Cape Peninsula University of Technology

FRAMEWORK FOR EFFECTIVE MANAGEMENT OF COST TOWARD SUSTAINABLE HOUSING DELIVERY

By

Imisioluseyi Julius Akinyede

Dissertation submitted in fulfilment of the requirements for the degree

Doctor of Engineering: Civil Engineering

in the Faculty of Engineering

at the Cape Peninsula University of Technology

Supervisor: Dr J A Fapohunda

Co-supervisor: Prof R Haldenwang

Bellville Campus

DECLARATION

I, Imisioluseyi Julius Akinyede, declare that the content of this thesis represents my own unaided work, and that the thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

Signed …………………………………… Date……………………………………...

ABSTRACT

The study developed an operational techniques for construction managers toward achieving affordable housing production process. This will alter the conventional practices of housing delivery in South Africa. Thus, housing will be available and affordable for all people irrespective of income. In South Africa, high construction cost is a huge challenge toward the possibility of providing affordable housing delivery to the country's citizens. This inability to provide inexpensive housing consistently is due to deficiencies in production techniques. Thus, achieving quality housing delivery requires skilful management. The deficiencies occur through unsustainable design practices in the use of construction resources, construction cost issues, frequent changes in design issues, matching resources availability with cost and time management problems, and attitude of stakeholders in sourcing cost efficient resources for use on site. This problem denies low-income earners the ability to purchase personal houses. As such, the research gap for this study was identified. In order to adequately resolve this problem, operational techniques for effective management of cost toward sustainable housing delivery is investigated, "To develop the framework for effective management of cost toward sustainable housing delivery, and empirically validate it". This will, consequently, raise the hope of poor people in accessing affordable housing steadily and continuously within their income.

The objectives of this study inspired the methodology applied toward ensuring that appropriate management techniques of construction cost lead to sustainable housing delivery for people, irrespective of their income levels. This approach aids competent evaluation and determination of resolutions for the challenges of sustainable housing delivery, together with the problem of shortage of low-cost housing in South Africa. Furthermore, the conceptual framework for this study was developed through extensive review of literature concerning the historical background of housing delivery in South Africa, including areas such as cost constraint issues, design and management issues, settlement issues, sustainable construction and teamwork on site, for example.

Explanatory sequential mixed method was adopted in achieving the aim and objectives of this study. This method facilitates the preliminary investigation of the high cost of construction toward delivery of sustainable housing through interviews, validating the concept in the conceptual framework. In addition, a quantitative questionnaire was distributed to collect relevant data for this study. Respondents were selected and screened based on their relevance toward this study. Data collected from the construction operators were analysed via the application of descriptive statistics with the use of MonteCarloPA and Principal Component Analysis (PCA). The results obtained were validated through a qualitative process, with collected qualitative data transcribed and analysed using the content analysis method.

Spearman’s rho correlation and logistic regression analysis were used to determine variables that predicted cost increase as a result of constant variation and housing delivery within a stipulated period. This process facilitates the development of the framework for effective management of cost toward sustainable housing delivery.

Findings deduced demonstrate that availability of skilled workers on site enhances affordable housing delivery, including the establishment of standard design to promote affordable housing delivery, and planning of increased workforce productivity to achieve sustainable housing delivery. Advisably, teamwork must be thoroughly planned among workers while implemented at each phase of housing production. Further findings illustrate the variables that predicted cost increase and housing delivery within a stipulated period. Other relevant findings show that factors like economic instability, stakeholder interests, and inappropriate definition of *labour* affect housing delivery.

The study established a framework of factors that will be used by construction operators to achieve cost effective production processes for affordable housing delivery and to develop affordable housing delivery concept planning and design for construction cost reduction. The required sustainability techniques established by the study will curb the shortage of affordable housing delivery and the over-budgeting that has escalated the unaffordable housing crises for the people of South Africa.

The study recommended that government must allow community participation in the housing production scheme from the inception of the project to the delivery of housing. This can be achieved by organising relevant and comprehensive training to guide the community involvement in the inspection of the project, toward off any unnecessary delay and encourage utilisation of the local materials with employment of the local skilled workers.

Keywords; Affordable housing, Budgeted cost, Building, Construction Cost, Framework, Production, Resources management, Sustainability, Sustainable housing, Sustainable requirements.

ACKNOWLEDGEMENTS

- Glory, honour, and adoration be unto the God Almighty for the great opportunity given me to complete the study. I will forever be grateful to the Creator of heaven and the universe.
- To whom much is given, much is expected. I would like to acknowledge the tutoring and guidance of my supervisors, Dr J Fapohunda and Prof R Haldenwang, toward the successful completion of this study.
- The research knowledge and analytical experience gained will not be forgotten. I acknowledge the assistance rendered by Mrs Kamalie Ashadia, HOD of the Civil Engineering Department, and the administrative staff department of Civil Engineering for their willingness to assist me during this study.
- I thank Mrs Tony Stringer, the acting Assistant Dean of the Faculty of Engineering for her useful advice and assistance at the point of need, as the advice helped immeasurably during this research study.
- Furthermore, my gratitude extends to Mr Lance Wentzel, the Acting HOD of Construction Management and Quantity Surveying, for his financial support. I cannot forget the assistance rendered by the administrative staff of the department at all times, especially Ms Daniel Charlene, Department Secretary.
- The love and kindness shown to me by the academic staff of the Department of Construction Management and Quantity Surveying during this study, especially that of Mr Robin Fisher and the Simpeh family for their appreciated financial support.
- My special thanks to the entire family of Akinyede and Ojudu for their financial support. I cannot overlook help rendered by my blood brother, Mr and Mrs Sola Akinyede, Mrs Bolanle Fasuba (nee Akinyede) and Mrs Mojisola (nee Ojudu). My gratefulness extends to all family and friends who in one way or another supported me throughout this study, people like Mr Peter Gboyega, Mr Deji Abegunde and Mr Deji Aladejana.
- Lest I forget, I wish to appreciate Pastor (Dr) and Mrs Olarewaju Fatoba of Household of God RCCG, Belhar, South Africa, for their prayers toward completion of this study, including the love and kindness received from all parish members.
- Finally, the efforts of professionals working in the South Africa construction industry providing necessary information for this research study are highly appreciated.

DEDICATION

The research study is dedicated to God Almighty for his infinity mercy and guidance throughout this study.

And to my beautiful family – my dearest wife, Mrs Adenike Akinyede, and my children – for their endurance, prayers, cooperation and tolerance for six years of my absence from home.

LIST OF PUBLICATIONS

Akinyede, I.J., Fapohunda, J.A & Haldenwang, R. (2017). Evaluation of critical factors for achieving quality housing delivery within budget, America Society of Civil Engineering (ASCE) International conference on sustainable infrastructure, October 26-28, 2017 (sustainable cities for an uncertain world), New York, USA.

Akinyede, I.J., Fapohunda, J.A. & Haldenwang, R. (2017). Modality of achieving sustainable affordable housing delivery within constraint of cost and quality during production process, Canada Society of Civil Engineering (CSCE) Annual conference May 31 to June 2017 (Leadership in sustainable infrastructure), Vancouver, Canada.

Akinyede, I.J., Fapohunda, J.A. & Haldenwang, R. (2017). Evaluation of stakeholders' influence on affordable housing delivery during production process the 11th built environment conference Association of Schools of Construction of South Africa (ASOCSA) 6-8 August 2017, Durban, South Africa.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY

Terms/Acronyms/Abbreviations	Definition/Explanation
Affordable	Facility to be available within budgeted cost without disadvantage to quality
Budgeted cost	The amount of money assigned to a project for completion
Budgeting	Preparation of a financial arrangement for a construction process and allocating the resources connected with the project (i.e. cash, materials, machine and labour)
Cost	The amount of money needed for materials, professional fees and other monetary values in building production processes
CE	Civil Engineering
CIDB	Construction Industry Development Board
CCM	Construction Cost Management
Estimate costs	Process of estimating the required monetary resources needed to complete housing production processes
GB	General Building
Housing	Group of residence specially prepared for people
Low income earner	People living on a very low stipend
Lowest class	Class of people below the middle class
Money	Funds used to purchase construction resources (i.e. machinery, workforce and materials)
Middle class	Social class that is generally comprised of white-collar workers with an income higher than manual workers
NGO	Non-Governmental Organisation
PMBOK	Project Management Book of Knowledge
PCA	Principal Component Analysis
SPSS	Statistical Package of Social Science
SACPCMP	South African Council for Project and Construction Management Professions
SACAP	South Africa Council of Architectural Professions
Sustainable housing	The construction of homes and buildings that meet people's needs in terms of the economy and the environment. Sustainable housing is referred to as an energy efficient building, healthy building, ecological building and green building. A building that is available, continuous and consistent in delivery: this can be achieved through efficient management of sustainable design, construction resources and construction cost
Sustainable design	Development that meets the needs of the present generations without compromising the ability of the future generation to meet their own needs
UN	United Nations
WBDG	Whole Building Design Guide

CHAPTER ONE

1. INTRODUCTION OF THE STUDY

1.1 Introduction

The study developed framework for effective management of cost toward sustainable housing delivery in order for construction cost to remain within the limit of budgeted cost for government agencies, the construction industry and the stakeholders. As a result, inexpensive housing will be available at a low cost for citizen of South Africa. Even though, sustainable housing delivery over budget is a challenge worldwide, as actual construction cost of housing delivery is often much higher than budgeted cost. As the process of affordable housing delivery in Africa is considerably complex, this results in high construction cost. Unfortunately, low-income earners suffer greatly in terms of purchasing or having ease of access to affordable housing in South Africa. The deficiencies occur through incompetence in delivery of inexpensive housing, unsustainable practices with construction resources, inadequate matching of resource availability with construction constraints, design related issues, and inadequate consideration of stakeholder influence on housing delivery. The impact of these problems is an increase in population density of low-income earners residing in shantytowns in South Africa and across Africa.

Sustainability is comprised of three dimensions: economic, social and environmental. The integration (or lack thereof) of these three dimensions in the housing production process demonstrates a substantial research gap for the development of a framework for effective management of costs for sustainable housing delivery. While numerous researchers have studied the challenges associated with housing delivery (Tanko *et al.,* 2017; Akadiri *et al.*, 2012; Windapo *et al.*, 2017; Akinmoladun & Oluwoye, 2007; Conte & Mono, 2011; Burnett, 2007), few research contributions have been carried out specifically on the delivery of sustainable housing that is affordable, available and deliverable within budget.

Sustainability is applied in a different context for the conservation of natural resources. *Sustainability* is defined as the ability of the present generation to use natural resources without compromising the ability of the future generation to meet their needs (Un-Habitat, 2012; Robichaud & Anantatmula, 2010). The other sections of this chapter discuss the background of this study, aim and objectives, significance of the study and scope of the study. Additionally included is a brief introduction of the research methodology, delineation of the study, thesis outline, ethical considerations for the study and key assumptions.

1.2 Background of the study

Construction industry production techniques are faced with high costs of construction in delivering sustainable housing, primarily due to the inexperience of construction stakeholders toward prudent use of construction resources for low-cost housing delivery. It is necessary for stakeholders to understand the integration of sustainability with housing production. Sustainable construction supports effective management with the purpose of achieving comfortable, safe, productive, secure, healthy and cost-effective housing (Whole Building Design Guide [WBDG]; Programme of the National Institute of Building Science Guide, 2017; Morris, 2007). Similarly, Omolabi and Adebayo (2014) explain that Africa has not yet embraced sustainable housing delivery despite the clear benefits toward development. This is because many African nations have neglected to study and failed to understand their own environmental conditions, methods of operation, production, material availability, technological advancement or the availability of skilled workers (Windapo *et al.* 2017; Akinmoladun & Oluwoye, 2007; Laryea & Ibem, 2014; Taylor & Normal, 1994).

Nevertheless, Jiboye (2011) clarifies that a rise in population of African nations, mostly in population-dense areas, has led to shortage of habitable dwelling places. The situation resulted in diverse urban problems like homelessness, overcrowding, poor living conditions, a deplorable environment, increased rate of poverty, escalating social vices and inadequate infrastructures. In addition, Ademiluyi (2010) reports that the number of people living in slums has spiked due to unaffordable housing delivery caused by exorbitant construction costs. Accessibility to adequate housing in developing countries is obviously a problem that necessitates improvement. Developed nations such as the United States of America, Canada, Britain, France, Japan and Germany have been successful in sustainable housing delivery based on their economic practices, social and political situation and developmental issues. While Agenda 21 at the 2012 conference in Rio de Janeiro confirmed the right of every citizen to adequate housing as established in 2006 as a human right, the proportion of poor people living in slums in developing nations continues to escalate (Olotuah & Bobadoye, 2009; Goebel, 2007).

Moreover, Agenda 21 at the 2012 Rio de Janeiro conference clarified that adequate water and sanitation provisions were special requirements necessary for suitable human settlement even though these are still deficient basic needs in most developments. To this end, it is evident that modernisation within settlement planning for sustainable housing for urban development in developing nations is not exercised because of economic challenges and exceedingly rapid urban growth (Goebel, 2007). This, then, calls for adequate planning and management procedures intending to decelerate urbanisation and population growth. Still, the majority of housing delivered remains unaffordable for low-income earners and affordable only for high-income earners.

A study conducted by Nengwekhulu (2009) in South Africa determined an inarguable need for the provision of sustainable housing for poor people residing in slums, incorporating proper facilities for water and environmental sanitation. Abisuga and Oyekanmi (2014) explain that cities in both developed and developing nations consume two thirds of global energy use through construction activities that generate pollution. Similarly, Melchart (2007) argues that activities carried out by the building industry have been responsible for the degradation of the environment. Likewise, Abisuga and Oyekanmi (2014) affirm that construction production processes in Africa are characterised by high construction costs in housing delivery because of negligence of effective management of activities within the construction industry.

According to Morris (2007), sustainable housing delivery must satisfy environmental, economic and social factors. To that end, stakeholders are designated the responsibility of proper management of these environmental, economic and social factors. But this has not come to fruition considering that the required procedural steps are inappropriately executed. Abisuga and Oyekanmi (2014) argue that development and implementation of sustainable housing in developing countries is, in actual fact, an illusion. The possibility of achieving sustainable housing delivery in Africa is flexible and potential, but deterred by both external and internal factors such as the imitation of certain ideologies not practiced in Africa.

Burnett (2007) expresses that *sustainable housing* is a building that minimises disturbance through improving the functioning of local, regional and global ecosystems. Sustainable housing optimises efficiencies in resource utilisation, management and operational performance, as well as minimising risk to human health and the environment. Kilbert and Groosikopt (2005) have discovered that sustainable housing delivery has major features that enhance environmental ecosystems; for instance, use of materials that are environmentally friendly, efficient and adequate design, renewable energy, and maximum use of indoor environmental quality measures.

Similarly, Boswell and Walker (2004) explain four ways of achieving sustainable development which cut across the interaction between environment, available resources, economy and people, highlighted as follows:

1. effective protection of the environment;

2. prudent use of natural resources;

3. social progress which recognises the need of individuals; and

4. maintenance of high and stable levels of economic growth and employment.

Morris (2007) explains that sustainable development is vital for natural resource conservation and protection. In view of this, construction operators are expected to study the environment where building production activities are underway to learn how to preserve the natural resources on a particular construction site.

Stakeholders are advised to engage themselves in the sustainable housing delivery planning to balance the budgeted cost and actual functional requirements (Adebayo & Adebayo, 2001). Thus, client interest, specifically in terms of cost effectiveness, should be matched with the quality of housing to be delivered (Amo, 2012). Consequently, the cost of construction involved in a project must be given consideration that coincides with the costs of operation and maintenance (Akinmoladun & Oluwoye, 2007).

Understandably, management goals can be attained if sustainability and housing delivery are integrated to enhance adequate planning at the initial stage of a housing production process (Adebayo & Adebayo, 2001). According to Ali and Al Nsairat (2009), inadequate implementation of social amenities and poor economy for housing development in developing nations necessitates sustainable housing. It is imperative to attain efficient housing by adopting adequate sustainable design during housing production processes to ameliorate the high cost of housing construction (Ajayi, 2012).

Sustainable housing production processes, beginning with the client briefing, encompass concept planning and designing. To achieve effective housing production, economic feasibility should also be considered a parameter for selecting the best approach for housing delivery. Sultan and Kajewski (2004) clarify that adequate decisions at the initiating stage of the housing production process will enhance sustainable housing delivery. Correspondingly, decisions made during production have greater influence than those made at the closeout stage when the building production process has been finalised. Similarly, Abdullahi and Aziz (2011) concur that planning at the initiating stage of the housing production process will influence future maintenance of housing; also, adequate design decisions made initially will have a stronger bearing on operating costs.

The evidence emerging from the literature reveals that unsustainable practice, unsustainable design and high costs in the delivery of housing were caused by shortage of affordable housing for many decades and the more current economic crisis. Meanwhile, concept planning and designing for construction cost reduction poses a challenge to both government agents and construction firms. These gaps necessitate a framework for effective management of cost toward sustainable housing delivery.

1.3 Problem statement

Housing delivery processes in developing nations are challenged by unaffordable housing delivery because of construction costs escalating above the anticipated budgeted cost. This denies many people from accessing affordable housing. Due to unsustainable practices and high construction costs, less financially privileged people have no choice but to be constrained to slums with little or no access to basic amenities (Akinmoladun & Oluwoye, 2007; Akadiri *et al.*, 2012; Adebayo & Adebayo, 2001). Ogunbiyi *et al.* (2014) explain that inadequate planning at the initiating stage of design, briefing at the design stage, coordination at the planning stage and closeout stages were not handled effectively during production processes, further deterring affordable housing.

Equally, Sultan and Kajewski (2004) clarify that sustainable housing delivery and sustainable development have been the two significant issues in developing nations resulting from a near constant escalation in costs of construction activities and resource usage during production. These issues demonstrate the urgency to use adequate design, effective implementation of decisions taken at planning stage of production, assessment of cost effectiveness, and quality at closeout stage of production, in efforts to facilitate timely delivery of affordable housing to the people (Adedeji, 2012).

Adebayo (2002) establishes that unemployment, poverty, inadequate access to facilities, inadequate access to quality housing and deficiencies in social amenities affect the poor due to high cost of housing delivery. These and other prevalent problems underscore the urgent development of a framework for effective management of cost for sustainable housing delivery (Olayiwola, Adeleye, & Ogunshakin, 2005). Even though much has been written concerning sustainable housing, no one has yet established an effective framework for sustainable housing delivery within budgeted cost. Most houses continue to be delivered at high costs, with affordability remaining challenged (Olutua & Aiyetan, 2006; Olagunju, 2014)

To buttress the above statement, Odediran and Windapo (2014) describe *cost* as one of the most significant variables of project performance and as the driving force of project success. Construction project cost is acknowledged globally as exceeding the initial budget due to poor financial planning, cost control, design inaccuracy, additional works, variation orders and a surplus of construction errors. Correspondingly, Adedeji (2008 cited in Adedeji, 2012) clarifies that a barrier to the realisation of effective housing in Africa is reflected in successive government efforts associated with the cost of housing delivery having integral problems such as inadequate planning in the use of materials, abandonment of local materials and increased demand for sophisticated housing structures. Olutua and Aiyetan (2006) believe that sustainable housing delivery is efficient in resource utilisation and operational performance, minimising risk to human health and environment.

After critically review the existing theory, the researcher discovered that existing literature is incomplete and inadequate in some significant way. On the point that previous literature has overlooked an important perspective which would have had the potential to further our understanding of the challenges of sustainable housing delivery in African nations. Consequently, this study provided a superior literature through "*Gap-spotting methods"* that discuss on housing challenges from briefing, planning, design and implementation, on this basis the research questions are proposed. The Gap identified through the study of McGaffin, Spiropoulous & Boyle, (2019); Windapo *et al.,* (2017) clarified that "Housing affordability in South Africa has been a significant challenge in recent decades. Efforts from both government and private sectors have been unable to quell the enlarging housing deficit in the country because of high cost of construction". The challenges of housing deficit happen through attitude of the stakeholders in sourcing cost efficient resources for use on site, frequent changes in design issue, unsustainable practice in the use of construction resources and construction cost issue (Brown-Luthango, Reyes, & Gubevu 2017; Windapo *et al* 2017).

From the above discussion, the research problem states that as sustainable housing production processes and maintenance are both confined by budgeted cost, delivery of sustainable housing is dependent on efficiencies in the management of construction cost. Sustainable housing has both direct and indirect effects on society, the economy and certainly the environment. With above stated problems, there is clear reason to develop a framework to assist in effective cost management for sustainable housing delivery.

1.4 Research questions

The research question of the study is centred on '*how can affordable housing be delivered within budgeted cost through sustainable design, methods and practices during the production process?'* Five sub-questions are addressed to support the above question:

1. What are the factors that inflate the cost of sustainable housing delivery over budget?
2. What are the factors that affect design in the delivery of housing?
3. What is the impact of cost on management of construction resources in delivery of sustainable housing by construction operators?

4. How could budgeted costs be effectively utilised without inflating cost of construction for sustainable housing delivery?

5. How could a framework for effective cost management for sustainable housing delivery be established to restrain the cost of construction within the budgeted cost?

1.5 Aim and objective of the research

The aim of this study is to investigate influencing factors and then develop a framework for effective cost management toward sustainable housing delivery, for construction cost to remain under the limit of the budget. With this intent, several relevant objectives have been established to attain the aim of this study. These objectives are as follows:

1. to identify factors that inflate cost of sustainable housing delivery over budget;
2. to establish the factors that affect unsustainable design in delivery of sustainable housing within budget;
3. to found the impact of cost on management of construction resources in delivery of sustainable housing by construction operators;
4. to ascertain how budgeted cost could be effectively utilised without detrimentally impacting sustainable housing delivery; and
5. to develop the framework for effective cost management toward sustainable housing delivery for construction costs to be restricted to within the budgeted limit.

1.6 Significance of the research study

Sustainable housing delivery optimises efficiencies in resources utilisation and operational performance while minimising risk to human health and environment (Burnett, 2007). Lehmann (2006) argues that the enhancement of sustainable housing practice is linked with adequate design for achieving a reduction in density of urban space, in which sustainable design will augment developments with lower running cost. Melchart (2007) has discovered that pollution, inadequate green area, flooding, inadequate sanitation and diseases are all triggered by the destructive environmental impact of building production processes.

To avert this destructive environmental impact, the design team must have the appropriate knowledge for balancing all associated economic, social and environmental issues. This changes the planning patterns applied by the construction operators at the initiating stage when assessing a building project, thereby increasing the possibility of the sustainability of housing delivery (Akadiri *et al.*, 2012). Adebayo and Adebayo (2001) add that construction operators have not integrated effective construction techniques or sustainable design principles into production, with the consequential effect of housing delivered at high construction costs, housing which is unaffordable to low-income earners. Similarly, South African contractors are struggling to integrate sustainable design into their production process (Adebayo & Adebayo, 2001; Rosenberger, 2003). Due to that, housing is delivered at high construction costs (Adebayo & Adebayo, 2001; Rosenberger, 2003).

This study defined a better approach for minimising the cost of managing the delivery of affordable housing, as scheduled. This requires thorough investigation of sustainable housing delivery and procedures, with the intent of making housing delivery accessible to the poor at affordable costs. Several factors are associated with the cost of producing and delivering affordable housing in Africa nations (Omolabi & Adebayo, 2014):

- unsustainable design;
- frequent changes in design issue;
- construction cost issue;
- construction resources syndrome;
- unsustainable methods; and
- practices during production.

To bridge the gap left from previous research studies, the concern of the research study was evaluated as vital, on this basis the research questions of this study are defined.

The study significantly determine the efficient ways of achieving housing production within budget and to deter the economic effect of high cost of housing delivery on low-income earners (Ogunbiyi *et al.,* 2014; Windapo *et al.,* 2017). Inadequate enlightenment about standards of housing delivery or the surroundings in which houses are situated is crucial to both the client and construction operators (Akadiri *et al.,* 2012). Developing nations are unable to implement sustainability policies on housing delivery to suit their own level of economic development and the environment by integrating sustainability into housing production (Goluchikov & Badyina, 2012; Morris, 2007). Construction operators are frustrated with unpractical decisions regarding housing design, starting right from the initiating stage of production processes, because construction stakeholders are not sufficiently enlightened about the right methods and practices with construction resource usage for sustainable housing delivery (Ogunbiyi *et al.,* 2014). It is equally important to safeguard cost-effective housing that is affordable to client and users (Burnet, 2007; Abisuga & Oyekanmi, 2014).

From the identified gaps established from the literature review, the contribution of this study will involve a housing and delivery procedure framework for the following:

1. Effective management of budgeted cost for government agents, construction firms and construction operators to achieve cost effective technologies, since budget for affordable housing is identified as methodology intended to specify a reasonable precise physical standard and economical use of housing.

2. Development of affordable housing delivery concept planning, and the design for construction cost reduction, considering that the application of the concept is under-scrutinised in developing nations.

3. Identifying the required skills in housing delivery management and in-depth knowledge of sustainable integration into design, construction cost, resources, methods and practices during production processes to mitigate challenges of shortage of affordable housing for many decades and in the current economic crisis.

Significantly, this study offers a paradigm to support and inculcate cost effective practices for effective management of construction cost as a standard for affordable housing processes.

1.7 Scope of the study

The concentration of this study focuses on exploration of concerns on sustainable housing delivery and construction procedure for sustainability and on a survey of skills for affordable housing delivery and in-depth knowledge of sustainability integration into design and resource usage for developing nations, particularly in South Africa. The study focuses on South African construction industry activities, exploring information on the housing production process across all nine provinces, with the intention of obtaining findings that are adequate and relevant, emanating from general opinions among the construction operators working within housing delivery companies. The study is restricted to housing delivery companies registered under Construction Industry Development Board (CIDB) with grade 3, 5 and 9 general building (GB) and Department of Human Settlement located in the Western Cape and Gauteng provinces to gather information. Attention will be focused on those construction companies with vast experience in housing delivery.

1.8 Methodology and methods

The methodology for this study involved both qualitative and quantitative methods, using a mixed-method approach known as *triangulation methods*. A mixed-method research approach was appropriately employed in this research study to develop an effective research strategy, exploiting the advantages of qualitative and quantitative techniques. Again, this study employs the use of mixed-methods approach because a combination of qualitative and quantitative methods will provide a clearer understanding into the research problem than a single research approach method. Creswell (2003) describes a *mixed-method* as a process that involves collecting, analysing and integrating mixing (that is, qualitative and quantitative) within a study.

Creswell (2003) further expresses four questions which are central to the design of a research approach. Addressing these four questions will give direction to a study:

- What is the methodology?
- What is the method to use?
- What data will be collected?
- What will be used to analyse data collected?

After critical examination of Creswell's (2003) questions, the researcher set to apply these methods of sequential mixed method approach in conducting this study with quantitative and qualitative techniques. Two different type of mixed method design are considered for this study, which are concurrent mixed method and explanatory sequential mixed method. The concurrent mixed method research design happen when the intent is to concurrently merge quantitative and qualitative data to achieve specific aim of a study. While explanatory sequential mixed methods design occurs at a stage when an investigator conducted quantitative research analysis and at that moment builds on the results to explain in more details than with qualitative research. Thus, explanatory sequential mixed method is significant to this study, and types of mixed methods and the theory associated is adequately explained in chapter 4.

The research process of sequential mixed method is indicated in figure one, and this research process is used to achieve the aim and objectives as specified in figure two.

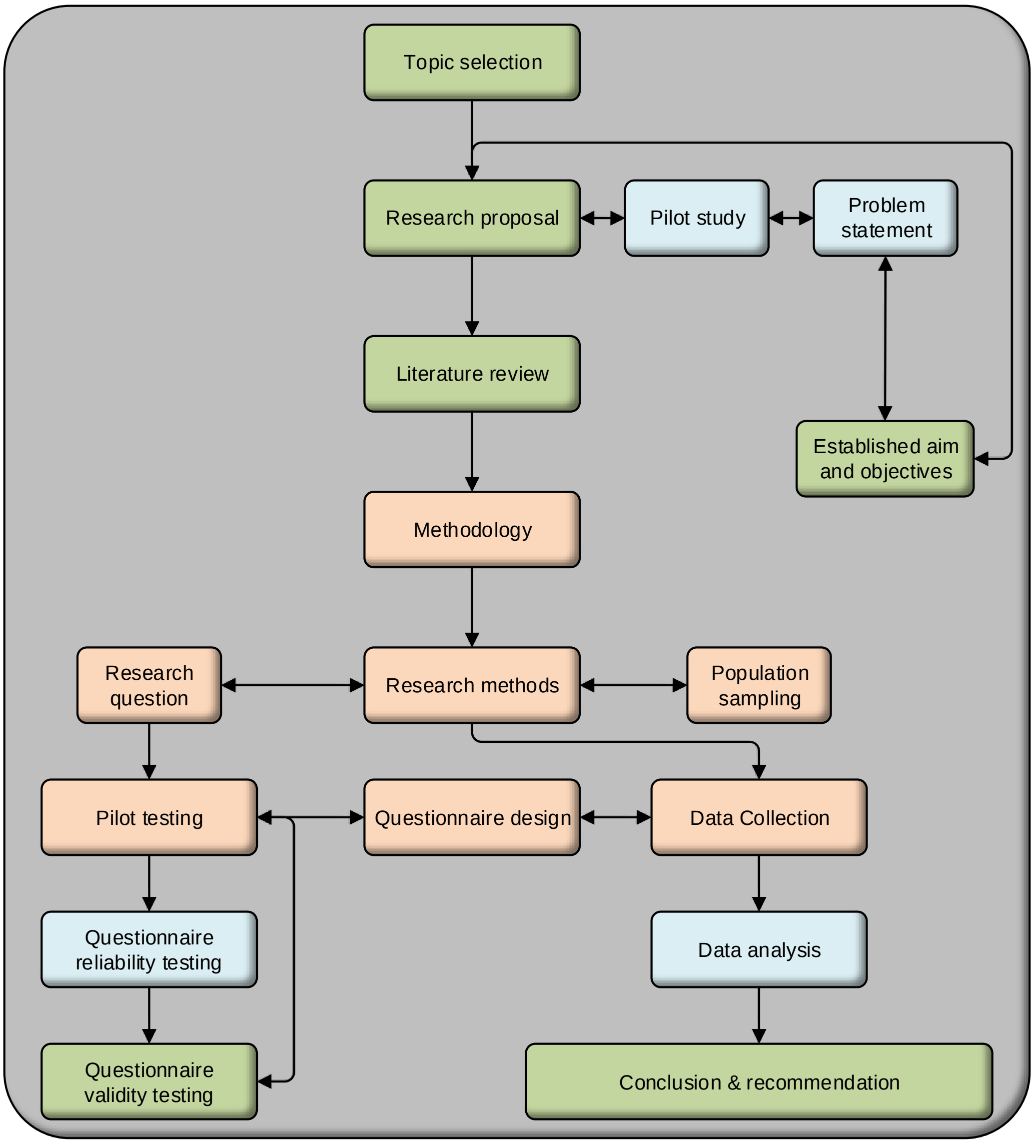

Figure 1.1: Research process

As this study engaged both quantitative and qualitative methods to address the research questions, data were collected through quantitative questionnaires and qualitative interviews.

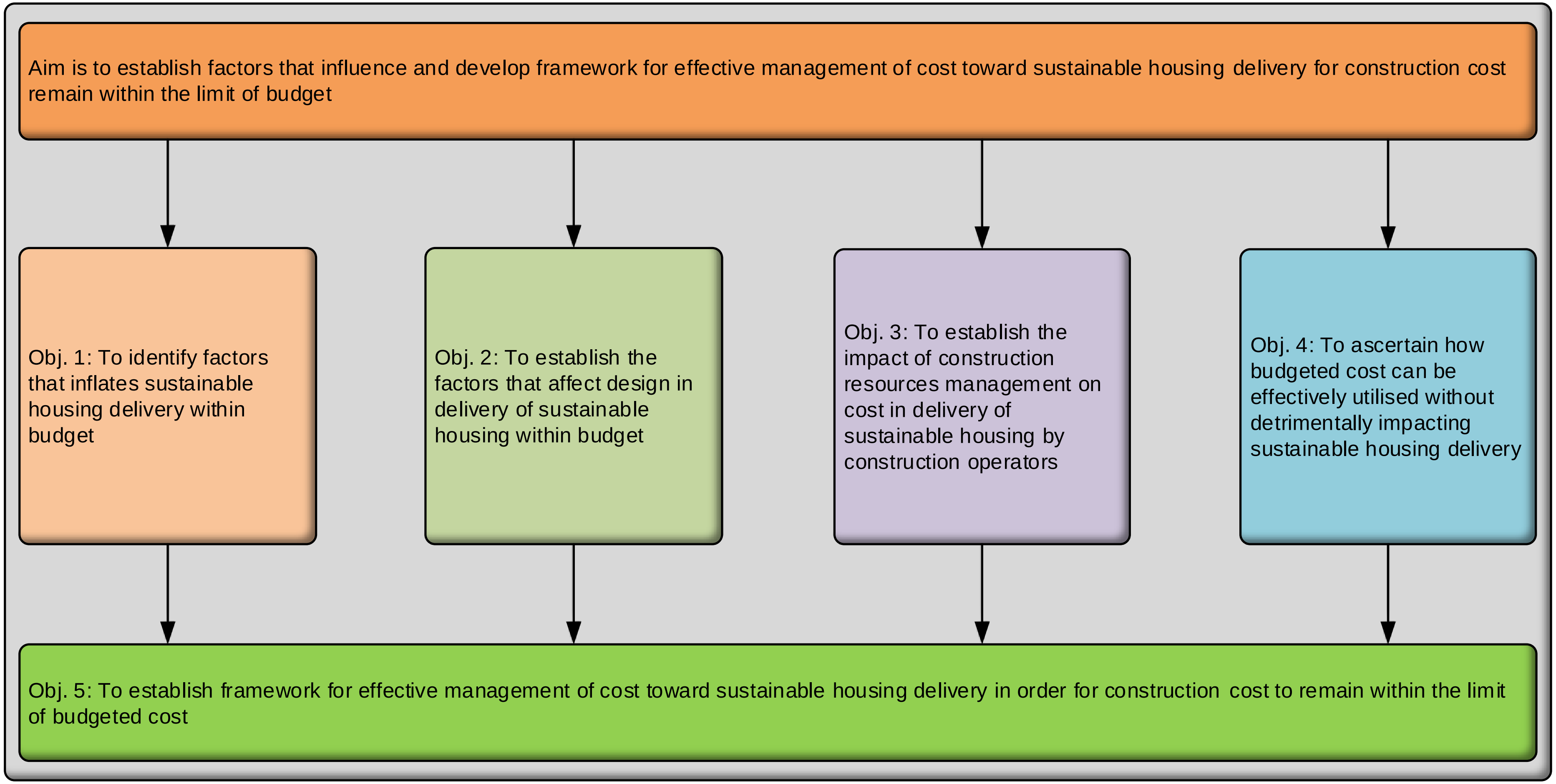

Figure 1.2: Illustration of the connection between the aim and objectives and the process involved in achieving them

The quantitative questionnaires were analysed using Statistical Package of Social Science (SPSS) version 25, through descriptive and inferential statistics; qualitative data collected were analysed through content analysis. Content analysis is a widely used qualitative research technique, the content analysis has three distinct approaches: directed, conventional and summative approach. All three approaches are used to interpret meaning from the content of text data and thus, adhere to the naturalistic paradigm. The qualitative approach validated the results obtained from the analysed data of quantitative approach. *Validity assurance*, as described Tashakkori and Teddlie (2010) and Fapohunda (2010), is the process of checking how a research instrument measures what it claims to measure. In this context, a c*ontent validity procedure* will be employed in this study to eliminate overlapping information and to determine if the study actually measures what it is supposed to measure. A *reliability procedure* will be employed to measure the accuracy and consistency of instruments in this study. Figure 1.1 shows the research process for this study, while Figure 1.2 indicates the connectivity of aim and objectives of the study. The detail of the methodology and methods of the study are discussed in Chapters 4 and 5 of this study.

1.9 Delineation of the research study

This study set standard for affordable housing delivery within the income realm of lowest salary earners. The study methodically carry out its objectives to achieve the targeted aim of the study:

- Data was collected from experienced construction operators working in the South African construction industry.
- The gathered information was presented to architectural firms and offices to enquire about the effect of design factors on housing delivery.
- Data was collected from the Department of Human Settlement in South Africa.

1.10 Thesis outline

The thesis structure is presented in Figure 1.3. The chapters contain relevant content expressing the introduction, methodology, analysis, findings and conclusion, with necessary recommendations for future work and study. Concise descriptions of these chapters are given below:

Chapter 1**:** this chapter contains the introductory aspect of the study, including the background information, aim and objectives, problem statement, preliminary literature review, methodology, limitations, key concepts and full chapter outline.

Chapter 2**:** this chapter comprises the literature on sustainable housing delivery and techniques, cost effectiveness, affordability and accessibility of housing, and management issues during production. The key aspects of reviewed literature include cost constraints issues, design and management issues, management principles and practices, construction resources and relationship with constraints, teamwork, sustainable construction, development issues, sustainability integration, stakeholder involvement, production processes in phases, settlement issues, and the historical background on housing delivery in South Africa.

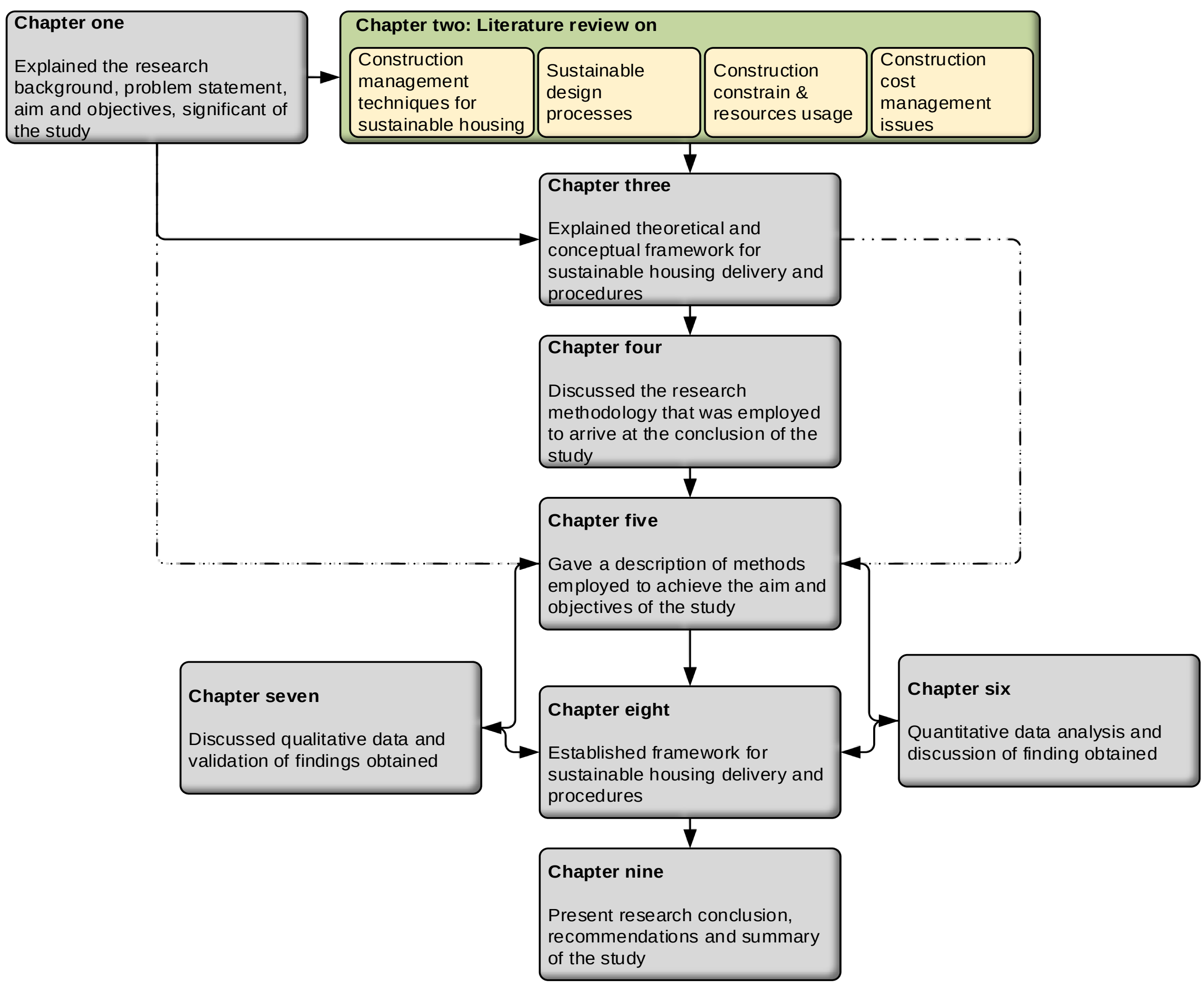

Figure 1.3: Outline of thesis structure

Chapter 3**:** this chapter contains the theoretical and conceptual framework of the research study. Specifically, it comprises the introduction of a theoretical framework for sustainable housing delivery within budget and conceptual framework for sustainable housing delivery and procedure. The theoretical framework segment involves design of the research construct; sustainability integration as a mean of cost reduction of affordable housing delivery; and include supporting housing delivery mechanism through environmental, social and economic sustainability, however through this process of conceptual framework; the study objectives was established.

Chapter 4**:** this chapter consists of methodology employed to propel this study toward the establishment of a framework for effective management of cost toward sustainable housing delivery. The qualitative and quantitative approach referred to as mixed method was used. The methodology will link all the chapters, most especially chapter three on the basis that issues raised in connection to the 5-objectives was discussed.

Chapter 5**:** this chapter contains the methods that will be used to conduct the research study to attain a realistic conclusion. The method involves scientific planning, and numerical, statistical and observation approaches. This chapter has a link with chapter four which consist of the methodology, and on this process the techniques to investigate to investigate issues in this study arises.

Chapter 6**:** this chapter encompasses the results obtained from quantitative data analysis and discusses the findings concerning sustainable housing delivery and procedures. This chapter consist of the analysed results through the use of descriptive and inferential statistical techniques, analysed results are arranged according to the questionnaires design and the study objectives sequentially.

Chapter 7**:** this chapter contains the qualitative analysis of the research study. The chapter consist of discussion on validation of the results obtained from descriptive statistics and principal component analysis. Qualitative data collected are analysed through content analysis and reported accordingly.

Chapter 8**:** this chapter contains the establishment of a framework for sustainable housing delivery and procedure. The chapter consists of explanation on underlining factors impacting each of the concepts/paradigms instituted in chapter three, and through this process, the framework was established.

Chapter 9**:** this chapter contains the conclusion, recommendations and final summary of the research study. The chapter comprises of relevant findings, based on this available facts and findings obtained recommendations are made on the importance of the framework established by this study.

1.11 Ethical considerations for the study

Ethical research polices are considered and not violated as stipulated by the Cape Peninsula University of Technology. Permission are obtained from the appropriate participating organisations in the survey exercise carried out during this research. The names of the selected respondents, the construction firms, construction operators and team managers are made anonymous. Quality assumptions was made in regard to the following steps:

- competence and conduct of interviewers;
- capturing of quality data from the respondents;
- correct and complete questionnaires; and
- analysis done accurately.

1.12 Key assumptions

It is assumed that construction companies and consulting firms proposed for the survey will cooperate by allowing access to their sites and offices.

1.13 Contribution to the body of knowledge the study findings

The aim of this study is to investigate influencing factors and then develop a framework for effective cost management toward sustainable housing delivery, for construction cost to remain under the limit of the budget. This has not been significantly investigated by previous study. Even though, “Ibem and Aduwo (2015) developed a framework for understanding sustainable housing for policy development and practical actions”, yet the study did not discuss management problems of housing as regards to frequent changes in design issues, construction cost issues, construction resources syndrome and unsustainable practices. In another way round, McGaffin, Spiropoulous and Boyle, 2019; Windapo *et al.,* 2017; Ubisi, Khumalo and Nealer, 2019 clarified that Housing affordability in South Africa has been a significant challenge in recent decades. Efforts from both government and private sectors have been unable to quell the enlarging housing deficit in the country, especially at the lower end of the residential market.

The challenges occur through unsustainable practices in the use of construction resources, high cost of construction problem, frequent changes in housing design during production, matching resource availability with cost and time management, and attitude of the stakeholders in sourcing cost efficient resources for use on site (Omolabi & Adebayo, 2014; Windapo, 2017; Brown-Luthango, Reyes, & Gubevu, 2017; King *et al.,* 2017). Consequently, the study investigated these concern issues and resolved the challenge through:

1. Developed framework for effective management of cost toward sustainable housing delivery in order for construction cost to remain within the limit of budgeted cost for government agencies, the construction industry and the stakeholders. As a result, inexpensive housing will be available at a low cost for citizen of South Africa.
2. Established an operational techniques for construction operators toward achieving affordable housing production process. This will alter the conventional practices of housing delivery in South Africa. Thus, housing will be available and affordable for all people irrespective of income.
3. Instituted the factors that inflate cost of sustainable housing delivery over budget; and established the factors that affects design in delivery of sustainable housing within budget.
4. Founded the impact of cost on the management of construction resources in delivery of sustainable housing by construction operators.
5. Ascertained how budgeted cost could be effectively utilised without detrimentally impacting sustainable housing delivery.
6. Established the critical factors of achieving quality housing, and stakeholders influence on sustainable housing delivery, and satisfaction of needs and interest.
7. Determined the predictors variable (independent variables) that will be used to predict the management of dependent variables (cost increase as a result of variations) and project delivery within time, cost and quality.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Introductions

Sustainable housing delivery intends to enhance affordability, availability, consistency and quality housing for the people. Similarly, it boosts economic development and social integration into the community. Sustainable housing production processes are specifically designed to meet present day needs for housing; however, the adequate delivery of housing is interrupted by frequent changes to design and unplanned disturbances that interfere with the intended progress of work on site. Moreover, resource wastage during production impacts competence and interferes in production processes: this is critical to cost efficiency (Abisuga & Oyekanmi, 2014). This chapter presents literature concerning sustainable housing delivery, including techniques, cost effectiveness, affordability and accessibility of housing, and management issues during production. The key aspects of the literature reviewed are cost constraints, design and management issues, management principle and practices, construction resources and relationship with constraints, teamwork, sustainable construction, development, sustainability integration, stakeholder involvement, production processes in phases, settlement issues and the historical background on housing delivery in South Africa.

2.1.1 Costs as constraint toward delivery of sustainable housing

Excessive construction cost has long been a core problem challenging the efficiency of sustainable housing delivery in developing nations (Gan *et al.,* 2017; Bakar *et al.,* 2010; Atkinson, 1999). This high construction cost is prohibitive in the areas of affordability and accessibility to housing by people in need of inexpensive housing (Abdul Raham *et al.,* 2013). Similarly, poor design, inadequate planning, ineffective production techniques and management inefficiencies are all sources of high construction cost affecting efficiency in housing delivery to the people (Adebayo 2012). Lack of accessibility to sustainable housing delivery has resulted in economic problems and social deficiency among the people (Ahmad & Choi, 2011). Challenges related to unaffordable housing delivery happen as a result of the high cost of construction in developing nations, responsible for the inaccessibility to inexpensive housing in Africa (Omolabi & Adebayo, 2014; Windapo *et al.,* 2017; Adebayo & Adebayo, 2000). The incompetency of construction operators in integration of sustainability into housing production processes has, unarguably, a detrimental effect on affordable housing delivery, as well as social, cultural and environmental issues in developing nations (Adedeji, 2012; Amaesh & Crane, 2006; Basiago, 1998).

As a result, this situation of unaffordability, inaccessibility and poor construction techniques has severely impacted people globally (Ademiluyi, 2010); the situation has forced people to remain in squatter camps along urban peripheries, with calamitous overcrowding issues and unsustainable activities within the settlements, adversely affecting people and consequently leading to constant fluctuations in environmental conditions (Sultan & Kajewski, 2003). A study by Sultan and Kajewski (2003) expounds that cost increase of construction has rendered it extremely difficult for construction operators to identify the approaches to apply toward sustainable housing delivery during the production process. As the economy of developing nations is challenged with unsustainable practices toward affordable housing delivery (Adebayo, 2002), the economic progress of the people is restricted; people are confronted by disastrous unemployment and poverty. As these dire situations increase – social segregation, inadequate accessibility to transport facilities, lack of proper hygiene, and spacious location for settlements – they infringe on social development, directly impacting people's lives and well-being (Adullahi & Aziz, 2011).

Olutuah and Adesiji (2009 cited in Epenyong *et al.* (2012) explain that high cost of construction in the delivery of housing has escalated crime amongst people living amidst severe population growth in cities. Construction operators have neglected to integrate sustainability into housing production processes as a means of enhancing youth employment. They also neglect productivity, economic development, social interaction and employment opportunities (Akinmoladun & Oluwoye, 2007). Thus, inadequate accessibility to these indices of productivity by the youth results in youth taking to crime, thereby negatively affecting society (Amo, 2012; Abdullahi & Aziz, 2011). Similarly, Windapo *et al.* (2017) explain that high cost of construction has made it difficult for youth to participate in the construction process, exacerbating poverty and high vulnerable to risk. Correspondingly, Fagbenle *et al.* (2012) clarify that inaccessibility of the youth to construction activity and quality housing, as the high cost of construction makes the venture into construction training uninteresting, deprives them of an avenue for achieving economic attainment.

Unsustainable practice toward cost effectiveness worsens housing delivery consistently since construction operators cannot integrate sustainability into housing delivery (Aibinu & Odeyinka, 2006). To this end, Ukoje and Kanu (2014) explain that mass housing schemes were organised in developing nations mainly to deliver housing to the lowest income earners; however, the intention of the government was frustrated by a lack of proper planning and implementation by agents. These actions, unfortunately, incapacitated the delivery of low-cost housing into the city for those in need (Aribigbola, 2008).

Ukoje and Kanu (2014) clarify that the *incompetent performance of contractors* during housing production processes further impacts the high cost of construction toward delivery of housing. Contractors and government agents are advised to undertake capacity building toward achieving cost effectiveness in the delivery of housing, specifically for low and middle classes (Ukoje & Kanu, 2014). Urgen *et al.* (2015) clarify that high cost of construction impeding delivery of sustainable housing occurs as result of a lack of ability of construction stakeholders to manage cost effectiveness, quality work, timeframe and schedule control at each phase of construction.

