concept of sustainability in the South African construction industry as regards materials usage during building construction**

The concept of sustainability in the South African construction industry as regards materials usage during building construction was evaluated and findings obtained show that enforcing the Green Building Council of South Africa (GBCSA) policy on selection and usage of building materials in every construction projects would enhance the production of sustainable buildings. This result implies that enforcing the adoption of the GBCSA policies as a contract requirement in every construction project would aid the government in controlling the adverse effects of materials usage during construction towards the promotion of environmental and economic sustainability.

Effective adoption of the GBCSA's green star rating system in assessing the selection and usage of materials based on socio-economic, environmental and technical criteria is an approach to ensuring that the supply chain sustainability requirements are met at the contractually stage of the project. This would enable the construction stakeholders to certify that the production processes comply with the principles of sustainability from the early stages of the building; in cases of non-compliance, corrective actions are quickly adopted.

The availability of construction materials in the market when required was identified by majority of the respondents as the most important factor to consider in ensuring optimum materials usage during building production. This implies that shortage or unavailability of construction materials when needed on site during construction may result in production time wastage, materials deterioration and wastages, labour unproductivity and production cost overruns. To avoid these consequences at the production phase, construction stakeholders are advised to adopt a strategic plan at the conceptual phase of the project to ensure materials are acquired at the required quantity, cost and time towards increased workforce productivity. Strategic planning before procurement at design stage enables the engineers/contractors time to develop a feasible plan in meeting building specifications with the available materials in the market.

### **5.2.2 Effectiveness of materials procurement strategies in the construction industry.**

Findings derived from the analysed data shows that materials can either be procured using the Traditional Materials Procurement strategy (TMPs) or Electronic Materials Procurement Technology strategy (EMPTs). The Electronic Materials Procurement Technology strategy (EMPTs) is most frequently and effectively used in the materials sourcing, tendering and negotiation phase of materials procurement. The EMPTs gives the contractors the opportunity to search for the required materials from a wide range of suppliers within a short period of time. However, it was found that majority of the companies who participated in the survey adopts the TMPs in analysing the lifecycle of materials to be purchased, selecting qualified suppliers for negotiation, tracking materials from suppliers to site, negotiations of materials cost and quality. This implies

that the EMPTs and TMPs are being used concurrently in the construction industry for materials procurement.

Considering the benefits of EMPTs in the activities of materials acquisition, which includes: easy access to updated construction materials information, speedy project delivery and quicker and easier materials comparison in-terms of cost and quality; construction stakeholders are encouraged to adopt the use of EMPTs towards the enhancement of sustainability in the processes of building production without considering the short-term initial cost of installation which is feared to be the cause for the resistance to the adoption of EMPTs in the construction industry. It is of essence for construction professionals to note that the long-term benefit of EMPTs includes the assurance of a controlled lifecycle cost in building production, which is a strategy in enhancing the sustainability of the building.

### **5.2.3 Impact of government policies on materials procurement implementation.**

The impact of government policies on materials procurement implementation was evaluated and the finding obtained show that Section 217 of the constitution for effective materials procurement system (fairness, transparency, equity etc.) is the most effective government policy in the implementation of materials procurement. The Section 217 of the 1996 postulates the use of procurement as a policy tool to provide opportunities to Historically Disadvantaged Individuals' (HDIs) in the society; the Construction Industry Development Board Act (CIDB) 38 of 2000 was enacted to promote and implement policies, programmes and projects, including those aimed at procurement reform, standardisation and uniformity in procurement documentation, practices and procedures within the framework of the procurement policy of government; and the Public Finance Management Act 1 of 1999 (PFMA) was enacted to establishes a regulatory framework for SCM in national and provincial departments and state-owned enterprises. This implies that the government has a significant influence on the implementation of procurement as policy tool in the country.

Section 217 (2), clause 4.27 of the constitution states that to achieve the goals of sustainability in the organs of state, vendors who are in compliance with all environmentally-related legislation should be bought from; environmental awareness amongst suppliers, government officials, service providers and contractors should be

promoted; develop a policy with respect to the use of construction materials and waste treatment to manage the total life cost of sustainable construction. These Acts and policies were enacted to encourage the procurement of alternative and indigenous materials for affordable and sustainable buildings production in the construction industry. This is a tactic adapted by the government to promote the participation of the Small, Micro and Medium Enterprises (SMMEs) in procurement towards economic growth and to control the increasing rate of corruption in the process of materials procurement.