Ogunbiyi *et al.* (2014) reveal that the benefits of sustainable housing delivery within budgeted cost have many positives rewards: a competitive advantage, improved progress flow, quicker productivity, improvement in environmental quality and enhancement in compliance with lowest earners expectation. Ogunbiyi *et al.* (2014) further clarify that achievement of these sustainable housing delivery benefits is based on proper understanding of sustainable construction principles, and integration of these principles, toward management of budgeted cost specified at the initiating stage of production.

Kuroshi *et al.* (2007) explain that *material management* is a problem in the delivery of sustainable housing, as the source of materials for production processes influence cost of housing delivery, so if materials are not sourced locally, this has significant economic implications on the people purchasing the housing and the overall cost of construction. Windapo *et al.* (2017) identify factors that affect material delivery as follows: available, useable during production, non-toxic, recyclable, renewable, reducing waste, local source and durable. Consideration of these factors is significant toward sustainable housing delivery during the production process. Kuroshi *et al.* (2007) further clarify that the high cost of building materials in African nations has a detrimental effect on social, economic and environmental factors of the people since housing delivered at high construction costs means that availability of housing for low-income earners becomes increasingly scarce. As such, a majority of the population in developing nations still reside in poorly constructed shantytowns.

Tunji-Olayeni (2014) has discovered that *skill performance* is yet another problem rife in the construction industry, with the consequence being, again, housing delivered at high construction costs above the budgeted cost initially specified. The challenges to improving performance become a problem in terms of cost overruns, time overruns, poor quality work and low productivity (Smallbone, Leig & North, 1995). Inadequate skill performances exert socio-economic problems on the people in regard to unsustainable and unaffordable housing production processes (Adebayo & Adebayo, 2001). Similarly, Fajana *et al.* (2011) also learned that ineffective management of construction cost causes housing delivery above the budget specified, a situation creating a disparity between healthy economic development and a dearth of employment opportunities. Since productivity of construction operators is challenged with performance, this is problematic on the economy, the society, and the immediate environment surrounding the people, especially since the people are not fully involved in housing production processes (Burnett, 2007).

Omolabi *et al.* (2014) identify *delay factor* in housing delivery as another major challenge toward the efficiency of construction operators, also exacerbating construction costs during the production process. Along this line, Omolabi *et al.* (2014) further delineates those factors inducing delay as follows: lack of funds to finance a project to completion, changes in drawings, lack of effective communication amongst the parties involved in the housing production process, lack of adequate information from the consultant, poor decision-making and contractor insolvency. Amusan *et al.* (2014), on the other hand, explain the opposite: that effective management of workforce toward sustainable housing delivery will enhance delivery of housing within the budget and time specified.

Omolabi *et al.* (2014) have discovered that these delay factors contribute immensely toward unsustainable housing delivery, with the consequent effects of unsustainable housing delivery on people being unemployment, social segregation, poverty, and squatter and slum settlements. Ofori (2007), however, clarifies that the *client role* is vital toward productivity in the delivery of sustainable housing within the budget specified.

Ofori (2007) reveals that *client enlightenment* and training on sustainability is essential for sustainable planning, design, maintenance, and efficient construction. Likewise, Carter and Rogers (2008) explain that *sustainability enlightenment* will enhance the efficiency of the client partaking in sustainable housing delivery for the poor; this action will likewise minimise the social, economic and environment effects on the people.

According to Owoyemi (2011), constant *training of construction operators* on sustainability will enhance productivity and cost effectiveness during production. Omolabi *et al.* (2014) have identified factors that will enhance the productivity of a workforce toward sustainable housing delivery within budget: periodic training of staff, good remuneration systems, good occupational health, constant retraining of staff and safety on site.

According to Omolabi *et al.* (2015), billions of dollars are being poured into infrastructural investment in the delivery of sustainable housing. However, little emphasis is placed on the future maintenance of such infrastructure during the planning, design, construction and closeout stages; essentially, future maintenance is ignored. Wentworth and Makokera (2015) reveal sources of finance for African nations through aid flow, remittances, development finance, private equity and bonds and foreign direct investments. Donors believe that these finances will be applied appropriately in economic sectors, especially in infrastructural development, to cater for transportation, energy, water, sanitation, information and communication (Ding, 2008; Declaration, 1992). Likewise, Wentworth and Makokera (2015) state that the targeted aims of the donor are for development of social services such as hospitals, clinics, education, and delivery of low-income housing. Nevertheless, governments of developing nations and private sectors were unable to manage finances efficiently and effectively for addressing infrastructural backlog (Desai & Desale, 2013). Based on these challenges, Wentworth and Makokera (2015) advise that African governments should redefine their engagement with private sectors through adequate planning, sustainable design and construction techniques for cost efficient housing delivery.

2.1.2 Cost effectiveness in sustainable housing delivery

Olutua and Aiyetan (2006) have identified *cost* as a significant factor to be considered for effective management, starting from the initiating stage through to the closeout stage in delivery of sustainable housing, as cost has an influence on the environment, economy and society in efforts to achieve comfortability. Similarly, Nega (2008) explains that adequate planning for cost efficient projects during production processes, essential for sustainability, can measure user requirements. Azhar *et al.* (2008) identify *cost limitation* as one of those factors confining building production processes of construction cost within budget. Abdul Rahman *et al.* (2013) advise that clients and construction operators must be conscious of the fact that as time, quality and cost are interrelated in achieving the delivery of housing, *any* little shift during production to *any* of these factors will affect the others, thereby impacting sustainable construction. Similarly, Desai and Desale (2013) clarify that proper monitoring during production processes will also assist in delivery of sustainable housing at cost, time and quality specified, in order to satisfy societal interest, environmental expectation and individual economy attainment. Likewise, Memon *et al.*

(2011) reveal that cost is an inspiring force for success in building production processes as well as being imperative throughout the entire construction management life cycle. Ganiyu and Zubairu (2010) have also established that effective management of construction cost has been *the* primary problem confronting developing nations' construction industries in delivery of projects at specified budgeted cost.

Nega (2008) argues that the inability of construction operators to deliver sustainable housing satisfying to social interest, the economy and the environment within time specified and cost expected is a major problem in African nations. Memon *et al.* (2011) suggest that delays in production processes and delivery of sustainable housing have been identified as a primary factor responsible for the failure to achieve sustainability in Africa. Similarly, Sultan and Kajewski (2004) explain that inappropriate planning for schedules at initiating and implementation stages are responsible for arguments among construction stakeholders, also resulting in late delivery of projects at inflated construction costs.

2.1.3 Sustainable housing construction

Sustainable housing construction processes have been identified as playing a substantial role in the world environmental crisis; however, these processes afford the largest solution toward mitigating world climate change (Adebayo, 2002). Developing nations have the highest number of slum and squatter settlements in the world from the rapid urbanisation of their cities (Goebel, 2007). This rapid growth is escalating sustainable housing as an urgent requirement for mitigating shortages of housing as well as illegal and inappropriate activities of people which intensify environmental pollution (Hill & Bowen, 1997). Clearly, sustainable housing construction systems in developing nations are derisory, in need of rectification. Governmental support is required urgently to reverse this situation and bring about effective sustainability practices (Ding, 2008, Habitat U.N., 2012).

Zhu and Liu (2004) expound that developing nations could develop in a more sustainable way, provided urgent tasks disseminate the concept of sustainability, with practices implemented in urban construction projects. Evidently, it is impossible for developing nations to simply copy the experiences of developed countries, since developing nations have a much higher population and housing density, and much less availability of reusable energy per square floor area (Ahmad & Choi, 2013). Therefore, it is necessary to investigate the sustainable housing technologies applicable to regions of various climates and economic conditions, as well as the requirements for sustainability to occupants and owners in various places (Bakar *et al.,* 2010).

According to Zimmermann *et al.* (2006), sustainability has been enshrined as a goal of society to ensure the satisfaction of present needs does not compromise the ability of future generations to meet their needs; this is thus a ‘social objective’, achievable only when all areas of society cooperate in fulfilling the associated demands (Carter & Fortune, 2007). Conte and Manno (2012) clarify that ecological sustainability is, in turn, a basic prerequisite for sustainable economic and social development. Zimmermann *et al.* (2006) explain that the first step in formulating an effective response to this challenge, focusing solely on environmental issues, entails the contribution required from the various areas of human activities for the achievement of sustainable development. Zimmermann *et al.* (2006) further state that without binding sub-targets for different sections, it is nearly impossible to move systematically toward a sustainable society. Daly (1990) clarifies that sustainable construction sets out to define the requirements necessary for housing and structures in contributing to the achievement of a sustainable society. According to Goebel (2007), the tolerable impact of housing, in terms of energy demand and pollutant loads during construction, maintenance and operation, are determined by efficiency of decisions taken at the initiating stage of a housing production process.

The evolution of the concept of sustainable development provides a basis for advancing the understanding of sustainable construction (Idrus & Ho, 2008). Hill and Brown (1996) explain that the principles of sustainable construction are divided into four pillars – social, economic, biophysical and technical – with a set of over-arching, process-oriented principles to be adhered to as a checklist in practice. Clearly, a multi-stage framework is required, endorsing the application of environmental assessment and environmental management systems for construction projects (Hill & Brown, 1996).

According to Hawang and Ng (2013), a competent project manager is vital to project success. While many studies have examined competency of project managers, few have done so in the context of green construction. Therefore, Ibem *et al.* (2011) argue that there is a need to identify challenges faced by project managers who execute green construction projects and to determine the critical knowledge areas and skills necessary to respond to such challenges. Similarly, Edun-Fotwe and McCaffer (2000) explain that project managers in today’s construction industry are faced with a situation whereby the fundamental roles and functions they perform are witnessing a gradual shift in priority. Carter and Rogers (2008) present that to maintain professional competency, project managers in construction adapt to this changing industry environment by relying on knowledge and skill acquired through training and experience. Moreover, Hawang and Ng (2013) offer that the extent to which training enables project managers to effectively adapt to changing demands has considerable relevance, not only for the training of future project managers, but more importantly, the kind of management and general manpower policies that construction organisations can adopt toward sustainable housing delivery.

According to Zwikael *et al.* (2005), project managers in different countries run projects of a similar nature but in different ways. Differences may derive from cultural distinctions as well as unequal importance given by project managers and their customers to the various success measures of the project. Dziekonski (2017) suggests that many present projects taking place in both developing and developed nations have international stakeholders interest. The importance of identifying cultural differences has escalated, as these differences may have to be bridged when executing such projects toward the achievement of delivery of cost-effective housing. Tam *et al.* (2004) argue that the construction industry plays a vital role in meeting various needs of society and enhancing quality of life. However, Jaillon and Poon (2008) claim that the responsibility for ensuring that construction activities and products are consistent with environmental policies needs to be defined, with solid environmental practices involving reduction of waste.

As construction activities have an undeniable impact on the environment, the consciousness of environmental damage is essential for a reduction in environmental degradation (Rahardjo, 2000). Tam (2004) explains that there will be a similar reduction in waste generation, minimising waste in landfills. Sustainable construction must be well-planned to avoid damage to existing natural resources. Ding (2008) explicates that most construction activities cause a great deal of damage to the environment, as the construction process changes the natural features, replacing them with artificial features. Vlek and Steg (2007) concur, explaining that waste generation during production causes damage to the environment, and emissions generated during material production for the construction industry pollutes the air, causing damaging health issues. Hence, sustainable sensitivity is essential for any construction approach during production processes in the delivery of sustainable housing (Ding, 2008).

2.1.3.1 Sustainable housing development

Sustainable housing delivery is an approach for development; sustainable housing development engenders awareness of the challenges to the environment, the society and the economy of the people (Adedeji, 2012). Ajayi (2012) states that unsustainable development, the opposite of sustainable, poses challenges to the economy, social interactions, civilization and cultural heritages. According to Ayoola and Omole (2014), the challenges of unsustainable practices on the poor need immediate attention from governments, including regional and local. Similarly, Aribigbola (2008) specifies that community, local and national institutions, NGOs, and individual involvement must *all* play a prominent role in sustainable development. Odebiyi (2010) also expounds that sustainable housing development is important, not only for national growth, but for sustained individual growth. Sustainable housing delivery, therefore, is vital for the numerous economic challenges in Africa, including unemployment, poverty, low standards of living, poor health, defective transportation, segregation, squatter and slum settlements and facility problems. Alternatively, Odebiyi (2010) argues that a sustainable housing production process is a viable solution to high construction costs, as sustainability enhances high technology that in turn lowers the affordability of housing more in the reach of the poor.

Rosenberger (2003) explains that as there is inequitable development in Africa as a result of social and economic effects, and further mismanagement of the situation is aggravated by a substantial housing backlog. Similarly, Ajayi (2012) clarifies that development in African nations is hindered by credit facilities. Since the number of people who are in desperate need of housing increases on a daily basis, private ownership of housing is not sufficient to provide the sheer quantity of housing needed by the poor. However, and quite positively, Ibem *et al.* (2011) argue that sustainable development *can* be achieved if adequate emphases of improvements are on the economy, social arena, and the environment of the poor. In line with this, Okon and Ukwayi (2012) explain that half of the population in developing nations are homeless, primarily as a result of ineffective planning for management of resources made available for sustainable housing delivery for the poor.

Dada and Oladokun (2008) suggest that *resource mismanagement* has been a substantial barrier of sustainable housing delivery, and yet construction stakeholders treat this clearly significant problem of mismanagement with relative unimportance. This is one primary reason that delivery of housing at high construction cost, above budget, remains a perpetual problem in developing nations (Habitat U.N., 2013). Ihuah and Eaton (2013) therefore argue that sustainable practices and their integration into housing production processes is the *only* major route for development in African nations, as in developing nations, the current housing deficit is a challenge to the poor in terms of economic development, unemployment, poverty and lack of decent accommodation (Habitat U.N., 2011).

According to Mohammad *et al.* (2015), *housing* is one of the essential elements in sustainable development. Comfortable housing is essential for human existence. Nevertheless, the provision of housing in developing nations has become difficult for construction operators due to lack of proper management of technical principles for housing production processes within budget (Jiboye, 2010). Nakweenda (2014) discovered that the majority of the African population are affected by housing deficit as a result of inaccessibility to finances for decent accommodation. The inability to access finance by the poor has escalated the level of poverty in Africa; consequently, people's involvement in housing production processes will enhance employment opportunities and living levels (Omolabi & Adebayo, 2014). Chaarawi *et al.* (2016) explain that informal settlements in African nations attract a larger population than formal settlements; this scenario has become a significant problem. The fact still remains that most of the houses delivered within formal processes generate excessive construction costs, making it difficult to entice an increasing number of people to secure housing within the formal sector (Olagunju, 2014).

Sustainability integration into housing production processes is one strong solution to informal settlements in African nations (Chaarawi *et al.,* 2016). For that reason, Kazadi (2016) has made clear that the establishment of capability assessments among construction – before and during housing production processes – will certainly enhance sustainable housing delivery. The assessment of the capacity of those involved in housing production processes will improve efficiency; as a consequence, then, the assessment will influence large developments in African nations (Kazadi, 2016).

2.1.3.2 Urban development

Urban development is to promote the delivery of sustainable housing that is interspersed with green grass, trees and flowers, and to enhance the efficiency of building functionality (Brehemy, 1997). Moreover, good landscaping will augment transportation around buildings to grow sustainable cities full of environmental efficiency (Conte & Mono, 2011; Ademiluyi, 2010). To achieve sustainable housing development, construction operators should embrace sustainable site planning, construction techniques and policies that will reduce air pollution and decrease gaps between built and natural systems (Conte & Mono, 2011). Urbanisation challenges include the migration of people from their original location to elsewhere for better living, a situation that leads to reduction of accessible and desirable housing and thereby increases the prevalence of poor housing and the expansion of slums (Habitat U.N., 2012).

2.1.3.3 Living within the environment limits

All people should determine to live a life of sustainability to maintain the performance of the environment (Brown, 2011). According to Edun-Fotwe and McCaffer (2000), construction activities should be controlled at planning and implementation stages to avoid any negative impact on the environment. Furthermore, housing policies must be designed to meet people's diverse needs, promoting people's well-being, social cohesion, and inclusion, and, of course, equal opportunities (Hassan, 2011). As activities of people pollute the environment, and this pollution has negative influences on development, significant efforts are required from the government, institutions and individuals to curb pollution and environmental degradation (Ogwueleka, 2013). Abubakar (2014) explains that most cities in Africa are witnessing a movement of people from rural areas into city centres in a desperate search for income opportunities. Consequently, cities are challenged with the proliferation of informal settlements, since the poor, unable to afford high construction costs of housing delivery, are forced to remain in slums and squatter camps (Habitat U.N., 2012). The continuous activities of the poor in these squatter settlements impinge on the positive development of cities (Brown, 2011).

According to Ogwueleka (2013), the infusion of sustainability into housing delivery will promote delivery of affordable housing within the reach of the poor, along with generating less waste during construction. Clearly, there is a need for sustainable development adequately implemented in African cities (Habitat U.N., 2012). Meijer *et al.* (2014) explain that the majority of cities in developed nations have a competitive problem that challenges housing development, based on the fact that international organisations are present in most cities of developed nations, influencing the realms of social, economic and environmental development of the people (Ajiboye, 2012). The presence of these international organisations in cities has both a positive and negative impact on the poor: the negative effect is the repercussion on the high cost of construction toward sustainable housing delivery (Meijer *et al.*, 2014).

Similarly, Baussauw (2014) explains that as the presence of industries in major cities of developed nations attracts people from all over the world, this generates conflict among the tourists and local city inhabitants struggling for transportation, reaping congestion and tourist pollution throughout the city. The governments of developed nations should take a decisive step toward establishing a system for managing city-wide tourist activities which reduce congestion and pollution (McGaffin *et al.,* 2019; Baussauw, 2014)

2.1.3.4 Integration of sustainability into development

Sustainability is defined as the ability of the present generation to meet their needs without compromising the ability of the future generations to meet their needs (Habitat U.N., 2012). To achieve continuous use of natural resources by present and future generations, sustainable housing development is imperative (Adebayo, 2002) because it enhances efficiency in housing usage, people's health, ease of transportation, employment opportunities, and the reduction of poverty among the poor, all the while promoting equity (Habitat U.N., 2013). Similarly, Hassan (2011) acknowledges that sustainable housing development will improve social and economy development and reduce environmental degradation as sustainable housing development encourages people's participation in community development (Habitat U.N., 2012).

According to Waziri and Roosli (2013), African nations are void of adequate policy on sustainable implementation, making it difficult for the majority to have control over environmental degradations. Waziri and Roosli (2013) further express that while a few African nations do have a policy on sustainable housing delivery, this policy is merely a conventional system of housing delivery without sustainability integration. Hence, this situation challenges people's involvement in housing production processes: delivery of housing within the reach of the poor remains high in demand without adequate fulfilment (Ademiluy, 2010). A recommendation specifically for African nations has been made – people should be allowed to participate in the consultation surrounding sustainable housing policy formation to achieve social, cultural, economic and environmental efficiency for development (Habitat U.N., 2012). Ojonemi (2013) expounds that rural development, in particular, should aim toward improvement of productivity, thereby increasing the income and well-being of the people. Ojonemi (2013) further emphasises that rural development can only be achieved if the African nations establish transformation policy that involves changes vital to the social, economic structure and rural settings in which people are currently struggling to survive. Similarly, Abubakar (2010) expounds that planning for modernisation in Africa is a challenge: to that end, African nations should establish a policy on sustainability integration into resource usage and effective technology bringing down construction cost for sustainable housing delivery into the reach of the poor.

2.1.3.5 Impact of decisions on housing delivery within sustainable dimensions

Decisions taken (or not taken) in regard to the formulation of policy in the delivery of affordable housing is clearly inadequate within Africa because Africa nations have not achieved success in housing delivery within an affordable level for the poor (Habitat U.N., 2012; Abubakar, 2010). Approaches to sustainable housing development have a serious consequence for people's survival: poor planning for community development is a challenge to African nations; and poor planning for housing development diminishes people's standard of living to the barest minimum (Ajiboye, 2012). Decisions made by the government pertaining to housing delivery lack the grit and characteristics that challenge the efficiency of affordable sustainable housing delivery for the poor (Garip & Sener, 2012).

Oral and Gritilioglu (2008) admit that cities' historical urban centres are negatively affected, having lost desirability and beauty from the inability of the government to conduct effective planning for sustainable housing development. Therefore, many nations, whether developed or developing, are desirously in need of a solution to alleviate the burdens of slums and squatter settlements in and surrounding the cities (Habitat U.N., 2012). Thus, government decisions on policy implementation for sustainable housing development will be merited by the range of development of cities in terms of regaining lost glory of beauty and liveability (Oral & Gritilioglu, 2008).

According to Ugonabo and Emoh (2013), adequate planning for design decisions will entail designing appropriate strategies for effective housing delivery in Africa. Furtherance to this discussion, Ugonabo and Emoh's study (2013) identified those factors inhibiting effective housing development in African cities, including lack of secure access to land, high cost of construction, limited access to finance, high cost of land registration, bureaucratic procedure on land issuance documents, uncoordinated policies and policy implementation.

Correspondingly, setbacks concerning sustainable housing delivery arises from decision-making concerning the development of African cities that does not include public participation (Abisuga & Oyekanmi, 2014). This action challenges effective implementation of sustainable housing delivery within reach of the poor (Amba, 2010). Governments usually consider the rights of the few privileged people toward the formulation of policy (Habitat U.N., 2012). In fact, the majority of policies pertaining to sustainable development in Africa are more severe on the poor than the rich (Aibinu & Odeyinka, 2006). Government policies encourage slums and squatter settlements among the poor indirectly, rather than discouraging the excessive costs of construction, so that housing could potentially be affordable (Ogwueleka, 2013).

Clearly, special urban development toward the enhancement of social cohesion and economic attainment among the poor is imperative (Ali & Al Nsairat, 2009). Governments must consider an adequate land regime to increase accessibility for the poor to land and social amenities (Akingbade, 2012).

2.1.4 Government involvement in sustainable housing

African nations have been on the list of non-achievers of sustainable housing development: housing policies of governments have been unsuccessful for a plethora of reasons, such as nepotism, corruption, poor political willpower in implementation strategies, lack of transparency and poor due process (Amba, 2010; Oyenkachi, 2014). Governments of developing nations *must* focus on establishing comprehensive policies that enhance sustainable housing delivery for the poor (Oyenkachi, 2014). Housing provision in Africa is dominated by socio-economic inequalities and slum settlements replete with unsustainable living conditions and social exclusion (Bricks Academic Forum vii, 2015). Similarly, Ribeiro and Dwyer (2015) agree that social and economic development is challenged by inadequate sustainable housing delivery in African nations, as housing development is characterised by a deficiency in facilities, high cost of construction and vast inequalities.

According to Li *et al.* (2012), policy formulation on housing planning and design should include participation of the public; in so doing, the interest of stakeholders would be captured systematically. Sustainable integration into housing production processes can be achieved if adequate planning is introduced into affordable housing delivery. Ng (2014) argues that the onus is on government to establish public infrastructural and construction projects which improve the well-being of the people, and to impact development of people through social, economic and environmental improvements. However, inadequate implementation of these policies by contractors and construction operators continues to hinder community development (Amba, 2010).

Several success factors must be considered by contractors toward sustainable housing delivery: favourable investment environment, economic viability, strong technical strength, sound financial package and appropriate risk allocation via contractual arrangement (Dada & Oladokun, 2008). According to Shan and Yai (2011), factors that hinder public involvement in infrastructural development include inadequate policy formulation, economic development, legislative and regulatory improvements and planning.

2.1.5 Consideration for sustainability integration into construction

Sustainability integration into construction decisions is significant for affordable housing delivery, community development, economic attainment of the poor, poverty reduction and well-being of the poor (Habitat U.N., 2012; Okafor, 1988; Adebayo & Adebayo, 2001). Most African nations, though, are challenged with insufficient construction decisions toward community settlement and affordable housing delivery (Akadiri *et al.,* 2012).

Unsustainable policy decisions on housing delivery by African governments contribute immensely toward incompetence of the contractors in affordable housing delivery (Olotuah, 2000). Ademiluyi (2010) explains that policy formulation by African governments has failed to address challenges in construction production processes, challenges which include low capacity, inadequate experience of workforce, weak financial basis, inadequate opportunities, financial mismanagement, lack of subsistence, lack of professional development, poor working environment, low productivity, low quality delivery and poor technology improvement. Likewise, Osmani and Reilly (2009) explain that decisions taken regarding sustainable housing delivery at the start of each production process are inadequate, resulting in poverty, unemployment and stunted economic growth.

By the same token, the major problem for comfortable human settlement arises through inadequate policies by government toward housing delivery (Olotuah & Bobadoye, 2009). Government policies on people's participation in housing delivery are major stumbling blocks toward development. Since people are usually not afforded the privilege of choosing between renting and home ownership, and accommodation is exceedingly difficult to find, accessibility of housing remains challenging (Aribigbola, 2008). Adequate decision taken by construction operators on sustainable housing delivery at the initiating stage is essential toward housing accessibility (Olayiwola *et al.,* 2005). Ikejiofor (1999) argues that construction operators should consider effective decisions at early planning stages of housing production processes to enhance living conditions of the poor. Yakub and Salawu (2012) concur that adequate decisions taken on sustainable housing delivery by construction operators at the initiating and planning stages will enhance living conditions of the poor through better access to basic services, health care and safety.

2.1.5.1 Decision taken on sustainable housing delivery

Fundamental steps and principles must be considered at each stage of the housing production process when taking decisions on sustainable housing delivery (Oyenkachi, 2014). Basic approaches toward sustainable housing delivery include identification of sustainable housing delivery problems, visions and clear objectives of sustainable housing delivery, planning for sustainable housing delivery, implementation of sustainable decisions and financial plans for sustainable housing (Declaration Rio Conference, 1992).

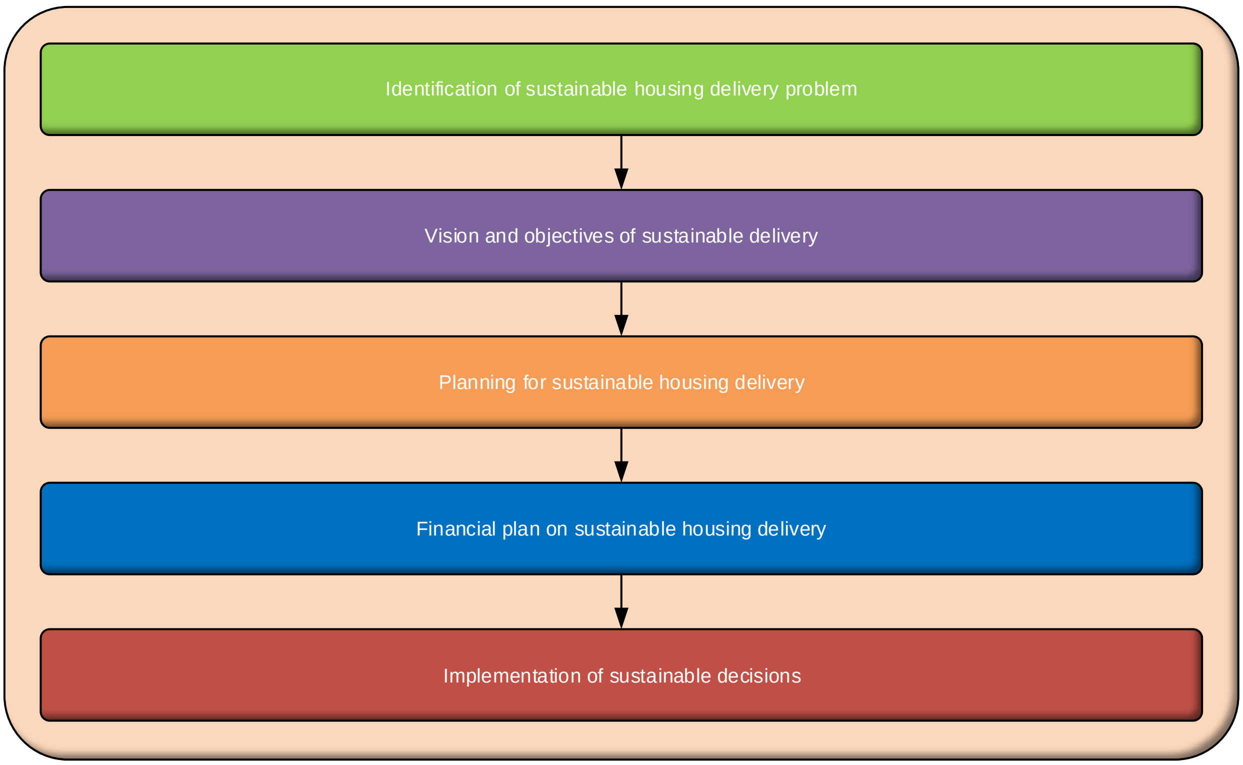

Figure 2.1: Basic approach toward sustainable housing delivery

Figure 2.1[1] indicates basic approaches toward sustainable housing delivery, as follows:

- identification of sustainable housing delivery problem;
- vision and objectives of sustainable housing delivery;
- planning for sustainable housing delivery;

---

[1] Diagram in Figure 2.1 adapted from Akinyede (2017)

- financial plan for sustainable housing delivery; and
- implementation of sustainable decisions.

2.1.5.2 Identification of sustainable housing delivery problems

Challenges in sustainable housing delivery must be adequately stated at the initiating stage for an effective production process (Adedeji, 2012). Therefore, the challenges must be identified and adequately solved at *every stage* of the production process, used as a guide by construction operators during production toward achieving affordable housing delivery for the poor (Adebayo 2002). Hence, the problem statement must address these economic, social and environmental challenges of people (Declaration Rio Conference, 1992).

2.1.5.3 Vision and objective of sustainable housing delivery

Habitat U.N. (2012) also agrees that vision and objectives of sustainable housing delivery must be clearly defined at the initiating stage of a housing production process; this will enhance the efficiency of construction operators. Construction operators should be fully aware of the facts that define the objectives, with a clear emphasis on viable schemes that contribute to an improved economy for the poor, improved social interaction among people and improved environmental development of people, all essential for planning (Billson, 2010; Basiago, 1998). Clearly, all three of these factors must be acknowledged by construction stakeholders at *every* stage of a housing production process (Gibson, 2006; Habitat, U.N., 2012).

2.1.5.4 Planning for sustainable housing delivery

The concept of sustainable housing planning and development is based on several requirements: contractors and construction operators should consider requirements of the poor at the initial stage of sustainable housing planning; and they must monitor the implementation process at each phase of the production process (Cohen, 2006). Additionally, contractors should consider the basic needs of both the present and future generation toward housing production processes, so that there *will* be future and present job creation, access to water and safe health facilities (Gibson, 2006; Cohen, 2006). Hence, a major consideration for sustainable housing planning is for people development. Consideration must be given to the improvement of quality of life, including access to social services, and cultural and medical care (Declaration Rio Conference, 1992).

2.1.5.5 Financial plan on sustainable housing delivery

Affordable housing development and delivery are notable problems affecting both developed and developing nations globally (Gan & Hill, 2000). Consequently, most construction companies deliver housing at high construction costs way above the budgeted cost for production presenting a challenge to the poor for accessing affordable housing (Mulliner *et al.,* 2013). To achieve sustainable housing delivery for the poor, there is an urgent requirement for adequate and targeted financial planning and recognition of people's actual needs in terms of economic and social development (Hashim, 2010). Then sustainable housing production processes will be achieved within the acceptable corridor of cost effectiveness, effective technology and construction systems (Gan & Hill, 2009).

Efficient financial plans derived from construction stakeholders and operators during sustainable housing production processes will significantly aid quality housing delivery, job creation, economic attainment, people's well-being and social interaction amongst communities (Sullivan & Ward, 2012). Maliene and Malys (2009) expound, again, that inadequate decisions taken in regard to financial plans by construction stakeholders during sustainable housing production processes will result in severe social and economic challenges for the poor.

2.1.5.6 Implementation of sustainable decisions

To Gordillo and Harmandez (2006), implementation of decisions on sustainable housing delivery should include the development of living space from the concepts of environmental, technological and social dimensions. Likewise, Goebel (2007) explains that theoretical and practical references must be obtained related to technological, economic, environmental and social aspects of urban housing policy for sustainable housing construction. Winston (2010), too, expounds that implementation of decisions taken at the initiating stage of sustainable housing production processes by construction operators are challenged by a lack of shared vision and appreciation for sustainable housing. Correspondingly, Gibson (2008) advises that adequate building regulations are necessary for compliance with building regulations to achieve expertise in green building methods for perceptions of high-density housing, for quality design, and for social regeneration and plentiful resources.

Aribigbola (2008) explains, though, that government policies on housing lack merit for improving the well-being of people; furthermore, most financial institutions assigned the responsibility of financing housing delivery programme are not efficient in their dispositions. Aribigbola (2008) further believes that the African governments must re-define their policies on housing delivery for economic, social and environment enhancement.

2.1.6 Affordable housing delivery policy and effect

The demand for sustainable housing amplifies daily as accessibility to decent housing by the poor, both in developed and developing nations, becomes more and more difficult (Hutchings & Christofferson, 2005). Previously, governments of developing nations have enacted policies for housing which have not adequately cared for people's needs in terms of decent accommodation and sufficient well-being (Habitat U.N., 2012: Yakub & Salawu, 2012). Sengupta's 2006 study identified major challenges regarding effective sustainable housing production processes as antiquated housing policies which include high municipal tax, stamp duties and sanction fees. These policies have both direct and indirect influences on the poor in terms of accessibility of low-cost housing.

Tjandradewi *et al.* (2006) argue for the establishment of national and international partnerships on the exchange of housing programmes, as doing this will enhance efficiency in sustainable housing delivery. Bontenbal (2009) explains that as sustainable housing delivery in urban cities has particular challenges of the decentralization of authority, it is necessary for proper decentralization of authority by urban planners with private sectors, so that poverty, unemployment and economic issues among the poor will be drastically reduced.

According to Lee *et al.* (2008), conservation policies are major concerns regarding housing delivery as most conservation policies have proven ineffective toward sustainable housing delivery for the poor. Instead, there are unintentional policies that promote sustainable housing delivery. Sviam (2003), for example, expounds that policies surrounding low-cost housing delivery toward addressing the issue of housing shortage result in an increase of urban population and consequently escalates unemployment and difficulties of economic development. Thus, the acute housing shortage amongst the poor is responsible for slums and squatter settlements in and around cities.

More than half of all urban populations are living in unplanned settlements (Ahmad & Choi, 2011). Modest planning policy intervention of the government for development has not yielded any benefits for cities, since the majority of the urban population lacks access to efficient transportation, decent housing and quality health facilities. Sriranga (2000) clarifies that land allocation policies in developing countries are ineffective, failing to provide adequate housing for low income earners. Furthermore, Kundu (2004) explains that land security policies for the poor have not been adequately established in developing nations, making life difficult for the poor as the majority of the population in developing nations do not have accessibility to housing.

Research of Sivam (2002) has determined that governments of developing nations do not have adequate policies on land for affordable housing delivery. Therefore, poor people, the largest percentage of the population, cannot afford the high price tag on land and are forced to settle in slums. Government policy in most developing nations has not sufficiently addressed the issue of quantitative and qualitative demand for housing in cities. Subsequently, this challenge forces poor people to settle in urban periphery, inimical to the health of the poor (Ahmad *et al.,* 2013).

2.1.6.1 Sustainable housing delivery challenges

Housing is noted as one of the essential elements in human existence; however, housing remains a notable challenge in African nations (Jiboye, 2010). And African nations recorded the highest numbers of housing deficiencies as compared with other continents. Housing deficiencies continue to increase with high rates of urbanisation and rapid population growth (Jiboye, 2011). In other words, while more people need more homes, homes are not being constructed at a cost people can afford. In addition, inadequate policies from governments affect sustainable housing delivery, leading to high rent, overcrowding and poor living conditions (Mohammed *et al.,* 2015).

More recent housing policies formulated by African governments have not yielded visible positive effects on the life of the poor despite the enormous amount of money spent on housing (Olayiwola *et al.,* 2005). There are, for example, various housing delivery programmes established for sustainable housing for the poor, but these appear to be a merely a mirage for the poor (Amao, 2012). Olusanya (2012) suggests the problem is that the concept of sustainable housing delivery has not been adequately explained by governments to the constructors. The meaning of *sustainable housing delivery* to contractors is excessive profits as a result of high cost of construction in the delivery of housing. But the concept of *sustainability* needs to be adequately explained in policy formation for realistically achieving efficient housing production processes.

According to Olagunju (2014), there is high proportion of housing unit shortfall in African nations as governments simply cannot meet housing needs of the people because of budgetary constraints and other competing needs. Likewise, Jiboye (2011) has determined that the critical challenges to African governments concern making housing adequate and sustainable: the constant rise in population and unstructured size increases of African cities have hitherto led to acute shortages of decent and affordable housing while also exacerbating various other urban problems ranging from overcrowding, deplorable environments, poor living conditions, inadequate infrastructure and homelessness.

The work of Maina (2013) found that public housing delivery in developing countries often involves the provision of housing 'units'; occupants transform such units to suit their interests and changing needs, attempting to improve housing stock. This practice has been the focus of many research studies intending to inform policymakers regarding changing housing development. Ayoola and Omole (2014), for example, conducted a study in which they reaffirmed that housing continues to be a challenge to the poor in African nations: despite the fact that various housing policies have been formulated and implemented in the past, there remains a serious shortage of adequate and affordable housing for the poor, those who constitute a high percentage of the urban population.

Innovation in modern architectural technology will facilitate widespread utilisation of sustainable commercial buildings for social development (Han *et al.,* 2013). Sebti *et al.* (2013) explain that adaptation to harsh climate conditions in African nations, over the recent decades, means that African nations have undergone some changes to their initial urban structures. Accelerated and uncontrolled modern urbanisation has had negative implications, devaluing thermal characteristics and affecting the life of the poor. According to Odediran *et al.* (2013), serviceability and comfortability of housing edifices are functions of its facilities and materials of construction. The degree of quality of facility and material specification determine the level of comfort and well-being of the user.

2.1.6.2 Sustainable settlement and resourcefulness

According to Habitat III (2016), the primary objective of Earth Summit 1992 was to generate new commitments from national governments on global environmental issues. The primary intention of the summit was to focus international attention on the role of cities as central actors in sustainable development, thereby bestowing a specific role on local governments by the United Nations for sustainable development processes (Brugmann, 1996). Rees (1994) explains that human settlements development can be achieved conceptually and practically, in line with political and economic factors, and in the context of the current man-environment dilemma; but to do this, basic ecological realities and prevailing definitions of key concepts are necessary. Bruff and Wood (2000) suggest that sustainable housing development provides the context within which local planning policies are now being prepared and can be esteemed as a potentially important aspect of a central government proposal for modernising local government for human development.

Langeweg (1998) points out that sustainable development and sustainable housing delivery have for a long time been considered the beginning of the implementation of environmental policy, with Agenda 21 leading the way to economic development, social equity and global efficiency, factors considered requirements for sustainable development and human settlements. Kelly and Moles (2002) believe that Agenda 21 stresses the importance of local accountability, interactive citizenship and quality of life. Thus, to achieve effective human settlements at local and provincial levels, sustainable indicators must reflect community values, concerns and hopes for the future.

According to Rotheroe *et al.* (2003), good practices for human settlements and affordable sustainable housing delivery have been constrained, with the economic aspect of sustainability as the critical missing piece in the practice. Sustainable development and human settlement action plans were prepared for cities in developing nations (Rahardjo, 2002). Thus, according to Okon and Ukwayi (2012), it is necessary to bolster an effective system that will involve stakeholders to ensure commitment; such approaches are to safeguard stakeholders and encourage active involvement in decision taking toward achieving effective sustainable development and human settlement.

2.1.7 Sustainable housing production process

Sustainable housing production processes require a strategic design approach to develop sustainable housing, service systems and environmentally friendly innovation (Olagunju, 2014). From this perspective, it is argued that the design competencies should move toward those of the strategic design, introducing the concept of strategic design for sustainability and the design of an innovation strategy, thereby shifting the business focus from designing physical housing only, to designing an entire *system* of affordable housing delivery and services (Iwaro & Mwasha, 2013). This *system* would be jointly capable of fulfilling specific client demand, while re-orienting current unsustainable trends in production and consumption practices (Manzini & Vezzoli, 2003).

According to Pulselli *et al.* (2007), sustainable housing delivery involves integration of design practices based on the definition of *green housing* and criteria for a common method of standard measurement. The green building rating systems – such as LEED and BREAM – provide national standards for developing high-performance sustainable housing. However, integrated environmental accounting methods and global sustainable indicators are still needed to evaluate the general environmental performance of a building (Campbell, 1996). Housing is substantially challenged by global environmental problems such as the use of non-renewable energy, the over-exploitation of materials, the exhaustion of resources and the wasting of energy. These challenges must be thoroughly and adequately addressed during sustainable housing production processes (Kwon *et al.,* 2011).

The work of Hart (1997) identifies several major challenges to sustainability, which include greenhouse gases, use of toxic materials, contaminated sites, scarcity of materials, insufficient reuse and recycling, urban majority unemployment, industry emissions, contaminated water, lack of sewage treatment, overexploitation of renewable resources, and misuse of water for irrigation. These challenges must be adequately addressed during sustainable housing production processes to achieve effective delivery of affordable sustainable housing (Oyebanji *et al.,* 2017).

According to Seyfang (2010), sustainable housing delivery can *only* be achieved through grassroots innovations involving community-led initiatives for sustainable development of strategic green niches with the potential for wider transformation of mainstream society. Thus, involvement of community for sustainable housing delivery initiatives during production will enhance economic development, social interactions and sustainable environment (Patel, 2016). According to Priemus (2005), sustainable housing production processes should involve social cohesion, community sustainability, citizen participation and lifestyle improvement.

Sustainable housing delivery should be considered as an improvement to people's well-being and happiness (Oyebanji *et al.,* 2017). The construction industry has been challenged with the concept of increased productivity, efficiency, infrastructure value, quality and sustainability, as well as reduced life cycle costs and duplication of communication among stakeholders during housing production process (Priemus, 2005). These identified challenges must be integrated into sustainable housing delivery during the production process to attain improved efficiency in housing delivery (Arayici *et al.,* 2012; Nour, 2007).

The work of Arayici *et al.* (2012) has determined that the building information modelling (BIM) approach will enhance sustainable housing delivery since it involves socio-technical matters. Adoption of BIM into housing production processes will incorporate people in the process with technology equally (Azhar *et al.,* 2008). Hence, sustainable housing production processes and depletion is an issue for international concern. As sustainable production strategies need different approaches, various concepts have arisen in recent decades to address economic, social and environmental problems, such as economic development production, cleaner production, cleaner technology, waste minimisation and recycling, eco-design and designs for sustainability (Bartlett & Howard, 2000). Still, a new strategy is required to stimulate the change in current production and consumption patterns and develop more efficient production plans toward achieving affordable housing for the poor (Monts, 2002).

2.1.7.1 Sustainability consideration on environmental resources

Bugaje (2008) informs that the construction industry and its production processes have been accused of exacerbating numerous environmental problems ranging from excessive consumption of global resources in terms of construction and building operation, to pollution of the surrounding environment resulting in environmental degradation. Research on green building materials to minimise detrimental environmental impact is already underway for implementation (Burnett, 2007). Still, dependent on the design of a housing project to achieve sustainable development, these practices are not sufficiently handled for sustainability (Ding, 2008).

According to Ding (2008), the goal of sustainability evaluation on environmental resources goes ever further at the design stage of housing project as it is important to consider at an early stage, prior to any detailed design or even before a commitment is made to go ahead with development. Yet unfortunately, little or no concern has been given to the significance of selecting a more environmentally friendly design that focuses on the use of sustainable materials at the initiating stage, the stage when environmental materials are best incorporated into housing production process (Boswell & Walker, 2004).

Ekins *et al.* (2003) suggests the need to develop a classification of critical natural capital and their corresponding functions so that the term *environmental sustainability* can be more clearly defined during housing production processes, and in operational terms, than is often currently the case. Classification would permit the pragmatic determination of social and economic implications of prioritising environmental sustainability in policy making on housing production processes, through investigating precisely how economic and social options are constrained if critical environmental functions are sustained (Crawley & Aho, 1999).

According to Bugaje (2006), renewable energy usage in African nations is challenged. The various national energy policies of African nations require attention to achieve sustainability. Moreover, the excessive usage of wood as fuel is already creating a considerable environmental problem, especially in the northern regions of Africa. While Iwaro *et al.* (2013) explain that African nations have the potential to solve these energy problems if appropriate infrastructural support can be provided for harnessing the abundant renewable resources in the continent, to do so skill and experience must be pooled together in addressing this and other key issues.

Foster (1985) explains that the United Nations on environmental development should endeavour to employ Marshall Information that will involve intellectual, political and organisational resources, tapping into these to achieve the objective of natural conservation. Dyllick and Hockerts (2002) clarify that effective resource usage can be achieved during production processes through six criteria: sustainability eco-efficiency, socio-efficiency, eco-effectiveness, social effectiveness, sufficiency and ecological.

According to Okon and Ukwayi (2012), as the building sector recognises the impact of construction activities on the environment, a change is necessary to mitigate the environmental impact of the building sector. The building sector, therefore, should decide to focus on *how* to achieve sustainable design for effective use of environmental resources for sustainable housing delivery (Priemus, 2005). One of the drivers of sustainable design is public policy and growing market demand for environmentally sound products and services. The primary aim of the change in practices by the building sector is to reduce environmental impact and environmental performance (Haapio & Viitaniemi, 2008; Torcellini & Crawley, 2006). The provision of effective construction resource usage will enhance environmental and building construction performance (Cole, 2005).

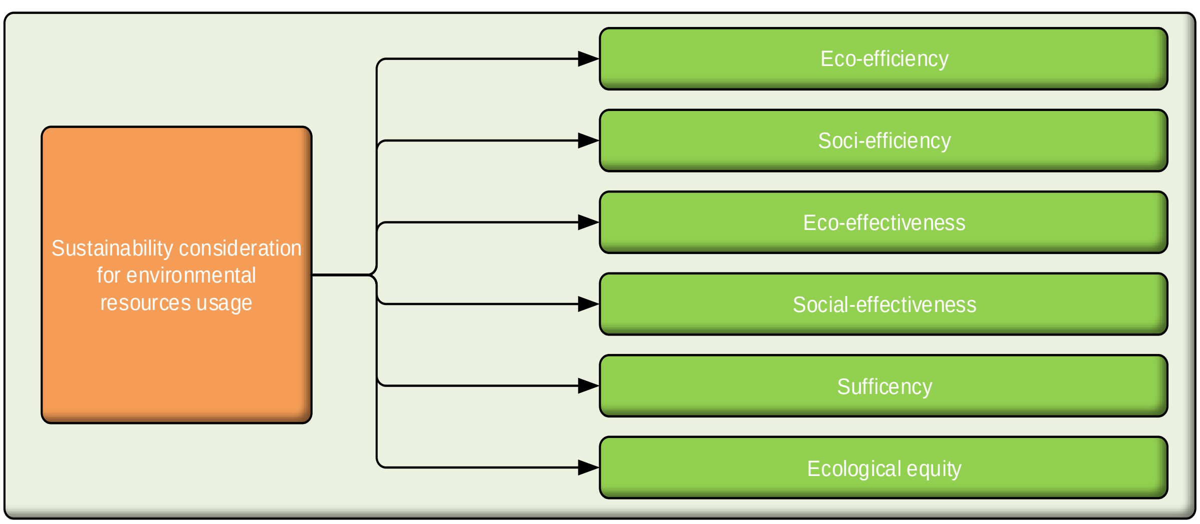

Figure 2.2: Concept of classification of effective criteria for resources usage during production

Environmental degradation has long been a serious consequence of human activities and one clear impact of housing production processes (Cole, 2005). These effects have historically been on a local scale, visible to the community. The present environmental challenges are now *global* in scale and generational in magnitude and remediation (Crawley & Aho, 1999). This magnification of this environmental problem requires different qualitative approaches to address the situation. Adequate policy formulation *can be* a solution, if law is enforced, as it has historically been viewed as the most appropriate means of combating acute localised environmental transgression, particularly if sufficient information is available to formulate workable regulation, setting targets and measurements for effectiveness (Cole, 2003). Figure 2.2[2] above indicates the concept of classification of effective criteria for resource usage during production to achieve sustainable housing delivery.

2.1.7.2 Sustainable construction team during production process

According to Robichaud and Anantatmula (2010), sustainable building construction experienced significant growth between 2000 and 2010. Hence, communities are becoming increasingly aware of the benefits of sustainable construction, especially as well-known dignitaries – including documentarians, politicians, celebrities and journalists – draw attention to the built environment's impact on greenhouse gas emissions and natural resource consumption. Factors receiving attention include cost of building materials, higher energy prices and regulatory incentives, further thrusting the sustainable housing market into growth and expansion (Dada & Oladokun, 2008). Nonetheless, obstacles to sustainable housing continue to assert themselves, including the incapability to deliver sustainable housing within acceptable constraints. The burden is on project teams to establish effective project management processes for the successful delivery of affordable housing within a client's budget (Davila & Wouters, 2005).

Sustainable housing delivery has been a major concern in both developed and developing nations, as the majority of the world's population are challenged with housing quality leaving many people homeless (Iheme, 2015). With heightened awareness of environmental pollution, natural resource depletion and the accompanying social problems, concern for sustainable development and sustainable construction has magnified throughout the world. The construction of housing

[2] Diagram in Figure 2.2 adapted from Akinyede (2017)

consumes large amounts of natural resources, contributing immensely to the emission of CO_2 gasses (Habitat U.N, 2012).

Due to emerging facts surrounding natural resource depletion, United Nations Habitat has enlightened government and relevant institutions on improving conservation and sustainability of natural resources. Steps for sustainability of natural resources include shortened construction times, lower overall construction cost, improved quality, enhanced durability, better architectural appearance and enhanced occupational health (Kwon *et al.,* 2011). Also worthy of consideration are safety, material conservation, less construction site waste, fewer environmental emissions, reduction of energy and reduction of water consumption. These identified factors, if adequately addressed, will enhance the effectiveness of sustainable housing delivery with less environmental impact and fewer detrimental effects on people (Chen *et al.,* 2010).

PMBOK (2008) explained that collaboration amongst construction stakeholders during the production process is significant toward sustainable housing delivery, indispensable for the reduction in cost of construction. Hence, teamwork enhances effective communication, quality assurance and trust among construction operatives. Akintoye *et al.* (2000) clarify that collaborative agreement between the contractor, suppliers and clients will enhance effective housing production processes. Similarly, Bakar *et al.* (2010) suggest that teamwork will overcome barriers to the success of housing delivery such as workplace culture, lack of senior management commitment, inappropriate support structure and frequent conflicts on site.

A sustainable construction team is the conglomeration of sustainable housing construction experts at the initiating stage of production (Doppelt, 2009). At this stage, sustainable construction experts are selected and referred to as a *sustainable construction team*; the responsibility vested on this sustainable construction team is sustainability integration into constructability and architectural design (Duncan, 1996). Effective decisions taken on constructability and architectural design will thereby significantly enhance sustainable dimensions (economic, social and environment) and consequently improve sustainable housing delivery for the poor (Hill & Bowen, 1997).

Chan *et al.* (2010) mention seven latent factors that the construction team should apply toward effective production for sustainable housing delivery: 1) long-term cost; 2) constructability; 3) quality; 4) first cost; 5) impact on health and community; 6) architectural impact; and 7) environmental impact. These seven latent factors of sustainable construction methods are discussed as follows.

2.1.7.3 Long-term cost

Chan *et al.* (2010) explain that a sustainable construction team should consider the long-term cost of sustainable housing delivery at the initiating stage of a housing production process. Likewise, Jailoon and Poon (2008) claim that the criteria for long-term cost – life cycle cost, speed return on economic investment, durability, environmental loading capacity and maintenance costs – must be adequately considered at the initiating stage of housing production processes toward affordable housing delivery for the poor.

2.1.7.4 Constructability

Song *et al.* (2005) explain that a sustainable construction team has a vested responsibility to consider constructability toward sustainable housing delivery; *constructability,* defined in terms of buildability, integration of building services, construction time and lead-time, can be used to further define the efficient use of construction resources, the safety of a construction site and the requirements of the client (Chan *et al.,* 2010).

2.1.7.5 Quality consideration

Chan *et al.* (2010) clarify that *quality* is a significant factor toward sustainable housing delivery. Sustainable construction teams should evaluate quality during housing production processes as a means of reduction in disposal costs of construction waste, and reduction in costs due to defects and damages. As disposal costs are strongly linked with quality, quality must be adequately considered when selecting construction methods during a housing production process (Luo *et al.,* 2008).

2.1.7.6 First cost consideration

According to Tam *et al.* (2007), sustainable construction teams should consider the *first costs* – such as material cost, transportation cost and labour cost – toward sustainable housing delivery for selection of construction methods during the production process. Similarly, Chan *et al.* (2010) clarify that first cost consideration is essential toward housing delivery within the budget specified at the initiating stage of production process. As cost has been a traditional project driver when selecting construction methods, adequate consideration must be afforded to the first cost at *every* stage of the production process to reduce costs of housing delivery.

2.1.7.7 Impact of construction on health and community consideration

According to Nelms *et al.* (2007), a sustainable construction team should consider the impact of construction activities on health and the community when selecting construction methods during housing production processes. Construction teams should be conscious of worker health and safety, traffic congestion, occupant health, labour availability and community disturbances. It is essential that any selected construction methods have minimal negative impact on workers, on potential occupants and even on the surroundings (Chan *et al.,* 2010).

2.1.7.8 Architectural impact consideration

Chan *et al.* (2010) claim that it is of paramount importance that a sustainable construction team should consider the aesthetics of housing design for effective architectural design impact toward selection of construction methods at the initiating stage of a housing production. The growing demand for housing and comfort of the potential occupier necessitate designs for sustainable housing within the reach of the poor (Blismas *et al.,* 2008).

2.1.7.9 Environmental impact consideration

Declaration R (1992) explains that environmental degradation occurs through materials, energy consumption, waste, site disruption and pollution. A responsible sustainable construction team must be cognizant of the challenges of environmental impact in their decisions at the initiating stage of housing production, which include emission of gasses, global warming and scarcity of natural resources.

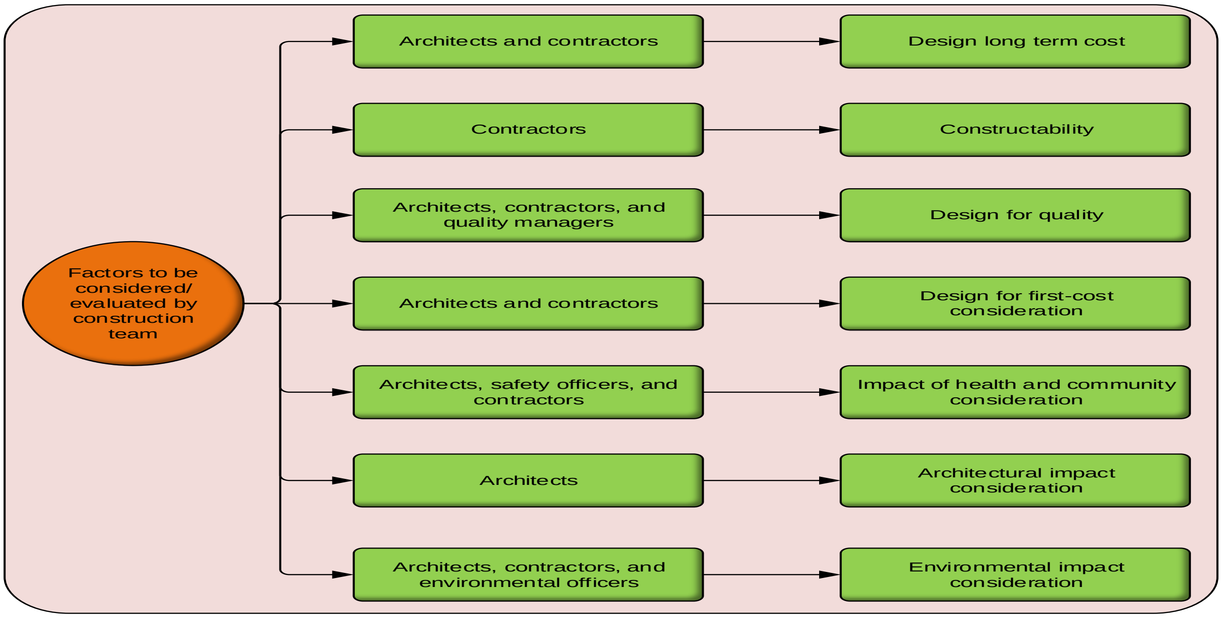

Figure 2.3: Foremost factors to be evaluated by construction teams for sustainable housing delivery during production processes

As environmental impact of housing production processes is significant toward the selection of construction methods, this action will augment sustainability of the construction environment during the production process (Goodier & Gibb, 2007; Chan *et al.,* 2010). Thus, in efforts to achieve sustainable housing delivery, Figure 2.3[3] above displays the foremost factors to be evaluated by construction teams for sustainable housing delivery during production processes.

2.1.8 Design issues for affordable housing

Iwaro and Mwasha (2013), agreeing that *adequate design* concerns the aesthetics of a building, suggest that successful integration of adequate design into a building production process requires careful insight for potential conflicting goals among the stakeholders for sustainable housing delivery at its earliest stages. This will, they believe, enhance delivery of sustainable housing at budgeted cost. Kwon and Kwak (2011), though, suggest that high performance of sustainable housing requires adequate designs that have clear objectives and a balanced integrated approach for achieving sustainable housing which is cost effective, safe, secure, accessible, functional, productive, historic and aesthetically pleasing (Iwaro & Mwasha, 2013).

---

[3] Diagram in Figure 2.3 adapted from Akinyede (2017)

Planning at the design stage involves plans for the component of building materials to be used during production for achieving delivery of affordable housing (WBDG National Institute of Building Science, 2014). Jong-jin Kim (1998) claims that applying sustainable housing practices is the easiest way of incorporating sustainable design principles in a production process. To achieve sustainable housing, a designer should design for better performance in *every* aspect of the sustainable housing production. Sustainable design for better performance enhances efficiency in resource usage; is affordable to erect, maintain and operate; and provides the comfortability needed by the occupant (Conte & Mono, 2011).

2.1.8.1 Sustainable design during housing production process

Roy (2000) states that with the growing awareness of environmental issues – from global climate change to problematic local waste disposal – the government has come under increasing pressure to reduce the environmental impact involved in the production of sustainable affordable housing and consumption of goods and services. To that end, Lehmann (2006) suggests that a response to the environmental problem will involve measures to reduce pollution and eliminate waste after their generation. The concept of sustainable product-services systems has emerged, distinct from the ideas of cleaner production, eco-design and design for the environment. This concept goes beyond the environmental optimisation of product and process and required radical and creative thinking to reduce environmental impact factors (Conte & Mono, 2011). Evidently, a sustainable product-service system attempts to create the design that is sustainable in terms of environmental burden and resource use whilst developing product concepts as part of complete sustainable systems that provides a service or function to meet essential needs (Iwaro & Mwasha, 2013).

Morelli (2006) reveals that the construction industry and industrial production are evolving toward models that more adequately address an epochal shift from mass consumption to individual behaviours and highly personalised needs. Such an evolution is facilitated by rethinking construction production processes. The role of the designer is, therefore, essential to the definition of effective and attractive design of sustainable housing delivery. Designers are now urged to find their own methodological approach to the design of product services systems. Similarly, Mont (2002) explains that sustainable housing production and consumption is an issue of current international concern although numerous approaches have been considered and concepts developed in recent years to address environmental problems such as cleaner production, cleaner technology, waste minimisation and recycling, eco-design and design for sustainability.

However, a new strategy is called for, one to stimulate the change in current production and consumption patterns through the adoption of sustainable design. Correspondingly, Aurich (2006) explains that technical services such as maintenance retrofitting, refurbishing or user training can significantly influence the economic and ecologic performance of high-quality sustainable housing production processes.

2.1.9 Construction wastes management and cost implication

Waste generated by the construction production and demolition processes has been a major challenge to the construction industry, environment and the community at large (Begum *et al.,* 2009). Effective waste management is significant for sustainability in term of waste reduction, reuse, and recycling; clearly, adequate monitoring and implementation in developing nations is needed (Lauritzen, 1992). In fact, the opposite – inadequate waste management – has a sizeable effect on the cost of construction. Waste is one of those factors that is responsible for the high cost of construction in the delivery of housing, through the cost of disposal of waste and costs of recycling waste (Lauritzen, 1998).

Again, the management and control of waste generated by construction activities have posed substantial challenges for modern society (Lauritzen & Hahn, 1992). Because of the scarcity of disposal sites and limitation of natural resources, recycling of construction and demolition waste has attracted considerable attention (Lauritzen, 1998). Waste generated in developing nations annually through construction production and demolition processes is enormous compared with the waste of developed nations (Kofoworola & Gheewala, 2009). A greater portion of waste disposed of in developing nations goes into landfills and open dump sites. Construction waste constitutes a major source of waste in terms of volume and weight, but its management and recycling are yet to be effectively implemented in developing nations (Begum *et al.,* 2009). In recent years, insignificant attention has been given to the management of construction waste, despite its detrimental impact on the environment and people's health (Lauritzen, 1998). If recycling is adequately promoted in developing nations, and subsequently implemented, more jobs will be available for the poor (Kofoworola & Gheewala, 2009).

Construction and demolition produce waste, and new construction and renovation produce waste in fairly equal amounts. Most developing nations dispose of their waste in a landfill (Chan-Li *et al.,* 1994). It was only recently that recognition was given to the integration of recycling and for diversion of waste components from the landfill to recycling plants (Lauritzen, 1998). The few recycling plants functioning in developing nations have generated job opportunities for the poor (Kofoworola & Gheewala, 2009).

As the construction industry has been identified as a major generator of waste, waste minimisation strategies are essential for reducing the cost of construction (Faniran & Cabin, 1998). Nevertheless, the construction industry in developing nations has unfortunately not applied adequate policies toward reduction of waste generated during housing production processes. This lack of adequate policy has created a scenario leading to delivery of housing at high construction cost during production processes (Begum *et al.,* 2009).

According to Faniran and Caban (1998), sources of waste in the construction industry include design changes; leftover material scraps; waste from packaging; non-reclaimable consumables; design/detailing errors; and inclement weather. Waste generated can be reduced if the source of generation of the waste can be minimised, but adequate attention must be given to the source of waste generation during housing production. In doing this, the cost of construction will be reduced. Begum *et al.* (2009) explain that effective waste minimisation strategies can be developed for housing production processes on site if inventory is taken for all waste streams, identifying the sources of waste streams, and determining the quantities and composition of the waste streams. The sources of waste can then be grouped by the cost of storage, disposal, economic value and treatment. This is necessary to ascertain the cost that will feed into waste management during housing production processes. Determining the cost of waste is significant to cost effectiveness of affordable housing delivery (Kofoworola & Gheewala, 2009; Rao & Misra, 2007).

Waste generated during housing production is a challenge toward sustainable housing delivery as it contributes to delivery of housing above budget. Therefore, sustainable waste management encourages the generation of less waste, the reuse of waste, the recycling of waste and recovery of waste (Yahya & Halim Boussabaine, 2006). *Waste* is defined as conscious and unconscious losses resulting from activities that generate direct and indirect cost without adding any value to the product. Construction operators should be conscious of the fact that cost reduction can be achieved by intentionally preventing the generation of construction waste during housing production processes (Formoso *et al.,* 1999). According to Yahya and Halim Boussabaine (2006), waste generated by a housing production process requires instantaneous waste management strategies for formulating an eco-management decision to deal with environmental impact associated with these wastes. The eco-management decision should be a target to encourage construction industry stakeholders to control environmental impact and reduce such impacts unceasingly. One of the most important elements of eco-management is the eco-costing of environmental impacts. Eco-costing is costs that take into account the direct and indirect environmental impact of cost generated from use of resources (Rao & Misra, 2007).

2.1.9.1 Cost in relationship to time, scope and quality in sustainable construction

The construction industry and its production processes are dynamic and pragmatic in nature; nevertheless, the concept of *housing delivery success* has remained confusingly defined in the construction industry. Housing delivery success is the ultimate goal for every housing production process (Windapo *et al.,* 2017), but *success* means different things to different stakeholders and construction operators. For example, researchers consider time, cost and quality as predominant criteria. While success in the construction industry hinges on a time, cost and quality relationship, the ability to manage this triple constraint relationship and the handling of construction resources determines the success of housing delivery (Akinmoladun & Oluwoye, 2007; Chan & Chan, 2004).

Memon *et al.* (2010) explain that one of the major challenges prohibiting sustainable housing delivery is inefficiency in the handling of construction resources in reference to the relationship between time, cost and quality during the housing production process. To achieve sustainable housing delivery, stakeholders and construction operators should ensure that construction resources are delivered at time and cost specified and that the quality of the construction resources matches with the stated requirements (Omoregie & Radford, 2006).

Sustainable housing delivery and production processes are the most poorly known aspects of management. Delays and cost overruns are the rules rather than the exceptions in construction: housing production processes suffer from seemingly endless challenges of costing and scheduling. Cost overruns of 100 to 200% are common before a housing project can be delivered, making sustainable housing delivery extremely difficult (Sterman, 1992). Bryde *et al.* (2013) argue that stakeholders must adequately establish the criterion of managing time, cost and quality at the initiating stage of the housing production process. The criterions are time reduction from the time specified, or accomplishing timely completion of the housing project. Criterions for cost management include cost reduction, effective planning, estimating, budgeting and containing costs of the production process in best efforts to accomplish affordable housing delivery within budget (Atkinson, 1999). The quality criterion during housing production involve a quality increase, effective quality planning, quality assurance and quality control (Sterman, 1992).

To achieve effective delivery of affordable housing, the relationship between construction constraints must be effectively established during the housing production process (Windapo *et al.,* 2017). Two techniques to be applied toward affordable sustainable housing delivery are constrained resource scheduling (resource allocation) and resource levelling (resource smoothing) (Hegazy, 1993). According to Moselhi and Lorterapong (1993), *constrained resource* is an attempt to reschedule the housing production process so that a limited number of resources can be utilised efficiently while keeping the unavoidable extension of housing delivery time to a minimum. Alternatively, *resource levelling* is an attempt to reduce the sharp variation in resource usage during production while maintaining the original time specified for housing delivery. The practice of these techniques by construction stakeholders will enhance sustainable housing delivery within budget.

2.1.9.2 Cost and construction resources relationship for sustainable housing delivery

Most researchers agree: sustainable housing delivery is challenged by inefficiency of management of the relationship between cost and construction resources during housing production processes (Ajiboye, 2012). The success of any housing production process depends entirely on how proper and effective the management of construction resources flow. Numerous researchers have determined that various resource factors affecting cost management result in delivery of housing above the budgeted cost specified (Rahman *et al.,* 2013).

According to Walker and Kwong Wing (1999), affordable housing delivery is challenged with transaction costs and production costs because these two are intertwined, not separated from one another, at the planning stage of a housing production process. The sole responsibility of the client and manager is to separate production from transaction cost, thereby rendering it difficult for the client to actually know the specific amount of money going into the housing production process. Ayoola and Omole (2014) state that to achieve an effective housing production process, the client needs to consider the internal cost in setting up a housing production process, including the cost of human resources such as consultants and other advisors. If costs are distinguished separately, more cost effectiveness will be achieved.

Potty, Irdus and Ramanathan (2011) explain that the current trend of *design and build* (D&B) has gained popularity within the construction industry due to its attractive financial aspect. However, many of these design and build housing projects have ended in the hands of contractors unable to proceed with delivery of housing within the time and cost specified. According to Aribigbola

(2008), the major reasons for housing to be delivered above the budget specified is that housing production processes frequently begin without a worthwhile investigation to ascertain the risks involved. Likewise, Atkinson (1999) concurs that contractors are engaged in housing production processes without basic judgment, risk awareness and adequate experience in a housing production process. If risk of time, cost overrun, and human and material safety are not adequately considered at the planning stage of a housing production process, this fosters a critical situation responsible for delivery of housing at construction costs above budget (Clark & Herrmann, 2004).

2.2 Management issues for affordable housing

Sustainable construction management is a programme designed for building production, organising and supervising small and large infrastructure projects, which include designing, material management, budgeting, scheduling and management of safety procedures (Bakar, 2010). Construction management is carried out in such a way as to minimise the impact of the process on the economy, environment and social factors, while exploiting the energy efficiency within the environment (Carter & Fortune, 2007). Similarly, Cole (2005) explains that practices of sustainability management during building production processes requires working under major headings: namely, design in the efficient usage of the budgeted cost, adhering to construction rules and regulations, lifetime use, delivery within the stipulated time, and easily demolished and recycled for another production.

At every stage of construction, stakeholders are to be committed to the careful use of resources and to reducing the negative impact of waste and pollution emitted by housing (Burnett, 2007). Therefore, *sustainable construction* refers to both the structure and the process; the efficient management of sustainable housing production processes will aid in achieving a structure that is more environmentally reliable during the entire life cycle of the housing (Akinmoladun & Oluwoye, 2007). Ukoje and Kanu (2014) clarify that a housing production process occurs in stages that can be referred to as *life cycle stages*: 1) site selection; 2) initiating; 3) planning; 4) design; 5) procurement of competent contractor; 6) construction; 7) operation and maintenance; and finally 8) renovation and demolition. Objectives of sustainable housing are achieved by adopting an efficient management procedure, optimising each phase of the project delivery process for sustainable housing delivery at the budget specified (Akinmoladun & Oluwoye, 2007).

Sustainable construction management involves giving equal consideration to economic, environmental and social factors in a local, regional and global setting by assuming responsibility for protecting the present and future generation's interest in accessing natural resources (Habitat U.N., 2012; Ademiluyi, 2010). Adequate management during production will enhance asset management and resource efficiency. Therefore, sustainable housing has higher expectations regarding the reliability of the housing and availability of the production assets, and enhanced desire to reduce construction costs without affecting the quality, maintenance cost and operating cost, while simultaneously reducing the expenditure on workforce, materials and energy (Davila & Wouters, 2005). Sustainable housing – referred to as an *energy efficient building*, *health building*, *ecological building,* and *green building* – can be achieved through efficient management of sustainable design, construction resources and construction cost (Xin & Rong, 2004). However, quality management standards must be established during a building production process to enhance sustainable housing delivery; this must be established at the planning stage and fully implemented at each construction stage by considering the economic implications (Fajana, 2011; Flores-Colen & de Brito, 2010).

2.2.1 Site management techniques toward sustainable housing delivery (PMBOK)

Effective management techniques for sustainable housing delivery are drastically needed for the recognition of the relevant energy, materials and construction constraints (Hassan, 2010; Hart, 2010). Most renewable energies generated by water, sun, wind, modern biomass, tides or thermals are enlarging significantly based on the potential for improving societies and quality of life, supporting poverty reduction and increasing sustainable housing development (Hill & Bowen, 1997). Accordingly, renewable energy is significant to sustainable housing delivery, an energy that is primarily generated by large hydropower generation projects that supply most of the renewable energy consumed by housing in developing nations (Hwang & Ng, 2013). This demands a proper construction performance in the areas of planning and management to deliver the energy and sustainable housing in accordance with specifications while respecting environmental and social concerns. This requires strict observance of sustainable construction guidelines (Jenkins, 2010). But a sustainable housing production process is complex and demanding and frequently faces time and cost overrun that impinges on initial planning and consequently on society at large (Pietrosemoli & Monroy, 2013).

Sustainable housing development enhances the quality of life, thereby allowing people to live in a healthy environment, improving social, economic, and environmental conditions for preservation of natural resources for the present and future generations (Ikerd, 1997). Brundtland (1985) World Commission on Environment and Development (WCED) determined that while sustainable housing development has gained much attention in all nations, urgent attention is still required in the area of management for efficient affordable sustainable housing delivery (Ortiz *et al.,* 2009). In the construction industry, both design and management processes differ significantly from one to another. The construction industry needs to harmonise construction systems and practical techniques that combine design *with* management toward affordable housing delivery (Demaid & Quintas, 2006).

Effective management of design, construction and resources is vital since sustainable design and construction are gaining significant momentum in the construction industry toward sustainable housing delivery (Shi & Chew, 2012). Yu and Yang (2016) reveal that the since the construction industry is one of the main pillars of the economic boom of so many countries, knowledge management in the construction industry is essential toward sustainable housing delivery relative to cost, time and quality, while also bringing in productivity improvements.

2.2.2 Project management knowledge area

A competent project manager is integral to sustainable housing delivery success. Despite the fact that many researchers have conducted studies pertaining to the competency of project managers, only a few researchers have done so in the specific context of sustainable housing delivery (Ihuah & Eaton, 2013). Hence, it is necessary to identify challenges confronting the project managers who execute sustainable housing production processes to determine the critical knowledge areas and skills required to respond competently and intelligently to such challenges (Jiboye, 2011). The identification of these particular challenges will establish a knowledge base for project managers, increasing their competitive advantage and their ability to effectively execute sustainable housing delivery (Hwang & Ng, 2013).

According to Hwang and Ng (2013), competencies of project managers on sustainable housing delivery should include competence toward success, adequate identification of critical challenges, adequate identification of knowledge areas and skills required, and adequate provision of a knowledge base. A construction manager needs project management knowledge areas because ten key competencies are required for sustainable housing delivery, as follows:

1) cost management;
2) time management;
3) quality management;

4) human resources management;

5) scope management;

6) communication management;

7) risk management;

8) procurement management;

9) integration management; and

10) stakeholder management.

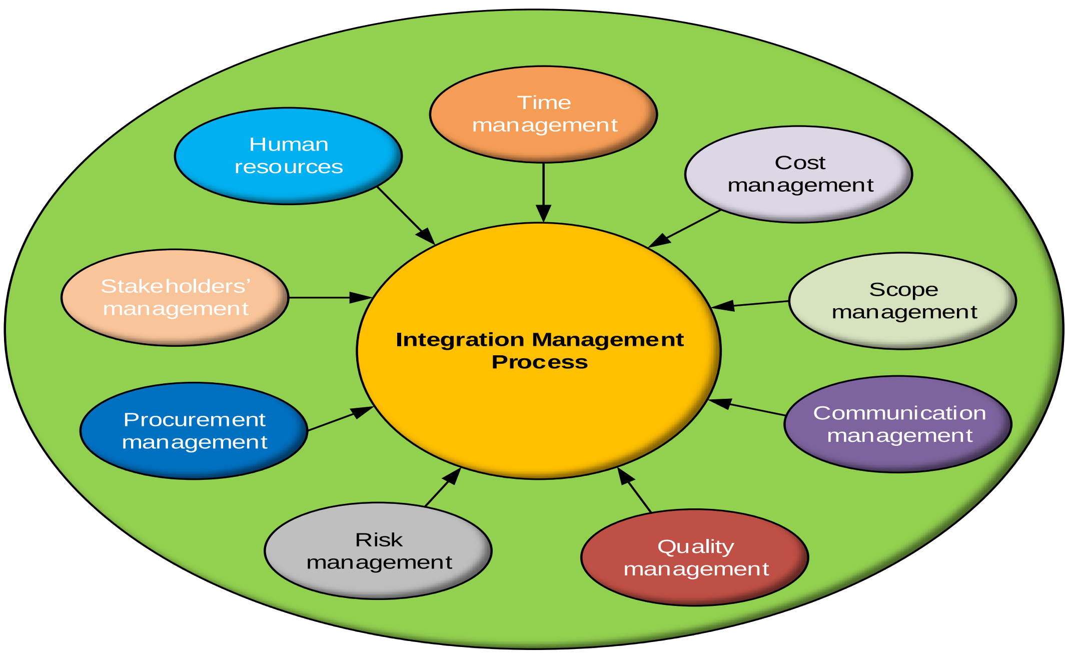

Figure 2.4: Ten key competencies of management knowledge required for affordable housing

Each of these knowledge areas will be discussed assessing effectiveness towards sustainable housing delivery (PMBOK, 2008). Figure 2.4[4] presents the ten key competencies of management knowledge required for affordable housing.

---

[4] Diagram in Figure 2.4 adapted from Akinyede (2017)

2.2.2.1 Cost management toward sustainable housing delivery

Sustainable housing production processes are developed with the intent of reducing the cost of constructing housing, improving safety or creating comfort (Jiboye, 2011). It is essential to evaluate the functional aspects of the completed structure such as cost effectiveness, habitability or structural safety, as well as those factors related to the construction process itself such as productivity and difficulty in construction activities (Lehmann, 2006). The development of methods for evaluating the production features of sustainable housing production lay far behind those which deal with functional consideration (Nakajima, 1998).

Consequently, focus on sustainability management in sustainable housing delivery is sharpening as its contribution toward value and cost effectiveness is growing in clarity and visibility (Makinde, 2014). The construction industry and its customers are broadening their interpretation of *value*, appreciating its subjective nature by adding concerns surrounding housing delivery and economic development of society (Manzini & Vezzoli, 2003). In 2002, the Institute of Value Management determined that the concept of cost/value in sustainable housing delivery relies on the relationship between the satisfaction of many differing needs and the resources used in obtaining this satisfaction (Zainul Abidin & Pasquire, 2005). Differing needs are likely to include aspects of high quality, cost effectiveness, good indoor environment, durability, low cost of maintenance and user-friendliness. Value management should also be integrated into sustainable housing delivery, as this affects the quality and cost effectiveness outcome (Zainul Abidin & Pasquire, 2005).

Sohmen and Dimtriou (2015) state that in the prevailing environment of scarce resources, it is vital that construction operators have a sound understanding of construction cost management of housing production processes with a zeal for cost effectiveness, economy and efficiency. In addition, it is essential for construction operators to control the cost of construction toward achieving sustainable housing delivery at the time, cost and quality expected (Mahadik, 2015). Construction operators need to be knowledgeable to make effective cost management decisions that will directly affect budgeted cost for sustainable housing delivery (Madhavi *et al.,* 2013). Moreover, construction operators need to work closely with the account section on site to integrate the contributory project budget into an overall programme budget that is economical, controlled and justifiable (Shmen & Dimtrou, 2015).

Abidin and Pasquire (2006), in their study on cost management, discovered that the rise of the sustainability phenomenon in modern construction would initiate the search for appropriate ways to enable the concept of sustainability to be imbued into sustainable housing delivery. Construction cost management (CCM), one well-known technique to assist in decision making during housing production, takes a strategic position toward incorporating sustainability issues into sustainable housing production processes (Olayiwola *et al.,* 2005). CCM has many intrinsic capabilities, heightening its potential as a sustainability delivery mechanism; this potential of construction cost management has not yet been fully realised by construction operators, though (Omolabi & Adebayo, 2014; Zainul Abidin & Pasquire, 2006).

Cost management for sustainable housing delivery involves estimating cost, determining budget, and controlling cost at every phase of the housing production process (Neutze & Jones, 2000; PMBOK, 2008; Crook & Whitehead, 2002). Cost management will be discussed under the headings below for insight and clarity.

2.2.2.2 Estimating cost for affordable housing delivery

Crook and Whitehead (2002) define *estimating cost* as the process of developing an approximation of monetary resources needed for materials, and human and machinery resources, to complete housing production process activities.

2.2.2.3 Determining budgeted cost for housing delivery

Budgeted cost involves the process of adding together the estimated cost of each activity to establish an authorised cost baseline for the housing production process (Neutze & Jones, 2000).

2.2.2.4 Controlling costs for housing production process

Clarke and Herrmann (2004) define *controlling costs* as a process involving monitoring the status of the housing production process to update the budgeted cost as well as managing changes to the cost baseline/starting point.

2.2.3 Scope management for affordable housing delivery

Scope management for affordable housing delivery includes all the work required to complete the housing production process effectively. Managing the housing production scope is primarily concerned with defining and controlling *all* requirements for delivery of affordable housing. The scope management can be divided into subheadings: assembling all requirements to meet housing delivery objectives; defining work breakdown structure; and identifying scope (Kerzner, 2013; Duncan, 1998; Guide, 2001; PMBOK, 2008).

2.2.3.1 Assembling all requirements to meet housing delivery objectives

Childerhouse *et al.* (2000) describe *assembling all requirements* as a process that involves defining and documenting stakeholder needs to achieve housing delivery objectives. As customer requirements are diverse in the house construction sector, the supply chain must be matched to best service these alternative marketplace conditions. Therefore, effective strategies must be employed, including making to stock, designing to order and fitting out to order.

2.2.3.2 Defining work break down structure for housing delivery

Work break down structure involves the process of subdividing housing deliverables and the housing production process into smaller components for effective management. However, lack of proper commitment toward project management methods and slow rates of methodology renewal are challenges to professionals (Kosekela & Howell, 2002).

2.2.3.3 Identifying housing delivery scope

Abdullah and Rahman (2012) state that *identifying housing delivery scope* is a process that involves validating acceptance of the completed affordable housing and its deliverables. The ineffective identification of housing deliverables has reaped adverse consequences on house buyers and the national housing delivery system.

2.2.3.4 Controlling affordable housing delivery scope

Controlling affordable housing is the process of monitoring the status of the housing production process and product scope and managing changes to the housing scope baseline (Edun-Fotwe & McCaffer, 2000). Adequate intervention from the government and involvement of public-private partnership (PPP) in housing policy will enhance affordable housing delivery. The involvement of the PPP in the housing delivery in some the cities in developing nations has enhanced more effective housing production processes following decades of somewhat ineffective housing policy systems (Senegupta, 2006).

2.2.3.5 Time management for sustainable housing delivery

Time management for sustainable housing delivery is essential, requiring the establishment of a programme of work and managing timely completion of a housing production process through estimates of activity duration, developing a schedule and controlling that schedule (Kerzner, 2013; Guide, 2001; PMBOK, 2008).

2.2.3.6 Evaluation of affordable housing delivery duration

The *evaluation* of affordable housing delivery duration involves the process of approximating the working period necessary for completing individual construction operation activities within estimated resources during the housing production process (Guide, 2001). Time has definitely been a significant factor toward affordable housing delivery. Hwang *et al.* (2013) explain that with the growth in demand for public housing, this clamour has motivated the governments of many developing nations to reduce the waiting time of future public housing owners and users, *requiring* these projects to be completed on time. Identified critical factors affecting schedule performance of public housing project delivery are as follows: availability of labourers on site, procedure of site management and coordination among various parties (Hwang *et al.,* 2013).

2.2.3.7 Developing housing delivery activities

Developing housing delivery activities is a technique that involves a process of analysing activity sequence, duration, resource requirement and schedule constraints to generate the housing production process and timely delivery schedule. The constraint in improving housing delivery for low income earners thus continues to be contingent on the area of affordability. The impact of housing development in reference to planning, design and management is crucial to affordability of housing (Adebayo & Adebayo, 2001).

2.2.3.8 Controlling affordable housing delivery time

Controlling affordable housing delivery time is a process involving monitoring the status of the housing production process, updating on housing delivery progress, and managing changes to the schedule baseline (PMBOK, 2008). These processes interact with each other: each process will occur at least once in every housing project and it must occur in virtually all the phases. The challenges affecting housing delivery within time are financial and coordination problems, and implementation during housing production processes (Mohd, 2007).

2.2.4 Quality management toward sustainable housing delivery

Cities in both developing and developed countries have been subject to severe social and economic pressures for the past nine years, resulting in an uneven spatial impact on the urban environment and giving rise to the concentration of the most deprived households in urban neighbourhoods (Brown, 2011). Consequently, African government objectives involved an attempt to implement revival of sustainable housing delivery or create a sustainable community to improve the quality of life (El-Haram & Horner, 2002). Sustainable housing is a key issue to consider in delivery of healthy and attractive communities, and such housing should be readily available, of high quality, economical, ecological, and aesthetical in design, comfortable and cost effective (Ekins *et al.,* 2003). Moreover, dwelling houses, apartments or housing premises must be set out in accordance with the conditions of the locality and must meet the requirements established at planning stage (Maliene & Malys, 2009).

Quality management toward sustainable housing delivery is essential, encompassing the processes and activities of the performing section on site that determine quality policies (Edun-Fotwe & McCaffer, 2000). Thus, the objectives and responsibilities of sustainable housing are to satisfy the need for which it was undertaken. But the outline of quality management toward sustainable housing delivery is comprised by several things: plan quality for sustainable housing delivery, perform quality assurance for sustainable housing delivery and perform quality control for sustainable housing delivery (Guide, 2001).

2.2.4.1 Implementing quality sustainable housing delivery

This involves the process of identifying quality requirements or standards for the sustainable housing delivery and documenting how the sustainable housing delivery will demonstrate compliance (PMBOK, 2008). Satisfaction of the people is the basic underpinning of sustainable housing delivery; satisfaction can be achieved through understanding, evaluating, defining and managing expectations so that people's requirements are met (Meredith & Mantel, 2011). This requires a combination of conformance to requirements to ensure that sustainable housing offers precisely that which it was created for, which include fitness for use and satisfaction with the intended purpose (Teck-Hong, 2012). To achieve the required sustainable housing delivery, one recommendation is to prevent over-inspection during production processes through quality planned, designed, and built in – not inspected in (Meredith & Mantel, 2011). The cost of preventing mistakes is generally much less than the cost of correcting them after flagging by a quality assurance team (PMBOK, 2008).

2.2.4.2 Implement quality assurance for sustainable housing delivery

This process involves auditing the quality requirements and the results from quality control measurements for sustainable housing delivery; to ensure appropriate quality, standards and operational definitions are used (Kerzner, 2013). To achieve cost effectiveness in sustainable housing delivery, quality assurance must occur under the umbrella of continuous process improvement as an interactive means for improving the quality (Cooke-Davies, 2002). Continuous process improvement reduces waste and eliminates activities that do not add value but rather escalate the construction costs of sustainable housing delivery thereby allowing production processes to operate at higher levels of efficiency and effectiveness (Kerzner, 2013).

2.2.4.3 Implement quality control for sustainable housing delivery

Quality control practice involves monitoring results from the executed quality activities to measure performance and recommend necessary changes. Quality standards expected from sustainable housing include efficient production processes and achievement of targeted goal (PMBOK, 2008). Expected results from sustainable housing delivery include cost effectiveness, affordability, availability and timely delivery. A sustainable housing delivery team should have a working knowledge of statistical quality control, especially sampling and probability, to accurately evaluate quality control productivity (Kerzner, 2013). For example, teams need to know the differences between avoidance of error, quality sampling and tolerances (PMBOK, 2008). Quality control will be discussed briefly under the subsequent headings.

2.2.4.4 Avoidance of error in sustainable housing delivery

Keeping error out of sustainable housing production processes will enhance reduction of waste and cost of construction. Similarly, regular inspection of activities of sub-contractors and materials supplied to conform to sustainable requirements will eliminate errors, thereby further reducing construction cost (Kerzner, 2013; PMBOK, 2008).

2.2.4.5 Quality sampling for sustainable housing delivery

Quality sampling activities on site involve constant measurement of production processes to ascertain conformity to requirements. Moreover, variable sampling should occur to ascertain that sustainable housing delivery conforms to stated requirement (Atkinson, 1999; Cooke-Davies, 2002).

2.2.4.6 Tolerance measurement for sustainable housing delivery

Tolerance involves measuring acceptable standards of sustainable housing delivery to conform to the requirement specified. The control limit should be applied to measure thresholds to ascertain if the sustainable housing production process is within the limit specified (Kerzner, 2013; Cooke-Davies, 2002).

2.2.5 Human resource management toward sustainable housing delivery

This activity involves the process that organises, manages and leads the team in an effort to attain sustainable housing delivery. A housing delivery team is comprised of the construction operators with assigned roles and responsibilities for completing sustainable housing delivery. The type and number of team members can alter with frequency as a housing production process advances (Guide, 2001). Involvement of all team members in sustainable housing delivery planning and decision making will be beneficial, as early involvement of all stakeholders enhances effectiveness in productivity (Kerzner, 2013). Thereafter, team members add their expertise during the planning process and strengthen their commitment to the housing production process (PMBOK, 2008). To achieve delivery effectiveness, a human resource management plan must be developed, and a team must be acquired, developed and managed (Kerzner, 2013; Guide, 2001). To achieve adequate discussion concerning human resource management, the following headings will be discussed briefly.

2.2.5.1 Improve human resource management plan for housing production process

Human resource management involves identifying and documenting sustainable housing delivery roles and responsibilities among construction team members, as well as identifying needed skills, reporting relationships among team members, and following a staffing management plan (Meredith & Mentel, 2011). To achieve effective productivity from such a team, a human resource management plan should encompass the potential scarcity of human resources; should identify training needs; should develop team building strategies during the production process; and should ensure compliance for sustainable integration and safety issues (Kerzner, 2013). Furthermore, a team must recognise and reward team members who effectively implement sustainable practices during housing production. Clearly, a staffing management plan is required for sustainable housing delivery (Meredith & Mentel, 2011; PMBOK, 2008).

2.2.5.2 Procurement of sustainable delivery team

Procurement involves the process of recruiting and confirming the availability of human resources and obtaining a housing production team to complete sustainable housing delivery processes. It is important to consider the following factors toward sustainable housing delivery (Kerzner, 2013; Meredith & Mantel, 2011; Cooke-Davies, 2002).

- The project manager in charge of a housing production process should adequately negotiate and influence other members for sustainable housing delivery. Teams are to provide the required skilled professionals for successful sustainable housing delivery (Kerzner, 2013; Guide, 2001; PMBOK, 2008).
- It is essential for the project manager to acquire the necessary human resources for sustainable housing delivery. Neglecting this process will affect timely delivery, budgeted cost, client satisfaction, quality and risks involved. In addition, it could affect the likelihood of success and ultimately result in inadequate housing delivery (Cooke-Davies, 2002).
- If it happens that an expert in sustainable housing delivery is not available due to time constraints or economic reasons, the project manager should organise and train personnel for the position, done in reference to regulatory and mandatory procedures established for sustainable housing delivery at the planning stage (Kerzner, 2013).

2.2.5.3 Create sustainable housing delivery team

This process involves improving the competencies of sustainable housing delivery team members and enhancing team productivity. As teamwork is a critical factor for sustainable housing delivery, developing an effective team is an essential ingredients for reducing construction costs (PMBOK, 2008). Project managers in charge of construction should intentionally motivate their teams by providing solutions to challenges on site, proffering needed support and rewarding solid performance (Kerzner, 2013), bolstering open and effective communication and strong trust among team members. In addition, project managers should manage conflict among team members effectively, and encourage collaborative problem solving and decision-making (Guide, 2001).

2.2.6 Communication management toward sustainable housing delivery

Communication management involves the process of ensuring timely and appropriate generation, collection and dissemination of information amongst team members (Guide, 2001). Effective communication creates a bridge between the diverse stakeholders involved, mitigating various cultural and organisational backgrounds, different level of competencies and diverse perspectives (Meredith & Mantel, 2011). The essential factors for effective communication include the design of effective communications for housing delivery, circulating effective information among team members and managing client expectations (Cooke-Davies, 2002; Atkinson, 1999; Meredith & Mantel, 2011; PMBOK, 2008). Overview of communication management for affordable housing delivery process includes the following subsections.

2.2.6.1 Classify stakeholder information interest toward housing delivery

Classifying involves identifying all construction operators participating in a housing project, and documenting relevant information regarding their interests, involvement and impact on housing delivery success (PMBOK, 2008).

2.2.6.2 Design communication for affordable housing production process

Designing involves determining the housing delivery stakeholder information needs and defining a communication approach toward those needs (Meredith & Mantel, 2011).

2.2.6.3 Circulate effective information among construction operators

Circulating involves making relevant information available to construction operators, as planned (Cooke-Davies, 2002; Meredith & Mantel, 2011).

2.2.6.4 Employ communication to manage expectations of stakeholders

These methods comprise communicating and working with stakeholders to meet their needs and interests during the housing production process, and addressing issues raised by stakeholders as and when they arise (Meredith & Mantel, 2011; Cooke-Davies, 2002; PMBOK, 2008).

2.2.6.5 Relate performance on housing production

Relating involves collecting and distributing performance information on housing delivery, including status reports, progress measurements and forecasts of future occurrences (Meredith & Mantel, 2011; Cooke-Davies, 2002).

2.2.7 Risks management toward sustainable housing delivery

Risk management in sustainable housing delivery involves the process of guiding risk management planning, documentation of risk in sustainable housing delivery processes, analysis of identified risks and planning for risk emanating during production (PMBOK, 2008). The objectives of risk management for sustainable housing delivery are to increase the probability of positive events and decrease negative events (Project Guide, 2001). A risk is an uncertain event that, if occurring, affects at least one objective of sustainable housing delivery. Objectives of sustainable housing delivery typically include affordability, cost effectiveness, quality and availability (Meredith & Mantel, 2011). Sources of risk during a housing production process may emerge through requirements or constraints (Cooke-Davies, 2002). Risk must be adequately anticipated to allow sufficient time and resources for appropriate management, and to reduce its impact on the housing production process (PMBOK, 2008). Processes outlined in the subsections below are followed for achieving effective risk management for sustainable housing delivery.

2.2.7.1 Design risk management for sustainable affordable housing delivery

This practice defines how to conduct risk management activities for affordable housing delivery (Atkinson, 1999; Cooke-Davies, 2002; PMBOK, 2008).

2.2.7.2 Classify risk involve in affordable housing delivery

This involves the process of determining which risks are likely to affect housing delivery and documenting their characteristics prior to and during production processes (Atkinson, 1999; PMBOK, 2008).

2.2.7.3 Implement qualitative risk analysis on sustainable housing delivery

This method involves numerically analysing the effect of identified risk on overall housing objectives during the production process (Meredith & Mantel, 2011; PMBOK, 2008).

2.2.7.4 Design risk responses for affordable housing delivery

This procedure comprises developing options and actions to enhance opportunity and to reduce threats to housing delivery objectives (Meredith & Mantel, 2011; Project guide, 2001).

2.2.7.5 Monitoring and controlling risks for effective delivery of housing

This technique involves implementing a risk response plan, tracking identified risks, monitoring residual risks, identifying new risk and evaluating risk effectively throughout the housing production processes (Meredith & Mantel, 2011; Project guide, 2001; Cooke-Davies, 2002).

2.2.8 Stakeholder management for housing production process

Stakeholder conflict has been reported as a primary reason for failure in several instances in infrastructural production processes. Hence, capturing and addressing stakeholder input is crucial to the success of housing project delivery (El-Gohary & El-Diraby, 2006). Stakeholder involvement in an infrastructural production process is an interdisciplinary domain spanning several disciplines – engineering, science, social science and marketing (Guide, 2001). However, the fragmented nature of knowledge in this domain impedes a housing project manager from leading a successful stakeholder involvement programme (PMBOK, 2008).

Stakeholders involved in housing delivery are defined as a group of persons or organisations involved in the housing production or whose interests may be positively or negatively affected by the completion of project (Guide, 2002). Moreover, stakeholders may exert influence over process and its deliverables, as well as over the team members involved in the process. The management team for housing production processes is saddled with the responsibility of identifying both internal and external stakeholders to determine project requirements and expectations of the various stakeholders involved in the production (El-Gohary, Osman & El-Diraby, 2006; Project guide, 2002).

Project team managers must ensure that influence of the various stakeholders in regard to housing production requirements has a successful outcome (Cooke-Davies, 2002). The overview of the relationship between stakeholders and production processes are grouped under 'stakeholder responsibility' and 'authority'; hence, identification of stakeholder interest in housing delivery and stakeholder benefits are significant to cost efficiency (El-Gohary, Osman & El-Diraby, 2006; Project Guide, 2001; Cooke-Davies, 2002).

2.2.8.1 Stakeholder responsibility and authority on housing delivery

Involved stakeholders have varying levels of responsibility and authority bestowed upon them, although this can change over the course of the housing production process (Wang & Huang, 2006). Stakeholder responsibility and authority varies from occasional contribution, administration support, and certain objectives influencing housing delivery (Wang & Huang, 2006; Westerveld, 2003).

2.2.8.2 Identification of stakeholder importance for housing delivery

Identifying stakeholders and understanding their relative degree of influence is critical for affordable housing delivery (Guide, 2001) as the inability to identify stakeholders and their influence on housing delivery will extend the timeline and raise construction costs substantially (Wang & Huang, 2006). Stakeholders may be interested in monitoring and evaluating housing project impact related to their field to make sure that the control is not greater than that which was anticipated in the planning phase of the housing production process (PMBOK, 2008).

2.2.8.3 Stakeholder objectives influence on housing delivery

An important part of a project manager's responsibility is to successfully manage stakeholder expectation during the production process (Oladin & Landin, 2006). But this can be difficult because stakeholders often retain conflicting objectives (PMBOK, 2008). Therefore, the project manager must ensure that housing delivery team interacts with stakeholders in a professional and cooperative manner to integrate the objectives of the stakeholders with the objectives of the housing production to achieve the established requirements (Wang & Huang, 2006).

Housing project success has been widely discussed in literature, with most studies focusing on success criteria during the production process, following the dimension of measuring housing delivery success (Angus & Bowers, 2005) with success mostly resting on the triangle of time, cost and quality. Other studies have discussed project success criteria, including organisation objectives, stakeholder satisfaction, customer benefits and the future potential for the organisation (Oladin & Landin, 2006). However, lack of consensus on identified success criteria has been a major problem toward solidifying common objectives for housing delivery (Wang & Huang, 2006).

2.2.9 Procurement management for affordable housing delivery

Procurement management for housing delivery includes the process of purchasing or otherwise acquiring materials and services needed from outside the housing project team (Project guide, 2001) for managing housing delivery and changing control processes required to develop and administer housing production processes (Atkinson, 1999). Discussion will centre on a procurement outline following design, effective guidance, administration and close out for housing production processes, guiding effective procurement for housing production processes, administering procurement for housing production, and closing procurement.

2.2.9.1 Design procurement for housing production

Design procurement entails making decisions regarding the type of materials to be purchased, specifying the quantity and quality of materials, and identifying the competency of the contractors and suppliers (Akinson, 1999).

2.2.9.2 Guiding procurement for housing production

Guiding procurement entails selecting competent contractors and suppliers for housing delivery jobs and awarding contracts with stringent conditions under the supervision of a specialist consultant (Akinson, 1999).

2.2.9.3 Administering procurement for housing production

Administering entails managing the process of awarding contracts to competent contractors and suppliers of material and interviewing specialists needed outside the construction team (Project guide, 2001). Moreover, administering involves managing the procurement relationship between contractors and suppliers, monitoring contract performance at planning stage, effecting changes, and making necessary corrections as the production process progresses (Meredith & Mantel, 2011).

2.2.9.4 Housing delivery processes integration management

This involves coordination of all processes related to the housing production process and managing activities within project management process groups (PMBOK, 2008). The outline includes clarification, consolidation, unification, and rigorous actions that are crucial to housing delivery; similarly, it includes meeting requirements and stakeholder expectations (Project guide, 2001). The outline of housing delivery integration management involves keeping a record of initial requirements that satisfy stakeholder objectives, matching all subsidiary plans to achieve requirements specified for housing delivery, finalising housing production processes across all the management process groups and formally closing out the production processes (Meredith & Mantel 2011). Baiden *et al.* (2006) explain that the housing project production team exists as an individually competent unit within the organisation, defining limits and integrating teamwork among the construction professionals which fluctuate based on team practices adopted and their relation to the procurement approach. Integration of common interests and practices is essential to affordable housing delivery.