#### **5.2.4 Impact of stakeholders on materials procurement before and during construction processes.**

Sixteen stakeholders' related factors that affect materials procurement efficiency toward sustainable building production were identified in the study. These factors were further sub-divided into client related factors, consultant related and contractor related factors. Slow or inadequate flow of finance from the client was identified as the major client related factor that influenced the efficiency of the materials procurement strategy adopted during construction. The client, being in a key position to influence the outcome of the construction project through the choice of the procurement methods and basis for the governance of a construction project, has the sole responsibility of making funds available. This implies that the efficiency of consultants and contractors towards a successful project delivery depends on the consistency of the financial and intellectual inputs from the clients especially during materials' procurement. The availability of funds for a construction project determines the pace at which construction activities are carried out and completed.

The optimum responsibility of the consultant is to ensure the clients get value for money by understanding the client's sustainability ambition for the project. This is achievable through constant exchange of ideals between the consultant and client. The profit-driven intention of contractors during construction is a major contractor related factor affecting materials procurement efficiency. Given that the primary motive of most construction contractors' is to maximize profit at the expense of the client's satisfaction, it is advised that before contracts are awarded to the contractors, a fortified financial backing and a signed document of past completed construction works should be presented by the contractor. Mahamid (2012:272) advised that to

optimize the system materials procurement adopted, it is the responsibility of the contractor to ensure that tenders are awarded based on accurate cost estimates and not necessarily to the lowest bidder. To avert the reoccurrence of these factors in a sustainable building project, clients and consultants must monitor closely the activities done on site by conducting inspections at appropriate times.

### **5.3 Limitations**

This study was conducted in the Western Cape Province of South Africa. The collection of data from construction professionals and contractors was a really challenging task in the course of the study. This was a result of the busy schedules of the respondents'. Majority of the respondents complained of their tight time schedules on site, attending contract meeting and the pressure on them to meet certain project completion time. Hence, they were unable to complete the questionnaires when they promised to. Other respondents' categorically stated that couldn't participate in the survey due to pending targets they are yet to meet. Due to the time constraints, a significant number of the questionnaires were returned incomplete and therefore discarded by the researcher. As a result, the findings of this study cannot be generalised in the context of materials procurement in other Provinces in South Africa.

### **5.4 Conclusion and Recommendations**

The production of sustainable building involves the ability to meet the present housing needs of humans without impelling on the ability of the future generation to meet their own needs. Thus, the enhancement requires significant resources (materials, machinery and manpower) management skills on the part of the constructions professionals for a successful project delivery. Failure in materials management which entails effective materials procurement will possibility result to materials' wastages, profit losses, project delay, time overrun and construction cost overrun. The procurement system in South Africa as a developing country is being regulated by the adoption of government legislations and policies. Enforcing the adoption of the Green Building Council of South Africa (GBCSA) policy on selection and the efficient usage of construction materials in every construction project stages is a significant drive towards the enhancement of sustainable building production. Enforcing the adoption of the GBCSA policy by the government as a contract requirement would improve the

possibility of achieving sustainability during building production. With reference to the GBCSA policy, the process of materials selection, procurement and usage are assessed at every phase of construction to regulate the impact of materials consumption. Adequate implementation of GBCSA from the initial stages of a construction project, by the construction stakeholders, will improve the contractual process of construction projects, the materials procurement process, in addition to the enhancement of efficient materials usage and reduction of materials' wastages during production processes. In addition, timely delivery of construction materials to site facilitates the effective usage of materials during construction by ensuring the market availability of materials proposed for construction through the influence of materials management during materials selection. Effective planning at the conceptual phase which involves the participation of the local government as a stakeholder would ensure that the project design plans comply with regulations as regards materials usage and improving the interaction between the design and construction team during and after construction.

The study showed that the Electronic Materials Procurement Technology strategy (EMPTs) is most frequently and effectively used in the construction industry in the process of materials procurement. To achieve a better maximise the benefits of EMPTs in the South African construction industry, especially in the public sector, the onus lies on the government to endorse definite policies on the adoption of EMPTs in the industry. As this is a transition from one management structure to another, the construction stakeholders' - with the government inclusive - should develop a plan or temporary policy which endorses the concurrent use of the TMPs and EMPTs for a name period of time. This is because the Traditional Materials Procurement strategy (paper based procurement strategy) is gradually phasing-out.

Secondly, it is recommended that organisations and government establishments should upgrade their infrastructures' on Electronic Information and Communication Technology (EICT) to ensure system reliability and enhance productivity in the processes of materials procurement. This is achievable by making the use of electronic and Internet facilities accessible, organising workshops on information technology and awareness should be implemented as the long term benefits EMPTs, regardless of the initial high financial investment required. Thirdly, as obtained from the interview, the

EMPTs is also of benefits to the SMMEs. However, to protect and promote the operations of the SMMEs in the industry, financial and technical support may have to be provided by CIDB and other government agencies in order to encourage and facilitate the adoption of EMPTs.