2.2.9.5 Housing production in phases toward achieving requirements

Housing production occurs in different phases as shown in figure 2.5, and undergoes certain processes toward achieving the stated objectives, divided as follows: initiation phase, definition phase, design phase, development phase, implementation phase and follow-up phase (Cooke-Davies, 2002). Dividing

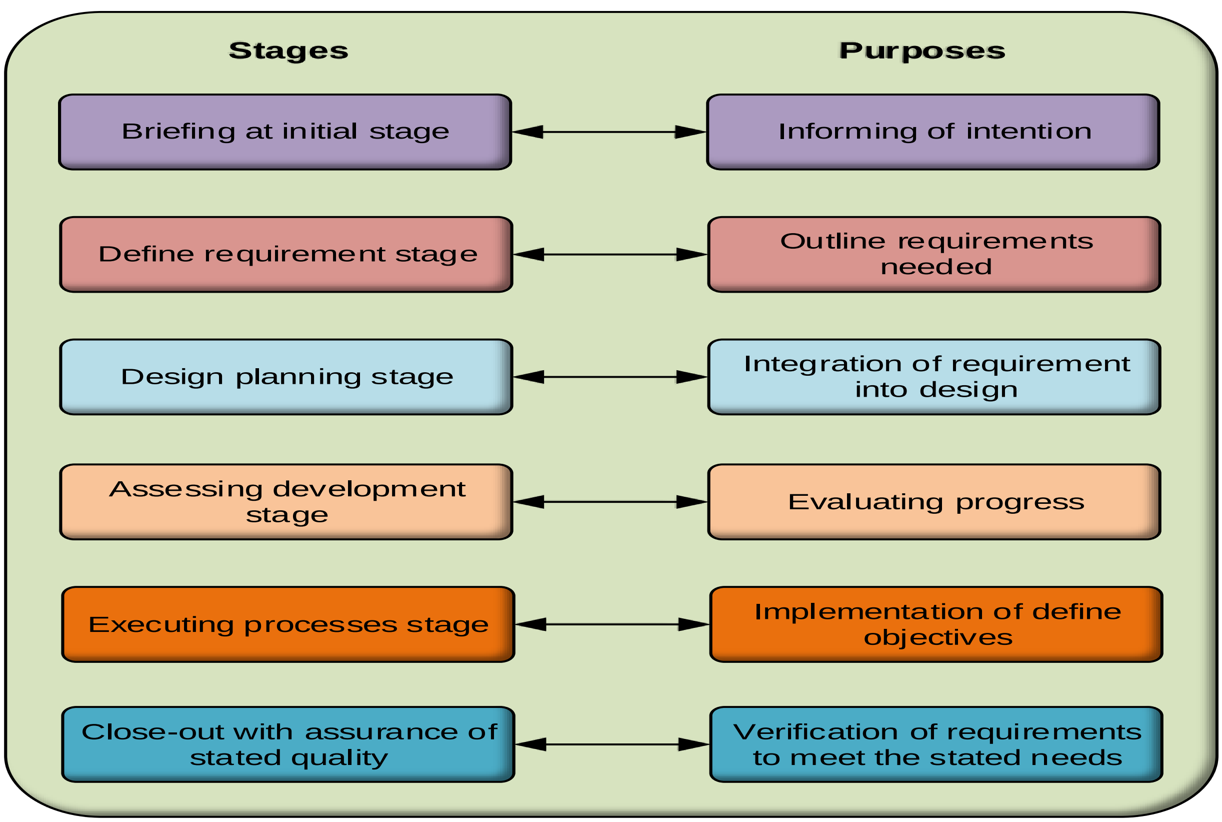

Figure 2.5: Housing production processes in stages

a housing project into phases makes it possible to lead more manageably in the best possible direction. In the process of organising, the total workload of a housing project is divided into smaller components, making it easier to monitor (Yu *et al.,* 2006). These stages are critical for cost effective, quality and affordable housing delivery (Cooke-Davies, 2002). Figure 2.5[5] above presents housing production processes in stages, and significant to effective planning and monitoring of housing delivery.

2.2.9.6 Briefing at initiating stage of housing production

One of the major factors enhancing affordable housing delivery is adequate briefing at the initiating stage among stakeholders (Yu *et al.,* 2006). Housing project briefing is a complex and dynamic process that involves identifying and conveying a client's actual needs and requirements accurately to the project team (Yu, Ann TW *et al.,* 2005). Although the briefing process is critical to the successful delivery of affordable housing, there are many limitations inhibiting its effectiveness (Jiboye, 2012). A briefing includes, for example, the identification of client needs, inadequate involvement of all relevant stakeholders in a housing project, inadequate communication between those involved in briefing, insufficient time allocated for briefing, briefing information being delivered during late design and construction stages, and contractors having no real understanding of client objectives (Yu, Ann TW *et al.*, 2005).

2.2.9.7 Define requirements stage of housing production

The initiating stage of the housing production process involves approving what has been planned, thereby allowing the project to enter the next phase of production, the definition phase. At this phase, requirements are specified and the objectives of the stakeholders are identified and documented for processing (Cooke-Davies, 2002).

2.2.9.8 Design planning stage of production

At the *design stage*, stakeholders are challenged with proper identification of the major necessities that are supposed to enhance affordable housing delivery (Atkinson, 1999). Therefore, a list of requirements at the definition stage will enhance efficiency in design choices.

---

[5] Diagram in Figure 2.5 adapted from PMBOK (2008) and Baar *et al.* (2006)

A well-defined objective at the design stage by stakeholders will stimulate affordable housing delivery at cost, time specified and at the quality expected (Cooke-Davies, 2002).

2.2.9.9 Assessing development stage of housing delivery

At the development stage, it is believed that everything necessary to attain affordable housing delivery is properly assigned, as indicated in the definition stage. However, this priority is not adequately addressed by the construction team rendering affordable housing delivery within cost and time specified difficult and perhaps unattainable (Baar *et al.,* 2006). Adequate completion of the development stage signifies efficient implementation of all requirements needed. Hence, all stakeholders involved in the process must be properly informed regarding the implementation stage before proceeding to cost effective housing delivery (PMBOK, 2008; Cooke-Davies, 2002).

2.2.9.10 Executing processes stage of housing production

This is the stage when the impact of preceding stages is noticed, implementing stage priorities using results obtained in previous stages (Atkinson, 1999). At this stage, efficiency can only be achieved provided all stakeholders involved in housing production adequately handle their areas of specialisation for implementation of stated objectives for housing production processes (Cooke-Davies, 2002). Steadfastness of the construction team in pursuing responsibilities is necessary to achieve stated requirements of affordable housing delivery (Baar *et al.,* 2006).

2.2.9.11 Closeout stage with assurance of stated quality

This is the stage when all requirements are verified to ascertain adequate implementation of stakeholder objectives in conformity with requirements for housing delivery (Cooke-Davies, 2002). At this point, the housing project that is about to be delivered is evaluated, writing the housing delivery report, clarifying if the housing to be handed over meets the budgeted cost, time specified and requirements expected (PMBOK, 2008). Most of the stakeholders involved are unable to define lessons learned because the process employed in completion of the building project is cumbersome and cannot be replicated in another project (Cooke-Davies 2002). So, a good project means experience gained which can be applied in subsequent housing projects (PMBOK, 2008).

2.2.10 Consideration of management principles and practice for housing delivery

Housing projects vary in size and complexity; but no matter how large or small, simple or complex, all must be worked under the umbrella of sound management principles and practice structures for effective project delivery (Lee & Kim, 2001). Effective project management will include strategies, tactics and tools for managing the design and construction of housing production processes and for mitigating key factors to ensure the client receives a facility that matches expectation for its functional intention (Ibem & Amole, 2010).

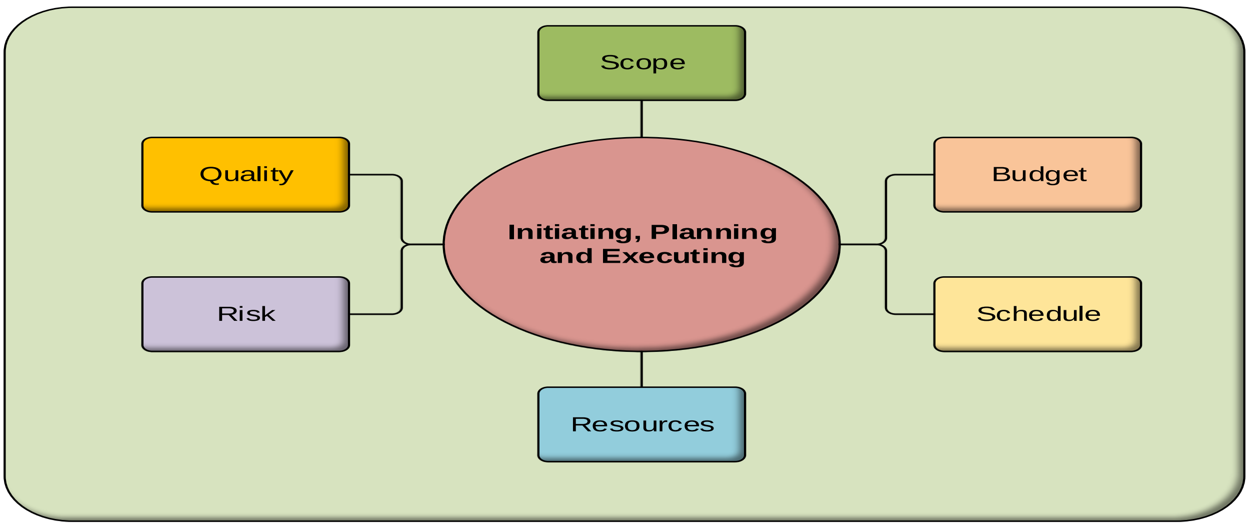

Figure 2.6: Management principles and practice for housing delivery constraints in sequence

This requires the implementation of management techniques that will control changes in the key factors of risks, resources, schedules and scope, and optimise cost of construction and quality control (Lee & Kim, 2001). Excellent housing production processes and stellar management are achieved through structured processes that include multiple phases: initiating, planning, executing, monitoring, controlling and then closing the project (Ibem & Amole, 2010). Figure 2.6[6] displays the sequence of management principles and practices for housing delivery constraints

2.2.10.1 Initiating process group

At the inception stage of any housing production process, it is critical to establish the budget, time and resources required to achieve the quality and scope of the project (Kerzner, 2013). These

---

[6] Diagram in Figure 2.6 adapted from NIBS (2016)

are significant for client and end-user satisfaction and expectation. Hence, efficiency and value-for-money in housing delivery can be determined through completion of projects on time, to budget and to a level of functionality that meets the mandatory needs (Windapo *et al.,* 2017). Adequate establishing of housing delivery processes will continue to enhance value and meet client and end-user satisfaction in terms of requirements through the expected life span of the house, as well as contributing to the environment in which it was established, benefitting the occupants socially and economically (Ibem *et al.,* 2011).

2.2.10.2 Planning process group

Planning for a housing production process requires a combination of efforts of all stakeholders involved in the decisions concerning cost, time of delivery, risk involved and quality expected. In addition, planning must be focused on sustainable affordable housing, economic development, protection of natural resources, planning for land use, and development of individuals and the community at large (Idrus & Ho, 2008). Therefore, stakeholders involved in housing production processes are saddled with the responsibility of working with a variety of government agents and private and non-profit organisations to draft housing delivery policies, regulations and incentives to entice goal achievability (Kerzner, 2013).

The government and other organisations involved in housing production processes now realise that the conventional methods are insufficient for meeting the needs of today's economic, social and environmental developments (Jiboye, 2011). Thanks to new techniques, stakeholders are now responsible to evaluate the whole-life value of housing to be delivered, factors that affect longer term cost of a housing in regard to maintainability, resources consumption and useful service life. All these factors must be integrated into the decision-making process (Kazadi *et al.,* 2016).

2.2.10.3 Executing process group

Managing complex housing production processes from beginning to closeout stage is a formidable challenge, even for the most seasoned construction operators. The executing process group are vested with the responsibility of controlling planning implementation and thereby have overall goals for competent teams to get housing delivered efficiently and effectively (Kolltveit & Gronhaug, 2004). Construction teams are established to complete housing production according to stakeholder expectation. At this stage, risk and design omissions and errors that affect quality are mitigated and changes requested from stakeholders are adequately addressed (Kazadi & Mahr, 2016).

Thus, to achieve efficiency and effectiveness, it is critical to evaluate core tasks of the executing process group such as direct management of housing delivery, implementation of quality assurance, procurement and development, circulation of information and management of stakeholder expectations (Kollveit & Gronhaug, 2004).

2.2.10.4 Monitoring and controlling process group

Technological and economic solutions for housing production have not adequately enhanced efficiency and improvement in housing delivery because of ineffective monitoring and controlling of planning and implementation processes (Baar, 2006). It is well established that most construction operators handling housing delivery find it difficult to create appropriate roles for managing and organising an effective production system, identifying priority problems, formulating policies and creating ways to have these policies implemented towards sustainable housing delivery (Lusthaus, Adrian & Perslinger, 1999). Monitoring and controlling processes are critical ingredients of housing delivery, as stakeholders are responsible to manage stated objectives toward achieving the aim of the housing project; likewise, stakeholders must achieve affordable housing delivery at the targeted cost, time and quality expected (Baars, 2006).

Thus, achieving an affordable housing production process is a critical process that requires the involvement of speciality stakeholders, matching their skills with various dates demanded by each phase of the housing production (Tommalein & Ballard, 1997). A well-organised housing production process will combine the efforts of all stakeholders and pool these efforts in the direction of efficiency to achieve targeted cost of construction, time of project delivery and quality expected (Li, Ng & Skitmore, 2013). The objectives of each stakeholder must be verified against achievement, expected interest must be certified, and assurance of certified requirements must be clarified and ascertained, documented in housing project reports, bringing the housing project to completion and handing the housing project over to the client (Li, Ng & Skitmore, 2012).

2.3 Funding of affordable housing

Even with the adoption of an affordable housing delivery policy by Habitat U.N., most cities in developing nations are challenged with shortages of affordable housing (Le Roux, 2011). Housing problems in major cities remain largely unsolved due to lack of finance, lack of a second-hand housing market, undeveloped real estate professions, unclear land and property legislation and an absence of proper property management support. Amid these challenges, lack of housing finance appears to be the core problem (Yeung & Howes, 2006).

Against the backdrop of an economic slowdown over a decade, the developing nations housing micro finance (HMF) section has stagnated. Constant increases in the price of housing delivery causes extensive energy crises affecting the operations of small and medium sized enterprises (SMEs) (Maina, 2013). In addition, frequent depreciation of developing nations' currency exchanging rates all had detrimental effects on the viability of housing loans. Hence, the objectives of financial sustainability proved difficult to combine with the social goal of providing finance for affordable and adequate dwelling for low-income groups (Derban *et al.,* 2002).

Across the developing nations of the world, professionals are grappling with challenges inherent in creating an enabling housing finance environment. While these challenges may appear overwhelming, there is a growing track of novel solutions and initiatives pioneered by governments, financiers, developers and households (Derban *et al.,* 2002) suggesting possible new opportunities for making the housing finance segment workable for the poor in Africa. The standard source of funding affordable housing can be categorised into housing microfinance, mortgage liquidity facilities, cement block banking and home loan guarantees for the informally employed and infrastructural financing loans. Hopefully, this practice can be replicated in developing nations (Steel & Andah, 2008).

2.4 Accomplishing cost effectiveness for affordable housing delivery

The challenges of determining the true costs of affordable housing delivery are critical in housing production processes (Ademiluyi, 2010) as these appear to be responsible for shortages of affordable housing delivery in both developed and developing nations (Stegman, 1991). Most housing projects are restrained without means of increasing budget beyond that which was specified at the initiating stage (Adedeji & Olotuah, 2012). It is essential that the requirements specified for housing projects are set by considering life cycle costs, as this will ensure that the budget supports any first cost premium that a life cycle cost effective alternative may incur (Stegman, 1991). Budgeted cost has been established for testing the liability of its assumption through employing effective cost management systems throughout the design and production processes (Stegman, 1991; NIBS, 2016; Ademiluyi, 2010; Adedeji & Olotuah, 2012).

As the client understandably desires a cost-effective housing delivery that meets requirements, a clear understanding of the functional and physical requirement of a housing project relative to budgeted cost is essential to ensuring its success (Olayiwola, Adeleye & Ogunsakin, 2005). A client aims to develop a housing project derived from urgent needs, a purpose and a desire resulting from cost effectiveness, meeting time specified and at the quality expected (Ademiluyi, 2005). Housing projects can be quantified to satisfy the emotional, cognitive and cultural needs of the housing occupants and the technical requisites of the programme it houses; then the housing project can be declared functionally successful (Olayiwola, Adeleye & Ogunshakin, 2005).

The likelihood of accomplishing cost effective affordable housing delivery is also determined by the level of competency of the quantity surveyor employed in conducting the estimation for housing delivery (Morrison, 1984). As accurately forecasting the cost is vital to the completion of any housing project, the quantity surveyor develops the cost information that the client, project manager and construction team need to make budgeting and feasibility determinations; through this process, cost effectiveness is achieved (Bartlett & Howard, 2000).

In most projects, the client typically employs the quantity surveyor to quantify building drawings; simultaneously, the contractors rely on their own quantity surveyor to manage estimation during biding processes and to consider the perspective of the client employed quantity surveyor to monitor cost of construction and bid purposes (Bartlett & Howard, 2000). Moreover, the contractor's quantity surveyor will determine the cost estimate for the construction bid and whether or not the company will bid for the construction contract. Thus, competencies at which the quantity surveyors are able to analyse the cost estimate for the intending housing project will determine the level of cost effectiveness for affordable housing delivery (Jiboye, 2012; Ademiluyi, 2005).

2.5 Communication among stakeholders during housing production process

A project stakeholder is an individual or group of people who have vested interest in the success of a housing project and the environment within which the housing production process is taking place. Again, a stakeholder is any individual or group who can rightfully influence delivery of affordable housing (Olander & Landin, 2005). Because of stakeholder input, negative attitudes and poor communication among stakeholders can severely obstruct the implementation of effective housing production processes, as such obstruction, conflicts and controversies concerning housing design and implementation through to closeout stage will result in cost overrun and time schedules surpassed (Wang & Huang, 2006; Gibson, 2006).

Greenwood (2007) explains that the opposite, good communication among the stakeholders, will enhance smooth spreading of information for housing delivery processes. Thus, effective communication will influence achievement of housing delivery *within* the objectives specified and stated requirements. Efficient communication among stakeholders will impact housing production processes as referred underneath:

- positive influence on decision making at planning and implementation stages;
- enhanced presentation of a strong point of view and stronger confidence and trust;
- efficient decisions on goals and requirements and solutions, accurately and timely;
- mutual relationships, less conflict and fewer controversies on design; and
- strong relationships toward achieving timely delivery at budgeted cost specified.

Effective stakeholder engagement in decision making and in the communication process during housing production processes will enable better planning and more information flow in housing

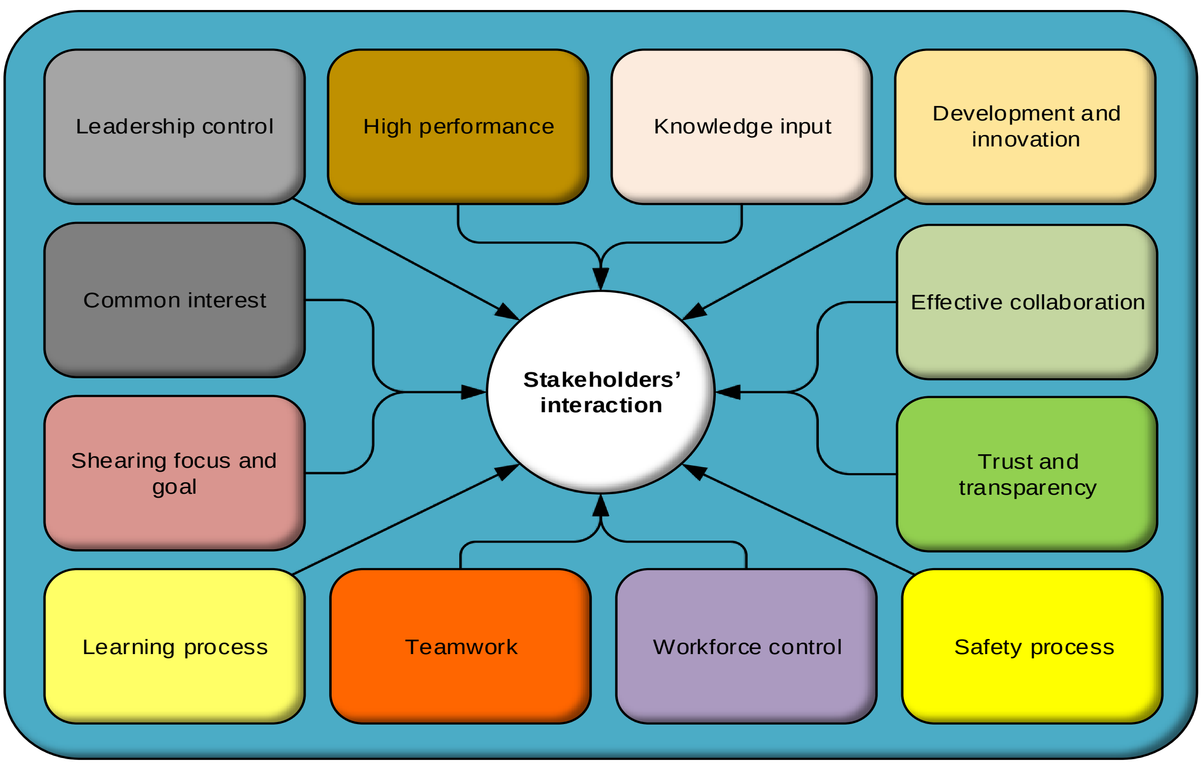

Figure 2.7: Framework of stakeholder interaction with significant factors during production

delivery policies, housing projects, programmes of work and related services (Amaechi & Crane, 2006). Benefits of stakeholder engagement include the opportunity to contribute as an expert in the area of specialisation toward planning and development of housing (PMBOK, 2008). Atkinson (1999) explains that effective communication on site will allow stakeholder concerns to be verbalised and allow full participation in decision-making processes. Figure 2.7[7] above, referred to as the framework of stakeholder interaction, if adopted during production, will enable each stakeholder to contribute meaningfully toward cost effective production.

2.6 Construction resources management

The achievement of sustainable affordable housing delivery requires a vigorous pursuit of efficient utilisation of labour, materials and equipment. Improvement of construction operator productivities should be a major goal for those responsible for cost control of housing delivery. Moreover, material handling for sustainable housing delivery, including procurement, inventory, shop fabrication and field servicing, also require special attention for cost reduction (Hendrickson & Au, 2000). Hendrickson and Au (2000) further clarify that the use of modern equipment and innovative methods for sustainable housing delivery has made possible a wholesale change in construction technologies in recent decades. Therefore, construction companies that do *not* recognise the impact of various innovations in construction resources and have *not* adapted to the changing environment have justifiably been forced out of the housing production process (Billson, 2010).

2.6.1 Efficient utilisation of labour

Labour utilisation in a housing production process is a concept that explains how effectively the construction industry uses its employees for efficient delivery of projects within aim and objectives specified at the planning stage (UK Essay, November 2013). There are important subjects that need to be considered when a construction firm evaluates the utilisation of its manpower. These include assessing the level of education of the personnel working in the construction firm, competency of the personnel, and the payment of salaries and other remunerations. These must *all* be adequately established for enhancement of productivity (Nubler, 2000).

Effective utilisation of human resources, significant in housing production, therefore serves as a contributing factor to the construction industry in the area of budgeting and financing (Edun-Fotwe

[7] Diagram in Figure 2.7 adapted from Akinyede (2017)

& McCaffer, 2000). In every construction firm, it is necessary to organise training and seminars for staff, including health and safety insurance, which influence worker efficiency (Project guide, 2001). An advantage of this action to the construction industry is to enhance the production process to more adequately achieve increased performance output of workers on site (Edun-Fotwe & McCaffer, 2000). Effective labour management is one of the most important techniques applied by the construction professionals. A competent professional in project management should vigorously pursue the efficient utilisation of labour with adequate labour management (Billson, 2010; PMBOK, 2008). The availability of skilled labour will then be sufficient to carry out efficient housing production to completion within the stipulated time, with no delay in deliver, thereby diminishing both time and cost (UK Essay, November 2013). But management of a project team is different from managing a team of employees because of the unique nature of each project and the consequent unique range of project management duties. Housing projects are strictly defined by result requirements, the cost and time constraints, and confined by the physical site environment in which they are implemented (Dziekoriski, 2017).

2.6.2 Efficient utilisation of materials

The effective procurement of materials for housing delivery represents yet another critical figment of the success of and housing production process (Patel & Vyas, 2011). Poor planning, inadequate identification of materials, poor storage, and improper handling procedures cause severe losses in labour efficiency and prolonged delays that indirectly increase total project cost (Bartlett & Howard, 2000). To competently control these challenges, effective management of materials toward reduction in construction costs is required (Patil & Pataskar, 2013). Material management and inventory control is effective for delivery of housing within budget specified; likewise, controlling delivery of materials is considered one of the best steps for saving time and making profit (Patil & Pataskar, 2011).

Material utilisation management is undeniably significant in the construction industry; materials represent major expenses in housing production. Therefore, the reduction in cost of housing projects requires effective management of material with the intent of minimising cost of procurement or purchase costs (Gulghane & Khandve, 2015). Material management is a major concern to stakeholders: even at the planning stage of housing production, construction operators must make critical decisions concerning material procurement and timely delivery. Hence, activities of material management must be adequately inserted into the project schedule, as this will impact the availability of materials at site, at the needed time, and will greatly impact the schedule of housing delivery (Gransberg, Popescu & Ryan, 2006).

The management and control of material procurement is through requisitions, bids, quotations and invoices, done with the intent of enhancing efficient production, while concomitantly avoiding material shortages and delays in housing production process (Madhavi, Mathew & Sasidharan, 2013). However, mishandling in procurement process and overlying decisions on material supply is difficult to avoid entirely. It needs to be constantly reined in and minimised to secure timely delivery of materials to the site during production (Gransberg, Popescu & Ryan, 2006). The material management and delivery to the site are generally handled by detailed craftsmen among the construction operators, with the aim of achieving delivery of quality materials and reducing delay in production (Madhavi, Mathew & Sasidharan, 2013).

2.6.3 Efficient utilisation of equipment

A solid housing foundation is based on efficient use of modern equipment, and such equipment is required to deliver quality and quantity of housing within stated time (Tatari & Skibniewski, 2006). Nakada (1997) states that equipment must be modern for efficient production and enhancement of construction costs within the limit of budgeted cost. Similarly, Tianliang *et al.* (2010) explain that there is a need for carefully designed earth moving equipment that is convenient, comfortable and easy to use, and not only that, the present-day sustainable construction techniques need equipment that is a friendly with non-polluting air machine. As the rate of agitating for modern equipment in construction industry is increasing on a daily basis, Kansei Engineering design environmentally friendly equipment for the construction industry. Demand has escalated for improvement in efficiency of construction machinery because the demand is basically on adoption of a hybrid power system used in automobiles to increase efficiency (Nakada, 1997). Tianliang *et al.* (2010) explain that global warming can be reduced through the use of modern equipment specifically designed for the conservation of natural resources and adjustments to stringent emission regulations. Therefore, manufacturers of earth moving equipment are more than ever before aware of the importance of producing environmentally friendly machines with significant improvement of fuel economy.

2.7 Review of South African housing production processes

South Africa is facing major shortages of low-cost houses to accommodate millions of her poor citizens. This social problem, originating under the country’s pre-1994 apartheid regime, is aggravated by constant increases in population and heavy migration sidled with slow and inadequate housing delivery (Mafukidze & Hoosen, 2009). The current housing and human settlement problems have become key issues as a result of shortage of affordable housing delivery. On this reason, Tomlinson (1998) reviewed South Africa housing policy, and revealed that the policies had resulted in a significant housing crises which manifested itself as overcrowded housing stock in the black township and emergency of informal housing in both the backyard of existing township houses.

Today, millions of South Africa's poor black households live in shacks, hostels and crowded houses in marginalized township and informal settlements, ostensibly awaiting access to government availed land and houses. The South African government and other stakeholders, since attaining democracy in 1994, have been creating, embracing and implementing various approaches to housing delivery, somewhat speedily, to meet this shortage of affordable housing and social welfare for the citizens (Mafukidze & Hoosen, 2009). Tomlinson (1998), providing an assessment of housing delivery in South Africa between 1994 and 1996, found that this period symbolically describes the process through which a new policy on housing production process and delivery was framed. Examining the debates around the housing policy and methods that were ultimately adopted, Tomlinson then presented the policy framework and programmes within which houses are to be delivered. Laying forward reasons for government failure to deliver on its housing promises during this period led to initial questions about levels of satisfaction that would need to be addressed once beneficiaries took possession of a housing preference.

2.7.1 South African historical background on housing delivery

The South African socio-political controls were affected by conservative rules and racial discriminating policies of apartheid for four decades. This has been a challenge for housing development, as the policy resulted in squatter settlements and land invasion, primarily in and surrounding major cities, which seems to undermine the development of adequate housing in South Africa (Huchzermeyer, 2003). In 1994, when the new democratic government took over, segregation and racial discrimination among the rich and the poor caused the rise of shanty towns and unplanned settlements in South Africa cities. The social economic implication of this segregation meant the government must establish capital subsidy for housing delivery for the poor to curb the large shortages of solid housing and large slum settlements in the major cities, and the huge number of migrants moving to South Africa (Tomlinson, 1998; Huchzermeyer, 2003).

Affordable housing provision has been a major focus of government in post-apartheid urban South Africa. There is a clear need for the government to address the numerous inequalities (one of which is housing) and continuing segregation, poor municipal services provision and contemporary rapid urbanisation (Tomlinson, 1998). The government white paper on affordable housing delivery (1994) prioritised the needs of the poor and encouraged community participation and involvement of private organisations in the delivery of one million houses within five years (Goebel, 2007). Agitation for affordable housing delivery and negotiations on housing policy in South Africa was reduced in 1994 with the launch of the new housing white paper. However, despite good intentions, contradictions with policy between housing procedures and delivery targets have undermined its real relevance to the poorest people of South Africa (Huchzermeyer, 2003). The government paper argues that shifts in housing finance have largely ignored the needs of the poorest section in South Africa; therefore, the inadequately integrated location of subsidized development for the poorest remain unchallenged. In addition, an evasive discourse on squatting does not lend itself to the formulation of mechanisms of intervention oriented around the needs of the poor (Tomlinson, 1998; Huchzermeyer, 2003).

2.7.2 Housing delivery under apartheid system

The apartheid regime in South Africa divided the country into white and black; white South Africans dominated the urban areas while black South Africans settled in rural areas. Housing delivery under apartheid (1948) started with large-scale investments in the black townships by the white South Africans (Marais, 2005). The apartheid policy encouraged segregation, slum and squatter settlements to separate the white and black: the blacks could not live in white areas but were forced to inhabit impoverished rural area known as Bantustans. Very little actual housing was constructed for the blacks by the apartheid government (Tomlinson, 2002; Tomlinson, 2014). Consequently, the new government that took over in 1994 readily developed a housing policy that addressed the shortage of housing, the remaining segregation and class settlements among the people, but this has been a continuing challenge to development of housing in South Africa. The apartheid regime spent only 1.3% of the annual budget on housing, suggesting that housing was not at all adequately funded before the new 1994 government (Marais, 2005).

The apartheid policies of the 1960s favoured the development of homeland areas and dormitory towns; however, these areas were dominated by prevalent poverty and rampant homelessness, somewhat similar to present-day South Africa (Marais, 2005). Similarly, Tomlinson (2002) explains that as a result of the long apartheid regime in South Africa, there are conflicts and challenges in the housing delivery system. The backlog of housing delivery is exacerbated by high unemployment, leaving millions of South Africans unable to afford quality housing with even just the basic necessities. So conflicts continue over access to basic services and housing payments, fights over the cut-off of water and electricity for non-payment of rates, and evictions for non-payment of monthly mortgages. These are predominantly the challenges of poor blacks.

2.7.3 New government involvement in housing production

In 1994, the ANC-led government adapted the reconstruction and development programme (RDP), an integrated socio-economic policy framework of the government. The set goal of RDP is to build 300,000 houses in a year with minimum of one million low cost houses to be constructed within five years, in efforts to aggressively combat shortages of housing. Presently, the South African housing policy is rooted in this housing white paper, published by the government in December 1994 (Tomlinson, 2002).

However, substandard housing remains a legacy of apartheid regime: 20 years after electing the first president to power through multiracial votes in South Africa, 3.3 million affordable houses have been built. But even so, slums and squatter camps are infiltrating areas surrounding the cities, meaning that the national, provincial and local governments are still battling with shortage of affordable housing and poverty (Tomlinson, 2002). As the government, unfortunately, failed to keep pace with the immense challenges of population growth, there is an urgent need by the human settlement agents to educate people about population growth which causes shortage of affordable housing in the major cities (Goebel 2007). While the government's goal is to provide affordable housing for the people, the ability of government to provide this housing in such large numbers is restricted by its macro-economic policy, a policy specifically for reduction in inflation and reduction in government expenditure to below 4% of GDP (Tomlinson, 2001). After two years of approval of the comprehensive plan for the development of sustainable human settlement – known as Breaking New Ground (BNG) – dramatic changes are beginning to occur in affordable housing delivery in South Africa (Rust, 2006).

South Africa offers many opportunities and many challenges; affordable and available living spaces for decent accommodation, including land, are the main challenges. The government is the number one stakeholder to provide housing; however, it has a poor record of not meeting its promises and not keeping up with the demands of the people (Tomlinson, 2002). Although government establishes policy and legislation purposely designed for standards and regulations related to servicing the housing demand, delivery of housing and provision of social amenities are associated with inadequate quality, lack of resources and constant increase of a housing backlog that translates directly into frustration and anger of the people (Goebel, 2007; Huchzermeyer, 2001).

Tomlinson (2002) states that access to financing by the majority of South African citizens is a major challenge to sustainable housing development. The 1994 white paper on housing delivery confirmed that 70% of the South African population is unable to afford finance for housing; only 10 to 15% of the people are able to afford limited finance from local lenders. The new government has a series of programmes that allocate subsidies according to a recipient's income, as shown in Table 2.1[8].

Table 2.1: Subsidy rates by the government

Monthly Beneficiary Income	Subsidy Amount
Zero salary to R1, 500	R16, 000
R1,501 to R2, 500	R10,000
R2,501 to R3,500	R5,500

The housing law section 26 of the constitution of the republic of South Africa states that "every citizen has the right to have access to adequate housing, no citizen may be evicted from their home, or have their home demolished, without an order of court made, after considering all the relevant circumstances. No legislation arm of the government shall permit arbitrary eviction". Hence, it is the responsibility of the government to take reasonable legislative measures within the resources available to achieve efficient realisation of citizens' rights. This is a special duty that enmeshes national government, as well as provincial and local governments, in shared responsibility for sustainable housing delivery for the citizens of South Africa (Tomlinson, 2001).

2.7.4 Involvement of construction industry in housing delivery in South Africa

Although construction industries in South Africa are responsible for the task of understanding and translating strategic sustainability objectives into affordable housing production processes, this has been established as an extremely challenging duty. Effective housing delivery has been aggravated by the multinational perspective of sustainability known as economy, society and

[8] Table 2.1 adapted from Richard (2001)

environment, including a lack of structured methodology and ineffective communication among the stakeholders at various levels of management (Ugwu & Haupt, 2007).

Sustainable housing development as a concept has been gaining increased acceptance worldwide across various sections, including the construction industry itself. Similarly, sustainable development has gained wide acceptance within various national governments, which have organised programmes to meet the objectives outlined following the June 1992 Rio de Janeiro Earth Summit (Ugwu *et al.,* 2006). But challenges of integration of sustainability into production process objectives are particularly acute in South Africa, a country needing extensive affordable housing delivery to stimulate economic growth, poverty alleviation, institutional strengthening, capacity utilisation building, and socio-cultural dimensions that will sustain peace, harmony and co-existence (Ugwu & Haupt, 2007). Hence, the industry has the responsibility of redirecting it actions and opinions toward sustainable affordable housing delivery to alleviate widespread poverty among the communities in South Africa (Ofori, Hindle & Hugo, 1996). Inadequate integration of sustainability into housing delivery development during the design stage keeps the realisation of effective design and construction for sustainable housing delivery in a difficult space in South Africa. Hence, to address sustainability in South Africa, there is an urgency to develop techniques to enhance effective participation of the stakeholders (Ugwu & Haupt, 2007).

2.7.5 Involvement of stakeholders in South African housing delivery

Affordable housing delivery to low income citizens across South Africa will reflect citizens' social rights to housing and will enhance citizens' sense of belonging. Therefore, decentralisation of the housing production process to involve strong community participation will continuously augment economic growth (Patel, 2016). Furtherance to discussion of stakeholder involvement, community participation in housing production processes for human settlement development in South Africa needs to focus on implementation of a central policy for development of driven strategies, through the establishment of two important conditions with respect to the conception and institutionalization of participatory processes. The communities and various other actors in housing delivery have not yet established a positional relationship. Private sector interest has hijacked the participatory dialogue, with community interest being side-lined (Miraftab, 2003).

The principles of inclusion of citizenship into housing production processes in South Africa are enacted at the planning and implementation stages. However, since housing allocation is devolved and power granted to local elites, an important aspect of citizenship making has been delegated with insufficient checks and balances (Patel, 2016).

The criteria of selection of citizen participation in housing allocation and production processes, through the use of identity and social relationship as eligibility toward allocation of housing, may cause conflicts by influencing existing social tension, xenophobia and political party contexts, and the actions derived from these conflicts will ultimately undermine citizenship ideas (Lalloo, 1998; Petal, 2016).

2.7.6 SMEs involvement in housing production process in South Africa

Prevalent poverty amongst the poor and an entrenched inequality among the citizens of South Africa are the main reasons for the establishment of the BBBEE act to promote employment amongst others SMMEs. BEE-SMMEs are frustrated with numerous challenges such as lack of management, lack of finance, bad governance, and legal and administrative hindrances. These identified challenges have made it nearly impossible for community involvement in sustainable housing production in South Africa (Migiro, S. MSMEs & Black Economic Empowerment in the Construction Industry).

With the government's main motive of eradicating poverty and the entrenched inequality in South Africa, the government established a scheme known as Black Economic Empowerment Act (BEEA). The intention of the programme is for the formation of the BEEA scheme, and to serve as a socio-economic transformation strategy to redress the disparities among the citizens (Tshikhudo, 2016). The purpose is to enhance equity incomes, increase wealth, increase the level of black participation (particularly black woman and youth ownership), and aid in the transfer and retention of skills (Migiro, S. MSMEs & Black Economic Empowerment in the Construction Industry; Tshikhudo, 2016). Since the establishment of BEEA in South Africa in 1995, small, micro and medium-sized enterprises have been actively promoted through job creation, income generation and distribution, market competition and innovation and revitalization of community (Robbins *et al.,* 2000; Migiro, S. MSMEs & Black Economic Empowerment in the Construction Industry). Small and Medium Enterprises (SMEs) play a prominent role in a nation's economic development, as the role they play in the economy of any nation is significant. Hence, SMEs are widely studied and of particular interest because they contribute greatly to innovation, economic competition, equity, redistribution and employment creation (Musabayana, 2013).

2.8 Research concern issues and Gap-spotting from the literatures reviewed

Comprehensive literature review was carried out by the researcher to institute the construct of research questions from existing theory in order to make a contribution to the scientific field. After critically review the existing theory, the researcher discovered that existing literature is incomplete and inadequate in some significant way. The previous literature has overlooked an important perspective which would have had the potential to further the understanding of the challenges of sustainable housing delivery in Africa nations. However, this study provided a superior literature that discuss on housing challenges from briefing, planning, design and implementation, on this basis the research questions are proposed. The point to note, constructing all-inclusive research questions is overtly creating an opportunity for a study to contribute to body of knowledge. Consequently, five research questions are deduced from the comprehensive literature reviewed as stated in chapter one section 1.4 of the study. This idea was drawn from paradigm combination of Gap-spotting of Schultz and Stabell (2004 cited in Sandberg and Alvesson 2011).

The knowledge of assumption obtained from Gap-spotting in the literature reviewed was discovered through the study of Sandberg and Alvesson (2011) identified three basic mode of Gap-spotting to design a research question, that include *confusion spotting*, *neglect spotting* and *application spotting*. The combination of this theory was applied by the researcher for the formation of the research questions. Thus, the study Gap was identified as stated below;.

- The literatures on housing delivery in South Africa confirmed that; "Housing affordability in South Africa has been a significant challenge in recent decades. Efforts from both government and private sectors have been unable to quell the enlarging housing deficit in the country, especially at the lower end of the residential market (McGaffin, Spiropoulous & Boyle, 2019; Windapo *et al.,* 2017; Ubisi, Khumalo & Nealer, 2019)".
- The challenges occur through *unsustainable practices* in the use of *construction resources*, *construction cost issue*, *frequent changes in design issue*, *matching resource availability with cost* and *time management*, and *attitude of the stakeholders in sourcing cost efficient resources for use on site* (Omolabi & Adebayo, 2014; Windapo, 2017; Brown-Luthango, Reyes, & Gubevu, 2017; King *et al.,* 2017). The above information depicted the basis for designed the research questions 1-5 which the study investigated. On this basis the theoretical and conceptual framework of this study in chapter three was postulated. Consequently, this study investigated concern issues, thus, resolved the challenge through proposed framework to enhance competence of construction operators towards

the use of sustainable techniques in delivering inexpensive housing affordable to the people of South Africa, regardless of level of income.

2.9 Summary

This chapter contains the review of literature related to this study; significant facts are extracted from previous studies. As a result, important headings are outlined in this chapter. On these bases, research questions and methodology used to achieve the aim and objectives of the study was established. The literature reviewed revealed significant information and figures vital to the establishment of the conceptual framework of this study. Notably, literature revealed that cost has long been a substantial problem confronting the efficiency of sustainable housing production processes worldwide, most especially in developing nations; high cost, for example, is experienced in the area of poor design and inadequate planning and management inadequacies. Through these trends, poverty, economic problem and segregation have dominated the communities of developing nations. In addition, poor construction techniques have severely affected people globally through high cost of construction. The situation has forced people to settle in squatter camps amidst dangerous environments flush with overcrowding issues. The literature also revealed that unsustainable practices toward cost effectiveness worsen housing delivery in developing nations. Similarly, the literature confirmed that construction operators fail to integrate sustainability into housing delivery since cost has been identified as significant factor from the initialling stage through to the closeout stage in delivery of sustainable housing. Cost influences the environment, economy and society. On the other hand, adequate planning for cost usage during project production processes is essential toward sustainability as this measures user requirements to achieve cost efficiency during production.

Importantly, while literature has proven that housing is an essential element in the human existence, housing remains a notable challenge in Africa. Despite governmental efforts in developing nations, African nations record the highest number of housing deficiencies as compared with other continents. And these housing deficiencies continue to increase concomitantly with the high rate of urbanisation and rapid population growth. Even now, housing polices in African nations have not yielded enough positive effect on the life of the poor considering the enormous amount of money spent on housing. In addition, various housing delivery programmes have been established for sustainable housing delivery for the poor, but these appear to be merely a mirage for the poor. The primary reason for the malfunction of housing policies is that concept of sustainable housing delivery has not been adequately embraced by African governments.

The subsequent chapter explains the theoretical and conceptual framework for sustainable housing delivery and procedure as an attempt to bridge the gap in literature while also contributing to the body of knowledge toward improvement of standard management for housing production processes. To achieve sustainability of integration into housing production processes, it is vital to establish a management system such as those focused on construction techniques, social satisfaction, construction constraint and resource usage that includes management of knowledge area, sustainable design, stakeholder and household satisfaction, cost, timely delivery and quality expected of housing. The research position is that appropriate management of construction cost will lead to sustainable housing so that housing will be available and affordable for all people irrespective of income.

Ugwu and Haupt (2007) show support by explaining that construction industries in South Africa are duty bound to translate strategic sustainable objectives into affordable housing delivery. Patel (2016) explains that effective system of sustainable housing delivery can be achieved through efficient resource management policies; moreover, decentralisation of the housing production process to involve strong community participation will continuously augment economic growth. But as this has been established as an extremely challenging duty, a solution to the challenge has not been resolved by any researcher. Effective housing delivery in South Africa has been aggravated by the multinational perspective of sustainability known as economy, society and environment, including a lack of structural methodology and ineffective design, resource control and communication among the stakeholders at various levels of management. As a result, this study’s aim is to establish factors that influence housing and thereby develop a framework for effective management of cost toward sustainable housing delivery for construction cost to remain within the limit of budget. The next chapter discusses the conceptual framework of this study.

CHAPTER THREE

3. THEORETICAL AND CONCEPTUAL FRAMEWORK FOR SUSTAINABLE HOUSING DELIVERY AND PROCEDURE

3.1 Introduction

The chapter comprises a conceptual framework involving a discussion of analysis tools, variations and context. The conceptual framework characterises ideas for development of affordable housing production processes. In addition, the conceptual aspect of this study aims to give a detailed explanation of concepts used in this research. The major reason for the establishment of a conceptual framework for this study concerns the improvement of longstanding issues affecting sustainability (i.e. economic, social and environment) with regard to affordable housing delivery to the people irrespective of income. Thus, construction cost of housing production processes must be efficient to enhance availability and consistent housing delivery to the people. A theoretical framework section of the study involves design of the research construct; sustainability integration as a means of cost reduction of affordable housing delivery; and supporting housing delivery mechanisms. In this chapter, the ideological construct of this study is established, and through this process, the research aim and objectives will be accomplished.

3.2 Theoretical perspective on sustainable housing production

3.2.1 Sustainable housing delivery concepts

Sustainable housing delivery has been identified as a multifaceted challenge in an industrialized and urbanized society because the quantity of housing needed is increasing; thus, permanent solutions to problems of affordable housing, availability and construction cost efficiency are imperative (Windapo *et al.,* 2017; Adebayo, 2002). Pugh (1986) explains that research for development of housing started in the 1960s. Since that time, the literature relating to housing has expanded greatly, establishing housing with a specialised status in economics, politics and sociology. Hence, the newer literature encompasses a full technical, statistical, theoretical, historical and ideological range, but within that range, housing studies have not been conceived and interpreted in a uniform way, with generally accepted concepts and principles or with uniformly fixed and precise methodological approaches.

Ibem and Amole (2010) confirm that housing is an integral part of human settlement that, as it fulfils basic life requirements, has an important influence on the productivity of a man's quality of life and health. But the majority of the people living in urban areas of developing nations are without access to decent housing at an affordable cost. Inadequate housing conditions remain a big hurdle, receiving attention from professionals, government, developers and even individuals in most developing nations.

Placing (2000) explains that the concept of *home* has been a focus of research since 1970 within the sphere of environmental psychology. Notwithstanding this awareness, there remains a dearth of critical and innovative theories and methods which scrutinize the standard of a *home.* A call has been made for a reappraisal of the concept. However, Placing (2000) further expresses that previous discussions concerning the concept of *home* within psychology tended to focus mainly on the experiential and personal aspects of home more than social and cultural attributes. Recent shifts, though, have occurred in discussions concerning *home* which have been inclined to disregard the experiential significance of home, so there is a need to focus more on the experience and use of a home.

3.3 National involvement, community and individual involvement in sustainability integration theory

Sustainable housing delivery is a worldwide challenge, as it involves improving the methods of production to achieve affordable housing; thus, effort is necessary to reach a higher effectiveness (Ayoola & Omole, 2014). Researchers are continuously investigating developments to achieve better technologies and improve working practices. But in the process of moving to new technologies, damage occurs to the environment and natural resources are depleted, all in an effort to lead change toward sustainability (Basiago, 1998). This change toward sustainability has generated fundamental questions regarding how to live life without depleting natural resources. Answers to such questions must come from national levels, down to communities and even down to individuals (Brugmann, 1996).

Doppelt (2009) confirms that as leading change toward sustainability is vital, businesses are attempting to effectively navigate through the difficulty transition from conventional to sustainable techniques. But many others are not transitioning, and the process is beset with impediments from failure to change the embedded ways of doing business to misconstruction of the problem at hand (Brugmann, 1996). However, real change is not only possible, it can be strategically nurtured and implemented by following the path laid by the early adopters of the sustainability integration into production vision (Habitat U.N., 2013). Doppelt (2009) further finds an ambiguity of leading change toward sustainability, if vision and leadership that are vital to sustainability are not adequately handled, as effective leaders set the tone and define their organisation with clarity of vision, belief and dedication.

3.4 Concept of impact factors

Kain and Quigley's theory (1975) expresses that land is a determinant factor for affordable housing delivery price: since competition for central location will bid up the price of land, centrally located land in urban cities is naturally more expensive than land located further from the centre, so naturally, the price of affordable housing will escalate in cities. Galster and Hesser (1981, cited in Salleh, 2008) explain that *theory of demand and needs of residential satisfaction* measures the difference between household actual and desired housing, and neighbourhood situations. It is one of the impact factors that necessitates affordable housing delivery. Because households make judgments about residential conditions based on their needs and aspirations, satisfaction with residential conditions indicates the absence of complaint as needs and demands are then satisfactorily met (Chan & Chan, 2004). Similarly, Kain and Quigley's theory (1975) explains that residential location and housing consumption decisions of urban households are based on utility maximising in which households attempts to maximise their real income.

Residential and neighbourhood satisfaction is a significant indication of housing quality and conditions that affect individual quality of life. Therefore, the factors that determine the satisfaction of the occupants are essential inputs in monitoring the source of housing policies. Another factor identified as *influence satisfaction in a dwelling housing* is the neighbourhood factor (Salleh, 2008). While factors contributing to low levels of satisfaction with neighbourhood facilities and environments have been identified as poor public transportation and lack of several important things – a children's playground, a community hall, a car park, security and a disability facility, for example – the absence of these shows that that little attention has been placed on the provision of decent neighbourhood facilities for a family-friendly environment (Brown, 2011; Salleh, 2008).

Housing policies and programmes have long been implemented by government agents and corporate organisations to ensure that *all* have access to adequate housing in developing nations (Goebel, 2007). To achieve sustainability in the housing industry, the government and its agents, corporate organisations and construction operators all must regulate housing delivery activities to suit household needs and wants by examining factors that account for housing satisfaction or dissatisfaction (Gyourko & Saiz, 2006). The factors that account for housing satisfaction include the following: local community and social capital investment and neighbourhood stability of ownership (Teck-Hong, 2012). The construction industry in developing nations is essential toward sustainable development. However, as the housing industry experienced significant growth in the 1980s then encountered property oversupply, the majority of the housing units remain unsold for reasons beyond the price factor, reasons ranging from poor location to unattractive houses (Teck-Hong, 2008).

3.4.1 Design concept impact

Sustainable design is a concept purposefully planned and developed for affordable housing delivery to meet a set of requirements. Thus, initial concept at the planning and development stage of the design process is significant because a better design process leads to a better design outcome (Maina, 2013; Makinde, 2014). Sustainable development for our cities is dependent on actions of today through adoption of sustainable design processes toward construction activities. Having sustainable cities is essential in our rapidly urbanizing world. Conceptual ideas work at the briefing stage of a housing production process when put into practice through a range of policies and planning strategies, with the ultimate objective of achieving urban sustainability (Dempsey, 2005). Achieving sustainable urban development is an intense task, with intricacies of the scale and variety of urban forms, and the friendly intermingling of environmental, social, and economic issues, suggesting that as every place is so different, meaningful action is nearly impossible (Okon & Ukwayi, 2012). Adequate planning for sustainable design will combat the challenges of urban overcrowding since cities has different situations concerning environmental, social and economic factors (Williams, Jenks & Burton, 2000).