The participation of the South African government in the process of procurement is aimed at ensuring work efficiency, accountability and transparency in the construction industry. Consequently, the objective of government policies in the implementation of materials procurement strategies is to promote the participation of SMMEs and HDIs of the public sector in the process of procurement. This, being the aim of Section 217 of the Constitution, entails the use of procurement as a justified policy tool in the South Africa. Thus, the Section 217 of the Constitution is recognised to have a high impact on the implementation of materials procurement the South African construction industry.

To maximize the positive impact of government policies on materials procurement, it is recommended that organs of state must determine implement a preferential procurement policy to protect SMMEs in the industry. Secondly, to reduce corruption in the process of materials procurement, the Section 217(1) with the operation principle of fairness, equity, transparency, competitiveness and cost effectiveness, should be afforded top priority to ensure the overall aim of Section 217 is complied with.

Slow or inadequate flow of finance from the client is a client related factor which affects the efficiency of materials procurement during sustainable building production. This could be as a result of the lack of communication between the client and consultants on what the production process of the building entails. The client who is in a key position to determine the pace and direction of any construction based on decision made and financially should be enlightened on the cost, benefits and other specification of sustainable building construction. This is to enhance the clients' understanding of the process of construction, pace to which funds are required, and an assurance that their finances are invested appropriately. Obscure design specification is the identified top consultant related factor that affects the efficiency of materials procurement implementation during sustainable construction. If adequately considered



by construction stakeholders during production process, there will be a significant improvement in the materials procurement phase to ensure construction cost-efficiency and timely project delivery. Construction design can be avoided through the procurement of competent architects and engineers' from the conceptual phase. Effective communication between the architects and other construction stakeholders at every construction phase through regular site meetings would resolve the issues on design specification obscurity, errors and omission.

The profit driven motives of contractors is another stakeholder-related factor affecting materials procurement efficiency. Contractors tend to award the purchase of required materials to the least cost tenderer as long as the materials are available for the construction work continuity without considering the quality of the materials purchased; sometimes suppliers are also selected because of the financial incentives the contractor stands to get from suppliers. Sambasivan and Soon (2007) suggested that to avert the reoccurrence of this factor in a project, clients and consultants must monitor closely the activities done on site. By so doing, the possibility of contractors awarding contracts to the lowest bidding supplier would be streamlined and will be based on cost estimate accuracy and merit.

The study concluded that proper consideration of these findings, by construction stakeholders in the private and public sectors of the industry, will enhance the production of sustainable buildings with production cost-efficiency and expected benefits of the building.

### **5.5 Areas for Further Study**

This research study recommends, among other issues, the need of 'comparative cost – benefit analysis of Electronic Materials Procurement Technology strategy (EMPTs) and Traditional Materials Procurement strategy (TMPs during sustainable building production, in the South African construction industry.

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## APPENDICES

### APPENDIX A- QUESTIONNAIRE FOR THE STUDY



#### EFFECTIVE STRATEGY FOR CONSTRUCTION MATERIALS PROCUREMENT DURING CONSTRUCTION TOWARDS THE ENHANCEMENT OF SUSTAINABLE BUILDING PRODUCTION IN WESTERN CAPE, SOUTH AFRICA

Dear Sir/Madam,

#### PARTICIPATION IN A SURVEY

You are cordially invited to participate in this research survey which aims at ascertaining an effective procurement strategy for construction materials towards the enhancement of sustainable building production in the South African construction industry. This study is primarily undertaken for **academic purposes** for a Master of Technology degree in Construction Management.

In context, *“sustainable building is a building that the process of construction and life-cycle of operation promotes healthy well-being of the inhabitants and environmental balance by considering the use of energy, water, land and material resources at every stage”*

*Achieving sustainable building effectively entails the consideration of all the principles of sustainability from the design stage, to ensure adequate use of construction resources which includes materials through the implementation of procurement strategy. This process requires appropriate steps in minimizing the negative impacts of building production on the environment, society and economy, at the lowest possible rate, for a sustainable building project delivery.*

Therefore, *“effective construction materials procurement strategy is a holistic process of purchasing materials at the most satisfactory quality, cost and time”. This effective process of purchasing is essential for contractors to remain competitive in the industry*

All information provided in this study will be kept strictly **CONFIDENTIAL**.

**Kindly complete the survey and return to:**

**Solanke Bukola Hannah,**

E-mail: [solankeb.h@gmail.com](mailto:solankeb.h@gmail.com) or [214269620@mycput.ac.za](mailto:214269620@mycput.ac.za) ,

**Department of Construction Management and Quantity Surveying**

Mobile: +27 (0) 78 163 3943

*Thanks for your cooperation and readiness to assist always*

## CONSENT FORM

Please tick as appropriate

1. I am aware that the information required by the researcher for in this study and it is perceived as an opportunity to contribute towards sustainable building innovation.
2. I understand my participation is voluntary and that I am permitted to withdraw at any point in the survey.
3. I hereby endorse my participation in the research survey

**Participant**  
(On behalf of the company)

**Date**.....**Signature**.....

**Solanke Bukola Hannah**  
(Researcher)

**Date**.....**Signature**.....

## QUESTIONNAIRE

### SECTION 1: BIOGRAPHICAL INFORMATION OF PARTICIPANTS

PLEASE, cross or tick as appropriate (X or √) to indicate your opinion.

1. Kindly indicate which best describes your company.

Project management firm	
Contracting firm	
Materials supplier	
Construction managing firm	
Government establishment	
Quantity Surveying consulting firm	
Others (Specify)	

2. Kindly indicate your age group:

20-25	26-30	31-35	36-40	41-45	46-50	Above 50

3. Please indicate your highest formal qualification obtained:

Matric certificate	Diploma	Bachelor / Honours degree	Masters' degree	Doctorate degree	Others (specify)

4. Kindly indicate your current position in your organization

Junior manager		Manager		Senior manager	
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5. How long have you been working in this position in years?

1-5 Years	6-10 Years	11-15 Years	16-20 Years	21-25 Years	Above 25 Years

6. Kindly rate your participation in Sustainable building construction?

0 Project	1-5 projects	6-10 projects	11- 15 projects

**SECTION 2A: SCHEMES FOR EFFECTIVE MATERIALS USAGE TOWARDS THE ENHANCEMENT OF SUSTAINABLE CONSTRUCTION**

7. The following are approaches to materials usage in construction towards enhancing sustainable building production. **Kindly rate their level of effectiveness.**

Note: **Ineffective = 1, Less Effective = 2, Effective = 3 Very effective = 4**

SCHEMES	1	2	3	4
Adopting a Life-cycle analysis (LCA) process for materials proposed for use	1	2	3	4
Enforcing the adoption of the Green Building Council of South Africa (GBCSA) guidelines	1	2	3	4
Adopting the principles of Sustainable Assessment Criteria (SAC) for proper materials analysis	1	2	3	4
Using renewable and reusable materials for construction.	1	2	3	4
Imbibing the principles of construction wastes recycling to reduce environmental pollution.	1	2	3	4
Adapting the process of dematerialisation at every phase of construction	1	2	3	4
The use of Eco-friendly technologies during construction	1	2	3	4

**SECTION 2B: IMPACT OF CONSTRUCTION MATERIALS MANAGEMENT ON MATERIALS SELECTION DURING BUILDING PRODUCTION**

8. The following are construction materials management strategies often considered **during** materials selection for optimum materials usage. **Kindly rank as appropriate**

Note: **Extremely important= 1, Less important = 2, Important= 3, Very important=4**

FACTORS	1	2	3	4
The influence of South African National Standards (SANS) policies on materials selection.	1	2	3	4
Work experience of construction workforce	1	2	3	4
Availability of materials in the market.	1	2	3	4
Materials specifications required for construction	1	2	3	4
The environmental impact of the materials	1	2	3	4
Sustainable nature of materials (recyclable or renewable materials)	1	2	3	4
Effects of the fluctuating cost materials on the total cost of construction	1	2	3	4
Procurement strategy considered for materials purchase	1	2	3	4
Communication level between the workforce during construction	1	2	3	4
Strategic planning before procurement at design stage.	1	2	3	4
General site organization which may affect the flow of materials on site	1	2	3	4

**SECTION 2C: FACILITATORS FOR EFFECTIVE MATERIALS USAGE TOWARDS THE ENHANCEMENT OF SUSTAINABILITY IN BUILDING PRODUCTION**

9. The following are **factors that facilitate** proper materials usage for sustainable building construction. **Kindly use the scale below to rate the factors as appropriate.**

Note: **Strongly disagree =1, Disagree =2, Agree =3, Strongly agree = 4**

<b>FACILITATORS</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
Effective communication amongst workers during construction.	1	2	3	4
Proper understanding of clients ideas at the conceptual phase of design	1	2	3	4
Government policies related to materials usage and disposal	1	2	3	4
Timely delivery of construction materials to site	1	2	3	4
Efficiency of the materials procurement strategy in place during construction	1	2	3	4
Proper project planning from the inception using sustainable building designs	1	2	3	4
Staff innovations on materials usage for effective materials utilization	1	2	3	4
Implementing waste reduction techniques during construction	1	2	3	4
Early learning on sustainable building practices in institutes' and universities'	1	2	3	4

### SECTION 3A: COMPARATIVE ANALYSIS OF MATERIALS PROCUREMENT STRATEGIES TOWARDS ENHANCING SUSTAINABLE BUILDING CONSTRUCTION

The following are the basic materials procurement strategies in use in the industry which invariably influences organisational performance.