3.5 Sustainability integration

The concept of *sustainability integration* means to respond to economic, social and environmental issues affecting sustainable housing delivery, as literally *sustainability* means a capacity to maintain production processes without significantly depleting the natural resources on which it depends (Jenkins, 2010). Bossel (1999) admits that sustainability has become a general accepted goal for human society, ever since we began to witness the deterioration of the environment worldwide. According to Bossel (1999), to actually know if people are on the path of sustainability, there must be an appropriate set of indicators of sustainable development for each country, region and community, even the world; however, this is certainly not an easy task as it entails knowledge of what is important for viability of a system involved and knowledge of how system that contributes to sustainable development.

Ikerd (1997) explains that sustainability has significant attachments with economic, political and social issues; consequently, numerous conferences have been convened internationally and locally to discuss the issue of sustainability and related topics. Sustainability is a long term, people-focused concept. While many attempts have been made at defining *sustainability*, most definitions are rooted in the general concept of international equity (Okon & Ukwayi, 2012; Habitat U.N., 2013). Ikerd (1997) confirms that sustainable development is a means meeting the needs and wants of people of the present generation, while leaving equal or even better opportunities for the generation to come to meet their own needs in terms of natural resources and economic development. Thus, sustainability is about sustaining a desirable quality of life for people, forever (Habitat U.N., 2013). Similarly, Bruntland also reported (1997, cited in Norberg & Cumming, 2013) a similar definition of *sustainable development* as development that meets the needs of the present generation without compromising the ability of future generation to meet their needs. The United Nations (1987, cited in Scherer, Palazzo & Seidi, 2013) defined *sustainable development* as development that meets the needs of the present without compromising the ability of future generation to meet their own needs, thereby suggesting that sustainability should be a central guiding principle of organisations, enterprises, governments and nations.

3.6 Economic sustainability integration

The United Nations (U.N.) stated that in the coming ten years, the world's population will be living mainly in cities; this will threaten cities with social conflict, environmental degradation and collapse of basic services (Habitat U.N., 2012). Consequently, the economic, social, and environmental planning practices of societies embodying urban sustainability have been proposed as remedies to combat these negative urban trends (Basiago 1998). Special attention is required from *every nation* to combat the menace of the increasing populations of urban cities, before the backlash of detrimental effects, which will adversely affect the environment of the city, and consequently the economy (Habitat U.N., 2012).

However, Basiago (1998) explains that since the days of Malthus, economists have ignored the quandary of resource depletion. Conventionally, economists have primarily been concerned with the efficiency of resource use. Most economists have been slow in developing economic models that account for resource scarcity and pollution. Occasionally, an economist worries that some resources may be in short supply, since these resources are used arbitrarily, but natural resources may face depletion and restrain the very growth for which they are developed (Hill & Bowen, 1997). Economic theory explains long-term growth and technical progress that has remained unsettled into the modern age. Sustainability integration into resource use will turn resource depletion around, if not totally conserve resources for use by future generations (Basiago, 1998).

The issue of sustainable development has grown into a worldwide discussion; the adoption of this comprehensive definition of sustainable development is a requirement for effective progress (Hill & Magnani, 2002). Therefore, barriers identified as impeding government policies toward development are lack of the proper promotion for four aspects of sustainability for development, which include ecological sustainability, economic sustainability, social sustainability and cultural sustainability (Hill & Bowen, 1997; Robert & Hill, 2002). The body of theory and practice that have added to the formulation of guidance for assisting in the design and discharge of sustainable development strategies has progressed through a series of models, models which have identified the presence of a number of stages for the development of policy methodologies for the promotion of sustainability (Robert & Hill, 2002). Various models have attempted to provide such guidance, including standard management system and national sectorial planning approaches. Though these models have much to contribute by way of nonspecific skills and the provision of understanding, they generally lack a deep appreciation of the wider consequences of sustainable development (Hill & Magnani, 2002).

3.6.1 Environmental sustainability integration

Environmental sustainability integration is defined as the rate of harvest or depletion of natural resources that should not exceed the rate of regeneration of natural resources (*sustainability yield).* Thus, waste generation during housing production processes should not exceed the adaptation capacity of the environment (*sustainable waste disposal)*. Environmental sustainable integration demands that depletion of non-renewable resources should be compared with the development of renewable substitutes for natural resource reduction to attain sustainability of resources (Daly, 1990).

To achieve effective sustainability of the environment and slowing of natural resource depletion, there must be adherence to the principles of the three pillars of sustainability. These state that for the complete sustainability problem to be resolved, the three pillars of sustainability must be successful (Habitat U.N., 2012), signifying sustainability of economic factors, social factors and environmental factors for the benefit of all people (Pearce, 1988). Environmental quality is significant to people's health, economy and well-being, necessary because of severe challenges emanating from *unsustainable* human activities, such as unsustainable consumption and production as well as various forms of pollution (Daly, 1990).

In recent decades, the world has encountered severe confrontations with the environment through constant climatic changes. Since 1970, the actual conflict between the economic system and the environment has been alarming, with the impacting factors identified with economic system being production, consumption and technology, while those of the environment identified as natural and man-made elements (Habitat U.N., 2012). These factors have become the subject of intensive studies in both developing and developed nations. Many nations have aggressively tackled environmental pollution – notably air pollution, water pollution and noise – with fair success (Nijkamp & Soeteman, 1988).

3.6.2 Social sustainability integration

The Bruntland Commission made the world aware of the concept of sustainable development in its seminar report; ever since then, government, at its various levels, has struggled to operationalise the concept in developmental policies. The root of concern for this struggle is because the concept of sustainability has a variety of meaning and differing degrees of concern to different people (Vlek & Steg, 2007). However, despite the fact that people have different opinions, the fact still remains that people share a consensus that natural resources are being depleted at a faster rate than the rate at which they are being replaced. Thus, awareness has proceeded to a growing appreciation of the importance of safeguarding the contribution that natural resources make to the development process, sustained over time (Habitat U.N., 2012; Vlek & Steg, 2007).

According to Munasinghe (1993), the concept of sustainability of the Brundtland seminar call is for integration of economic, social and environmental factors, and for establishing social development. Since then, several researchers have made a frantic effort to study the needs of people in an effort to determine solutions to social challenges. Recently, people have been contemplating the causes of the rise in price of housing delivery, and society is clearly worried about the type of working conditions under which housing is delivered (Carter, 2006). From this anxiety, researchers have commenced studies concerning social management issues, specifically to understand how factors of environment, safety and human rights will affect housing production processes. It is unwaveringly important to consider social factors surrounding the delivery of affordable housing (Carter & Roger, 2008).

Though the social dimension of sustainability has been widely accepted, the meaning of *social integration* has not been very clearly defined or agreed upon. Social sustainability has overlapping concepts of social capital, social cohesion, social inclusion and social exclusion (Dempsey *et al.,* 2011). The factors discussed by theorists and practitioners as contributing to urban social sustainability and social sustainable urban development are the following: education and training; urbanity; attractive public realm; participation in local democracy; decent housing; health; quality of life and well-being; local environmental quality and amenities; accessibility to local services and employment; peace and safety; neighbourhood; social order; and sustainable urban design (Habitat U.N., 2013; Dempsey *et al.,* 2011).

3.6.3 Theory of sustainable housing delivery awareness

Cater and Fortune (2007) report that governments of developed and developing nations have invested massively toward the improvement of quality of programmes on rented social housing over a period of time. The aim is to incorporate sustainability features within the building project associated with development programmes. Cater and Fortune (2007) explain the gap between policy and practices in two areas: 1) possession of sustainable development; and 2) the importance given to differing features of sustainability. However, Cater and Fortune (2007) clarify that the requirement to deliver sustainable social housing projects still presents challenges to professionals involved. Translating policy into actual practices requires a common understanding of the individual features of SD policies and how these features are addressed at various levels of a housing project.

Williams and Dair (2007) describe that developed and developing nations have introduced a number of initiatives into their policies to ensure that sustainable development schemes are produced. Therefore, every department within the governmental sphere is leading programmes to create a sustainable community, safeguarding sustainable materials and techniques of usage to promote the interest of the private sector in sustainable construction. Beauregard (1989, cited in Gunder, 2006) explains that sustainability is an essential mechanism of the government to provide rational societal guidance, management and coordination between the economic and social domains for the common good.

3.6.4 Theory of affordability of housing

The residential property market has witnessed significant price escalation over the past fifteen years. The economic theory, for instance, has explained that house price movement is inherent with regional economics and regional demographics such as income, cost of capital, stock price and population change. Thus, sudden price change could be expected to affect home ownership to an extent. However, it is well established that under any circumstance, the need for housing as a basic necessity persists, despite costs (Hashim, 2010). The permanent income methodology for housing affordability is a process that considers what different household types can afford spending on housing, after reconciling other necessary expenditures for living. It is a substitute to benchmark measures of affordability as used in social housing rents in developed nations. Hence, the 25% rule: this is the method most commonly used to access affordability of housing (Stone *et al.,* 2011).

Hashim (2010) confirms that owning a home for both accommodation and well-being is critical to most families' ultimate plan, as well as being regarded as an achievement of personal success. Considering the period of rapid economic growth, people have believed that housing prices will continue to surge, often making house ownership unaffordable. Affordable housing continues to be an important expression of family aspirations, and yet the most expensive investment by households. According to Olotuah and Bobadoye (2009), housing delivery plays an eminent role in the development of any country's economy in terms of financial wealth, employment, consumption, capital market and stimulation of the business cycle. Therefore, the prolonged increase in house prices makes the local economy vulnerable to an economic slowdown and increasingly prone to financial unsteadiness and inequity (Hashim, 2010).

Stone *et al.* (2011) explain that a *family budget* is identified as an approach to conceptualizing housing affordability; affordability standards, though, are based on a combination of decisions and overall measures of what households actually spend. Every household has its own condition of life; for each family, there are historically and socially determined concepts of what constitutes a decent standard of living. One indicator of this is the poverty line as the least possible entitlement as to the quantity and quality of essential goods and services a household could consume. Though budgeting is identified as a methodology that may be able to specify a reasonably precise physical standard for housing, still it cannot establish a precise monetary standard.

3.6.5 Theory of accessibility of housing

The theory of accessibility is the ability of the people to benefit from the features that are present in urban areas; similarly, accessibility of the environment is available to people when all necessary qualities that enhance urban areas are present. The ability to compete for site depends on whether or not people have the means to benefit from accessibility and harmony within the urban framework. Conventional theory states that productivity during production processes on site determine urban rent, which is highest at places of maximum accessibility (Jordaan *et al.,* 2004). Housing is durable and thus has an important effect on the evolution of cities. Over the course of a decade, cities with better amenities will grow faster. Similarly, collections of economic and human capital are also significant drivers of city growth, diversity in production and human capital. Smaller firms nurture urban growth, thereby encouraging accessibility to housing (Dranton & Puga, 2013).

The most significant way of differentiating urban areas from rural areas is the high concentration of activities and people. However, land in urban areas is a determinant factor for accessibility, as the price of land in urban areas tends to be higher than rural land due to the potential uses for industry and commercial purposes. Access to both industrial and residential locations is important because it impacts transportation costs. This can be established through utilities that depend on monetary factors including travelling costs to work, schools, shops, as well as open space tor public functions (Jordaan *et al.,* 2004).

3.7 Housing delivery procedure concept

In developing nations, the source of housing challenges stem from quality *and* quantity. Previously, governments have invoked various strategies for overcoming the enormous shortage through several housing reform programmes. Despite every effort of input by the governments and international organisations, housing continues to be a mere mirage to the common people of developing nations. While programmes have been initiated toward mass housing delivery such as affordable housing schemes that involve the use of private partnership efforts and numerous private finance initiatives models, these only account for 3% of the actual quantity required (Makinde, 2014).

Adebayo (2005, as sited by Makinde, 2014), clarifies that governments in developing nations initiated affordable housing delivery programmes for common people due to development and population growth in urban cities with subsequent serious shortages of housing. Government policy was directed primarily toward delivery of low cost housing on a large scale, even though state governments are not left out in such a housing delivery programme policy. However, while the execution of this programme contributed immensely to adequate housing delivery, the housing delivery process has not been sustainable over time because of the absence of thorough post-implementation strategies.

Table 3.1: Developed and developing nation's mortgage finance ratio (as a share GDP)

Country	**Mortgage finance to GDP ratio**
United Kingdom (UK)	80%
United State of America (USA)	77%
Hong Kong	50%
Europe (Average)	50%
Malaysia	32%
South Africa	31%
Botswana	2%
Ghana	2%
Nigeria	0.5
Other Africa nations	Mortgage finance is relatively very low

According to Okonjo-Iweala (2014), inattention to the housing sector in many African countries is a challenge; this situation is obvious through the investigation of economic data. The example of size of the mortgage finance, in both developed and developing nations, is indicated in Table 3.1[9] above.

Olayiwola *et al.* (2005) suggests, like so many others, that developing nations are challenged with delivery of quality and affordable housing for the poor. A case is cited in Nigeria where political, economic, social and environmental factors, along with the huge foreign exchange accumulated from the rise in oil price in the 1970s, have forced civilians and the military government to intervene in the urban crisis. Initial intervention, however, took the form of rent control (Omolabi & Adebayo, 2014). The failure and abandonment of rent control led to public housing productions in the urban centres. Debate continues regarding the improvement of public housing in Nigeria, as it was previously abandoned on the guise of the exercise being an extravagance; moreover,

[9] Table 3.1 adapted from Okonjo-Iweala (2014), 6th Global Housing Finance Conference

the economic pressure brought about by the structural adjustment programmes of economic recovery of the 1990s was also a contributing factor to abandonment of this promising programme (Olayiwola *et al.*, 2005).

Provision of adequate low-cost housing for thousands of people is undeniably one of the most serious problems in South Africa. In reference to statistics South Africa (2009), only 56% of all South Africans lived in fully-owned formal dwellings in 2009. The situation appears near impossible to whittle away the backlogs, especially as challenges with the standards of construction activities and the continuing influx of population into cities heightens the severity of the existing situation (Le Roux, 2011). As adequate housing is accepted globally as a basic human right, the United Nation Millennium Goals has put further pressure on governments to permanently resolve the issue of failure to provide adequate housing for all, including access to adequate water, sanitation and safety of environment (Habitat U.N., 2013). Hence, the provision of low-cost housing is a severe and intense problem, unique in character seemingly irresolvable. The system theory is regarded as one of the more successful attempts at addressing this serious problem (Le Roux, 2011).

3.7.1 Economic implication of housing delivery theory

According to Hassen (2000), housing delivery contributes to economic growth and job creation, with the economic implications of housing delivery being lower transaction costs, creating economic linkage, concentration of economic activities, responding to change, improving productivity capacity, creating wealth, creating jobs and boosting demand. Likewise, infrastructure development and housing production processes enhance productive employment opportunities: providing incomes, improving livelihoods, supporting welfare, promoting well-being and tackling poverty. It is well established that jobs have a transformative effect on the structure and impact of economic growth on wider development. Still, African economies are undermined by lack of infrastructure development necessary to enhance economic growth and structure diversity (Osikena, 2014). Thus, the concept of development through housing involves reconstruction and reindustrialization of the construction industry toward enhancement of effective production for economic growth. Similarly, it is necessary to establish effective planning for housing development to determine the best direction and pace of economic development (Bertoldi, 2010).

3.7.2 Social implication of housing delivery

Housing is significant, one of the most important needs of individuals, so while food and clothing are the first essential commodities, housing is the second. Housing needs for low income earners has reached an alarming stage in developing nations (Jiboye, 2012). In order to achieve adequate delivery of housing, governments have enacted various policies aimed at disabling the massive shortage of housing through numerous reform programmes. Despite concerted efforts by governments to improve housing production, good housing is still illusive to ordinary citizens in developing nations (Olayiwola & Ogunsakin, 2005). Those factors identified as hindering the ability to meet the social need of the people are numerous: insufficient funds, high interest rates, low per capita income, high costs of public houses, lack of security of income and lack of collateral. The solution to these identified challenges resides with the creation of a viable secondary mortgage market and compassionate urban renewal programme (Iheme *et al.,* 2015).

While every citizen has the right to adequate housing, the implementation of such right is a challenge in developing nations. Governments have invoked several policies to alleviate the shortage of housing, but clearly most of these programmes have not satisfactorily solved the problem of delivery of value and quantity of housing needed in developing nations (Omolabi & Adebayo, 2014). A case was cited in South Africa that the demand of the poor concerning housing has not been met due to a sizeable gap between demand and supply, an enormous gap which is widening rapidly while the patience of citizens concerning choices of housing is wearing thin (Mnisi-Mudunungu, 2011).

3.8 The conceptual framework of the study

The conceptual framework of this study involves analysis tools, variations and context. It makes distinctions and organises ideas for development of sustainable housing delivery, thereby developing knowledge about housing production techniques. The conceptual section of this study intends to offer a full description of concepts employed in this research and reveal concerns of the researcher contributing to ongoing discussion on techniques for sustainable housing delivery processes and integration of sustainability into production. The establishment of a conceptual framework for this study basically concerns the improvement of longstanding issues affecting *3-D of sustainability* (economic, social and environment) in relation to affordability, availability, consistency and continuous housing delivery to the people.

Sustainable, affordable housing delivery is centred on effective management techniques involving management knowledge, principles and practices, in accordance with sustainability policy regarding cost effectiveness in housing and economic development. The needs and requirements are critical issues surrounding affordability of housing; similarly, stakeholder influence on affordable housing delivery is quite severe for successful production of housing. Hence, the establishment of an effective framework of techniques for construction operators to manage stakeholder influence of certain variables is significant. Stakeholder satisfaction is pivoted on interest and need fulfilment.

Resource usage and construction constraint linkage issues are further challenges to the sustainability of housing. Therefore, to achieve sustainable housing development, a framework of management techniques must be established to diminish the gap between resource usage and construction constraints, as this hinders the process of affordable housing delivery. Similarly, design issues are dire to affordable housing, so again, efficient techniques are required to achieve sustainable design and avoid resource wastage which escalates the price for affordable housing.

Sustainability integration is fundamental to improvement of productivity and economic growth of the people. Thus, it is essential for all stakeholders and end users of sustainable housing to practice careful sustainability through the adoption of established principles of sustainability.

The conceptual framework for the management of techniques, resources and construction constraints for sustainable housing delivery is presented in Figures 3.1 and 3.2 below. Achieving standard management for affordability of housing hinges on the establishment of *construction techniques* through the application of management knowledge areas and management principles and practices. Correspondingly, *social satisfaction* is based on management of needs and requirements for stakeholders; *construction constraint* is based on management of cost, time of delivery and quality expected for affordable housing. *Construction resource issues* that result in wastage can be reduced through the careful management of productivity.

The ideological construct of this study is denoted as *management of cost of construction issues (MCCI);* on these bases objectives one and four will be resolved. The management of the *frequent changes in design issue* affects affordable housing delivery signified (MFCDI), connected with issue of unsustainable design to resolve objective two. Assessment criteria for management of the *construction resource syndrome* which causes wastage, and which affects productivity, based on knowledge, attitude and perception (KAPs) of stakeholders is denoted as (MCRS), linked with

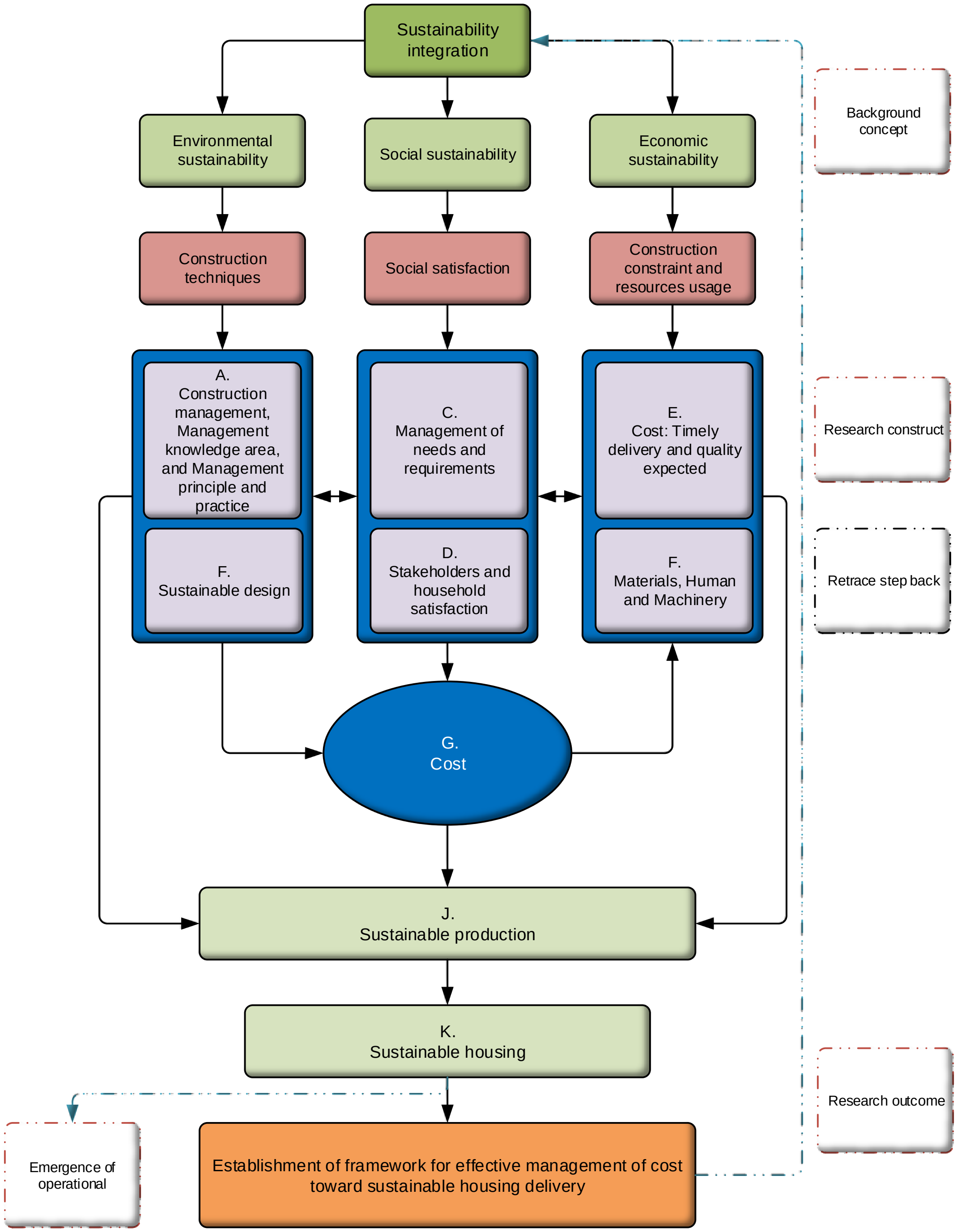

Figure 3.1: Conceptual framework for effective management of cost for sustainable housing delivery

objective three to resolve resource issues. The final ideological construct for this study is the *establishment of framework for effective management of cost toward sustainable housing delivery*

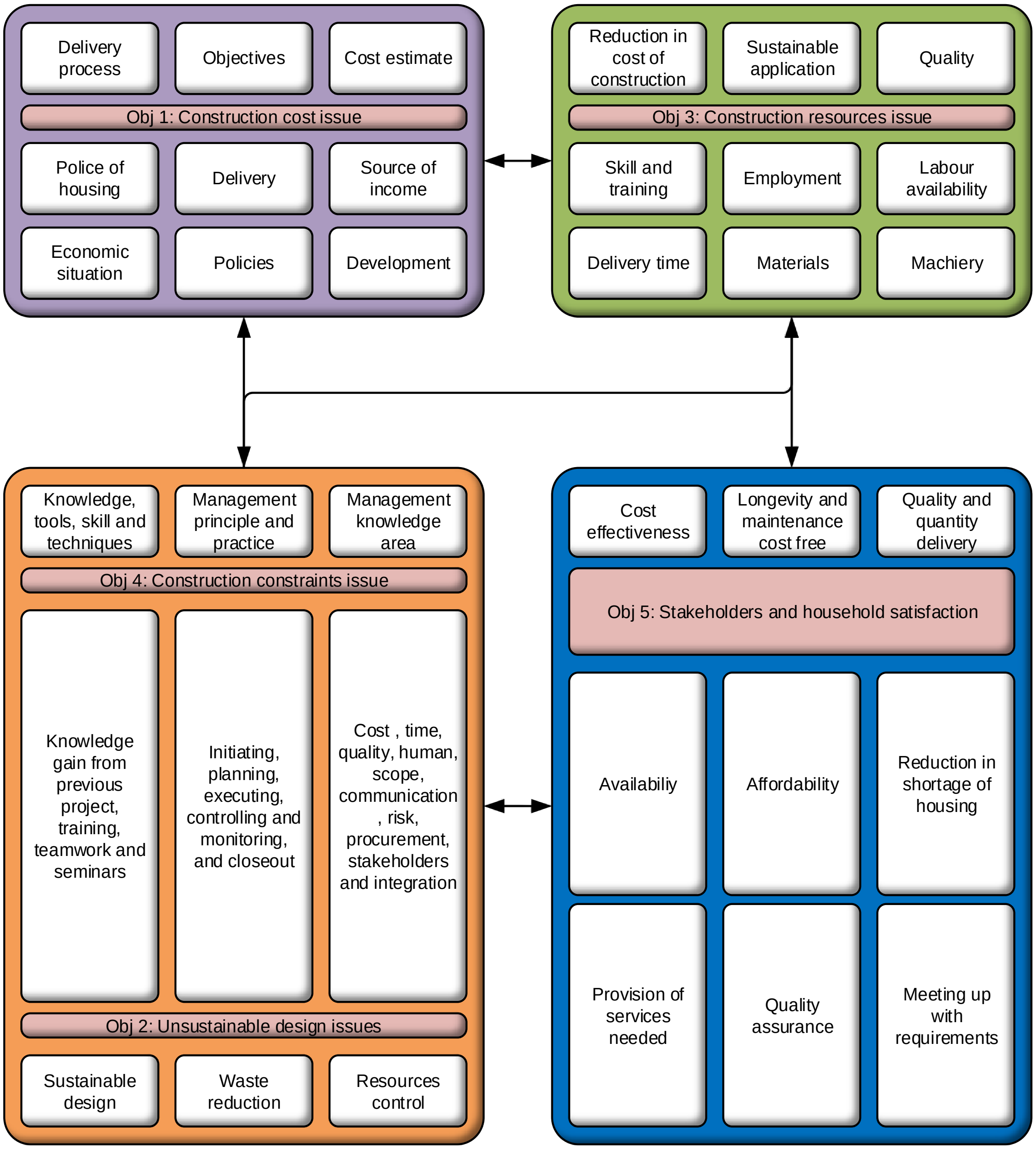

Figure 3.2: Interaction between research concepts

for construction cost to remain within the budgeted cost, interpreted as EMCSHD=MCCI+MFCDI+MCRS; objective five is connected with objectives one to four to establish a framework; alternatively it can be interpreted as MCCI+MFCDI+MCRS=EMCSHD. The integration of sustainability into these management techniques will enhance affordability of housing delivery. Therefore, expansion of interaction between research construct (Figure 3.1[10] & Figure 3.2) exemplifies the procedure through which the research aim and objectives are achieved. Figure 3.1 shows the linking between of AB, CD, EF, GJK and their constraint influence on cost toward sustainable housing delivery, necessitating the establishment of MCCI+MFCDI+MCRS=EMCSHD.

3.8.1 Housing delivery within budget

Housing delivery policies primarily seek to provide low medium-income households with housing through a variety of delivery mechanisms that combine essential basic services – water, sanitation, roads and electricity – within budgeted cost. The main objective is to facilitate the development of a wide range of community services necessary to be incorporated into sustainable human settlements (Ademiluyi, 2010; Hutchings & Christofferson, 2005). The housing subsidy programme, however, has had minimal little impact on poverty reduction, despite its scale and generous funding. Most government funding went to contractors to build new units of housing for the poor; it was assumed that these would replace homes in informal settlements that the poor had constructed themselves (Bradlow *et al.*, 2011; Bolnick & Bradlow, 2011).

Gyourko and Saiz (2006) explain that construction costs accounting for the bulk of the price of new houses has been relatively neglected. It is well documented that there are economically large differences in construction costs across developed and developing nations' housing market. The establishment of effective maintenance strategies is essential to control the first stages of degradation and prevent the failure of building elements. The selection of the most effective and appropriate strategies can enable better budget on location and can minimise the decline in the performance of buildings during their life cycle (Flores-Colen & Brito, 2010).

Construction delay during production processes is disruptive and expensive, further denying affordable housing delivery to low income earners. In developing nations, time and cost overrun have been identified as the most important factors responsible for abandonment of housing projects and contractor failure (Abinu & Odeyinka, 2006). Satisfaction of occupants in a building is related to the amenities that present. Moreover, user satisfaction is linked to cost effectiveness

[10] Diagrams in Figure 3.1 & Figure 3.2 adapted from Akinyede (2017)

and maintenance freedom of a structure (Kwon *et al.,* 2011). Thus, adequate planning for reduction in cost of housing maintenance is significant to minimise repairs and save cost, enhancing the cost efficiency of housing (Huynh, 2012).

The housing delivery objective is to provide affordable housing, rich in amenities, in a sustainable neighbourhood and with varieties of housing choices for low income earners. However, the situation of housing delivery in developing nations is worrisome: housing is delivered *above* the income of the majority of people. Consequently, virtually all developing nations are facing the serious problem of providing adequate accommodation (Olutuah & Bobadoye, 2009).

3.8.2 Construction resources issue

The construction industry is one of the most influential amongst existing industries, as it is responsible for enhancing economic growth and generating employment opportunities (Nubler, 2000). As such, the excessive cost of construction is the primary issue impacting effective performance of the industry. Housing production processes can vary from extremely profitable to barely worthwhile, and more often than not, end up costing the client *and* the contractor more than the initial budgeted cost (Dziekoriski, 2017). In the construction industry, the aim of housing project control is to ensure the project is completed on time and within budget, while achieving other project activities as time and cost are the two main trepidations requiring cost reduction techniques (Edun-Fotwe & McCaffer, 2000). Saving on the cost of construction is a seemingly endless goal within the construction industry. The most likely way to reduce construction cost is to develop innovative technologies and methodologies to enhance productivity (Mahadik, 2015).

Cost of construction can be reduced by improving productivity. Or in other words, costs go down when productivity goes up. Reducing the cost of housing can also occur from reducing the composite labour cost (UK Essay, November 2013): the most vital practices are that construction operators understand that resources like materials, plants and labour form the basis for the rate. Construction cost estimators must possess sufficient knowledge regarding the use of these resources before compiling an estimate (Billson, 2010). Estimators who lack experience and knowledge regarding the usage of resources are in fact dangerous estimators; good estimators will not only win tender bids for their company but also provide the price within which the housing project can realistically be constructed and completed (Adedeji & Olotuah, 2012; Billson, 2010).

Risk, cost, quality, time, safety and environmental sustainability, if effectively managed, will all impact cost reduction. Government, clients and designers should assume responsibility to manage their relevant risk and work cooperatively from the feasibility phase onwards to address potential risk in time. Similarly, contractors and subcontractors with solid experience in construction and management knowledge should be enployed to mitigate construction risk and carry out safe, effective and high-quality construction activities (Zou *et al.*, 2007).

Idrus and Ho (2008), having identified housing as the essential basic necessity of life, still note that housing is a major concern for people globally; it is often used as criteria to measure levels of enjoyment and standards of living of a country's citizens. Residential neighbourhood satisfaction is an important indicator of housing quality and condition, as this affects an individual's (and family's) quality of life. The factors which determine people's satisfaction are vital inputs in monitoring the success of housing policies. Housing provision policies for all, in *any* country, are crucial for ensuring social economic stability and promoting national development.

Jenkins (1999) explains that great success will be recorded in housing delivery if a community is allowed to participate in the production process through training of the people in knowledge in craftsmanship for sustainable housing delivery. Hence, training the community to be involved in housing production will enhance efficient production, reduce cost of construction, provide employment opportunity and generate an easy availability of labour. Wang and Li (2006) clarify that housing preferences are established on certain factors, with the most significant factors being family income, age, education and employment opportunities. Household decisions in the selection of housing in cities rely heavily on market situations.

However, problem of delay in housing production processes is a global occurrence, construction industries in developing nations included. The ten top factors *causing* delays in housing project delivery are as follow: 1) mistakes during the construction stage; 2) improper contractor planning; 3) inadequate contractor experience; 4) poor site management by contractors; 5) inadequate labour supply; 6) shortages in materials; 7) low equipment availability and high failure; 8) lack of communication between parties; 9) inadequate client financing and payment for completed work; and 10) problems with sub-contractors. The six major *effects* of delay on housing projects are as follows: 1) cost overrun; 2) time overrun; 3) abandonment; 4) litigation; 5) arbitration; and 6) dispute (Sambasiva & Soon, 2007).

Effective environmental policies are identified as the most important resources for providing sustainable housing production processes such as housing materials. The significance of sustainable housing materials will enhance employment opportunities for the people, since the community will be directly involved in the housing production process through the supply of local materials, thereby drastically reducing the cost of construction to accommodate affordable housing delivery (Muller, 2006).

Considering the comparative of wealth and peace, it is obvious that urban environments have grown more beautiful and people have become more fashionable, so that manufactured machines for housing production radiate positivity and harmony with the surroundings; this has been the forefront of household demands for quality (Tianliang *et al.,* 2010). Comfort of the people using machines for cleanliness and job satisfaction is considered highly valuable for efficient housing production. As earthmoving machinery is used on site, this equipment is highly visible to residents and passers-by in the vicinity surrounding the construction work. It also forms the primary environment of the operator of the machine (Nakada, 1997). Consequently, it is necessary to add to the basic design factors – durability and performance – as well as psychological comfort factors – feelings of familiarity and trust – to appeal on a regular basis to community in close proximity to the machinery as well as to promote operator satisfaction, pride and the desire to use the machinery on site (Tianliang *et al.,* 2010; Nakada, 1997).

3.8.3 Management of construction constraint

The management of a housing production process is complex enough without changes to a client's requirements, design and specifications; even so, changes are an all too familiar practice during housing production processes. To efficiently manage changes, construction operators must undertake effective detailed planning to integrate the work activities of professional consultants, suppliers and subcontractors. Frequent changes to design are unplanned disturbances that interfere with the intended advancement of work; the consequence of such interferences on a production process is critically detrimental to cost efficiency (Love *et al.,* 2002).

The standard measurement for the successful completion of a housing project by construction operators is specifically based on completion of housing project within cost and time specified; through this process the client and users are satisfied and thus happy. However, typical challenges confronting construction operators arise through cost, schedule and performance. As a result, these constraints are regarded as obstinate and unavoidable and, even more unfortunately, are regarded as acceptable during housing production processes; unfortunately, it seems more and more housing projects are delivered late (Newbolt, 1998).

In recent times, design and build (DB) construction techniques have garnered a reputation for the potential advantage in improving project performance. However, many challenges are also common with design and build procurement: for example, the interaction of design and build usually leads to increase in cost of construction and time overrun (Oyebanji *et al.,* 2017). The most significant factors that impact cost and time overrun are frequent changes in design coupled with communication failure during production processes and coordination lapses among construction stakeholders. To achieve improvement in time delivery of housing projects, and delivery within budgeted cost specified, effective management principles must definitely be established, and these principles must involve of management knowledge for fast-tracking construction activities (Chritamara *et al.,* 2002).

Housing production processes frequently experience cost and time overrun, with rework being a significant factor that tends to exacerbate this cost overrun (Hwang, 2009). CII (2005, cited in Hwang, 2009) clarifies that direct cost by rework accounts for 5% of total housing project costs. Rework must therefore be regarded as a factor affecting performance of construction operators and efficient production processes for housing delivery. Effective response is needed through the application of management knowledge toward sustainable housing delivery

3.8.4 Stakeholder and household satisfaction

According to Li and Skitmore (2013), the differences in the needs of stakeholders and occasional discrepancies in interest can also affect the delivery; this can occur either positively or negatively, through failure to address the concerns of stakeholders involved in housing production processes. Sometimes meeting their expectations actually poses a large challenge. The most effective way to address this challenge is by allowing every stakeholder involved in housing production to actively participate in housing project decisions at the initiating stage all the way through to the closeout stage. Stakeholder satisfaction is a certain measure of effectiveness of a completed housing project (Olander & Landin, 2005).

Housing has been collectively acknowledged as one of life’s most essential necessities, a major economic asset in every nation. Every attempt by the government, planners and stakeholders to improve the conditions of housing delivery has proved abortive. But with housing identified as national investment, with every individual having a right to adequate housing, the ultimate aim of a housing programme is to improve its adequacy to better satisfy the needs of the users (Jiboye, 2010).

Housing maintenance cost is increasing on a daily basis, primarily as a result of inadequate planning at the initiating stage of production processes for cost effective housing maintenance. The maintenance cost of housing continues to increase significantly in developing nations (El-Haram & Homer, 2002). While the problem of shortage of housing delivery has been a national discussion in developed nations, still the challenges increase without even an adequate remedial solution in developing countries. Similarly, urban populations are steadily increasing without adequate provision of housing in terms of mass and quality required for the poor citizens. Most of the population living in cities reside in dehumanizing environments, and those who are lucky enough to have the means to secure housing do so at abnormally excessive costs (Nubi, 2000).

Rapid increases in population and urbanisation and changing socio-economic patterns in developing countries over the last few decades have resulted in a rapid increase in the demand for housing. As demand for sustainable affordable housing increases, so the availability of housing decreases in supply: this miserable shortage of affordable housing has forced the poor to settle in squatter camps and shantytowns with far from adequate amenities (Sivam, 2002). Similarly, the problem of inadequate and unaffordable housing has been a recurring challenge in developing nations. To tackle this problem from various angles, government has to engender an enabling environment for the development of affordable sustainable housing for the benefit of society's poor (Akinmoladun & Oluwoye, 2007).

3.9 The significant of theoretical and conceptual framework and implication on proposed study

The theoretical part of this study explain the theory that will be used to develop the concept of the study. Theoretical segment of the study exemplify and explain the research questions, through this process ideological construct of this study is established. Therefore, theoretical framework connected the research aim, and objectives of the study with conceptual framework to establish concepts of sustainable housing delivery . The concern issues of sustainable housing theorised in this study for discussion are sustainable housing delivery concept, impact factors, design concept, impact of sustainable integration, social sustainable integration, theory of affordability of housing, theory of accessibility of housing, housing delivery procedure concept, economic implication of housing and social implication of housing delivery. This issues were extracted from the literature and used to develop conceptual framework.

The conceptual framework are used to develop sustainable housing delivery concepts, connect the five objectives of this study together to achieve the aim, through this process interaction between the research constructs was instituted. The interaction of research construct, further connect the objectives with the concepts and the research Gaps from the literature, on this basis the research questionnaires are design. The combination of theoretical and conceptual framework was used to determine the process for development of an innovation the study targeted.

3.10 Summary of Gap-spotting from previous concepts and existing knowledge to support the study opinion on affordable housing delivery

The concept of this study is to improve on longstanding issues affecting sustainability involving economic, social and environment, with regards to affordable housing delivery to the people irrespective of income. On the point that construction cost of housing production processes must be efficient and remain within budgeted cost to enhance availability and consistent housing delivery to the people. Literature from previous study are critically examined, The underlisted are the Gap-spotting concepts extracted from existing theory;

“The economic theory, for instance, has explained that house price movement is inherent with regional economics and regional demographics such as income, cost of capital, stock price and population change. Thus, sudden price change could be expected to affect home ownership to an extent. However, it is well established that under any circumstance, the need for housing as a basic necessity persists, despite costs (Hashim, 2010)”. On this basis the researcher developed opinion for affordable housing delivery concepts established in figure 3.1 and 3.2.

“The concept of *sustainability integration* means to respond to economic, social and environmental issues affecting sustainable housing delivery (Jenkins, 2010). Thus, Bossel (1999) admits that sustainability has become a general accepted goal for human society, ever since we began to witness the deterioration of the environment worldwide”. The investigator adopted the opinion that sustainability integration will enhance affordable housing delivery as stated by Jenkins (2010). Based on the facts that construction cost of housing will remain within budget for housing to be available consistently, the conceptual framework was established through this belief.

“The theory of accessibility is the ability of the people to benefit from the features that are present in urban areas; similarly, accessibility of the environment is available to people when all necessary qualities that enhance urban areas are present. The ability to compete for site depends on whether or not people have the means to benefit from accessibility and harmony within the urban framework (Jordaan et al., 2004)". On this point the researcher developed an opinion that housing is not available and affordable in Africa nations, because majority of low-income earners residence in shantytowns. Consequently, the figure 3. 1 and 3. 2 depicted research construct that the study investigated.

"The housing subsidy programme, however, has had minimal little impact on poverty reduction, despite its scale and generous funding. Most government funding went to contractors to build new units of housing for the poor; it was assumed that these would replace homes in informal settlements that the poor had constructed themselves (Bradlow *et al.*, 2011; Bolnick & Bradlow, 2011)". The researcher developed an opinion in relationship with Bradlow *et al.*, (2011); Bolnick and Bradlow (2011) that government subsidy programme on affordable housing delivery is challenged because of poor performance of the contractors in delivery of housing within budgeted cost. On this point the stakeholders and household satisfaction was queried for the establishment of framework for effective management cost toward sustainable housing delivery in figure 3.1 and 3.2.

3.11 Summary

This chapter contains the integration of sustainability in 3-D (environmental, social and economic factors) to achieve effective construction technology, social satisfaction, construction constraint and resource usage during production processes. On these bases, the study's conceptual framework was established. Interaction between these factors impacting affordable housing delivery within budget – management of construction constraints; inadequate construction resource issues; and stakeholder and household satisfaction – is imperative for sustainable housing delivery to the people. In this chapter, discussion was centred on concept of the research, and thereafter a conceptual framework was established which addresses critical issues that affect affordable housing delivery. The issues of construction constraints, affordability, construction cost, design, productivity, resource usage, management and stakeholder influence were intensely discussed, as each of these has a strong relationship with the aim and objectives of this study. The subsequent chapter comprises the methodology that was selected to achieve the aim and objectives of the research in relationship to the conceptual framework.

CHAPTER FOUR

4. RESEARCH METHODOLOGY

4.1 Introduction

This chapter contains the research methodology used in this study to achieve aim and objectives and the conceptual framework of the study. It includes quantitative and qualitative methods, a mixed method approach and a sequential mixed method. The research methodology is purposely for the establishment of the techniques that will be used to investigate the challenges of affordable housing delivery. Chapter 4 discusses methodology linked with Chapter 3, and on these bases, issues raised in connection to objectives one to five were discussed and methodology selected to investigate the issues was established accordingly.

4.2 Research methodology values

Research is commonly referred to as a search for knowledge; *research* can be defined as a scientific and systematic search for relevant information on a specific topic (Marshall, 1996). Actually, research is known as act of scientific investigation, inquisitiveness to obtain facts or gather information requiring the probing of the unknown to obtain these facts (Creswell & Poth, 2017). Research is purely an academic affair, a process involving, in a technical sense, the collecting and evaluating of data, formulating a hypothesis or suggesting solutions and reaching a conclusion (Kothari, 2004). Research cannot just be described as merely a process of gathering information, as frequently the process involves answering unanswered questions or creating that which does not currently exists. In fact, research is employed to create a phenomenon through the expansion of boundaries of ignorance (Goddard, 2004).

4.3 Research approach

The *research approach* is the intention to provide the reader with sense of the real facts. It is a vital part of any scientific study, regardless of the research area. Essentially, a research approach explains the most appropriate way of design for a research study, primarily emphasising scientific methods, data collection, data analysis, results obtained and final reports (Teddie & Tashkkori, 2006). A research approach can be categorised into four alternatives approaches, and these various approaches can be combined into a singular research project to discover a new phenomenon (Amaratunga *et al.,* 2002). The four potential research strategies considered for a research project include quantitative research, qualitative research, participatory action research and mixed methods research (Creswell, 2003).

4.3.1 Quantitative research

Quantitative research in natural science and social science can be described as a systematically empirical investigation of observable phenomenal via statistical, computational and mathematical techniques (Creswell & Poth, 2017). This involves the collection of quantitative data for analysis in numerical form, such as statistics, graphs and percentages. Quantitative research uses numbers and a statistical method, with techniques based on numerical measurements of specific aspects of phenomena (Creswell *et al.,* 2004). It requires explanation and prediction to generalise to other persons and places. Careful sampling strategies and an experimental design are aspects of the quantitative method aimed at producing generalisable results (Thomas, 2003). Quantitative research techniques are for testing objective theories by examining relationships among variables. These variables can then be measured with instruments so that data collected through quantitative questionnaires can be analysed using statistical procedures (Teddie & Tashkkori, 2006). The final written report on quantitative research has a set of structures consisting of introduction, review of literature, theory, methods, results, discussion and conclusion (Creswell, 2013).

4.3.2 Qualitative research

Qualitative research has a multi-method focus, connecting a naturalistic approach and interpretive approach to subject matter. Qualitative research techniques mean that researchers study phenomenon in their natural settings. It involves the studied collection of a variety of empirical materials – case studies, personal experiences, interviews and observations (Newman & Benz, 1998). Patton (1990, cited in Newman & Benz, 1998) defines *qualitative data* as detailed descriptions of situation, events, observed behaviour, people, interactions and direct quotations from people pertaining to their experiences and beliefs. According to Creswell (2013), qualitative research follows an approach for exploring the meaning that various individuals and groups attribute to a social and human problem. The process of qualitative research involves merging questions and procedures: data are collected through interviews and analysed by building inductively from particular to general themes. The researcher interprets the meaning of data collected by content analysis (Teddie & Tashkkori, 2006).

Table 4.1: Characteristics of quantitative and qualitative research

Characteristic	Quantitative Research	Qualitative Research
Type of data	Facts are described numerically	Facts are described in a narrative fashion
Analysis	Descriptive and inferential statistics	Identification of major theme
Scope of inquiry	Specific questions or hypotheses	Broad, thematic concerns
Primary advantage	Large sample, statistical validity, accurately reflect the population	Rich, in-depth, narrative description of sample
Primary disadvantage	Superficial understanding of participants' thoughts and feelings	Small sample, not generalisable to the population at large

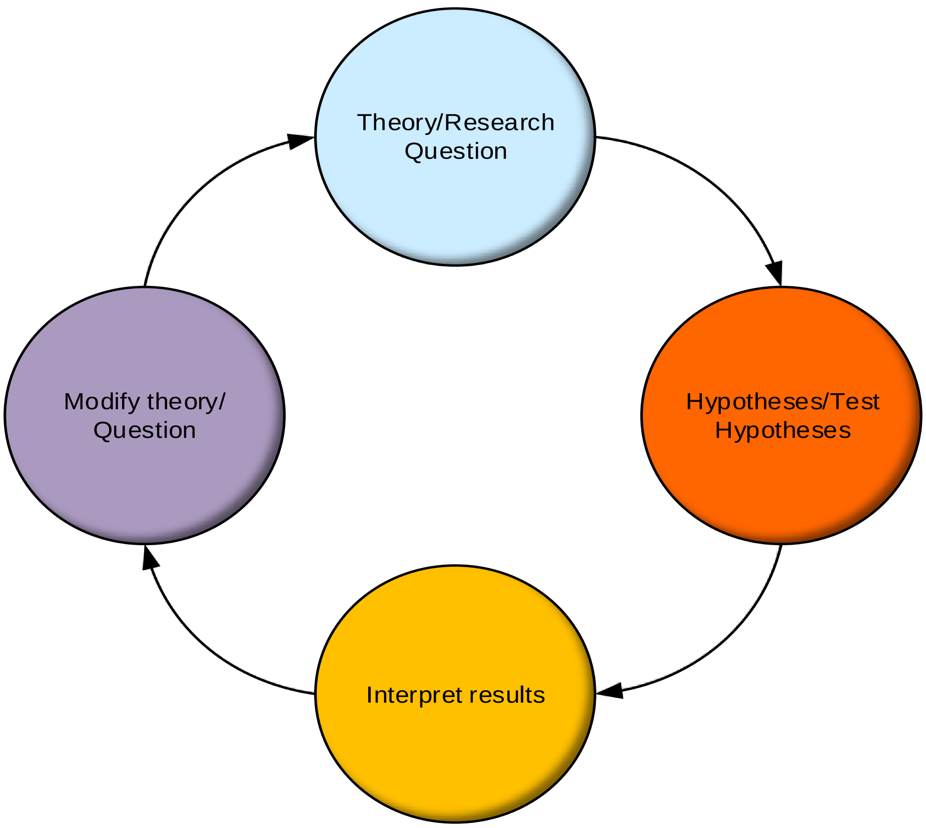

Figure 4.1: Classic research process

The main advantage of qualitative research is that it provides a substantially richer and more in-depth understanding of the population under study. Qualitative research techniques involve interviews and focus groups, encouraging research participants to proffer detailed and specific answers (VaderStoep & Johnson, 2008). Figure 4.1[11] above presents the different characteristics of quantitative and qualitative research so that a researcher can determine, with certainty, which of the techniques is most suitable for the intended study. Figure 4.1 demonstrates the classical research process.

4.4 Philosophies to consider in mixed methods research design

In order to give adequate explanation of mixed methods design, it is essential to considered philosophies of mixed methods research design. Creswell (2013) reveals four philosophies of a mixed methods research design to acquire a wide berth of information, including pragmatism, transformative worldview, critical realism and dialectic pluralism. Moreover, Creswell (2013) posed questions about theory: What is a theory? How do you find a theory? How will this theory be used in a mixed method study?

4.4.1 Pragmatism

According to Morgan (2007, cited in Tashakkori & Teddie, 2003), *pragmatic concepts* such as abduction, inter-subjectivity and transferability supersede the qualitative or qualitative dichotomies of induction/deduction, subjectivity/objectivity and generality. Morgan further implies that a pragmatic concept creates a range of new opportunities for thinking about classic methodological problems within a research study. *Pragmatism* is acknowledged as a deconstructive paradigm advocating the use of mixed methods in research, establishing the argumentative issues of truth and reality. Pragmatism focuses on facts surrounding research questions under inquiry (Tashakkori & Teddlie, 2003; Feilzer, 2010).