Kindly compare these two types of construction materials procurement strategies, from Section 3B to Section 3D

- a) Traditional Materials Procurement strategy (TPs)
- b) Electronic Materials Procurement Technology strategy (EMPTs)

10. (i.) Kindly tick (√) the procurement strategy often used in your company based on the factors listed below
- (ii.) Please write the appropriate rate number of effectiveness, choose between 1&4, in the box provided:

Note: **Ineffective effective = 1, Less Effective = 2, Effective = 3 Very effective = 4**

	<b>Often used (Tick only one)</b>		<b>Effectiveness (Between 1 &amp; 4)</b>
<b>MATERIALS SOURCING PHASE</b>	<b>TPs</b>	<b>EMPTs</b>	
Searching for potential suppliers for tendering and contract purposes	TPs	EPTs	
Sourcing for appropriate materials for the on-going project	TPs	EPTs	
Assessing the lifecycle (installation, servicing and maintenance requirements) of the materials to be purchased	TPs	EPTs	
Sourcing materials properties and information	TPs	EPTs	
Investigating information about selected suppliers (i.e. quality certification, financial statues and capabilities).	TPs	EPTs	
<b>TENDERING PHASE</b>			
Sending request for materials information (RFIs) to suppliers	TPs	EPTs	
Receiving request for quotes (RFQs) from procuring firm.	TPs	EPTs	
Responding to request for proposal (RFPs).	TPs	EPTs	

Selecting qualified suppliers for negotiation	TPs	EPTs	
<b>NEGOTIATION PHASE</b>			
Comparison of various materials	TPs	EPTs	
Negotiation of materials quality and quantities	TPs	EPTs	
Materials specification	TPs	EPTs	
Creating requisition orders based catalogue information	TPs	EPTs	
Tracking of new and pending transactions	TPs	EPTs	
Materials cost negotiations	TPs	EPTs	
Payments to supplier(s)	TPs	EPTs	
Materials tracking (from the moment it leaves the supplier to site).	TPs	EPTs	

### SECTION 3C: BENEFITS OF MATERIALS PROCUREMENT STRATEGY

11. The following are benefits of materials procurement strategy in the construction industry.

**Kindly tick as appropriate on the factors listed below as it affects the Traditional Materials Procurement strategy (TMPs) and Electronic Materials Procurement Technology strategy (EMPTs)**

Note: Strongly disagree =1, Disagree =2, Agree =3, Strongly agree = 4

BENEFITS OF MATERIALS PROCUREMENT	Traditional Materials Procurement strategy(TMPs)				Electronic Materials Procurement Technology strategy (EMPTs)			
	1	2	3	4	1	2	3	4
Reduces materials procurement cost	1	2	3	4	1	2	3	4
Serves as a preferred tool for sustainable procurement	1	2	3	4	1	2	3	4
Low cost of installation and usage	1	2	3	4	1	2	3	4
Creates a large staff-base possession (creates forum for mass employment)	1	2	3	4	1	2	3	4
Requires additional workforce training for effective implementation	1	2	3	4	1	2	3	4
Supports the operations of Small Micro and Medium scale Enterprises (S.M M.E) in the industry	1	2	3	4	1	2	3	4
Facilitates government participation in sustainable procurement	1	2	3	4	1	2	3	4
Aids speedy project delivery	1	2	3	4	1	2	3	4
Promotes easy access to updated construction materials information	1	2	3	4	1	2	3	4
Promotes quicker and easier materials comparison in-terms of cost and quality	1	2	3	4	1	2	3	4
Promotes technical skills improvement of the company's procurement staffs	1	2	3	4	1	2	3	4
Decentralizes materials procurement activities	1	2	3	4	1	2	3	4

**SECTION 3D: BARRIERS OF MATERIALS PROCUREMENT STRATEGY**

12. The following are barriers of materials procurement in the construction industry.

**Kindly tick as appropriate on the factors listed below as it affects the Traditional Materials Procurement strategy (TMPs) and Electronic Materials Procurement Technology strategy (EMPTs)**

Note: Strongly disagree =1, Disagree =2, Agree =3, Strongly agree = 4

BARRIERS OF MATERIALS PROCUREMENT	Traditional Procurement strategy (TMPs)				Electronic Materials Procurement Technology strategy (EMPTs)			
	1	2	3	4	1	2	3	4
Resistance to change in the construction industry	1	2	3	4	1	2	3	4
Size of procuring company (size of available manpower)	1	2	3	4	1	2	3	4
Lacks standardised documentations in materials requisition and procurement	1	2	3	4	1	2	3	4
Ineffective Government policy on materials procurement	1	2	3	4	1	2	3	4
High fear of fraud	1	2	3	4	1	2	3	4
Lack of general awareness in the industry	1	2	3	4	1	2	3	4
Ineffective system of communication between contractors and supplies.	1	2	3	4	1	2	3	4
High cost of materials procurement	1	2	3	4	1	2	3	4
Risk of information error during information transfer or duplication	1	2	3	4	1	2	3	4
Cumbersome nature of the materials selection	1	2	3	4	1	2	3	4
Size and fragmentation of the construction industry	1	2	3	4	1	2	3	4
Permits unplanned purchases from random suppliers at a higher price (Maverick buying)	1	2	3	4	1	2	3	4

**SECTION 4A: IMPACTS OF GOVERNMENT POLICIES ON THE EFFICIENCY OF MATERIALS PROCUREMENT STRATEGIES IMPLEMENTATION**

13. The following are Government policies that facilitate the effective implementation of sustainable materials procurement in the South African construction industry.

**Kindly rate the impact of these policies on the implementation of materials procurement**

Note: Less effective = 1, Effective = 2 Very effective = 3 Extremely effective = 4

GOVERNMENT POLICIES	1	2	3	4
The Construction Industry Development Board Act (CIDB Act 2000) on sustainable procurement prescripts for Best practices in the industry	1	2	3	4
The impact of Preferential Procurement Policy Framework Act (PPPFA) towards the Reconstruction and Development Programme (RDP) in the industry	1	2	3	4
Principles of section 217(1) of the constitution for effective materials procurement system (Fairness, transparency, equity etc.)	1	2	3	4
The Broad-based black economic empowerment towards Protecting disadvantaged citizens (B-BBEE)	1	2	3	4

Public Finance Management Act	1	2	3	4
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**SECTION 4B: OBJECTIVES OF GOVERNMENT POLICIES IN MATERIALS PROCUREMENT**

14. The following are objectives of government policy in the implementation of materials procurement strategies during sustainable building production in the South African construction industry

Kindly **indicate the extent** to which these objectives facilitate the implementation of materials procurement strategies, using the scale below

Note: **To a small extent =1, Moderate extent =2, Large extent =3, extremely large extent = 4**

OBJECTIVES	1	2	3	4
Registration of contractors based on CIDB Acts for effective procurement practices	1	2	3	4
To remedy the effect of apartheid and inequalities (Black empowerment)	1	2	3	4
To support the participation of small and medium enterprises in the growth of economy	1	2	3	4
To obtain optimum use of indigenous resources (limiting materials importation)	1	2	3	4
Improving the economic statue of the country (GDP)	1	2	3	4
Protecting individuals disadvantaged by discrimination (Preferential procurement policy)	1	2	3	4
Enforcing the use of Eco-labelling standards for construction materials	1	2	3	4
To standardise the construction materials mark of approval (SABS mark of approval)	1	2	3	4
Creating job opportunities for local contractors to meet the policy aim of the B-BBEE	1	2	3	4

**SECTION 4C: BARRIERS TO THE INFLUENCE GOVERNMENT POLICIES IN MATERIALS PROCUREMENT**

15. The following are barriers to the implementation of materials procurement based on the impact government policies.

Kindly **tick as appropriate** using the scale below

Note: **Strongly disagree =1, Disagree =2, Agree =3, Strongly agree = 4**

CONSIDERED FACTORS	1	2	3	4
Lack of materials procurement supportive structures in the government	1	2	3	4
Lack of long term perception in sustainable procurement implementation by the Government	1	2	3	4
Resistance to sustainable change by government officials	1	2	3	4
Level of corruption in the government	1	2	3	4
Inefficient guidance or best practice Acts for sustainable materials procurement	1	2	3	4
High growing rate of corruption in the construction industry	1	2	3	4



Political interference in general decision and policy making	1	2	3	4
Inconsistency in policy implementation				
Lack of accountability and supportive government structure				

**SECTION 5: CONSTRUCTION STAKEHOLDERS RELATED FACTORS  
AFFECTING MATERIALS PROCUREMENT EFFICIENCY TOWARDS  
SUSTAINABLE BUILDING CONSTRUCTION ENHANCEMENT**

16. The following are stakeholders' related factors affecting materials procurement efficiency towards sustainable construction enhancement. **Kindly tick as appropriate using the scale below:**