4.4.2 Transformative worldview

Transformation worldview is described as learning that involves how to negotiate and act upon purposes, values, and states of mind and meanings rather than those that are adapted uncritically from other people (Mezirow & Associates, 2000, cited in Taylor, 2008). The transformative worldview process is circumscribed by a frame of reference understood as structures of assumptions and expectations that frame an individual's tacit point of view and influences thinking, beliefs and actions. *Transformation* is referred to as revision of a frame of reference in concert with reflection on experience that is addressed by theory of perspective transformation

---

[11] Table and diagram in Table 4.1 & Figure 4.1 adapted from VaderStoep & Johnson (2008)

(Mezirow 1996, cited in Taylor, 2008). Stetsenko (2008) suggests that an activist transformation stance advocates that people come to know themselves and collaboratively transform the world in view of their aims. This entails that all human activities are instantiations of influence of collaborative transformative practices that are focused on both the past and the future and therefore are deeply instilled with ideology, ethics and values. However, claims of different visions and ideologies by people are major reasons for employing a mixed method design approach in a research study.

4.4.3 Critical realism

Bhasker (2014) states that *critical realism* contends for the necessity of ontology; *ontology* means being able to speak and understand apart from human thought and language. It found that things exist apart from experience and knowledge of those things. Critical realism, then, correspondingly argues for a structured and differentiated account of reality in which differences in stratification and change is fundamental. In the real sense, critical realism claims the study of things, mostly a new ontology; similarly, the mixed method design approach claims innovation and the establishment of truth in a research study by employing quantitative and qualitative techniques within a single study.

Critical realism is defined as a philosophy of science based on ontological ideologies that concern theory of knowledge, including methods, scope, validity, opinion and belief in a research study. Critical realism theory provides philosophies that can be employed by researchers developing theoretical explanations of innovation (Bhaskar, 2014; Mingers, Much & Willcocks, 2013).

4.4.4 Dialectic pluralism

Goertzen (2010) explains that theoretical conceptualization of pluralism in psychology is called *dialectical pluralism*. It is well-established that this approach provides an effective and efficient basis for scientific progress in a research study. Three primary components of dialectical pluralism are developed as follows: 1) it contends that tension between competing theories should be sustained in the hope of producing evaluative or integrative solution; 2) it contends that the unity-disunity debate in psychology is reframed as a continuum; and 3) it contends that oscillating periods of convergent and divergent pluralism will provide a productive model for scientific progress in a study. This third theory states that inter-contextualism is discussed as an underlying philosophical foundation for dialectical pluralism.

Walsh-Bowers' (2010) argument is based on social contextual analysis, unification and dialectical pluralist impulses that can resolve psychology's historical disunity. Unifiers and dialectic pluralists seem to exploit the context of justification by focusing on a coherent argument, whereas sceptics in the debate over unification concentrate on irrational dimensions that constitute the social-historical context for an epistemic position on pluralism and alliance. Smythe and McKenzie (2010) argue that human thinking is ontologically and epistemologically dialectically pluralistic, advocating an integrated approach to disciplinary pluralism based on mutual, dialogical engagement among psychologically diverse traditions. Therefore, the use of a mixed method design approach that involves both qualitative and quantitative methods will address issues relating to divergence of opinions and beliefs among people.

4.5 Mixed method research

Mixed method research is the combination of quantitative and qualitative techniques, referred to as *triangulation in action.* Triangulation is the combination of methodologies in a study of the same phenomenon; it collects various kinds of data bearing on the same phenomenon. It can capture a more complete, all-inclusive and contextual representation of the units under study. The use of triangulation in a study will uncover unique variance which otherwise may have been neglected by single methods. Most especially, qualitative techniques will expose hidden facts through interviews (Hussein 2009). To achieve high technical quality, broad and detailed research, mixed method research has the capability to address this because it incorporates qualitative and quantitative idioms and technical data. A mixed-method research study involves the use of quantitative and qualitative methods to collect data analysis and report findings obtained in a single research (Creswell, 1999).

Mixed methods research is a methodology for conducting research that involves gathering, analysing and integrating quantitative data, such as experiments, surveys and qualitative methods that involve focus groups and interviews. Mixed methods research combining qualitative and quantitative approaches is an up-and-coming method that is achieving increasing interdisciplinary acceptance. However, in spite of a growing acceptance of the mixed method approach, there is still an absence of support for mixed methods through funding (Plano Clark, 2010).

Clark *et al.* (2008) clarify that in the past century, researchers constantly relied on quantitative research to answer numerous research questions. However, between 1980 and 1990, the majority of researchers turned to the use of qualitative research. As many researchers in recent times have developed an interest in the combination of qualitative and quantitative approaches to develop a phenomenon, this approach, again, is referred to as *mixed methods.* Similarly, Stentz *et al.* (2012) explain that leadership in research has a link with the long history of the quantitative approach, carrying on as the most commonly employed approach amongst leadership researchers. Many researchers in a diversity of fields, in fact, have been applying a mixed method design to their research to advance theory. Mixed method designs are used for collecting, analysing and combining both quantitative and qualitative data in a single study; in other words, it can be considered a series of studies to both explain and explore specific research questions.

Creswell (2011) offers a detailed explanation that mixed method has emerged in the last decade as a research approach popular in many disciplines and nations, funded by many agencies. However, it is not surprising that critical communities have surfaced through published journals and conference proceedings papers. These critics have emerged from diverse nations of the world, and even though concerns have mounted about criticism, the criticism is still ignored by social scientists and the mixed methods community.

Cameron and Molina Azorin (2011) explain that mixed method research has now become established as a legitimate methodological choice, presently applied by researchers from across a variety of disciplines. It appears as if no single consensual definition of *mixed methods* has yet arisen. The mixed method approach involves qualitative and quantitative methods from different paradigms, or the use of multiple methods within the same paradigm, or multiple approaches within a method.

Creswell and Plano (2007, cited in Cameron & Molina Azorin, 2011) define *mixed methods research* as a research design with philosophical assumptions that guide the collection and analysis of data and the mixture of qualitative and quantitative data in a single study or series of studies. Its central evidence is the use of quantitative and qualitative approaches in combination, providing a clearer understanding of research problems than either approach alone. Creswell *et al.* (2008) has discovered five essential characteristics of mixed method research, as stated below:

- Mixed methods research responds to questions and hypothesis, collects both quantitative and qualitative data, and analyses it.
- The use of rigorous procedure is common with mixed methods to conduct qualitative and quantitative research.

- Mixed methods combine quantitative results and qualitative findings to discover a new phenomenon.
- Mixed methods developed a procedure for data collection, analysis and integration known as *mixed methods design.*
- Mixed methods use theory for the procedure of data collection, analysis and integration.

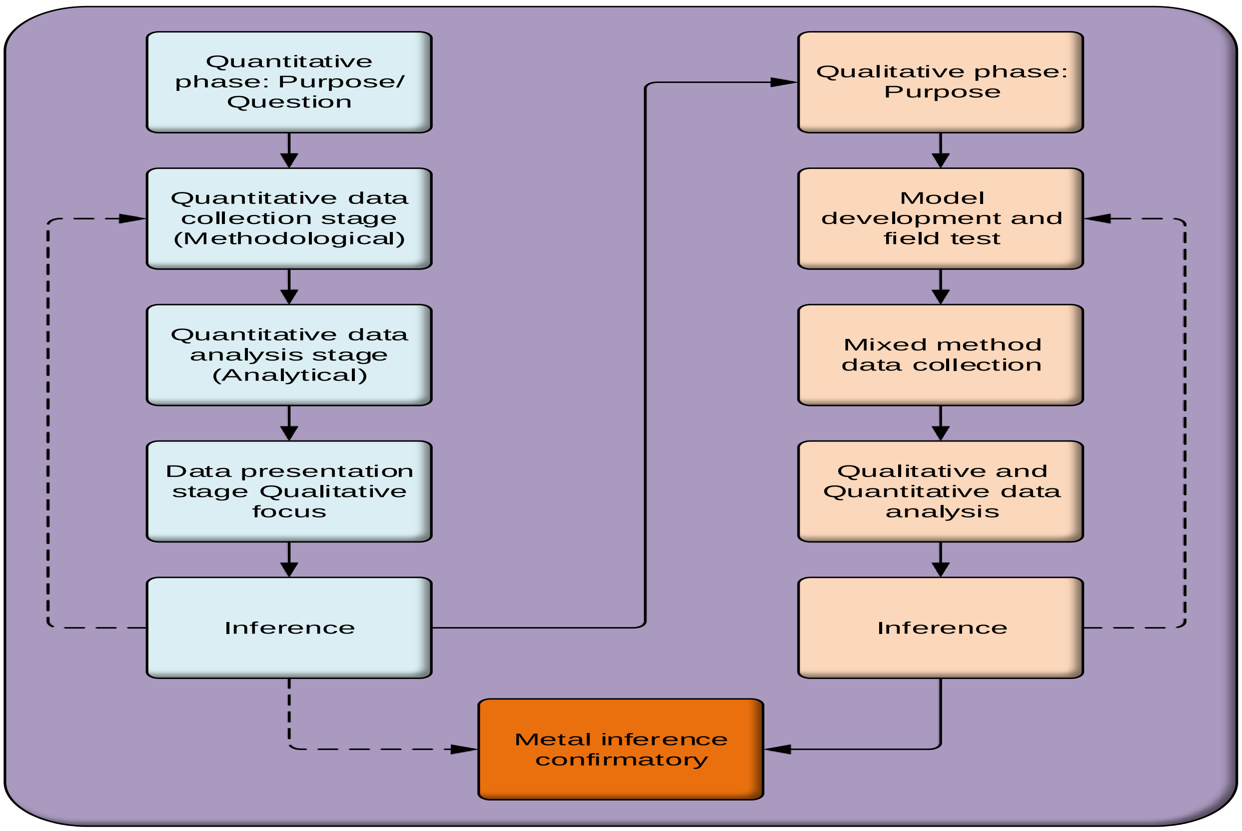

Figure 4.2: Mixed method design approach

Teddie and Tashakkori (2006) have discovered that mixed method multi-strand designs are the most complex of designs within the matrix. Thus, mixed quantitative and qualitative methods of approach may occur both within and across all three stages of a study. There are four branches of this design considered the most valuable of the mixed method design: concurrent mixed design; sequential mixed design; conversation mixed design; and fully integrated mixed design. A sample of mixed methods design is presented according to Figure 4.2[12] above, showing a mixed method design approach.

4.5.1 Consider specific design for a study

Concurrent mixed methods research design occurs when the intent is to concurrently merge quantitative and qualitative data to achieve the aim established for a study; hence, the researcher combines both qualitative and quantitative research to achieve the study aim and objectives. This design is referred to as *concurrent design,* a process whereby a researcher collects quantitative correlational data as well as qualitative individual or group interview data

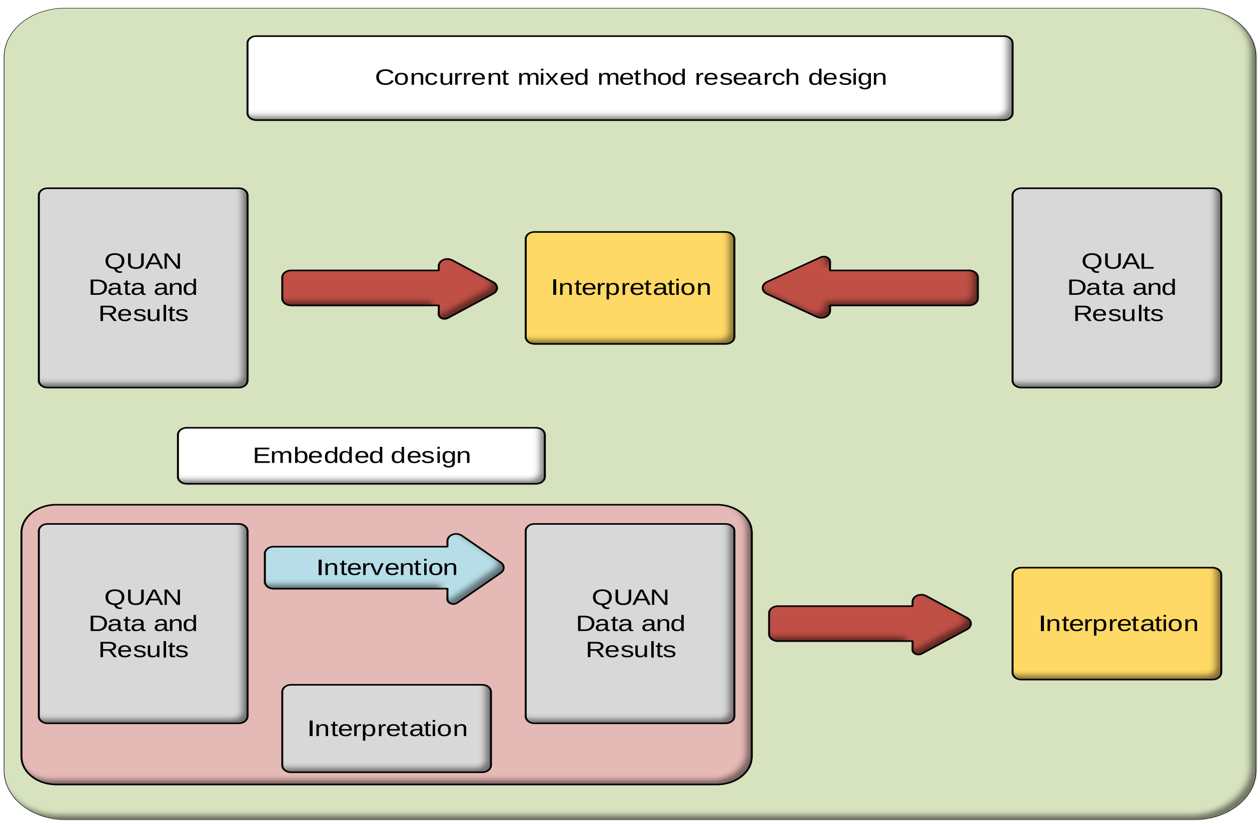

Figure 4.3: Concurrent mixed method

and combines the two to best understand participants. Thus, data analysis consists of merging data and comparing the two sets of data and results to achieve a new phenomenon (Creswell &

---

[12]Diagram in Figure 4.2 adapted from Teddie & Tashakkori (2006)

Plano Clark, 2007). A typical concurrent design method is explained in Figure 4.3[13] above. Note: QUAN=Quantitative and QUAL=Qualitative.

4.5.2 Sequential mixed method design

Sequential mixed method design occurs at a stage when a researcher conducts quantitative research analysis – that moment builds on the results to explain in more detail than with qualitative research. The sequential mixed method is considered explanatory because the initial quantitative data results are explained further with the qualitative data (Creswell, 2013). Similarly, Katsulis (2009, cited in Tashakkori & Teddie, 2010) explains how exploratory

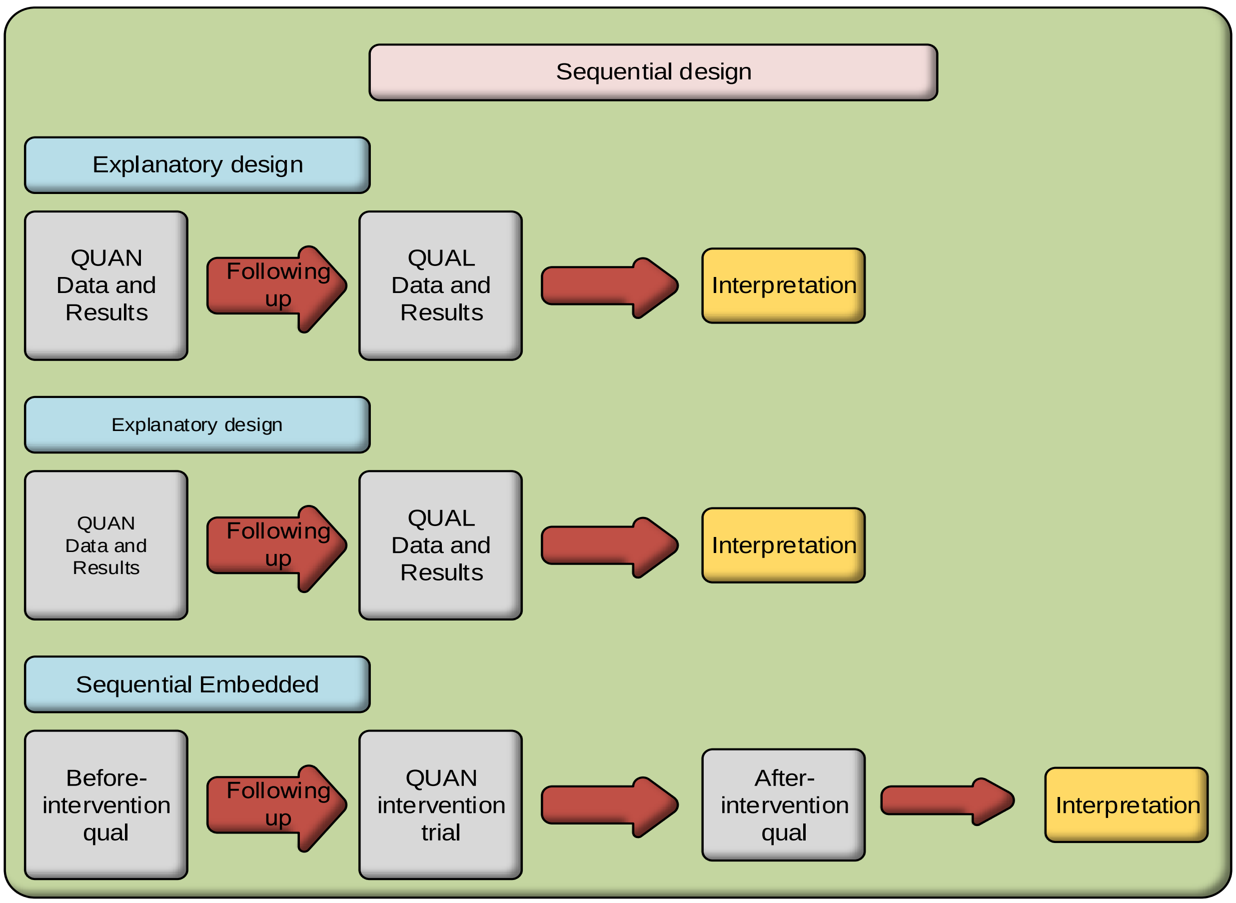

Figure 4.4: Sequential mixed methods design

[13] Diagram in Figure 4.3 adapted from Creswell & Plano Clark (2007)

sequential mixed methods design data can be integrated at different stages of the research process. It first occurs through observation: the findings from observations were integrated into two ways – semi-structured interviews and in-depth interviews – to collect qualitative data, then this data undergoes analysis and results are obtained. Quantitative techniques follow up with qualitative methods to collect data, analyse the data and obtain results through questionnaire surveys. Figure 4.3 and Figure 4.4[14] above show typical sequential mixed methods design. Similarly, Figure 4.5[15] explains sequential mixed methods design (adapted from Katsulis, 2009; cited in Tashakkori & Teddie, 2010).

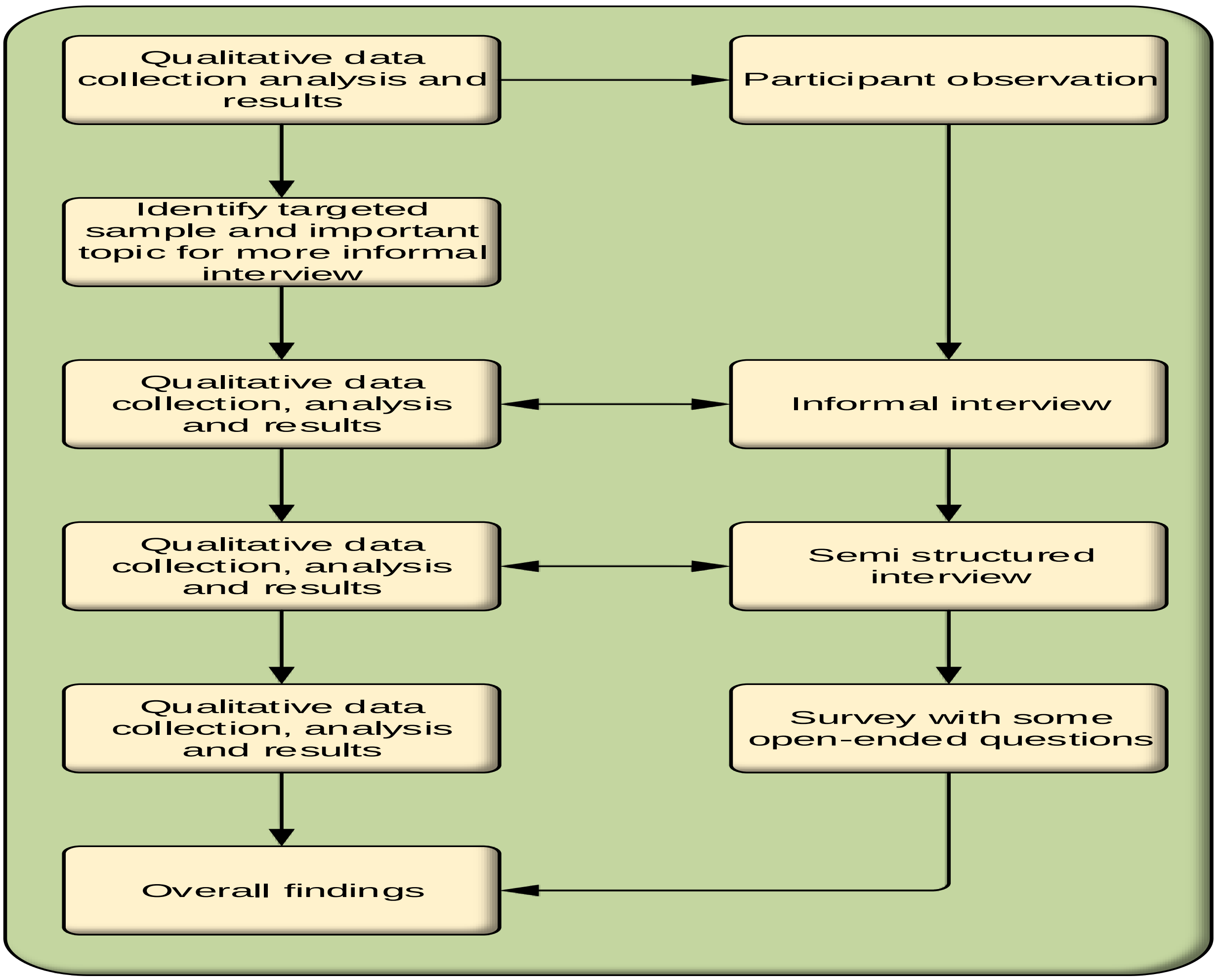

Figure 4.5: Sequential mixed methods design

[14] Diagram in Figure 4.4 adapted from Creswell (2013)
[15] Diagram in Figure 4.5 adapted from Katsulis (2009), cited by Tashakkori & Teddlie (2010)

Justification for the use of mixed methods in this study

The justification for the use of mixed methods research has numerous reasons, the comprehensiveness of the research study is one of the major advantage of using mixed methods approach. Others are increased confidence in findings, mixed methods exemplify contradiction between quantitative results and qualitative findings, and quality data are collected through combination of quantitative and qualitative in a single research. Similarly, Onwuegbuzie and Leech (2004a cited in Johnson and Onwuegbuzie 2004) explained that mixed method research as the third research paradigm can help bridge schism between quantitative and qualitative research. In addition to the justification for the use of mixed methods approach, mixed method approach allowing both explanation and analysis in the same study, the results obtained through mixed methods have a broader perspective of the overall research problem, Johnson *et al.,*(2007 cited in Pluye, Gagnon, Griffiths and Johnson-Lafleur 2009) defined mixed method as a combination of qualitative and quantitative methods conducted by researcher or research team, for the broad purpose of gaining breadth and depth of understanding or corroboration within a single study. Therefore, justification of using mixed methods for this study centered on comprehensiveness of the study outcome, collation of quality information and confidence in findings. This section supplement the discussion 5.4 of chapter 5.

4.6 Summary

This chapter comprises the methodology adopted for this study and describes the use of quantitative and qualitative techniques as applied to this research study. The mixed methods approach for the study was explained, giving details regarding the benefits of using mixed methods. The philosophy to be adopted in the use of methodology was explained adequately in this chapter. However, the methodology in this chapter is only a forerunner to the methods applied for the investigation of the research questions and collection of data. The research value for this study was accurately explained in Chapter Four, with the characteristics of qualitative and quantitative vividly clarified in this chapter. Through this methodology, effective techniques to carry out research were adequately established, and accurate information was collected through the research process. Moreover, this chapter contained an explanation on the general methodology that prepared the ground for the specifics of methodology as presented in Chapter Five. The next chapter is a continuation of the research methodology, comprising methods and routes for achieving the aim and objectives of the study.

CHAPTER FIVE

5. RESEARCH METHODS

5.1 Introduction

This chapter is comprised of the research methods used to conduct the research toward a realistic conclusion, a process that involves scientific planning, and numerical, statistical and observation approaches. This chapter links with Chapter 4 which established the methodology of the study, as from this process the techniques for investigating issues in this study has arisen. The methods are for problem identification, to find solutions, and for data generation. This chapter comprises the methods employed to achieve the aim and objectives of research study through information gathering processes. The systems used are population sampling, probability sampling techniques, non-probability sampling techniques, data collection, interviews, questionnaire design, data analysis, descriptive statistical analysis, factor analysis, PCA analysis, correlation and logistic regression analysis, measurement of reliability and finally, validity.

Laurel (2003) explains that research methods are used to gathered information concerning a study. However, methods vary for gathering information, with various types of instruments used in data collection. Research methods include quantitative and qualitative techniques, whereby the use of these two techniques in a research study depends on the choices of a researcher in regard to the research objectives. The use of the qualitative method involves an interview process whereas the quantitative aspect of research involves questionnaires. The combination of the two techniques in a study is known as a *mixed method design* approach. Methods are for identifying a sample of respondents in one location, generating and collecting data and determining the most appropriate solution to the originally identified problem (Creswell & Poth, 2017).

5.2 Research operations require satisfaction of certain requirements

According to Buckley *et al.* (1975, as cited by Amaratunga *et al.*, 2002) research is conducted in the spirit of investigation, relying on facts, experiences, concepts, hypotheses, constructs, laws, principles and assumptions. An operational definition of *research* requires satisfaction of the below conditions:

- It must be an orderly investigation of a defined problem.
- Appropriate scientific problems must be used.

- Adequate and representative evidence must be gathered.
- Logical reasoning uncoloured by bias must be employed in drawing conclusions based on the evidence.
- The researcher must prove the validity or reasonableness of the conclusions.
- The cumulative results of research in an area must yield general principles or laws that may be applied with confidence under similar conditions in the future.

5.3 Philosophical standpoint of the study

The philosophical standpoint of this study is essentially on outline of an epistemological basis of the research paradigm which was provided in Chapter 4 of this study. O'Gorman and MacIntosh (2014) suggest that when embarking on any research project, it is good practice to acknowledge an epistemological or philosophical basis for claiming to know what the researcher believes is known. This is referred to as a *research paradigm*.

O'Gorman (2008, cited in O'Gorman & Macintosh, 2014) describes commonly used terms in research studies in regard to the philosophical standpoint of a study, as indicated in Table 5.1[16] below. The main purpose of this present study is to survey the opinions and understanding of participants concerning the challenges investigated in this study. Bearing in mind the common terms established by O'Gorman (2008), this study then used epistemology, induction, axiology, ontology, metaphysics, methodology, philosophy, paradigm, rhetoric and reflexivity as guiding principles to achieve the research aim and objectives. The exempted principle among these others that is not applicable to this study is the *deduction principle* which deals with the proof of using evidence to test for a hypothesis.

The study engaged quantitative techniques informed by closed-ended questionnaires to test the research questions among selected participants. A qualitative technique was engaged to validate findings obtained from the quantitative aspect of the research. Similarly, observations of opinions and feelings were obtained through structured and unstructured interviews from

[16] Information in Table 5.1 adapted from O'Gorman (2008), cited by O'Gorman & Macintosh (2014)

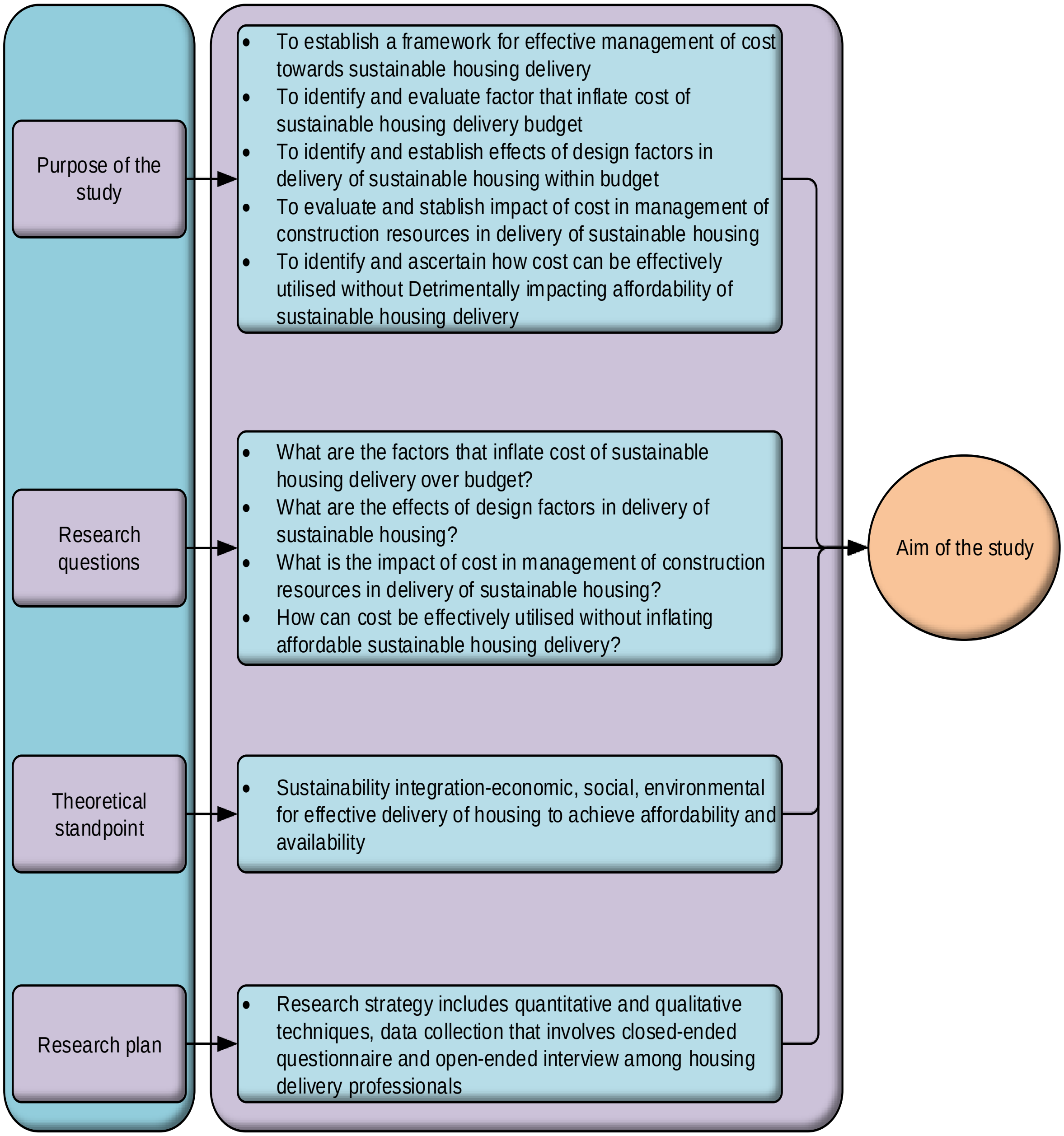

Figure 5.1: Indispensable part of the study

volunteering participants working in the construction industry, specifically dealing with housing delivery. Figure 5.1[17] presents an indispensable part of this study as the philosophical standpoint.

---

[17] Diagram Figure 5.1, Figure 5.2 & Figure 5.3 adapted from Akinyede (2017)

Table 5.1: Common terms in research studies

Term	Meaning
Epistemology	The branch of metaphysics that deals with nature of knowledge, its presuppositions and foundation, and its extent and validity. The study of knowledge, the theory of what constitutes knowledge, and the understanding of a phenomenon. How the researcher explains himself as a knower; how researchers arrived at their belief.
Deduction	A prior argument; driving a proof or using evidence to test a hypothesis.
Induction	A posterior argument; driving knowledge from empirical investigation.
Axiology	Branch of philosophy that dealing with values, as those of ethics or religion.
Ontology	The branch of metaphysics that deals with nature of being and of reality.
Metaphysics	The branch of philosophy that concerns the ultimate nature of existence.
Methodology	The study and application of methods.
Philosophy	The academic discipline concerning making explicit the nature and significance of ordinary and scientific beliefs, investigating the intelligibility of concepts by means of rational argument concerning their presuppositions, implications, interrelationships; in particular, rational investigation of the nature and structure of reality (metaphysics), the resources and limits of knowledge (epistemology), the principle and import of moral judgment (ethics), and the relationship between language and reality (semantics).
Paradigm	Theoretical framework within which research is conducted.
Rhetoric	The art or study of using language effectively and persuasively; in particular, the style of speaking or writing, specifically the language of a particular subject, as in a dissertation process.
Reflexivity	Critical self-aware examination of belief and knowledge claims. Need for conscious, reflexive thinking about the researchers own thinking, and the research critiques of his own pre-understanding and effect on the research.

5.4 Justification of sequential mixed method design approach for the study

According to Morse (2016), a *mixed method design* is the process of incorporating one or more methodological strategies or techniques drawn from a second method into a single research study to access some part of the phenomena of interest that cannot be accessed by the use of the first method alone. The use of mixed methods design renders the study broader, more complete, than if a single method was used. Similarly, Hussein (2009) advises that researchers share the concept of using both qualitative and quantitative design methods as complementary rather than rival camps, as mixing methods gives strength and overcomes weaknesses inherent in single method design.

Chow *et al.* (2010) clarify three advantages of using a mixed methods approach:

- an increase in the comprehensiveness of overall findings;
- expansion of the dimensions of the research topic; and
- an increase in the methodological rigor as both quantitative and qualitative findings can be checked for consistency.

Thus, using a mixed methods approach can greatly enhance understanding and satisfaction in a research study.

Tashakkori and Creswell (2007) enlighten that a mixed method design approach harnesses the power of both qualitative and quantitative techniques to provide a broader perspective for studying a challenge. For example, qualitative methods may reveal an irregularity in a study, while quantitative methods may complement the efforts of the qualitative techniques to achieve the aim and objectives of the study. Likewise, engaging mixed method designs encompasses the potential for rigorous research as it expands procedures to obtain facts; the process of involving quantitative and qualitative in single research is to achieve richness in the study. Hence, quantitative research demands the use of descriptive statistics and mathematical calculations for better findings, whereas the qualitative aspect of the research entails interviews for deeper insight into the root of the problem (Creswell *et al.,* 2004).

After critically reviewing a few of the existing methodologies, the sequential exploratory research technique is proposed for this study, as indicated in Figure 5.2 below. A preliminary investigation was conducted surrounding factors impacting sustainable housing delivery as revealed in existing relevant literature. The levels of significance of the identified factors were determined through interviews and questionnaire surveys administered to construction operators.

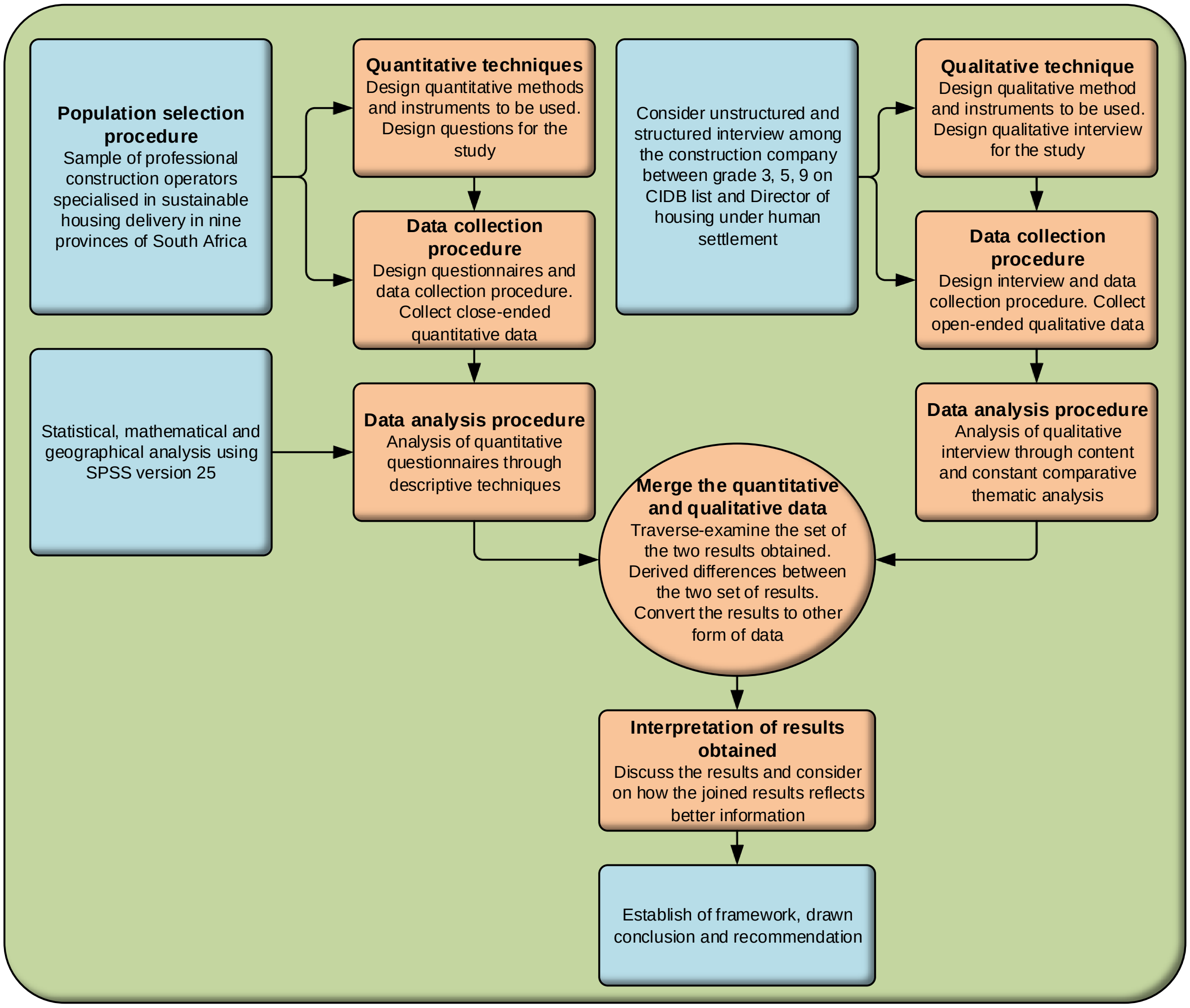

Figure 5.2: Stages of implementing sequential mixed method design for the study

5.4.1 Research design methodology approaches

Methodology refers to the actions and techniques in research to assemble facts. These techniques involve the process of carrying out preliminary investigations concerning design questions for study and data collection. In addition, methodology involves the process of reviewing relevant literature. Methods spell out precisely what needs to be done in a research study to obtain appropriate knowledge (Teddlie & Tashakkori, 2006; Creswell, 2013). Although the aim and objectives of a research study are achievable through sequential mixed methods design, accuracy of information is certain when this technique is employed in a research study. Similarly, Creswell (2013) reveals that quantitative and qualitative research together helps to gain a more complete understanding of the research subject. A mixed method research approach is significant in experimental and social research, in which researchers collect, analyse and integrate both quantitative and qualitative research in single study or sustain a long-term programme of enquiry to address research questions for appropriate information.

5.4.1.1 Research design approach

Van Wyk (2012) describes *research design* as a process of planning for linking the conceptual research problem to the relevant empirical research. Research design specifically states what data is needed, what method will be used to collect data and the analysis of the data collected,

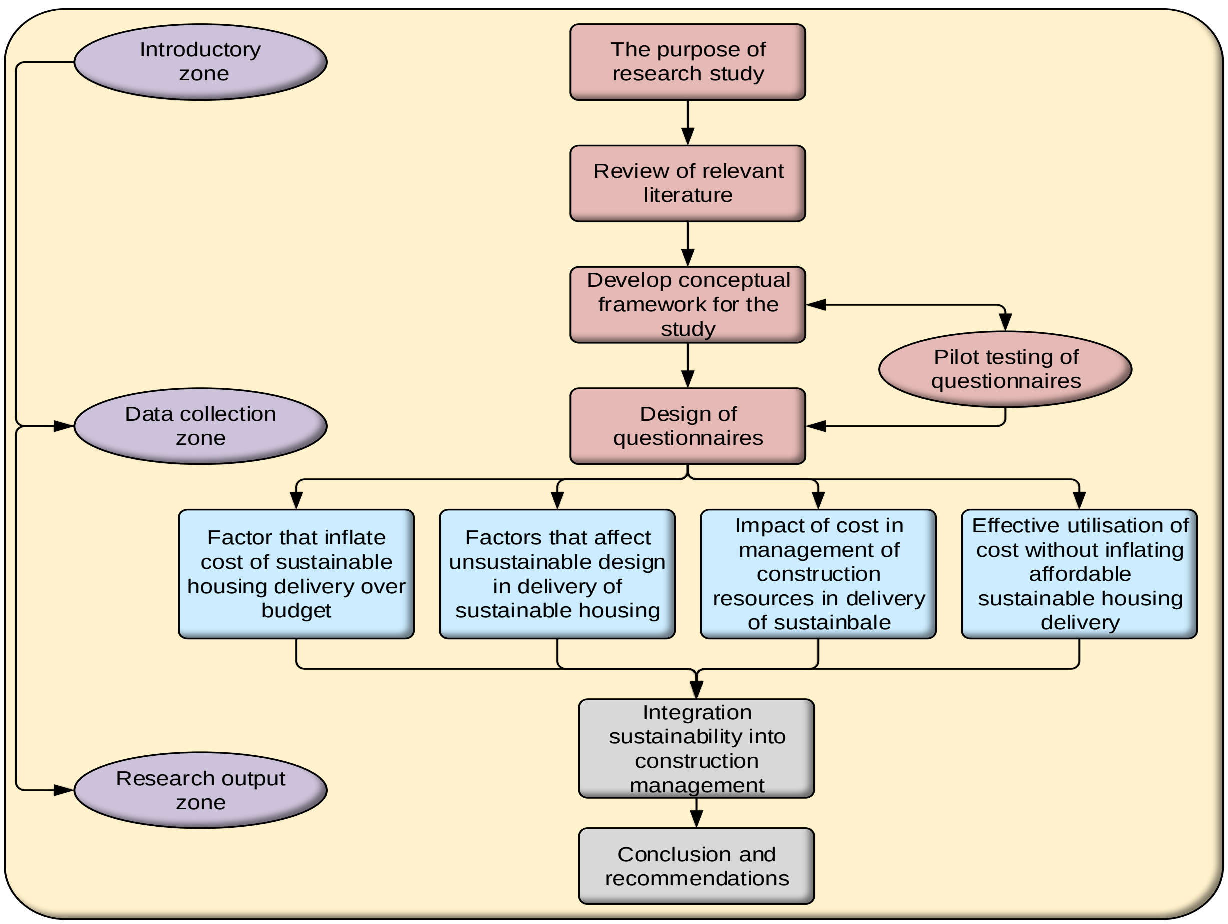

Figure 5.3: Research process

and how these instruments will measure what is intended to generate valid answer to the research questions. Likewise, Yin (2013) clarifies that *research design* defines priorities, concepts, methods and instruments most suitable for conducting research. The goal of a study is pivoted on research design; it helps achieve theoretical prepositions which in turn reflect a set of research questions and review of relevant literature.

This study intends to deliver a new phenomenon; therefore, a mixed method design approach was used to achieve this aim and the corresponding objectives designated for this study, especially since the majority of previous researchers have not use *Gap-spotting technique* that involve a mixed method design approach in their study for problem probing. Literature reviewed vividly clarified that the involvement of quantitative and qualitative methods in a single study provides a deeper understanding of a research problem. The method that will adequately address the set of research questions in this study is, therefore, a mixed method research design. The clarity of the research process is adequately explained in Figure 5.3 above.

5.4.1.2 Discussion on collected information from archives

Important information was gathered for this study through many avenues: critical reviews of previous studies by researchers concerning sustainable housing delivery; records in archives revealing the high cost of construction in delivery of housing; stakeholders and household satisfaction was investigated in regard to availability and affordability of housing challenges. The archived documents reviewed included journals, conference papers, drawings, literature, pictures, textbooks, newspapers, magazines, keynote speeches, government policy notes on housing, policy implementations on housing, and rules and regulations for housing. Subsequently, gaps were identified on the basis of a conceptual and theoretical framework which comprises the backbone of the study and which was developed, as indicated previously in the Chapter 3.

To validate the existence of the challenges identified in the review of archives, preliminary investigation was conducted through qualitative interviews amongst professionals specialising in housing delivery. Afterwards, questionnaires – after pilot testing – were distributed to enquire about the obvious glitches of housing delivery. The outcome of the investigation confirmed the existence of the problem even more drastic than previously articulated in journals and conference papers.

5.4.1.3 Design of data collection process

The data collection process involves strategies and methods for gathering information in order to establish facts to be investigated by a research study. The data collection process has viable options which include the sending of mails, face-to-face interviews and visitation with participants in an effort to gather information. Davers and Frankel (2000) describe the *data collection process* as a technique in which the researcher plans or defines the strategy and methods to be used to gather information for a study, a process which usually includes establishing types of literature to be reviewed, questionnaires designed, and the type of analysis engaged. Through the data collection process, the researcher will decide on the ethics for obtaining accurate and complete data. This research study involved the following processes to gather information through secondary data collection: informative survey of literature, including journals, articles and book reviews. Figure 5.2 summarises the data collection process for this study.

The study adopted two literature review strategies to gather data: preliminary and comprehensive literature reviews. Other processes considered for the collection of data for this study included primary data collection processes; fact-finding processes; population for the study; population sampling process; non-probability sampling technique; purposive sampling techniques; chain sampling approaches; interviews; participant observation surveys; and questionnaires. The other methods employed in this study for achieving quality results included a quantitative data analysis process and qualitative data-content analysis, reliability and validity tests, descriptive statistical methods and inferential statistical methods.

5.4.1.4 Preliminary literature review process

A *preliminary literature review process* in a study gives a detailed description of the challenges under investigation through the research. Preliminary literature review questions are generated, and the aim and objectives of the study are correspondingly generated. Likewise, Parker (2001) enlightens that preliminary literature reviews were used to gather information for research studies, as through a preliminary literature review, a series of questions are generated. Thus, to generate questions for this study, preliminary literature processes were carried out through reviews of journals, textbooks, conference papers and magazines related to sustainable housing delivery. Concurring, Joliette (2006) clarifies that a preliminary literature review helps to investigate more deeply into the problem underpinning the study. The evidence obtained from this preliminary literature reviewed was used to determine the main question for this study: how can sustainable housing be delivered within cost during the production process?

Main problems for the study were revealed through the preliminary literature review, which states: Housing production processes and delivery occur at high construction costs, too far above the reach of the poor; consequently, the availability of housing for the lowest class remains challenging in most developing nations (Habitat U.N., 2012). The aim and objectives of this study generated from a preliminary literature review were established in Chapter 1.

5.4.1.5 Comprehensive literature review process

Eggar *et al.* (2003) describe a *comprehensive literature review process* as a technique that involves a deeper review of related journals, conference papers, magazines, newspapers, keynotes speeches, workshops, seminar notes, polices and government rules and regulations related to a particular study, useful to gather facts and evidence underlining the need for the study. Eggar (2003) further clarifies the significance of a comprehensive literature review as uncovering the information for the established sub-questions and objectives of a study; formation of data source; hints for establishing research techniques; and information concerning types of data to be collected for particular study. Through a comprehensive literature review, data analysis procedures were established.

Subsequently, this study established significant proof, through a comprehensive literature review, substantiating five sub-questions and objectives to inaugurate facts relevant to the high costs and excessive time for housing delivery. The comprehensive literature review for this study gave evidence for the founding of a sub-problem established in this study. The all-inclusive methods for data collection and analysis were obtained through the comprehensive literature reviewed for this study.

5.4.1.6 Primary data collection process

Hox and Boeije (2005) state that the *primary data collection process* originates data collection for specific goals: data collection can be informed by qualitative and quantitative techniques. The focus of primary data collection in a study is for quality data collection. Primary data collection techniques involved in this study include both qualitative and quantitative methods; these procedures were used to extract data from professionals working in housing construction. Primary data collection was carried out to obtain valuable information concerning the problem identified by the study; similarly, information was gathered concerning the main question of the study, to determine with confidence whether or not the identified challenges exist.

5.4.1.7 Exploratory process for the study

Marchionini (2006) states that an *exploratory process* is a fact retrieval and knowledge acquisition process for research studies, fundamental to uncover underground information concerning the problem under investigation. Olshavsky and Spreng (1996) clarify that an exploratory study is a novelty evaluation process. The researcher conducted an exploratory study to uncover the underlying problem by revealing evidence. The practical exploratory study involved the investigation of impact factors of sustainable housing delivery extracted from the review of literature. Through this exploration, the most influential factors for affordable housing delivery were established, while the less influential factors were deleted after all the factors has been verified from amongst the professionals specialising in housing delivery via interviews and enquiries.

5.4.2 Population for the study

To properly establish the main study, the population for the study was critically considered as significant for accurate data collection. Therefore, the ability of the respondents to read and write and to interpret and comprehend information through interviews and questionnaires were measured, essentially to determine the most appropriate sample from among the population of construction operators specialising in housing delivery, who have the skill to adequately interpret the interview for their own understanding and answer the questionnaire easily without complications. The population for this study was discussed under population sampling. Kindig and Stoddart (2003) explain that *population* has a variety of meanings to different researchers and has a slightly different meaning from its general definition. While *population* need not refer to people or animate beings only, but can also consist of objects or things, researchers describe *population*, in general, as a collection of human beings, cases and non-living objects.