Note: **Strongly disagree =1, Disagree =2, Agree =3, Strongly agree = 4**

<b>STAKEHOLDERS FACTORS</b>	1	2	3	4
<b>Clients related factors</b>	1	2	3	4
Lack of interaction between the client and the other construction stakeholders	1	2	3	4
Changes in orders and requirements stated by client	1	2	3	4
Slow or inadequate flow of finance from the client	1	2	3	4
Choice of design approved by the client	1	2	3	4
<b>Consultants related factors</b>	1	2	3	4
Delay in temporary valuation preparation	1	2	3	4
Obscure design specifications	1	2	3	4
Lack of communication between the architect and other stakeholders	1	2	3	4
Reluctance of engineers and architects to work	1	2	3	4
Scarcity of specified materials in the market	1	2	3	4
Errors / omission in the bill of quantities given to the client	1	2	3	4
Missing details in quality and quantity specifications	1	2	3	4
Changes/ variation in the Bill of Quantities	1	2	3	4
<b>Contractors related factors</b>	1	2	3	4
Contractors ability to translate designs and understand materials specifications	1	2	3	4
Absence of contractor participation in the design stage	1	2	3	4
Profit-driven motives of contractors	1	2	3	4
Relationship with sub-contractors	1	2	3	4

*Thank you so much for your time*

## APPENDIX B - SEMI-STRUCTURED QUESTIONNAIRE FOR RESULTS VALIDATION

### Interview guide

1. To ensure economic sustainability during building production through production cost reduction and waste minimisation:
  - ❖ How can the adoption of Green Building Council of South Africa (GBCSA) policy during materials selection during sustainable building production be encouraged?
  - ❖ How does the timely availability of materials influence effective materials usage during sustainable building production?
  - ❖ How can the cost of sustainable building production be reduced to encourage productivity?
2. Effective materials procurement is a strategy of ensuring economic sustainability during building production as materials claim over 50% of the total cost of production.
  - ❖ How effective is the electronic materials procurement strategy used for materials acquisition in your organisation?
  - ❖ What are the problems currently experienced with the adoption of paper-based procurement strategy?
  - ❖ What are the perceived factors barring the adoption of electronic procurement system in the construction industry?
  - ❖ Which procurement strategy best promote the operations of the SMME in the construction industry, TMPs or EMPs?
3. What are your thoughts on the raise of corruption in the government with regards to materials procurement in South Africa?
4. The Section 217 of the 1996 Constitution proposes that procurement as a policy tool must provide opportunities to Historically Disadvantaged Individuals in the society such as SMME
  - ❖ How effective is this Section 217 of the constitution as regards materials procurement?
5. What are the objectives of government policies in the process of materials procurement?
6. What key roles do consultants and contractors play during materials procurement to ensure the process of sustainable construction is enhanced?
  - ❖ **In your own opinion, how can the process of materials procurement system be improved in the (Western Cape) South Africa construction industry towards economic sustainability?**

**APPENDIX C - CONFERENCE PAPERS PUBLISHED IN THE COURSE OF THE STUDY**

**ASSOCIATION OF SCHOOLS OF CONSTRUCTION SOUTHERN AFRICA,  
9<sup>TH</sup> BUILT ENVIRONMENT CONFERENCE, 31 MAY–2 JUNE, 2015,  
DURBAN, SOUTH AFRICA; PP. 169-182.**

**Cost and Benefits Analysis of Sustainable Building Production in  
Western Cape Province, South Africa**

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**ABSTRACT**

**Purpose:** The increasing demand for shelter in the developing world is alarming. The provision of these facilities involves intense construction activities. Although construction activities in the past decades have been observed to impact the environment adversely, researchers opined that the adoption of sustainable buildings will significantly reduce the impacts of construction activities on the environment. Conversely, the high cost of total production has been a barrier to sustainable building adoption. Hence, this paper is set to ascertain the cost benefits of sustainable building production.

**Design/methodology/approach:** This paper evaluates the perceptions of construction stakeholders (contractors, consultants and clients) on the cost and benefits of sustainable buildings using a questionnaire survey. Quantitative data collected were analysed using descriptive statistical techniques.

**Findings:** Findings from the analysis shows that the concepts and benefits of sustainable building production are familiar ideologies in the construction industry. In addition, the evaluation disclosed that achieving the benefits of sustainable buildings depends on the collaborative effort of the construction stakeholders and government towards construction materials cost reduction during construction.

**Response to conference theme:** This paper provides empirical findings to the conference sub-theme on sustainable green building thus promoting sustainable construction education.

**Originality and value:** This paper has recognised that the costs of materials for construction and procurement processes are core contributors to the high cost of producing sustainable buildings. The results can be useful to all construction stakeholders to enhance the adoption of sustainable buildings with the cost and benefits of production in perception. These combined efforts encourage stakeholders' participation in the production of sustainable building to reduce the environmental impacts of construction and improve social-economic statuses of the population.