Hinde (2014) describes *population structures* and their heterogeneity as one of the most important aspects of populations. People are certainly not all the same: most populations contain people of various ages and mixed genders. The difference in ages and gender of a population are the most significant ways of identifying people. However, there are many other ways in which people can differ, for example, educational level, physical environment, occupations, marital status and incomes. The population that was sought for this study consisted of professionals working in the construction industry specialising in housing delivery. Since the study is investigating sustainable housing delivery, the study wisely involved those specialists in sustainable housing delivery as the population required to adequately answer those challenging questions posed in Chapter 1.

5.4.2.1 Sample the population

According to Faugier and Sergeant (1997), the major concern in research is the sample of the population to be used. The selection of sample design is dependent of the goal established by the researcher. Quantitative design uses representative sampling strategies to make implications about an entire population. While the qualitative sampling aspects of a research design avert simplifications and generalisations, this sampling provides maximum theoretical understanding of group progress. Faugier and Sergeant (1997) further contend that time and resources are obvious factors in any sample selection between large and smaller samples, as the smaller one is more rigorous. Conversely, the more sensitive or threatening the phenomenon under study, the greater potential for respondents to hide their involvement and the more difficult obtaining a sample is likely to be. Similarly, Lee (1993, cited in Faugier & Sergeant, 1997) determined that there will be a problem obtaining population sampling if the parameter of the population is unfamiliar to the researcher.

The sample of population that was considered among the larger population working in construction industry in South Africa is professionals working in construction company between Grade 3, 5, 9 on the Construction Industry Development Board (CIDB) list, including architects, project managers, contractors, contract managers, site engineers and quantity surveyors. These professionals are important in that these professionals have held strategic positions on their respective construction sites. Most site activities are heavily under the control of the professionals; hence, it is believed that their daily responsibilities will enhance their ability to answer the questions appropriately and informatively.

5.4.2.2 Non-probability sampling approach

The study involves *non-probability sampling techniques* to select a sample from the larger population for this study. The construction industry in South Africa has a large population, but it is certainly unrealistic to involve the entire population of the construction industry. Therefore, a sample of the population is drawn from among the professionals to answer to those factors that affect cost of sustainable housing delivery within budget; factors that affect unsustainable design in delivery of housing; factors that impact cost on management of construction resources in delivery of sustainable housing by construction operators; and factors that inhibit effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery.

Marshall (1996) contends that *non-probability sampling techniques* allow for a selection of a portion from among the larger population to be studied by a researcher, and quantitative research enhances the study of larger populations. Complex questions require a larger sample of population, and a variety of sampling techniques are necessary to reach quality findings. A qualitative research study, however, requires a smaller sample, and a qualitative researcher, believing that some informants are richer than others, selects those who will provide appropriate answers to the questions under enquiry.

5.4.2.3 Purposive sampling techniques

This study employed *purposive sampling techniques* to identify the parameter of the population selected in order to collect quality data. The sample for this study included the nine provinces in South Africa, namely, Western Cape, Gauteng, Eastern Cape, Free State, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape, and North West. Public housing construction is more prevalent in Gauteng, Western Cape, Eastern Cape, and KwaZulu-Natal than in the other provinces, likely due to higher populations, more industries, and the presence of the government seat and international organisations.

As the demand for housing in these provinces is acute, professionals who specialise in housing delivery are frequently busy working on sites. Therefore, 2934 respondents were targeted in these provinces since they accommodate a large proportion of the professionals, especially as most head offices of the construction industry are located in these provinces as well. As affordable housing delivery is a general problem throughout South Africa, this study enquires into the challenges through questionnaires and interviews to attain highest levels of accuracy for data collection, and to determine the specific problems and solutions for effective housing delivery in South Africa. Chapter 6 section 6.10 vividly explains sample size for this study.

Tongco (2007) states that the *purposive sampling technique* is a type of non-probability sampling that is most effective when researchers need to study a certain problem in a particular place with a knowledgeable expert. Purposive sampling techniques typically apply to qualitative and quantitative research methods. The naturally prejudiced mind contributes to its efficiency, and the approaches stay robust even when tested against probability sampling. Using purposive sampling is fundamental to the quality of data collecting, thereby ensuring reliability and ability of the respondents.

5.4.2.4 Chain sampling approach

The study employed the technique of *chain sampling* to collect data from the targeted respondents. The researcher contacted notable respondents in the Western Cape and Gauteng provinces among the identified sample of population to gather names and email address of respondents who, because they specialise in sustainable housing delivery, have the required knowledge to answer the questionnaires satisfactorily, without impediment. The use of this technique is successful because the process helps locate and connect those noble respondents from Limpopo, Free State, North West, Mpumalanga and Kwazulu-Natal.

Snijiders (1992, cited in Faugier & Sargeant, 1997) confirms that the chain sampling approach is an attempt to study a population hidden from the researcher for whom an adequate list, and consequently a sampling frame, is not readily available. The chain sampling method, one technique available for the collection of quality data, was developed as an original solution to overcome a population with hidden skills. It is an informal way to reach a population, as more informal techniques are planned to make inferences with regards to a population of individuals. Similarly, Hendricks and Blanken (1992, cited in Faugier & Sargeant, 1997) argue supportively that if a study is proposed to be primarily explorative, descriptive and qualitative, chain sampling offers practical advantages in obtaining information on difficult-to-observe phenomena, primarily in areas involving sensitive issues.

5.4.3 Qualitative Interview for data collection

This study involves the use of *qualitative interviews* to gather information from the targeted respondents. The interviews were conducted in the form of both *structured and unstructured interviews* to gather quality data from the selected populations of professionals working in construction organisation GHKQ in South Africa. The researcher conducted various interviews among the respondents to seek out the root of the problems causing the high cost of construction in the delivery of housing in South Africa. Consequently, the researcher was able to gather significant information exposing the underpinning causes of shortages, unaffordability, low quality and low quantity of housing in South Africa. Lucia *et al.* (2007) argue that face-to-face interviews help the researcher *feel* the perceptions of the respondents and their concerns in regard to the questions asked, aiding in the collection of raw information from the respondents.

5.4.3.1 Participant observation survey

The participant observation survey for this study was conducted in two approaches: observer as participant and participant as observer. The researcher became an observer as participant and participant as observer at a few of the construction sites in efforts to access to some drawings, and in so doing, the researcher was able to collect significant information through these two approaches ranging from causes of errors in housing designs and frequent changes in design by stakeholders. Thus, the researcher was able to conclude that errors in design and frequent changes in design cause substantial delay, ultimately leading to the high cost of construction in delivery of housing in those construction sites surveyed. Fraekel *et al.* (1993), likewise, believe *participant observation* is a situation whereby the researcher becomes a participant observer; in this situation, the researcher was able to ask questions of the groups studied and observe necessary documents.

5.5 Questionnaires survey methods

Quantitative *questionnaire survey methods* were employed in this study because the study relied on a larger population for surveying since the study is set to collect data from the selected professionals working in South Africa. Hence, quantitative questionnaires are significant for the survey of the main and sub-questions established in Chapter 1 from among construction professionals registered in South Africa.

The questionnaires for this study encompass two approaches – closed-ended quantitative questionnaires and open-ended qualitative questionnaires – as both these approaches play a significant role in gathering information for the study. The quantitative questionnaires for effective management of cost for sustainable affordable housing delivery were disseminated to extract information from a wide range of sample groups in the targeted population. Quantitative questionnaires in this study used Likert Scale questions: 1-5 and 1-4. The Likert Scales were used purposely to elicit a range of opinions from the respondents, so respondents are able to contribute meaningfully toward the alleviation of challenges of unaffordable housing and high cost of construction in delivery of housing. The qualitative questionnaires were in the form of structured and unstructured interviews to collect data from the selected sample of targeted population. This approach did not employ Likert Scale questions, as only oral opinions were requested.

Moser and Kalton (2017) confirm that *questionnaire survey methods* are designed to investigate a cause-effect of a problem in a particular location, a social survey technique for fact-finding.

Likewise, Brace (2008) argues that the questionnaire survey method is a widespread technique among researchers, designed for the collection of quality data from a sample population. Brace (2008) further claims that questionnaires are written in many different ways, used in many different circumstances, and apply multiple data gathering procedures. It should be clear to any researcher undertaking data collection through a questionnaire survey that questionnaires are imperative to the success of a research study. Good questionnaire writing in a research survey reaps major rewards in delivering the best and most accurate findings for the achievement of the aim and objectives of a research study.

5.5.1 Questionnaire design

The preliminary and comprehensive literature reviewed for this study produced the information on which the questionnaires were designed; in addition to these sources were exploratory studies. Through the literature reviewed, the aim and objectives of this study were established, significantly considered as the basis of the questionnaires. The questionnaires were purposely designed for the collection of quality data from the selected professionals in the South African construction industry. The questionnaires were aimed at collecting the most accurate, reliable intelligent information and data to discover the most appropriate solution to the lingering problems of availability, unaffordability and high construction costs of housing delivery in South Africa. Figure 5.4[18] indicates the sequence of achieving the aim and objectives of this study from the literature review, questionnaire design and data collection, through to the establishment of a framework and recommendations. Table 5.2 presents a detailed explanation with regard to how the questionnaires were designed for the study.

According to Saris and Gallhofer (2007), researchers make many decisions which adversely affect the quality of questionnaire design for the respondents. Hence, the consequences of decisions on questionnaire design must be well-understood by the researcher; then the researcher will design optimal questions for the research study. Saris and Gallhofer (2007) further confirm those factors that should be considered by researchers for testing the quality of a questionnaire:

- use of a pilot to test the questionnaires;
- check on face validity;

[18] Diagram in Figure 5.4 adapted from Akinyede (2017)

- prediction of quality of the questions with some instrument;
- prediction of the reliability of the questions with some instrument; and
- control of the routing in the questionnaires.

Thus, the questionnaire for the study is designed as follows:

The process of designing the questionnaires for this study is grouped into sections; the sections ranges from **A** to **I**, with the information separated to achieve the aim and objectives specified in the study. Each section has been discussed separately for clarity and for establishment of facts. Figure 5.4 shows a detailed procedure for the achievement of the objectives of the study.

5.5.1.1 Section A: Respondent details

Section A of the questionnaire requested a detailed description of the respondent's company and practices; this is significant to ascertain the background of each respondent in construction activities.

5.5.1.2 Section B: Professional affiliations

The professional affiliation, termed as the position of the respondents in their individual company, was requested in Section B of the questionnaires, important to this study to purposely establish each respondent's level of responsibility and number of years the respondent has invested in the position.

5.5.1.3 Section C: Housing delivery differentiation

Section C is important to the study to ascertain which housing projects each of the respondents has been involved with in the past, because housing delivery is comprised of a diversity of operations. Hence, the type of housing project in which the respondent was actually involved, in the past or at present, and the uses of those houses, must be known for clarity of information.

5.5.1.4 Section D: Questions to uncover hidden facts

Section D of the questionnaires requested various information paramount to this study. The respondents were to provide information concerning the estimated budgeted cost, time of delivery, procedure used for the procurement of their housing projects, in the past or at present, and lastly, the respondents were required to provide information about the housing projects in which they have involved.

5.5.1.5 Section E-1: Administrative and management rules and practices for housing delivery

This study enquired about the administrative and management rules and practices by the respondents in their respective firms, information essential for establishing how effective a company is in terms of adhering to good organisational planning and practices at various sites, and in achieving affordable, available, quality and cost-efficient housing delivery for the people. Hence, a Likert scale – 1-Extremely not applicable; 2-Not applicable; 3-Moderately applicable; 4-Applicable; and 5-Extremely applicable – was presented as answers to determine the precise level of opinion of each respondent on the applicable practices.

5.5.1.6 Section E-2: Learning processes

The learning processes engaged in construction companies have been investigated to determine procedures considered by construction stakeholders to improve skills of workers in their respective companies or sites toward affordable housing delivery for the people. A Likert scale of 1-Extremely not applicable; 2-Not applicable; 3-Moderately applicable; 4-Applicable; 5-Extremely applicable was used to glean opinions from the respondents on how skills are being improved on sites.

5.5.1.7 Section F: Factors affecting cost of sustainable housing delivery within budget

Section F investigated the most significant factors affecting cost of sustainable housing delivery within budget. These factors are obtained from literature reviewed, and the construction professionals need to consider these important factors during housing production processes to achieve efficiency and cost-effective housing delivery. These factors have a dual impact of both negative and positive influence on housing delivery. Hence, the degree of influence of these factors must be verified among the stakeholders by seeking their opinions and establishing the sequence of significance of those factors toward housing delivery. A Likert Scale of 1-Strongly disagree; 2-Disagree; 3-Agree and 4-Strongly agree was used to assess these factors on sustainable affordable housing delivery. A neutral opinion is avoided purposely so as not to include respondents without a clear opinion in this study.

Literature revealed that most Likert scale should made of four or six points. On the point that analyses have shown scales with more than six categories are rarely tenable as a result of limitation in working memory capacity. Nemoto and Beglar (2014) clarified that four points are desirable for your respondents and for respondents with low motivation to complete the questionnaires because 4-point scales are easy to understand and they require less efforts to answer. Nemoto and Beglar (2014) further explain that neutral or middle category should not be used for three reasons (1) Likert-scale categories should be conceptualised in the same way as physical measurement (2) middle/neutral categories cause statistical problem in that analysis of rating scales often shown that neutral categories disturb measurement in the sense that they do not fit statistical model well, because neutral is design to be more difficult to endorse than disagree (3) a neutral category is unnecessary because researcher should only include items on a questionnaires that respondents can answer.

5.5.1.8 Section G: Investigating factors affecting unsustainable design in delivery of housing

This section was developed purposely to probe factors that affect sustainable design in delivery of housing, since errors and frequent changes in design were established prevalent problems hindering effective housing production. Only the most significant factors affecting sustainable design were extracted from literature. Thus, respondent opinions were requested to give a verdict on the strongest impacting and clearest sequence of influence of these factors. A Likert Scale of 1-Strongly disagree; 2-Disagree; 3-Agree; and 4-Strongly agree was employed to access this information regarding sustainable housing delivery.

5.5.1.9 Section H: Impact of cost on management of construction resources in delivery of sustainable housing by construction operators

The impact of cost on management of construction resources in delivery of sustainable housing was investigated through the establishment of the strongest impacting factors and sequence of effect. These factors were obtained from literature reviewed.

5.5.1.10 Section H1: Effect of human resource management on budgeted cost

Construction resource management was identified as one obstructing problem toward affordable housing delivery within budgeted cost specified. Consequently, these factors identified are the most influential factors on the effective management of human resources. Section H1 establishes this fact and presents these factors before each respondent to identify the most significant factors in order of influence on cost of construction and delivery of sustainable housing. A Likert Scale of 1-Perfectly unacceptable; 2-Unacceptable; 3-Quite acceptable; 4-Acceptable; and 5-Perfectly acceptable is used to determine the level of acceptance of the construction professionals specialising in housing delivery, and the influence of these factors on human resource management toward cost efficient housing.

5.5.1.11 Sub-section H2: Effect of building material management on budgeted cost

Building material management was discovered to have both negative and positive effects on the cost of housing delivery according to the literature. Factors impacting efficient building material management are listed in Section H3. Based on these emerging facts, the construction professionals were requested to identify the most significant factors in order of importance and their level of agreement with these factors on cost of sustainable affordable housing delivery. A Likert Scale of 1-Strongly disagree; 2-Disagree; 3-Agree; and 4-Strongly agree was used determine the level of agreement.

5.5.1.12 Sub-section H3: Machinery management effect on cost

The machinery management effect on cost was developed in this section to ascertain its degree of influence on sustainable housing delivery and high construction cost. A Likert Scale of 1-Strongly disagree; 2-Disagree; 3-Agree; and 4-Strongly agree was used to determine the level of agreement with factors listed in Section H2 as the most influential among constructional professionals specialising in housing delivery.

5.5.1.13 Section I: Effective utilisation of cost without inflating affordable sustainable housing delivery

Section I is fundamentally developed to establish those factors that affect effective adherence to budgeted cost without inflating cost of construction for sustainable housing delivery; cost is clearly significant toward effective delivery of affordable sustainable housing. As the most prompting factors were extracted from literature reviewed, the opinion of stakeholders who specialise in housing delivery were sought to determine the level of effectiveness of the listed factors toward sustainable housing within budgeted cost specified. A Likert Scale of 1-Ineffective; 2-Slightly ineffective; 3-Slightly effective; 4-Effective; and 5-Perfectly effective was used to establish respondent opinions.

5.6 Collection of data for the main study

As questionnaires are designed purposely to collect accurate and quality data for this study, the questionnaires must be tested among the selected professionals who are specialists in housing delivery. Therefore, pilot testing of the questionnaires is required to be certain that the questionnaires measure what they are intended to measure for the study, as the target is to establish the aim and objectives of the study.

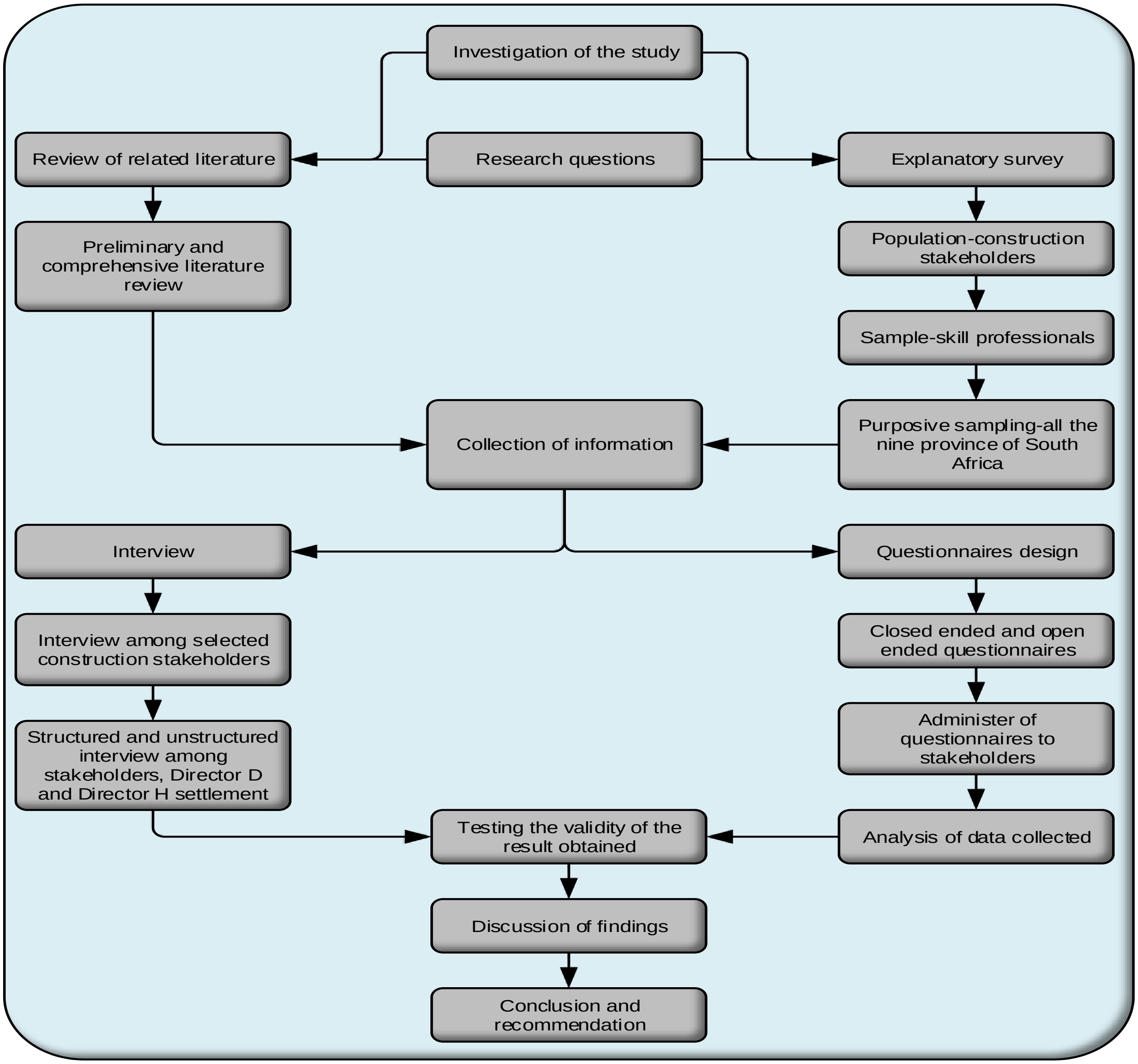

Figure 5.4: Sequence of achieving the research objectives

Table 5.2: Summary of questionnaire design at a glance

Section Number	Title of the Section	Objectives to be address by each section
Section A	Details of the sustainable housing delivery specialist	To distinguish the particular opinion of specialist in housing delivery
Section B	Professional affiliation	To establish area of specialised skill among the professionals
Section C	Housing delivery differentiation	To identify type of housing projects in which the professionals are involved
Section D	Budgeted cost involved in each project and delivery time	To investigate the budgeted cost involved in each of the project and delivery time
Section E	Administrative management rules, practices and learning process involved in affordable housing delivery	To determine level of application of administrative rules and practices in delivery of housing by specialised firm
Section F	To identify factors that inflate cost of sustainable housing delivery over budget	Objective one
Section G	To establish factors that affect unsustainable design in delivery of sustainable housing within budget	Objective two
Section H	To establish the impact of cost on management of construction resources in delivery of sustainable housing	Objective three
Section I	To ascertain how cost could be effectively utilised without detrimentally impacting sustainable housing delivery	Objective four

Table 5.3: Procedures considered for the achievement of objectives of the study

Objectives of the study	Outcome	Steps toward achieving objectives
To identify factors that inflate cost of sustainable housing delivery over budget	Integration of factors into sustainable housing delivery toward cost effectiveness and availability of housing	Objective 1 will be achieved through exploratory study conducted, review of relevant literature to the study, observation and questionnaires survey
To establish the factors that affect sustainable design in delivery of sustainable housing within budget	Design cost efficient and sustainable housing that meet the need of stakeholders and end users	This objective can be achieved through inspection of drawings, observations, review of similar literatures to the study and design of questionnaires for survey
To establish the impact of cost on management of construction resources in delivery of sustainable housing by construction operators	Integration of sustainability into human, materials and machinery resources for cost effectiveness, quality and quantity sustainable housing delivery for construction professionals	The achievement of this objective is significant to interview on site, review of literature, observation through participation and design of questionnaires for survey
To ascertain how budgeted cost can be effectively utilised without detrimentally impacting the affordability of sustainable housing delivery	To determine efficient management of construction constraints for construction professionals toward affordable sustainable housing delivery for low income earners	Objective 4 will be achieved through interview, observation on site, review related literatures, design of questionnaires for survey
To establish a framework for effective management of cost toward sustainable housing delivery for costs to remain within the limit of budgeted cost.	To achieve the integration of sustainable techniques for affordable housing delivery for construction professional for cost of construction to remain within budgeted cost specified.	The achievement of fifth objective is based on review of literatures, validity of the most vital results obtained in the analysis of data collected for objectives 1-4, and integration of these findings into sustainability

5.6.1 Pilot testing of questionnaires

Pilot testing of questionnaires, essential to determine the accuracy of the questionnaire survey, must occur by trying it first on a few selected people specialising in the field of study. In other words, questionnaires are purposely pre-tested to determine if everyone in the selected sample understands the questions in the same way. Through pilot testing of questionnaires, the researcher can ascertain if respondents feel uncomfortable answering any questions. Similarly, the timeframe for answering the questions will be established, and respondents who are able to answer the questions adequately will be identified by the researcher through the pilot testing of questionnaires.

Collins (2003) makes clear that traditional researchers, engaged with standardising data collection instruments and procedures to avoid irrelevant words in a question, have proven that experience in questionnaire design is important, coupled with pilot testing of questionnaires, to ensure valid and reliable results. Thus, standardisation is one of the concepts of pilot testing questionnaires, so that respondents are able to understand the questions asked, and that all respondents are willing to answer the questions. Davis (1992) recommends that a panel of experts review questionnaires to minimise inappropriate questionnaire design. Likewise, Van Teijlingen and Hundley (2001) explain that pilot testing of questionnaires is a critical element of good research design, intensifying the prospect of good data collection.

The basis for drafting the questionnaire for this study comes from the literature reviewed, interviews and the exploration conducted. The pilot testing of the questionnaires was first presented to the panel of six registered professionals specialising in housing delivery and sustainability in one of the housing projects in Cape Town. The professionals reviewed the questionnaire and made useful suggestions to be inputted into the questionnaires; the suggestions were adequately integrated into the drafted questionnaires. The second pilot testing of questionnaires was conducted among thirty-one specialists selected from among housing construction professionals (details in section 5.4.2.1). The professionals answered the questions adequately and offered comments on some of the factors in the questionnaires. Twenty-five questionnaires were retrieved from the respondents and corrections were made accordingly.

Thereafter, the questionnaire was presented to the researcher’s supervisor for review, with supervisor comments further strengthening the quality. Afterward, the supervisor advised that the questionnaires be sent to a professional specialising in construction management to further edit and proofread the questionnaires, thereby achieving further simplicity, clarity and ease of comprehension of the questionnaires for the respondents. Following this advice, the questionnaires were subsequently sent out for editing and proofreading, with editor comments playing a prominent role in enhancing the quality of the questions.

5.6.2 Administering of questionnaires

The researcher considered many options for administering the questionnaires to the selected professionals working in the construction company registered under CIDB to gather information for the main study. After carefully consideration of options available, the researcher adopted two approaches: for the first-approach, questionnaires were delivered to the respondents by hand; while for the second approach, the questionnaires were emailed to respondents working in other provinces.

The administering of questionnaires through email was done in two ways; the researcher sent questionnaires directly to the respondents' emails. Some of the respondents helped the researcher in locating other respondents specialising in sustainable housing delivery who were working in another province; thereafter, the first respondents forwarded the questionnaires to the emails of second respondents. The first respondents collated the questionnaires after answers has been inputted and returned to the researcher, a technique referred to as *chain sampling* (section 5.4.2.4). To select an accurate population for the study, references were made in regard to lists of architects, quantity surveyors, contract managers, project managers,

Table 5.4: Total number of registered contractors by grade as at 31 March 2017/2018

grade	Tender value limit (R)	Class of Work		Total
		CE	GB	
3	2,000,000	816	600	1416
4	4,000,000	817	805	1622
5	6,500,000	689	597	1286
6	13,000,000	760	647	1407
7	40,000,000	401	312	713
8	<130,000,000	142	112	254
9	>130,000,000	67	41	108

CE=Civil Engineering works; GB=General Building works; R=Rand

Table 5.5: List of SACPCMP professionals and candidate registration per province 2017/2018

No.	Name of Province	Number of professionals and candidates per province
1	Eastern Cape	575
2	Free State	146
3	Gauteng	1739
4	KwaZulu-Natal	748
5	Limpopo	196
6	Mpumalanga	213
7	Northern Cape	57
8	North West	82
9	Western Cape	586

Table 5.6: List of SACPCMP registered professionals who comply with CPD

No	Category of registration	Number of registered professionals	Number of compliant registered professionals
1	Pr.C.Mentor	23	14
2	Pr.CPM	1602	421
3	Pr.CM	735	135
4	C.Mentor	3	1
5	Pr.CHSA	27	18
6	CHSM	78	23
7	CHSO	187	9
Total		**2655**	**621**

site engineers and general building contractors in all nine South African provinces according to the CIDB list of registered contractors. The list of registered contractors and architects is shown in Table 5.4[19] and Table 5.5 above, respectively. Similarly, information concerning other professionals used as the population for this study was obtained from annual reports of professionals, as indicated in Table 5.4, Table 5.5[20], and Table 5.7 and Table 5.9 below, excluding Table 5.8 which contains information obtained from the list of green building accredited professionals.

---

[19] Information in Table 5.4 adapted from the CIDB Annual Report 2017/2018
[20] Information in Table 5.5, Table 5.6 & Table 5.7 adapted from the SACPCMP and SACAP Annual Reports 2017/2018

Table 5.7: List of registration architects by province

Category of registration	Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Limpopo	Mpumalanga	Northern Cape	North West	Western Cape
CAD	9	14	91	17	14	12	2	8	21
CAT	20	5	71	46	6	8	1	1	27
CSAT	10	2	58	27	2	4	-	-	28
CANT	20	11	122	27	1	3	3	-	68
PAD	19	12	101	27	15	14	7	8	39
PAT	3	3	41	27	2	4	4	2	24
PSAT	14	1	98	30	6	4	-	3	56
Pr Arch	37	25	273	82	4	9	5	11	109
Total	**132**	**73**	**855**	**283**	**50**	**58**	**22**	**33**	**372**

Table 5.8: List of engineers in green building accredited professionals by province

Category of profession	Eastern Cape	Free State	Gauteng province	KwaZulu-Natal	Limpopo	Mpumalanga	Northern Cape	North West	Western Cape
Structural Engineer	1	-	15	8	-	-	-	-	7
Consulting Engineer	2	-	22	2	-	-	-	-	19
Civil Engineer	-	-	13	7	-	-	-	-	13
Total	**3**	**-**	**50**	**17**	**-**	**-**	**-**	**-**	**39**

Table 5.9: List of candidates and professional quantity surveyor by region as at 31 March 2017/18

Province		Candidate	Professional QSs	Total
Eastern Cape	M	117	119	309
	F	55	18	
	T	172	137	
Western Cape	M	144	288	546
	F	72	42	
	T	216	330	
Northern Cape	M	11	16	35
	F	4	4	
	T	15	20	
Free State	M	46	69	151
	F	21	15	
	T	67	84	
Gauteng	M	464	677	1547
	F	228	178	
	T	692	855	
KwaZulu Natal	M	184	210	519
	F	86	39	
	T	270	249	
Limpopo	M	60	39	134
	F	30	5	
	T	90	44	
North West	M	26	37	80
	F	11	6	
	T	37	43	

Table 5.9 continued

Province		Candidate	Professional QSs	Total
Mpumalanga	M	46	38	114
	F	18	12	
	T	64	50	
Others	M	31	82	124
	F	8	3	
	T	39	85	
Total		**1682**	**1897**	**3559**

Table 5.10: Summary of list of professionals used as population for the study

No	Name of profession	Number of professionals
1	Construction Manager	135
2	Construction Project Manager	421
3	Professional Quantity Surveyor	1897
4	Professional Registered Architect	372
5	Professional Engineer	109
Total		**2934**

5.6.3 Determination of sample size for the study

Berlett (2001) explains that determination of sample size is a common task for researchers as inadequate, inappropriate and excessive sample size will influence the quality and accuracy of research. Considering the population in Table 5.4, Table 5.5, Table 5.7, Table 5.8, and Table 5.9[21] above, the researcher employed Checkmarket-sample size survey method obtained from *www.checkmarket.com* to determine appropriate sample size of population for the questionnaire survey. The methods were applied as follows: the sample size of the population for this study was determined from Table 5.10, as the Table indicates a variety of populations in reference to checkmarket which explain different confidence levels and margins of error. The researcher considered a confidence level of 95% and margin error of 5%, respectively, and overall population determined for the study is 2934 as inputted in Table 5.11[22]; the sample size falls between 278 and 370, since 2934 can be found between a population of 1000 and 10000, as shown in Table 5.11.

To obtain an accurate sample size for the study, the researcher adopted the second method of checkmarket-easy sample size calculator to calculate a representative sample size for the study from *www.checkmarket.com*. The overall population of 2934 was inputted into the calculator, and a confidence level of 95% and margin error of 5% were selected from the calculator and inputted. The calculator automatically generated the required sample size at 340 for the overall population. Checkmarket established that 20% of an estimated response rate is required for the sample size of a study, further explaining that 30% is distinct as really, really good for an estimated response rate.

The researcher administered the first batch of 1056 questionnaires to the selected sample of professionals from 2 November 2016 to 7 December 2016. Questionnaires were administered by hand and through email. Seventy-eight questionnaires were retrieved from respondents, with thirteen questionnaires voided, as one step considered for achieving collection of quality data. The second batch of 821 questionnaires were administered by hand delivery and through emails between the months of April, May, and June 2017, with 42 questionnaires eventually

---

[21] Information in Table 5.8 & Table 5.9 adapted from the "list of green building accredited professionals" and "South Africa Council of Quantity Surveyor Annual Report, March 2017/2018

[22] Information in Table 5.11 adapted from www.checkmarket.com

Table 5.11: Checkmarket for sample size of population in unit

Population	Confidence level = 95% Margin error			Confidence level = 99% Margin error		
	5%	2.5%	1%	5%	2.5%	1%
100	80	94	99	87	96	99
500	217	377	475	285	421	485
1000	278	606	906	399	727	943
10000	370	1.332	4.899	622	2.098	6.239
100000	383	1.513	8.762	659	2.585	14.227
500000	384	1.532	9.423	633	2.640	15.055
1000000	384	1.534	9.512	633	2.647	16.317

completed successfully by respondents and retrieved by the researcher. The third batch of 360 questionnaires was also administered in of July 2017 through hand delivery and emails; in the long run, nine of these questionnaires were retrieved; however, two questionnaires were voided based on discovered errors.

In the end, the number of questionnaires retrieved from respondents totalled 65+42+7=114. Ultimately one hundred and fourteen (114) questionnaires were reclaimed and collected as data by the researcher. As quality data collection is important to this study, all necessary techniques were implemented toward achieving correctness and accuracy in data collection. Similarly, as reliability of respondents who answered these questions is crucial to the study, all necessary fundamentals issues were considered for achievement of quality data for the study.

The response rate for the study is 114**.** Checkmarket-sample size survey method established that 20% estimated response rate is required for a study, and 30% is really good. Hence, to determine the percentage of response rate for this, the calculation was conducted as follows: 114/340X100%= 33.5%, approximately 34%, higher than ‘really good’. Hossain *et al.* (2016) explains that checkmarket online sample size calculator was used to determine the size of population for cross-sectional survey carried out in Pakistan. The recent study that use Checkmarket Sample Size Survey method to calculate sample size of population are Sallam *et al* (2019) and Oyeneyin *et al* (2019). Sallam *et al* calculated sample size with a margin of error of 5% and 95% confidence interval, while Oyeneyin *et al* 2019 calculated sample size with a margin of error of 4.06% and 95% confidence interval. However, the statement above confirm that Checkmarket Sample Size Survey method has been used by previous study to determine sample size.

Tashakkori and Creswell (2007) specify *quality data* as significant toward effective collection, as it is a synopsis of the ability of respondents to answer questions that will determine the quality of data, rather than quantity. Tashakkori and Creswell (2007) further expound those factors that the researcher must bear in mind during conceptualization of data collection for a study, such as robustness in data design, adequate planning for data collection and sample of population used. According to Strong *et al.* (1997), data quality problems may arise through lack of proper conceptualization of data collection, organisation and accessibility of respondents.

5.6.4 Qualitative data collection

The qualitative data collection for this study is critical toward exposing hidden information other methods are unable to uncover from the inner recesses of respondents' minds, as qualitative interviews more intricately expose perceptions or feelings of respondents. Fact finding is essential concerning techniques that will necessitate effective delivery of sustainable housing for the people. The population this study engaged for interviews is a concern toward achieving quality data collection. Hence, the researcher postulated engaging with the most experienced professionals within the construction industry specialising in housing delivery, as well as government officials in housing department.

According to Guest *et al.* (2006), the maximum population that a researcher can used for in-depth interviews ranges from 12-60 participants, after which a saturation point will be reached, a point at which no new information on themes will be observed in the data. Similarly, Morse (2000) explains that the quality of data and the number of interviews per participant usually determines the amount of usable data: the greater the amount of usable data obtained from each person, the fewer the number of participants needed. To achieve the richness of data collection for qualitative analysis, a large number of participants, from 30-60, is required.

The researcher made an inference from Guest *et al.* (2006) and Morse (2000) as to the number of participants who will be engaged in qualitative interviews. Hence, the study involved the most experienced four participants from among the population sample. Four case studies were selected from the construction industry specialising in housing delivery, while one of each case study was selected from the Government Official working in department specialise in housing delivery. To secure participants, an invitation letter was sent to each participant. Each expressed interest in the group interview, indicating sincere interest for involvement in the interview. The detailed outcomes of the interviews are discussed in Chapter 7 regarding content analysis for validation of results obtained in quantitative analysis.

5.6.5 Reliability and validity test

The testing of reliability of questions and validity of obtained results and instruments used for this study is vital toward achieving the aim and objectives of this study.

5.6.6 Reliability measurement

Reliability testing is a technique employed to determine if the instruments used in a study and data collected actually measured what was intended, accurately and consistently, in a concept under investigation. Reliability is certain in a study if the techniques are used repeatedly and the same results obtained within a certain timeframe. This study addressed reliability by testing the research questions and the factors in the questionnaire. Most of these results are explained in Chapter 7 under reliability and validity testing. Cronbach's alpha coefficient was used to perform this reliability test. Similarly, Altheide and Johnson (1998, cited in Morse *et al.,* 2002) explain that exclusion of rigor in a research study means a study loses its expediency and is rendered false. Thus, every research method applied significant attention to reliability and validity. Challenges to rigor in qualitative enquiry remarkably match the prospering of statistical packages and the development of computing methods in quantitative research.

Morse *et al.* (2002) explain that reliability and validity remain appropriate concepts for accomplishing rigor in qualitative research. Morse *et al.* (2002) further argues that qualitative research should reclaim responsibility for reliability and validity through effecting verification strategies that are integral and self-correcting during the investigation. Trochim (2006, cited in Fapohunda, 2010) explains that researchers are concerned with whether or not techniques are measuring what is intended to be measured, and to ascertain if observations are influenced by the circumstances in which they are made.

5.6.6.1 Validity measurement

Validity measurement is of utmost importance to this study, as it is upon this which the verification of results obtained from quantitative analysis rely for achieving the aim and objectives of the study. The testing of the validity of results obtained in the analysis of data is verifying the extent to which instruments used in a study adequately measure what they are intended to measure. Validity testing was applied to the results obtained from the quantitative data analysis, the qualitative interviews among the five three-participant groups, to enquiry if the instrument measures what it is supposed to measure. The validation report is presented in Chapter 7. Golafshani (2003) explains that validity and reliability are common in quantitative research as they are reassessed in the qualitative research paradigm. Therefore, validity and reliability are entrenched in a positive viewpoint. The two techniques should be redefined for their use in a real-life approach. Winter

(2000 cited in Golafshani, 2003) defines *validity* as evidence, universal law, objectivity, deduction, truth, reason, actuality, mathematical data and fact.

5.6.6.2 Data analysis techniques for the study

Data analysis techniques employed in this study, focusing on modelling and knowledge discovery, are both statistical and linguistic, as various techniques are used purposely for understanding the message contained in the data collected from respondents. Data analysis is mathematical in nature, involving descriptive and inferential statistics. This study employed descriptive statistics to analyse and summarise background information concerning the sample population of this study. Descriptive statistics include mean, standard deviation, median, charts, tables and frequencies, while the study employed inferential statistic to make inferences and predictions about the population sample, including relative index analysis, analysis of variance, factor analysis, KMO and Bartlett's test of Sphericity.

5.6.6.3 Descriptive statistical data analysis

Descriptive statistical data is referred to as numbers that are used to summarise and describe the details of data collected; descriptive statistical data analysis uses data to describe the details of the population through numerical arithmetical calculations, graphs, pie-charts and tables. Descriptive statistics form the basis on which data collected through quantitative questionnaires are analysed and described. This study uses four types of descriptive statistics:

1. measure of central tendencies;
2. measure of dispersion;
3. measure of frequency; and
4. measure of position.

The measure of central tendency used in this study includes mean, median and mode; types of measures of dispersion used in this study are variance, range and standard deviation; measures of frequency types include count, frequency and percentage; and the measure of position used in study includes percentile ranks and quartile ranks.

5.6.6.4 Measure of central tendency: mean scores

Mean is referred to as an average of set of data values. Mathematically, it can be calculated as the sum of all data values divided by the number of data values. Hence, mean, median and mode are used to gather information about a population from sample size of a study population.

$$\text{The calculation of means} = \frac{\text{Sum of all data value}}{\text{Number of data value}}$$

Symbolically, $\overline{X} = \frac{\sum X}{n}$

Where $\overline{X}$ (read as X[1] bar[1]) is the mean of the set of X value; $\sum X$ is the sum of all the X values; and n is the number X values divided by the number of data value.

This study uses mean scores to collect information from the sample of the population employed for investigative questions. According to Manikandan (2011), mean has different types, including arithmetic mean, geometric mean, weighted mean and harmonic mean. An arithmetic mean simply means average, achieved by adding all values in a data set divided by the number of observations in it. The advantage of mean is that it uses every value in the data, thereby enhancing a solid representation of the data.

5.6.6.5 Measure of frequency: percentage and frequency

The study involves the measure of frequency to properly organise data into a meaningful form so that information from the data can be seen clearly. Frequency distributions are used to categorise the study’s population, representing data in the form of tabulation. Through the use of frequency distribution, the entire glance at data is simplified. Similarly, Gravetter *et al.* (2000) confirm that frequency is one of the methods employed in descriptive statistics to construct frequency distribution; this can be in tabulation (table form) or presented graphically.

5.6.6.6 Measure of dispersion: variance, range and standard deviation

This study uses *measure of dispersion* as one type of descriptive statistic to describe data analysis. Under this measure of dispersion, range, variance and standard deviation were presented to provide descriptive details concerning the data. Manikandan (2011) vividly explains uses of range, variance and standard deviations in a data description. Thus, *range* of data is known as the difference between the largest and smallest observation in the data, while *standard* *deviation* is the most commonly used measure of dispersion, mathematically, represented by the square root of sum of squares deviation from mean, divided by the number of observations.

5.6.7 Factor analysis for data

The study applied *factor analysis* to reduce the dimensionality of a set of a data collected from the quantitative questionnaires. Factors are known as variables; however, factors have different meanings and consequences for use in differing contexts. A factor expresses itself through its relationship with other measured variables. Factor analysis involves the use of SPSS package as a data reduction technique, while it takes a large set of variables and looks for a way that the data may be reduced or summarised using a smaller set of factors or components. This action is performed through correlation of a set of variables (Pallant, 2013). Costello and Osborne (2005) describe factor analysis as a widely utilised and broadly applied statistical technique in the social sciences and related fields. It has many options varying in terminology across different software packages. Costello and Osborne (2005) provide practical information on making best decisions regarding factor analysis through the application of rotation, extraction, sample size and the number of factors interpreted.

According to Jolliffe (1986), principal component analysis (PCA) is one option in a programme for factor analysis; the two techniques are really quite distinct. However, principal component analysis and factor analysis both aim to reduce the dimensionality of a set of data, although the approaches to do so are different for the two techniques.

5.6.7.1 Principal component analysis, correlation and logistic regression analysis for framework of sustainable housing delivery and procedures

The establishment of a framework for effective management of cost of construction for affordable housing delivery and integration of sustainability into housing production processes and procedures are the major concerns of this study. The achievement of this investigation pivots around the use of principal component analysis, correlation and logistic regression analysis. The significance of using descriptive statistics, PCA analysis, correlation and logistic regression analysis rests on statistical techniques for building and testing statistical models. These crossbreed techniques can be used to analyse and understand structural relationships between dependent and independent variables. Similarly, Zwick and Velicer (1986, as cited by O' Connor, 2000) explain that the uses of factors and principal components analysis are required to decide on a number of statistical issues including the number of factors to be retained, extraction and rotation techniques and the procedure for computing factors scores. Pearce and Ferrier (2000) confirm that though the use of statistical modelling techniques such as logistic regression is increasing, relatively little attention has been devoted to the development and application of appropriate evaluation techniques for assessing the predictive performance of a model. However, evaluating the predictive performance of model is a vital step in model development.

5.6.7.1.1 Correlation analysis

Pallant (2013) clarifies that *correlation analysis* describes the strength and direction of the linear relationship between two variables. Although there are a number of different statistics available from SPSS, these all depends on the level of measurement. Thus, this study involved the use of Pearson's correlation coefficient and Spearman's correlation coefficient to analyse data. More information concerning the use of correlation analysis ir presented in Chapter Eight.

5.6.7.1.2 Logistic regression analysis

The study used logistic regression analysis to test models to predict categorical outcomes with two or more categories. According to Pallant (2013), logistic regression allows researchers to test models to predict categorical outcomes. Predictor (independent) variables can be either categorical or continuous, or a mix of both in the one model. This study used a multicollinearity test among the independent variables for checking correlation among the predictors. More information about logistic regression analysis can be found in Chapter 8.

5.7 Summary

This chapter comprises the methods employed in the investigation of the research questions and collection of quantitative and qualitative data for the study. Moreover, this chapter contains the use of descriptive statistics analysis and reliability and validity testing to assess the instruments used, and to explain data analysis procedures employed in this study. The chapter explained the philosophical standpoint of the study, justification of sequential mixed method design approach for the study, research design methodology approaches, research design approaches, discussion on collected information from archives, design of data collection process and the preliminary and comprehensive literature review process. The population used for this study was discussed, along with data collection and analyses processes which involved the use of descriptive statistics, Principal component analysis (PCA), factor analysis, correlation analysis and logistic regression analysis. This chapter is a forbearer to Chapter 6, as the information contained in this Chapter 5 forms the basis of the structure of Chapter 6. The subsequent chapter is comprised of the methods used to analyse the data collected through a quantitative process, with results discussed according to the aim and objectives of the study.

CHAPTER SIX

6. DATA ANALYSIS AND DISCUSSION OF FINDINGS

6.1 Introduction

This chapter, comprising the analysis of data collected through quantitative questionnaires, is split into various sections to present the result of the data analysis in a logical sequence. The quantitative data collected were analysed by descriptive and inferential statistical techniques. The respondents' details, professional affiliations and housing delivery differentiation as well as administrative management rules and practices used in the company of the respondents for housing delivery were analysed. The analysis of factors that affect cost of sustainable housing delivery within budget, factors that affect unsustainable design in delivery of affordable housing within budget, the impact of cost on management of construction resources in delivery of sustainable housing by construction operators, and effective utilisation of budgeted cost without inflate cost of construction for sustainable housing delivery were fully discussed. The results obtained from the analysed data were used to establish a framework for sustainable housing delivery and procedure, described in Chapter 8.

6.2 Responses to questionnaires by respondents

Data were collected from the respondents through quantitative questionnaires administered by hand delivery and emails, as explained in Chapter 5. The respondents employed in this study for collection of data are professionals specialising in sustainable housing delivery and procedure in the construction industry registered under CIDB Grade 3-9 in the nine provinces of South Africa, with 2237 questionnaires administered to respondents, and 114 questionnaires retrieved for analysis.

6.2.1 Section A: Respondent's details

Table 6.1 consists of information on each respondent's company. Available evidence from the analysis revealed that the majority of respondents are working in a construction company, and the least among the respondents participating are from a quantity surveying firm. This implies that adequate information will be collected, since the highest number of the respondents comes from a construction firm and only two from quantity surveying firms.

Table 6.1: Respondent details

Variables (Respondent details)	Frequency	Percentage (%)
Architectural firm	6	5.3
Project consultant firm	16	14.0
Structural firm	2	1.8
Construction firm	88	77.2
Quantity surveying firm	2	1.8
G-Total	**114**	**100**

6.2.2 Respondent's years of experience in their respective company

The data analysis in Table 6.2 displays each respondent's years of work experiences in their respective companies. The largest group of respondents had 1-5 years' experience decreasing to the group with 26-30 years' experience. The 21-25 years of experience group is an outlier with only two respondents. This information depicts that young professionals with their years of experience ranging from 1-10 years are fully on ground in the housing delivery construction site. Nevertheless, more experienced workers are needed to enhance the efforts of young, talented professionals for quality housing delivery.

Table 6.2: Respondent's years of experience

Variable (Respondents years of experience)	Frequency	Percentage (%)
1-5 years	37	32
6-10 years	34	29.8
11-15 years	19	16.7
16-20 years	12	10.5
21-25 years	2	1.8
26-30 years	10	8.8
G-Total	**114**	**100**

6.2.3 Section B: Respondent's professional affiliation

The analysed data in Table 6.3 shows the professional affiliation of respondents who partook in the research survey. The professional group with the highest representation are the quantity surveyors, and the lowest is the contract managers and contractors. This signifies that there are enough professionals to provide information on cost estimation and appraisal for quality work done, enhancing the quality of collected data.

Table 6.3: Respondent's professional affiliation

Variable (Respondent professional affiliation)	Frequency	Percentage (%)
Architects	12	10.5%
Project managers	33	28.9
Site engineers	7	6.1
Contract managers	6	5.3
Contractors	6	5.3
Quantity surveyors	50	43.9
G-Total	**114**	**100**

6.2.4 Respondent's years of experience in current position

Table 6.4 contains each respondent's years of experience in their current position. Although young and promising professionals has the highest number on site, the fact is that more experienced professionals are urgently needed on site to achieve affordable housing delivery. Nevertheless, suitable information is collected based on the available experience of the professionals.

Table 6.4: Respondent's years of experience in current position

Variable (Respondent's years of experience in current position)	Frequency	Percentage (%)
1-5 years	71	62.3
6-10 years	26	22.8
11-15 years	10	8.8
16-20 years	5	4.4
21-25 years	1	0.8
26-30 years	1	0.8
G-Total	**114**	**100**

6.2.5 Section C: Housing delivery differentiation

The majority of respondents participating in the survey confirmed their involvement in delivery of new housing, while few numbers of respondents say that they partake in renovation of housing. It is worth mentioning that statistics in Table 6.5 are connected to the truth that most of the respondents engaged in the survey are experienced professionals in housing delivery. The percentage of respondents participating in new housing signifies that quality data has been collected.

Table 6.5: Housing delivery differentiation

Variable (Housing delivery differentiation)	Frequency	Percentage (%)
New housing delivery	93	81.6
Renovation of housing	21	18.4

6.2.6 The use of housing project

Table 6.6 contains information concerning respondents who engaged in public and private residential building delivery: a high percentage of respondents have partaken in private residential housing delivery is 66.7%, while 33.3% of the respondent involve in public home. Nonetheless, the number of the respondents that partook in public housing delivery is infinitesimal when compared with the group that are involved with private housing. The information suggests that respondents are highly connected with the community and understand the plea of the people in regard to housing. Data collected is accurate.