**KEYWORDS:** Benefits, Conventional buildings, Construction stakeholders, Cost, Sustainable building.

## Impacts of E-Commerce on Construction Materials Procurement for Sustainable Construction

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### ABSTRACT

The demand for sustainable building construction has gone viral in the construction industry with the aim of satisfying the present and future needs of construction stakeholders. Thus, selection and procurement of appropriate materials that satisfy the principles of sustainability is paramount in construction. Irrespective of the importance of this phase in construction, the traditional method of materials procurement has been found to be inefficient considering the increased innovations and diversity of materials available for construction. This paper explores the implementation of E-commerce especially e-procurement as a strategy for improving the process of materials procurement in the South African construction industry. This study is exploratory in nature and data was obtained quantitatively through questionnaires administered to 150 construction professionals in construction companies in the Western Cape Province of South Africa. A total of 93 responses were retrieved and analysed using the descriptive statistical analysis in the Statistical Package for the Social Science (SPSS). The findings indicate the following as the importance of sustainability in materials procurement towards sustainable building production: building cost reduction, enhanced environmental protection and enhanced implementation of government policies. However, the implementation of e-procurement strategies in materials procurement are hampered by (1) lack of awareness, (2) resistance to change, (3) high cost of installation and operation and (4) internet fraud. Given the benefits and impacts of e-commerce, adequate implementation of these findings should proffer a suitable strategy in addressing the challenges of materials procurement towards sustainable building construction.

**Keywords:** Construction industry, E-commerce, E-procurement, Materials procurement, Sustainable building.

**CAPE PENINSULA UNIVERSITY OF TECHNOLOGY POST GRADUATE  
RESEARCH DAY, 26 NOVEMBER, 2015, CAPE TOWN, SOUTH AFRICA.**

**Stakeholders' Perspectives on Cost Parameters that Influence the  
Adoption of Sustainable Building Production in the Western Cape  
Province of South Africa.**

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**ABSTRACT**

The increasing demand for sustainable shelter has become a cause for alarm. As a result of the adverse effect of construction activities on the environment, researchers opined that the adoption of sustainable buildings production will significantly reduce these environmental effects. Conversely, the total high cost of production has been a barrier to the adoption of sustainable building principles. This study sets to ascertain the cost benefits of sustainable building production. The perceptions of construction stakeholders (contractors and consultants) on the cost and benefits of sustainable buildings was evaluated using a questionnaire survey. Quantitative data collected were analysed using descriptive statistical techniques. Findings show that the concepts of sustainable building production are familiar ideologies in the construction industry. The evaluation disclosed that achieving the benefits of sustainable buildings depends on the collaborative effort of the construction stakeholders and government towards construction materials cost reduction during construction. Findings revealed that the costs of construction materials and procurement processes are core contributors to the high cost of producing sustainable buildings. The results of this study will enlighten perception the construction stakeholders' on strategies of reducing the environmental impacts of construction and improve social-economic statues of the population through the adoption of sustainable buildings.

**KEYWORDS:** Benefits, Conventional buildings, Construction stakeholders, Cost, Sustainable building

**9<sup>TH</sup> CONSTRUCTION INDUSTRY DEVELOPMENT BOARD (CIDB)  
POSTGRADUATE CONFERENCE, 2 -4 FEBRUARY 2016, CAPE TOWN,  
SOUTH AFRICA.**

## **Strategies for Effective Materials Management towards Sustainable Construction Enhancement**

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### **ABSTRACT**

Despite the significance of the construction industry in developed and developing nations, construction activities tend to have adverse impacts on environmental and socio-economic aspects of society. This paper aims to evaluate the impact of construction materials management on materials usage efficiency towards the enhancement of sustainable building construction in the Western Cape Province of South Africa. The study adopts a quantitative research approach. Closed-ended questionnaires were administered to seventy (70) construction professionals in different construction companies in the Western Cape. The data obtained were analysed using the Statistical Package for Social Sciences (SPSS). Strategic planning before procurement at design stage, procurement strategy considered for materials purchase, enforcing the adoption of Green Building Councils of South Africa (GBCSA) policy in every construction projects in the country and evaluating the life-cycle analysis (LCA) of materials proposed for use were acknowledged as the predominant factors of materials management that enhance the construction of sustainable buildings. This study was delimited to construction professionals (project managers, procurement officers, engineers, and architects), contractors and company suppliers in the construction industry in the Western Cape Province of South Africa. The adoption of sustainable materials management principles during construction will have the following implications: increased competition amongst material manufacturers, leading to a reduction in material cost which will facilitate economic advancement; and a reduction of material wastage during construction by ensuring availability of material when required on site. Effective materials management during sustainable construction remains a significant attribute of a successful project which ensures waste reduction, cost profitability optimization and government participation in sustainable development through policy implementation related to construction.

**KEYWORDS:** Construction materials management, Materials selection, Materials usage, Sustainable building construction, Sustainable development.