Table 6.6: The use of housing project

Variable (Use of housing project)	Frequency	Percentage (%)
Public residential housing	38	33.3
Private residential housing	76	66.7
G-Total	**114**	**100**

6.2.7 Section D: Housing project characteristics

The respondents are asked to provide information on the characteristics of housing projects in which they have been involved: budgeted cost of the housing project; increase in cost of construction as result of variation in cost of housing project; time frame for the housing project delivery; completed time for the housing production; contracting procedures used in the awarding of the housing project; and the perimeters occupied by the housing. The information collected is discussed.

6.2.8 Budgeted cost of housing project involving respondents

Respondents are involved in dissimilar housing project costs ranging from R200000-R50B as indicated in Table 6.7. On the other hand, the preponderance of respondents involved in housing project cost, ranging from R1M-50B, indicate that projects are is quite huge in size, requiring professionals with sound cost management knowledge to complete the housing project within budgeted cost specified. Consequently, the information collected from the respondents is reliable and reasonable, because information is gathered pertaining to both small and huge housing projects.

Table 6.7: Budgeted cost of housing project in which the respondents are involved

Variable (Housing project delivery characteristics)	Frequency	Percentage (%)
R200000-R1M	18	15.8
R1M-R5M	48	42.1
R51M-R50B	48	42.1
G-Total	**114**	**100**

6.2.9 Cost increase as a result of variation

A large number of respondents indicated in their response that the housing project in which they are involved recorded cost increase as a result of variation. To the contrary, only a small number of respondents claim there is no cost increase as a result of variation in housing project in which they are involved. The information is clearly depicted in Table 6.8: the importance of this information is based on the fact that most of the housing projects are delivered above budgeted cost.

Table 6.8: Cost increase as a result of variation

Variable (Cost increase as a result of variation)	Frequency	Percentage (%)
Yes-cost increase as a result of variation	99	86.8
No-cost increase as a result of variation	15	13.2
G-Total	**114**	**100**

6.2.10 Timeframe specified for housing project

The values presented in Table 6.9 below indicate that the respondents surveyed completed their housing projects at different times, with the majority completing their project within one to two years, and the smallest number of respondents completing the project within six months. However, the most important information is that most respondents completed their housing project ranging from six month to three years, and even longer.

Table 6.9: Timeframe specified for housing project

Variable (Timeframe specified for housing project)	Frequency	Percentage (%)
6 months	9	7.9
1 year s	25	21.9
2 years	53	46.5
3 years	15	13.2
Above 3 years	12	10.5
G-Total	**114**	**100**

6.2.11 Time for the completion of housing project

The respondents were requested to give information concerning the time the housing projects are completed at their various site. A high number of respondents completed their housing project within the record time as shown in Table 6.10, although quite a few numbers of respondents completed their housing project above time and below timeframe. By contrast, the smallest number of respondents expressed that their housing project is yet on-going on site. The significance of statistics available after the analysis shows that housing projects are completed within time stipulated, substantiating the truth that housing project are not delayed in delivery.

Table 6.10: Time for the completion of housing project

Variables (Time for the completion of housing project)	Frequency	Percentage (%)
Completed within timeframe	59	51.8
Completed above timeframe	20	17.5
Completed below timeframe	11	9.6
Not yet completed	24	21.1
G-Total	**114**	**100**

6.2.12 Contracting procedure used for housing project

Respondents were asked to confirm the methods used to procure the housing project for their company, with results offered in Table 6.11 pointing to the reality that for construction management, contracting is the process used by the majority of respondents to procure housing projects. A few respondents say that design and build contracts, traditional lump-sum contracts, tradition cost-plus contracts and design and manage contracts are the processes used by their respective companies to secure housing projects. Information obtained signifies that respondents have acquired experience through differing activities. Since the respondents use different procedures to secure housing project, data collected is adequate.

Table 6.11: Contracting procedure used for housing project

Variables (Contracting procedure used for housing project)	Frequency	Percentage (%)
Design and build contract	25	21.9
Construction management and contract	55	48.2
Traditional cost-plus contract	11	9.6
Traditional lump sum contract	20	17.5
Design and manage contract	3	2.6
G-Total	**114**	**100**

6.2.13 Specific area occupied by the housing projects

As respondents were asked to explain land mass area occupied by the housing project, the majority of respondents state that the housing project in which they are involved occupies 1000m^2 and above, while fewer respondents say that the housing project in which they have participating occupies 500m^2. The importance of this statistic is based on the truth that housing projects are enormous with gargantuan involved costs; thus, cost management principles is desperately needed.

Table 6.12: Specific area occupied by the projects

Variables (Specific area occupied by the housing project)	Frequency	Percentage (%)
500m^2	37	32.5
1000m^2	25	21.9
Above 1000m^2	52	45.6
G-Total	**114**	**100**

6.2.13.1 The demography of the respondents and each company's organisational structure

Table 6.13 The demography of the respondents and organisational structure are shown as a whole so that the statistical distribution of the data analysis results can be viewed in totality, thereby allowing adequate comprehension. The 88% of the respondents are from construction firm, 93% are involved in new housing projects and 99% of the respondents confirm cost increase.

Table 6.13: Demography of respondents and organisational structure of each company at a glance

Factor investigated	Variable	Frequency	Percentage (%)
Respondents' details in reference to their organisation	Architectural firm	6	5.3
	Project consultant firm	16	14.0
	Structural firm	2	1.8
	Construction firm	88	77.2
	Quantity surveying firm	2	1.8
Respondents' years of experience in construction industry	1-5 years	37	32
	6-10 years	34	29.8
	11-15 years	19	16.7
	16-20 years	12	10.5
	21-25 years	2	1.8
	26-30 years	10	8.8
Respondents' professional affiliation	Architects	12	10.5
	Project managers	33	28.9
	Site engineers	7	6.1
	Contract managers	6	5.3
	Contractors	6	5.3
	Quantity surveyors	50	43.9
Respondents' years of experience in current position	1-5 years	71	62.3
	6-10 years	26	22.8
	11-15 years	10	8.8
	16-20 years	5	4.4
	21-25 years	1	0.8
	26-30 years	1	0.8
Housing delivery differentiation	New housing delivery	93	81.6
	Renovation of housing	21	18.4

Table 6.13 continued

Factor investigated	Variable	Frequency	Percentage (%)
Use of housing project	Public residential housing	38	33.3
	Private residential housing	76	66.7
Budgeted cost of housing project in which the respondents are involved	R200000-R1M	18	15.8
	R1M-R50M	48	42.1
	R51M-R500B	48	42.1
Cost increase as a result of variation for housing production	Yes-cost increase as a result of variation	99	86.8
	No-cost increase as a result of variation	15	13.2
Timeframe for housing project	6 months	9	7.9
	1 year	25	21.9
	2 years	53	46.5
	3 years	15	13.2
	Above 3 years	12	10.5
Time for completion of housing project	Completed within timeframe	59	51.8
	Completed above timeframe	20	17.5
	Completed below timeframe	11	9.6
	Not yet completed	24	21.1
Contracting procedure used for housing project	Design and build contract	25	21.9
	Construction management and contract	55	48.2
	Traditional cost-plus contract	11	9.6
	Traditional lump sum contract	20	17.5
	Design and manage contract	3	2.6

6.2.14 Testing for the reliability of the Likert scale questions used in this study

The information inputted in Table 6.14 shows the statistical analysis of the reliability of the Likert scale questions used in this study, with obtained results confirming that the reliability of the questions measure what is supposed to be measure. Thus, section E to K record Likert scale questions and the Cronbach's alpha co-efficient ranges between 0.8 to 1, signifying reliability of questions. The average of the Likert scale questions is 0.9. Drawing inference from these results, the Likert scale questions with 209 factors in this study are adequate and reliable. The most spectacular information in this section is about subsection H1 and section I, all the factors has mean value 3 and above, on this basis Cronbach's alpha co-efficient is 1, reliability of the factors is very high.

Table 6.14: Testing for reliability of Likert scale questions

Section No	Factors influencing	Number of factors	Cronbach's alpha co-efficient
Section E	Administrative management rules and practice for housing development	8	0.9
Subsection E	Learning process for affordable housing delivery	6	0.9
Section F	Factors that inflate cost of sustainable housing delivery over budget	25	0.9
Section G	Factors that affect unsustainable design in delivery of affordable housing within budget	36	0.9
Section H	The impact of cost on management of construction resources in delivery of sustainable housing by construction operators		
Subsection H1	Human resources effect on cost in delivery of sustainable housing	30	1
Subsection H2	The effect of building materials on budgeted cost during production processes	24	0.8
Sub-section H3	Management of machinery effect on cost during sustainable housing delivery	17	0.9
Section I	Effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery	29	1
Section J	Critical factors of achieving quality housing delivery	18	0,9
Section K	Stakeholders influences on sustainable housing delivery during production	16	0,8
G-Total	**All the scale questions used in the study**	**209**	**0.9**

6.3 Section E: Administrative management rules and practices for sustainable housing delivery

The professionals who specialised in housing delivery were asked to identify the most applicable management rules and practices from within their companies to achieve sustainable housing delivery. The levels of application were assessed, the data obtained were analysed through the use of descriptive and frequency statistics, and results obtained are shown in Table 6.15 and 6.16. respectively. The results illustrate that professionals working in housing delivery companies apply safety practices on site, policies on quality, and total quality management procedures for production, as these are the first top three factors with highest mean scores. All factors recorded mean scores above 3.0, denoting that all factors are applicable and significant for effective sustainable housing production processes.

Table 6.15: Descriptive analysis of administrative management rule and practice factors

Coding	Administrative management rule and practice factors	Minimum	Maximum	Mean	Std. Deviation	Variance	Rank
AMR8	Safety practices on site	1.00	5.00	4.50	0.83	0.69	1
AMR4	Policy on quality	2.00	5.00	4.18	0.99	0.98	2
AMR6	Total quality management procedure for production	1.00	5.00	4.15	0.90	0.82	3
AMR2	Establishment of cost control criteria on site	1.00	5.00	4.09	0.94	0.90	4
AMR1	Ethical consideration on site	1.00	5.00	3.91	1.07	1.16	5
AMR7	Keeping records of experience learned on project delivery	2.00	5.00	3.89	0.96	0.92	6
AMR5	Keeping achiever records	1.00	5.00	3.84	0.95	0.91	7
AMR3	Obedience to international standard organisation rules	1.00	5.00	3.82	1.14	1.31	8

6.3.1 Section E1

6.3.1.1 Frequency statistical analysis of administrative management rule and practices

The frequency statistical analyses of administrative management rules and practices are shown in Table 6.16. The majority of respondents state that administrative management rule and practice factors used are safety practices on site, policy on quality, and total quality management procedure for production. A smaller number of respondents, however, disagree with the notion that administrative management rules and practices are not applicable in their company. Nevertheless, adequate implementation of these rules and practices will enhance efficient housing production processes on site.

Table 6.16: Frequency statistics analysis of administrative management rules and practice factors

Factors (Safety practices on site)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Extremely not applicable	4	3.5	3.5	3.5
Not applicable	7	6.1	6.1	9.6
Moderately applicable	26	22.8	22.8	32.5
Applicable	35	30.7	30.7	63.2
Extremely applicable	42	36.8	36.8	**100**
G-Total	**114**	**100**	**100**	
Factors (Policy on quality)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Extremely not applicable	1	0.9	0.9	0.9
Not applicable	5	8.8	4.4	5.3
Moderately applicable	25	14.9	21.9	27.2
Applicable	34	25.4	29.8	57.0
Extremely applicable	49	50.9	43.0	**100**
G-Total	**114**	**100**	**100**	
Factors (Total quality management procedure for production)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Extremely not applicable	5	4.4	4.4	4.4
Not applicable	10	8.8	8.8	13.2
Moderately applicable	26	22.8	22.8	36.0
Applicable	32	28.1	28.1	64.0
Extremely applicable	41	36.0	36.0	**100**
G-Total	**114**	**100**	**100**	

6.3.1.2 Subsection E

6.3.1.2.1 Descriptive statistics analysis of learning processes for housing delivery

To determine actual efficient ways of acquiring knowledge for achieving definite methods for housing production processes required that information was asked from the respondents about how they acquire skill for production. Most respondents confirmed that they acquired skill

Table 6.17: Descriptive statistics analysis of learning processes for housing delivery

Coding	Learning processes for housing delivery	Minimum	Maximum	Mean	Std. Deviation	Variance	Rank
LP5	Learning from previous projects	3	5	4.09	0.77	0.60	1
LP2	Learning through teamwork on site	2	5	3.86	0.78	0.61	2
LP1	Organised skill improvement conference for construction operators	1	5	3.52	1.04	1.08	3
LP3	Learning through workshop training	1	5	3.45	0.96	0.94	4
LP4	Learning through research on housing delivery	1	5	3.35	1.15	1.33	5
LP6	Seminars organised for housing development	1	5	2.88	1.26	1.58	6

through all the variables listed in Table 6.17. Since all the factors recorded a mean score above 3, signifying that if the variable is adequately implemented, this will enhance skills of workers during housing production. The variable that does not enhance skill of respondents recorded 2.88 as a mean score.

6.3.1.3 Subsection E1

6.3.1.2.1 Frequency statistics analysis of learning processes for sustainable housing delivery

The learning processes for housing delivery were analysed used frequency statistics analysis, with results obtained indicating that the majority of respondents stated that the process is applicable in their company. Nonetheless, a small number of respondents claimed that the

Table 6.18: Frequency statistics analysis of learning processes for housing delivery

Factors (Learning from previous project)	Frequency	Percentage (%)	Valid percent	Cumulative percent
Extremely not applicable	5	4.4	4.4	4.4
Not applicable	12	10.5	10.5	14.9
Moderately applicable	35	30.7	30.7	45.6
Applicable	42	36.8	36.8	82.5
Extremely applicable	20	17.5	17.5	**100**
G-Total	**114**	**100**	**100**	
Factor (Learning through teamwork on site)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Extremely not applicable	0	0	0	0
Not applicable	5	4.4	4.4	4.4
Moderately applicable	28	24.6	24.6	28.9
Applicable	58	50.9	50.9	79.8
Extremely applicable	23	20.2	20.2	**100**
G-Total	**114**	**100**	**100**	
Factor (Organised skill improvement conference for construction operators)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Extremely not applicable	3	2.6	2.6	2.6
Not applicable	13	11.4	11.4	14.0
Moderately applicable	44	38.6	38.6	52.6
Applicable	37	32.5	32.5	85.1
Extremely applicable	17	14.9	14.9	**100**
G-Total	**114**	**100**	**100**	

Table 6.19: Descriptive statistics analysis of factors that inflate the cost of sustainable housing delivery over budget

Coding	Factors that inflate the cost of sustainable housing delivery over budget	Minimum	Maximum	Mean	Std. Deviation	Variance	Rank
FACSH2	Availability of skilled workers on site	1	4	3.4123	0.73847	0.545	1
FACSH5	Financial management on housing production	1	4	3.2368	0.69515	0.483	2
FACSH24	Adequate planning for production	1	4	3.2281	0.72911	0.532	3
FACSH7	Cost of housing materials in the market	1	4	3.1842	0.74745	0.559	4
FACSH1	Technology advancement	1	4	3.1754	0.68156	0.465	5
FACSH9	Constant additional work without contractual procedure on cost of construction	1	4	3.1404	0.93010	0.865	6
FACSH8	High cost of machinery	1	4	3.1404	0.80789	0.653	7
FACSH22	Contract management on site	1	4	3.1228	0.76587	0.587	8
FACSH23	Contractual procedure for housing delivery	1	4	3.1140	0.76145	0.580	9
FACSH6	Frequent changes in design of housing during production	1	4	3.1140	0.85971	0.739	10
FACSH16	High cost of labour for production	1	4	3.0614	0.83385	0.695	11
FACSH15	Duration of housing construction	1	4	3.0526	0.83974	0.705	12
FACSH21	Fluctuation of price of housing materials	1	4	3.0439	0.76875	0.591	13
FACSH12	Economic stability influence	1	4	3.0175	0.80905	0.655	14
FACSH10	Inadequate coordination of design phase and construction phase during production	1	4	2.9649	0.85113	0.724	15
FACSH25	Competency of government agents on housing development	1	4	2.9474	0.92976	0.864	16
FACSH11	Misunderstanding between design and construction team on site	1	4	2.9123	1.00054	1.001	17
FACSH4	Poor implementation of government policy	1	4	2.9123	0.81535	0.665	18
FACSH18	Absence of construction cost control for production	1	4	2.9035	0.92142	0.849	19
FACSH20	Inadequate materials for production	1	4	2.8509	0.99763	0.995	20
FACSH14	Government policies on housing	1	4	2.8509	0.81178	0.659	21
FACSH19	Currency exchange rate for importation of construction resources	1	4	2.8333	0.95858	0.919	22

Table 6.19 continued.

Coding	Factors that inflate the cost of sustainable housing delivery over budget	Minimum	Maximum	Mean	Std. Deviation	Variance	Rank
FACSH17	Inadequate labour availability on site	1	4	2.8246	0.83343	0.695	23
FACSH13	Cost of insurance for housing production process	1	4	2.7368	0.80981	0.656	24
FACSH3	Practices of foreign principles on site	1	4	2.6754	0.78137	0.611	25

process is not applicable to their company. This signifies that the process will augment skill at various phases of production. Table 6.18 above contains detailed information.

6.4 Section F: Descriptive statistics analysis of factors that inflate the cost of sustainable housing delivery over budget

With the literature reviewed for this study confirming factors that inflate the cost of sustainable housing delivery over budget, a survey was conducted among respondents to assess the most impactful factors inflating the cost of housing delivery using a Likert scale of 1-strongly disagree; 2-disagree; 3-agree; and 4-strongly agree. As a consequence, factors that inflate the cost of sustainable housing delivery over budget were investigated. The respondents strongly agree that 14 factors out of 25 variables will cause inflation of construction costs if not adequately monitored during housing production processes. Thus, while these factors recorded mean scores above 3, the respondents disagree that 12 factors will not affect construction cost of housing delivery. Statistical analysis is depicted clearly in Table 6.19 above.

6.4.1 Subsection F

6.4.1.1 Frequency statistics analysis of factors inflating cost of sustainable housing delivery over budget

The frequency statistics analyses of factors that inflate cost of sustainable housing delivery over budget were investigated, and data collected were analysed by frequency statistics analysis. Results obtained are shown in Table 6.20 below. A large number of respondents agrees that availability of skilled workers on site; financial management for housing production; adequate planning for housing production; and cost of housing materials in the market were the major factors tending to impact affordable housing delivery. Thus, adequate consideration and implementation of these variables at each phase of housing production are a necessity for available housing delivery to people. By contrast, a few respondents disagree that practices of foreign principles on site, cost of insurance and currency exchange rates for importation of construction materials will not inflate cost of housing delivery.

Table 6.20: Frequency statistics analysis of factors that inflate cost of sustainable housing delivery over budget

Factors (Availability of skilled workers on site)	Frequency	Percentage (%)	Valid percent	Cumulative percent
Strongly disagree	3	2.6	2.6	2.6
Disagree	8	7.0	7.0	9.6
Agree	42	36.8	36.8	46.5
Strongly agree	61	53.5	53.5	**100**
G-Total	**114**	**100**	**100**	
Factors (Financial management for housing production)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Strongly disagree	1	0.9	0.9	0.9
Disagree	14	12.3	12.3	13.2
Agree	56	49.1	49.1	62.3
Strongly agree	43	37.7	37.7	**100**
G-Total	**114**	**100**	**100**	
Factors (Adequate planning for housing production)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Strongly disagree	1	0.9	0.9	0.9
Disagree	17	14.9	14.9	15.8
Agree	51	44.7	44.7	60.5
Strongly agree	45	39.5	39.5	**100**
G-Total	**114**	**100**	**100**	
Factor (Cost of housing materials in the market)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Strongly disagree	4	3.5	3.5	3.5
Disagree	11	9.6	9.6	13.2
Agree	59	51.8	51.8	64.9
Strongly agree	40	35.1	35.1	**100**
G-Total	**114**	**100**	**100**	

6.5 Section G: Descriptive statistics analysis of factors that affect unsustainable design in delivery of affordable housing within budget

Respondents were requested to measure the factors that affect unsustainable design in delivery of affordable housing within budget. Table 6.21 presents descriptive statistics results of factors that affect unsustainable design in delivery of affordable housing within budget.

Table 6.21: Descriptive statistics analysis of factors that affect unsustainable design in delivery of affordable housing within budget

Coding	Factors that affect unsustainable design in delivery of affordable housing	Minimum	Maximum	Mean	Std. Deviation	Variance	Rank
EFD19	Improper design leads to failure in achieving client objectives	1	4	3.2456	.75915	.576	1
EFD6	Establish standard design for production	1	4	3.2105	.73441	.539	2
EFD25	Design of first-rate living conditions for a healthy environment	1	4	3.2018	.69358	.481	3
EFD26	Frequent changes of housing design by client affect construction cost	1	4	3.1930	.79687	.635	4
EFD1	Incorporating sustainable design principles	1	4	3.1930	.68971	.476	5
EFD24	Inadequate design affects cost of delivery	1	4	3.1842	.73552	.541	6
EFD20	Frequent changes to housing design cause variation	1	4	3.1667	.89162	.795	7
EFD22	Adequate design for new techniques will affect cost effective production	1	4	3.1579	.69866	.488	8
EFD23	Changes in design as a source of waste during production	1	4	3.1579	.73568	.541	9
EFD3	Design sufficiency and adaptable to meet people demand	1	4	3.1491	.69426	.482	10
EFD11	Constant promoting high standard design	1	4	3.1404	.70243	.493	11
EFD34	Design for better performance	1	4	3.1404	.78568	.617	12
EFD33	Complexity of design causes changes in design and affects cost	1	4	3.1404	.76282	.582	13
EFD7	Design for waste minimisation during production	1	4	3.1316	.84679	.717	14
EFD36	Design for implementation of new technology	1	4	3.1228	.74240	.551	15
EFD21	Errors and omission in housing design affects quality	1	4	3.1228	.87381	.764	16
EFD35	Sustainability integrated approach for housing delivery	1	4	3.1140	.78435	.615	17
EFD2	Discrepancies between drawing and specification impact	1	4	3.0965	.81977	.672	18
EFD13	Coordination of design changes during production	1	4	3.0877	.74740	.559	19
EFD4	Replacement of materials during construction affect cost of delivery	1	4	3.0789	.73043	.534	20
EFD9	Decision taking at planning stage causes changes in housing design	1	4	3.0526	.80751	.652	21
EFD12	Ambiguous design details cause changes in housing design	1	4	3.0439	.78018	.609	22
EFD10	Cost is affected by value engineering at design stage	1	4	3.0439	.80254	.644	23
EFD18	Design housing for environmental performance efficiency	1	4	3.0439	.69627	.485	24

Table 6.21 continued

Coding	Factors that affect unsustainable design in delivery of affordable housing	Minimum	Maximum	Mean	Std. Deviation	Variance	Rank
EFD27	Inadequate consideration for housing location at design stage causes change in design	1	4	3.0351	.77494	.601	25
EFD14	Changes in specification by consultant cause changes in housing design	1	4	3.0351	.90162	.813	26
EFD17	Procurement of new materials for housing delivery causes changes in design	1	4	3.0263	.75797	.575	27
EFD16	Inadequately defined scope of work for contractors causes change in housing design during production	1	4	3.0175	.77554	.601	28
EFD8	Design for re-use of materials	1	4	3.0000	.83082	.690	29
EFD32	Non-compliance of housing design with government regulation causes changes in design at implementation	1	4	3.0000	.85186	.726	30
EFD15	Design for the best use of land, infrastructure and services	1	4	3.0000	.77574	.602	31
EFD30	Prolonged procedure for management of design changes causes delay	1	4	2.9825	.67813	.460	32
EFD5	Government policy on housing design	1	4	2.9737	.76956	.592	33
EFD31	Safety consideration for housing delivery causes changes in design	1	4	2.9649	.79745	.636	34
EFD29	Non-involvement of contractors at initiating stage of design planning causes frequent changes in design	1	4	2.9649	.85113	.724	35
EFD28	Poor communication among design team and contractor at planning stage causes changes in design	1	4	2.9561	.82430	.679	36

The results are as follows: improper design leads to failure in achieving client objectives; establish standard design for better production; design of first-rate living conditions for a healthy environment; frequent changes of housing design by client affect construction cost; and incorporating sustainable design principles. The mean score of each of these factors is above 3. As these factors are significant to effective housing delivery processes, they must be adequately considered at the planning stage of production. By contrast, those factors not affecting sustainable design have a mean score below 3.

6.5.1 Subsection G

6.5.1.1 Frequency statistics analysis of factors affecting unsustainable design in delivery of affordable housing within budget

Table 6.22 contains the result of frequency statistic data analysis of factors that affect unsustainable design in delivery of affordable housing within budget. The results obtained indicate that the majority of respondents agree that improper design will lead to failure in achieving client objectives, and that failing to establish standard design for production, failing to design first-rate

Table 6.22: Frequency statistics of factors that affect unsustainable design in delivery of affordable housing

Factor (Improper design leads to failure in achieving client objectives)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Strongly disagree	3	2.6	2.6	2.6
Disagree	13	11.4	11.4	14.0
Agree	51	44.7	44.7	58.8
Strongly agree	47	41.2	41.2	**100**
G-Total	**114**	**100**	**100**	
Factor (Establish standard design for production)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Strongly disagree	2	1.8	1.8	1.8
Disagree	15	13.2	13.2	14.9
Agree	54	47.4	47.4	62.3
Strongly agree	43	37.7	37.7	**100**
G-Total	**114**	**100**	**100**	

Table 6.22 continued

Factor (Design of first-rate living conditions for a healthy environment)	Frequency	Percentage (%)	Valid percent	Cumulative
Strongly disagree	1	0.9	0.9	0.9
Disagree	15	13.2	13.2	14.0
Agree	58	50.9	50.9	64.9
Strongly agree	40	35.1	35.1	**100**
G-Total	**114**	**100**	**100**	
Factor (Frequent changes of housing design by client affect construction cost)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Strongly disagree	2	1.8	1.8	1.8
Disagree	21	18.4	18.4	20.2
Agree	44	38.6	38.6	58.8
Strongly agree	47	41.2	41.2	**100**
G-Total	**114**	**100**	**100**	

living conditions for a healthy environment, and failing with frequent changes of housing design by client all affect construction costs. Adequate matching of these factors with requirements and objectives established for housing delivery during planning and implementation stages is vital for affordable housing delivery. These are the key variables that must be considered for client satisfaction and cost-efficient production processes. Even so, a smaller number of the respondents disagree, insisting that these factors will not affect unsustainable design in delivery of affordable housing within budget; however, the disagreement is insignificant when compared to the large number in the group that agreed with the factors.

6.6 Section H: Descriptive statistics analysis of the impact of cost on management of construction resources in delivery of sustainable housing by construction operators

This section describes the detail analysis of descriptive statistics concerning the impact of cost on management of construction resources in delivery of sustainable housing by construction operators. In order to achieve clarity of analysis, these descriptive statistics of the impact of cost on management of construction resources were analysed in reference to the research questions presented in Chapter 1. This section is divided into three groups branded H1, H2 and H3, respectively.

Table 6.23: How human resource management have an effect on cost in delivery of sustainable housing

Coding	How human resource management have an effect on cost in delivery of sustainable housing	Minimum	Maximum	Mean	Std. Deviation	Variance	Rank
ICMCR23	Workforce productivities affect cost	1.00	5	4.1404	.75113	.564	1
ICMCR1	Involvement of all team members in planning and implementation	2.00	5	4.1316	.79281	.629	2
ICMCR4	Regular meetings on site for promoting efficient productivity	2.00	5	4.1140	.76145	.580	3
ICMCR10	Team-building strategies for production	1.00	5	4.0877	.90780	.824	4
ICMCR21	Prompt payment of wages by contractors will enhance productivity	1.00	5	4.0789	.85336	.728	5
ICMCR2	Develop staffing management plan	2.00	5	4.0789	.70579	.498	6
ICMCR29	Flexibility of construction operators in making timely management decisions on production	2.00	5	4.0702	.78390	.615	7
ICMCR28	Skill to define effective techniques for achieving objectives	2.00	5	4.0702	.73736	.544	8
ICMCR24	Skill to apply techniques for reduction in cost of construction during production	2.00	5	4.0526	.83974	.705	9
ICMCR9	A sound knowledge on quality design decisions and implementation	1.00	5	4.0526	.82914	.687	10
ICMCR27	Knowledge of good safety practices and awareness of personal safety during production	2.00	5	4.0351	.85113	.724	11
ICMCR30	Constant emphasis on making maximum usage of local labour force to achieve housing production	2.00	5	4.0263	.86690	.752	12
ICMCR3	Document delivery roles and responsibilities among construction team members	2.00	5	3.9912	73467	.540	13
ICMCR26	Ability of workforce to develop willingness in sustainability practices	1.00	5	3.9912	.88743	.788	14
ICMCR13	Build trust among construction team members	1.00	5	3.9912	.92646	.858	15
ICMCR15	Ability to define plan for effective use of resources available for production	1.00	5	3.9649	.86146	.742	16
ICMCR25	Wastage of workforce input during production process	1.00	5	3.9649	1.00380	1.008	17
ICMCR14	Reduction in delivery time through proper job allocation to workforce	2.00	5	3.9649	.87168	.760	18

Table 6.23 continued

Coding	How human resource management have an effect on cost in delivery of sustainable housing	Minimum	Maximum	Mean	Std. Deviation	Variance	Rank
ICMCR20	Aptitude to work under pressure to meet tight deadlines and adapt to changes affect cost of construction	1.00	5	3.9561	.85590	.733	19
ICMCR11	Ability to carry out effective implementation of techniques on housing production	1.00	5	3.9474	.81840	.670	20
ICMCR22	Ability to safeguard safety consciousness during housing production	1.00	5	3.9298	.93808	.880	21
ICMCR12	Emphasis on constant encouraging construction operators on skill advancement and development	2.00	5	3.9211	.81082	.657	22
ICMCR16	Steadfastness in carrying out commitments and obligations	1.00	5	3.8947	.88616	.785	23
ICMCR18	Skill in oral and written communication for keeping subordinates, associates, superiors and others adequately informed during production	1.00	5	3.8860	.92897	.863	24
ICMCR8	Constant training of workers for use of techniques	1.00	5	3.8772	.97890	.958	25
ICMCR5	Define quality accomplishment for housing production	1.00	5	3.8684	.82562	.682	26
ICMCR7	Skill to establish requirements, methods and techniques for housing production	1.00	5	3.8070	.85058	.723	27
ICMCR6	Time wastage by workforce during production	1.00	5	3.7105	1.02813	1.057	28
ICMCR19	Improper planning of workforce activities on site	1.00	5	3.6754	1.02617	1.053	29
ICMCR17	Shortage of experienced workers on site	1.00	5	3.5965	1.17284	1.376	30

6.6.1 Section H1

6.6.1.1 Descriptive statistics analysis illustrating human resource management's effect on cost of delivering sustainable housing

Surveys were conducted amongst respondents pertaining to how human resource management has an effect on cost in delivery of sustainable housing, using a Likert scale. Table 6.23 below contains descriptive statistics of the effect of human resource management on cost in delivery of sustainable housing. The analysed results indicate several things that will enhance productivity: workforce productivity affects cost; involvement of all team members in planning and implementation; regular meetings on site for promoting efficient productivity; team-building strategies for production and prompt payment of wages by contractors. These were the major factors having a significant effect on cost in delivery of sustainable housing, with the mean score of the factors at 4.0. However, the most significant information in regard to this analysis is that all the factors on Table 6.23 recorded a mean score above 3, signifying that all the factors impact the cost toward delivery of sustainable housing. The adequate consideration and application of these factors at the preliminary stage of production will positively improve productivity of the construction operators; hence, affordable housing delivery will be achieved.

6.6.2 Subsection H1

6.6.2.1 Frequency statistics analysis of factors illustrating human resource management effect on cost in delivery of sustainable housing

The frequency statistics analysis of factors concerning the impact of human resource management on cost in delivery of sustainable housing is explicitly outlined in Table 6.24 below. Results obtained point to the fact that majority of the respondents accepted that the following affect cost: workforce productivities; involvement of all team members in planning and implementation; regular meetings on site for promoting efficient productivity; and team-building strategies for production. To achieve effective application of these factors by the construction operators, sufficient consideration and application of these variables is vital at planning stages and implementation of requirements for housing delivery. On the other hand, a smaller number of the respondents did not support these factors, suggesting these factors will not affect affordable housing delivery. Considering all the facts available, regular meeting among the construction operators is vital,

Table 6.24: Frequency statistics factors of how human resource management has an effect on cost in delivery of sustainable housing

Factor (Workforce productivities affect cost)	Frequency	Percentage (%)	Valid percent	Cumulative percent
Perfectly unacceptable	1	9	9	9
Quite acceptable	19	16.7	16.7	17.5
Acceptable	56	49.1	49.1	66.7
Perfectly acceptable	38	33.3	33.3	**100**
G-Total	**114**	**100**	**100**	
Factor (Involvement of all team members in planning and implementation)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Perfectly unacceptable	4	3.5	3.5	3.5
Quite acceptable	17	14.9	14.9	18.4
Acceptable	53	46.5	46.5	64.9
Perfectly acceptable	40	35.1	35.1	**100**
G-Total	**114**	**100**	**100**	
Factor (Regular meetings on site for promoting efficient productivity)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Unacceptable	2	1.8	1.8	1.8
Quite acceptable	21	18.4	18.4	20.2
Acceptable	53	46.5	46.5	66.7
Perfectly acceptable	38	33.3	33.3	**100**
G-Total	**114**	**100**	**100**	

Table 6.24 continued

Factor (Team-building strategies for production)	Frequency	Percentage (%)	Valid percent	Cumulative percent
Perfectly unacceptable	2	1.8	1.8	1.8
Unacceptable	3	2.6	2.6	4.4
Quite acceptable	21	18.4	18.4	22.8
Acceptable	45	39.5	39.5	62.3
Perfectly acceptable	43	37.7	37.7	**100**
G-Total	**114**	**100**	**100**	

because it will close the communication gap that causes arguments and constant litigation on construction sites.

6.6.3 Section H2

6.6.3.1 The descriptive statistics analysis illustrating building materials' effect on budgeted cost during production process

The survey requested respondents to assess the effect of building materials on budgeted cost during production process toward delivery a sustainable housing using a Likert scale. The statistical analysis of the effect of building materials on budgeted cost during a production process were presented in Table 6.25 below, with results obtained showing evidence that building materials have a significant effect on the cost of construction during production process.

The major factors identified as having significant influence are as follows: quality of workmanship on materials to reduce waste; late delivery of construction materials; increase in the price of original materials specified resulting in the use of alternative materials; insufficiency of construction materials on site; exchange rate of dollar affecting time delivery of materials; and scarcity of housing materials in the country leading to importation of materials of higher prices from another nations. These most influential factors recorded the mean score above 3, whereas those factors derived from analysis which do not make an impact on budgeted cost during the building production process have a mean score below 2. Thus, analysis exposed the fact that materials have an important influence on the cost of sustainable housing delivery.

6.6.4 Subsection H2:

6.6.4.1 The frequency statistics analysis illustrating the building material effect on budgeted cost during a production process

The statistical analysis of the effect of building materials on budgeted cost during a production process were overtly stated in Table 6.26 below. The preponderance of respondents agree that quality of workmanship on materials will reduce waste; late delivery of construction materials to the site; increase in the price of original materials specified causing use of alternative materials; and insufficient of construction materials on site will all affect budgeted cost. Thus, cost of materials is significant because it is one of the determinant factors for construction costs.

Table 6.25: Effect of building materials on budgeted cost during a production process

Coding	The effect of building materials on budgeted cost during a production process	Minimum	Maximum	Mean	Std. Deviation	Variance	Rank
EBMC12	Quality of workmanship on materials will reduce waste	2.00	4.00	3.3070	.68002	.462	1
EBMC6	Late delivery of construction materials	2.00	4.00	3.2719	.65561	.430	2
EBMC3	Increase in the price of original materials specified causes the use of alternative materials	2.00	4.00	3.2281	.67882	.461	3
EBMC7	Insufficient of construction materials on site	1.00	4.00	3.2193	.66197	.438	4
EBMC20	Exchange rate of dollar affects time delivery	1.00	33.00	3.2105	2.93431	8.610	5
EBMC8	Scarcity of housing materials in the country lead to importation of materials with high price from another nations	1.00	4.00	3.1842	.77077	.594	6
EBMC5	Increase in price of construction materials	1.00	4.00	3.1579	.74761	.559	7
EBMC1	Use of foreign materials for housing construction has effect on budgeted cost	1.00	4.00	3.1228	.88388	.781	8
EBMC4	Use of materials that are environmentally friendly	1.00	4.00	3.1140	.72574	.527	9
EBMC15	Management plan for delivery of materials	1.00	4.00	3.0965	.63760	.407	10
EBMC24	Currency instability in the country affects prices of housing materials	1.00	4.00	3.0877	.71099	.506	11
EBMC2	Delay in importation of housing materials	1.00	4.00	3.0702	.88966	.791	12
EBMC22	Government regulation on housing materials usage affect	1.00	4.00	3.0526	.79648	.634	13
EBMC17	Project logbooks for records of activities and materials	1.00	4.00	3.0439	.68344	.467	14
EBMC9	Change in specification of materials during production	1.00	4.00	3.0351	.66426	.441	15
EBMC11	Inhibited innovations for housing materials	1.00	4.00	3.0263	.64438	.415	16
EBMC23	Currency exchange rate in country causes scarcity of materials	1.00	4.00	2.9737	.82506	.681	17
EBMC19	Cost of transportation and distribution of materials	1.00	4.00	2.9649	.70309	.494	18
EBMC16	Site activities plan for cost estimate	1.00	4.00	2.9561	.64342	.414	19
EBMC14	Source of estimate on site for calculating cost	1.00	4.00	2.9474	.71448	.510	20
EBMC13	Municipal government taxes and charges on materials	1.00	4.00	2.9298	.79511	.632	21
EBMC21	Increase in price of materials affect time delivery	1.00	4.00	2.8860	.88005	.774	22

Table 6.25 continued

Coding	Effect of building materials on budgeted cost during a production process	Minimum	Maximum	Mean	Std. Deviation	Variance	Rank
EBMC18	Seasonal changes in housing construction materials	1.00	4.00	2.8596	.67676	.458	23
EBMC10	Cost of finance construction materials by bank	1.00	4.00	2.8509	.73150	.535	24

Clearly, thoughtful attention is needed for the management of storing and supplying materials to the site. Through this process, cost of construction in delivery of affordable housing will be greatly reduced. A few respondents, however, disagree that the identified factors will affect cost of sustainable housing delivery regardless of management structure put in place by the construction operators.

Table 6.26: Frequency statistics analysis on the effect of building materials on budgeted cost during a production process

Factors (Quality of workmanship on materials will reduce waste)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Disagree	14	12.9	12.3	12.3
Agree	51	44.7	44.7	57.0
Strongly agree	49	43.0	43.0	**100.0**
G-Total	**114**	**100**	**100**	
Factor (Late delivery of construction materials)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Disagree	13	11.4	11.4	11.4
Agree	57	50.0	50.0	61.4
Strongly agree	44	38.6	38.6	**100.0**
G-Total	**114**	**100**	**100**	
Factor (Increase in the price of original materials specified causes the use of alternative materials)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Disagree	16	14.0	14.0	14.0
Agree	56	49.1	49.1	63.2
Strongly agree	42	36.8	36.8	**100.0**
G-Total	**114**	**100**	**100**	
Factor (Insufficient of construction materials on site)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Strongly disagree	2	1.8	1.8	1.8
Disagree	9	7.9	7.9	9.6
Agree	65	57.0	57.0	66.7
Strongly agree	38	33.3	33.0	**100.0**
G-Total	**114**	**100**	**100**	

Table 6.27: Management of machinery has an effect on cost in delivery of sustainable housing

Coding	Management of machinery has an effect on cost in delivery of sustainable housing	Minimum	Maximum	Mean	Std. Deviation	Variance	Rank
EMMC2	Cost of transportation of equipment to site	2.00	4.00	3.3684	.66868	.447	1
EMMC1	Maintenance cost of equipment on site	1.00	4.00	3.3509	.70375	.495	2
EMMC7	Lack of proper planning for use of equipment	1.00	4.00	3.2632	.67905	.461	3
EMMC17	Planning for the use of equipment on site	1.00	4.00	3.2632	.74135	.550	4
EMMC3	Equipment delivery time during production process	1.00	5.00	3.2544	.67590	.457	5
EMMC8	Idleness of hiring equipment on site	2.00	4.00	3.2105	.68451	.469	6
EMMC12	Overhead cost attributable to the equipment, affect cost of construction	1.00	4.00	3.2018	.68071	.463	7
EMMC10	Constant increase in cost of purchasing equipment	2.00	4.00	3.2018	.68071	.463	8
EMMC16	Inadequate management of equipment	1.00	4.00	3.2018	.70623	.499	9
EMMC4	Cost of equipment and import duties	1.00	5.00	3.1667	.69022	.476	10
EMMC	Site soil condition attracts the use of different equipment affect construction cost	1.00	4.00	3.1228	.74240	.551	11
EMMC6	Specific factory cost attributable to the equipment	2.00	4.00	3.1228	.69308	.480	12
EMMC5	Constant changes in hiring price of equipment	1.00	4.00	3.1140	.66197	.438	13
EMMC15	Faulty equipment on site for production	1.00	4.00	3.1140	.71345	.509	14
EMMC13	Procurement of appropriate equipment	1.00	4.00	3.0877	.72333	.523	15
EMMC14	Abnormal profit making from the manufacturers in selling equipment	1.00	4.00	3.0088	.78137	.611	16
EMMC9	Manufacturer's exercise tax on housing equipment	1.00	4.00	2.8596	.79687	.635	17

6.6.5 Section H3

6.6.5.1 Machinery management effect on cost in sustainable housing delivery

The survey conducted among the selected respondents using a Likert scale confirmed that the management of machinery has an effect on cost in delivery of sustainable housing. Evidently, the results obtained from descriptive data analysis show that cost of transportation of equipment to site, maintenance cost of equipment on site, lack of proper planning for the use of equipment, planning for the use of equipment on site, and equipment delivery on time during production processes were the major factors impacting sustainable housing delivery. The mean score of the major factors is above 3. Table 6.27 presents those factors essential for the management of construction equipment, as without efficient equipment on site, other resources cannot function perfectly for sustainable housing production processes.

6.6.6 Subsection H3

The frequency statistical analysis of the management of machinery and effect on cost of construction toward sustainable housing delivery (Table 6.28) clearly illustrates frequency statistics analysis on management of machinery and the effect on cost in delivery of sustainable housing; however, as several factors were ranked concerning management of machinery and the effect on cost toward delivery sustainable housing, the opinions of respondents were sought pertaining to these factors. Therefore, the respondents agree that cost of transportation of equipment to site; maintenance costs of equipment on site; lack of proper planning for use of equipment; and planning for the use of equipment on site – each will influence cost of construction toward sustainable housing delivery. The facts emanating from respondents are in conformity to these factors that influence affordable housing delivery, centred on the opinion that effective management of machinery on site will control *all* other resources to achieve cost efficient housing delivery process.

Table 6.28: Frequency statistics analysis on management of machinery and effect on cost in delivery of sustainable housing

Factor (Cost of transportation of equipment to site)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Disagree	12	10.5	10.5	10.5
Agree	48	42.1	42.1	52.6
Strongly agree	54	47.4	47.4	**100.0**
G-Total	**114**	**100**	**100**	
Factor (Maintenance cost of equipment on site)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Strongly disagree	2	1.8	1.8	1.8
Disagree	9	7.9	7.9	9.6
Agree	50	43.9	43.9	53.5
Strongly agree	53	46.5	46.5	**100.0**
G-Total	**114**	**100**	**100**	
Factor (Lack of proper planning for use of equipment)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Strongly disagree	1	.9	.9	.9
Disagree	12	10.5	10.5	11.4
Agree	57	50.0	50.0	61.4
Strongly disagree	44	38.6	38.6	**100.0**
G-Total	**114**	**100**	**100**	
Factor (Planning for the use of equipment on site)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Strongly disagree	4	3.5	3.5	3.5
Disagree	8	7.0	7.0	10.5
Agree	56	49.1	49.1	59.6
Strongly agree	46	40.4	40.4	**100.0**
G-Total	**114**	**100**	**100**	

6.7 Section I: Descriptive statistical analysis effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery

Investigations were conducted with respondents on effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery, because cost is significant.

Table 6.29: Effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery

Coding	Effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery	Minimum	Maximum	Mean	Std. Deviation	Variance	Rank
EUC27	Teamworks on site for housing production	2.00	5.00	4.0965	.77539	.601	1
EUC24	Project schedule/timetable for production	1.00	5.00	3.9561	.88638	.786	2
EUC28	General progress report on housing process	1.00	5.00	3.9386	.84440	.713	3
EUC26	Flexibility integration into housing design to accommodate future demand and changes	2.00	5.00	3.9123	.80443	.647	4
EUC29	Longevity integrated at design stage to achieve reduction in future maintenance	1.00	5.00	3.8947	.80230	.644	5
EUC25	Recognise the close relationship between design and construction cost	1.00	5.00	3.8860	.86994	.757	6
EUC23	Work programme on site	1.00	5.00	3.8421	.95546	.913	7
EUC9	Regulate the true cost at planning stage	2.00	5.00	3.8158	.88813	.789	8
EUC7	Accurate furcating cost of housing production process at planning stage	2.00	5.00	3.7982	.85373	.729	9
EUC8	Adequate establishment of client objectives at briefing	1.00	5.00	3.7982	.86403	.747	10
EUC18	Determine level of impact of construction constraint at planning stage	2.00	5.00	3.7807	.73784	.544	11
EUC21	Proper design and construction coordination	1.00	5.00	3.7632	.96214	.926	12
EUC20	Establishment of procedure for funding delivery during production	1.00	5.00	3.7544	.82614	.683	13
EUC22	Consider vary in size and complexity of housing and construction cost	2.00	5.00	3.7544	.77072	.594	14
EUC10	Contract agreement by law during production	2.00	5.00	3.7456	.91023	.829	15
EUC6	Determine level of competences of construction operators at planning stage	1.00	5.00	3.7368	.89297	.797	16
EUC19	Plan for efficiency use of all monetary resources during production	1.00	5.00	3.7368	.79881	.638	17

Table 6.29 continued

Coding	Effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery	Minimum	Maximum	Mean	Std. Deviation	Variance	Rank
EUC4	Made possible wholesale change in construction technology	2.00	5.00	3.7193	.74678	.558	18
EUC13	Site activities plan for estimate	1.00	5.00	3.7018	.84067	.707	19
EUC5	Human resources management plan on site	1.00	5.00	3.7018	.81934	.671	20
EUC3	Risk inventory on site for production process	2.00	5.00	3.6930	.88375	.781	21
EUC17	Establishment of cost control base on site	1.00	5.00	3.6667	.94697	.897	22
EUC2	Improvement on construction operators’ productivity	2.00	5.00	3.6667	.76038	.578	23
EUC15	Cost control plan for production	1.00	5.00	3.6579	1.05452	1.112	24
EUC14	Objectivities of financial sustainability	1.00	5.00	3.5877	.91990	.846	25
EUC11	Establish restraint methods towards increase budgeted cost at implementation	1.00	5.00	3.5702	.86187	.743	26
EUC12	Set requirement before life cycle cost at planning and implementation stage	2.00	5.00	3.5263	.73123	.535	27
EUC16	Determine detrimental effect and validity of housing loan	1.00	5.00	3.5088	.89488	.801	28
EUC1	Establishment of stakeholder interest	1.00	5.00	3.4561	.93260	.870	29

The statistical analysis results shown in Table 6.29 come from the Likert scale used to measure responses. Results obtained from analysis include the following: teamwork on site for housing production; project schedule/timetable for production; general progress reports on housing process; flexibility integration into housing design to accommodate future demand and changes; and longevity integrated at design stage to achieve reduction in future maintenance. The mean score of these factors is above 3, indicating that all factors will influence housing delivery; therefore, effective implementation of these factors during production will reduce construction costs of housing delivery and make housing available to more people.

6.7.1 Sub-section I

Frequency statistics analysis of effective use of budgeted cost without any cost inflation in construction for sustainable housing delivery was done. Table 6.30 shows the frequency statistics analysis of effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery. As a result, respondents were asked to identify the factors in

Table 6.30: Frequency statistics analysis of effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery

Factor (Teamwork on site for housing production)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Slightly ineffective	2	1.8	1.8	1.8
Slightly effective	23	20.2	20.2	21.9
Effective	51	44.7	44.7	66.7
Perfectly effective	39	33	33.3	**100.0**
G-Total	**114**	**100**	**100**	
Factor (Project schedule/timetable for production)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Ineffective	1	.9	.9	.9
Slightly ineffective	5	4.4	4.4	5.3
Slightly effective	26	22.8	23.8	28.1
Effective	48	42.1	42.1	70.2
Perfectly effective	34	29.8	29.8	**100.0**
G-Total	**114**	**100**	**100**	

Table 6.30 continued

Factor (General progress report on housing process)	Frequency	Percentage (%)	Valid percent	Cumulative percent
Ineffective	1	.9	.9	.9
Slightly ineffective	4	3.5	3.5	4.4
Slightly effective	26	22.8	22.8	27.2
Effective	53	46.5	46.5	73.7
Perfectly effective	30	26.3	26.3	**100.0**
G-Total	**114**	**100**	**100**	
Factor (Flexibility integration into housing design to accommodate future demand and changes)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Slightly ineffective	6	5.3	5.3	5.3
Slightly effective	24	21.1	21.1	26.3
Effective	58	50.9	50.9	77.2
Perfectly effective	26	22.8	22.8	**100.0**
G-Total	**114**	**100**	**100**	

sequence of effectiveness for the utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery. Not surprisingly, more than 90% of the respondents said that cost management techniques are effective for efficient utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery. Nevertheless, a smaller group of respondents did not concur with the fact that cost management techniques, if effectively utilised, will affect construction cost reduction for affordable housing delivery.

6.8 Descriptive statistics analysis of the critical factors of achieving quality housing delivery

The survey was carried out among respondents to measure the critical factors for achieving quality housing delivery using a Likert scale to rate the factors. The data collected were analysed through descriptive and arithmetical methods, with results shown in Table 6.31 revealing that quality assurance at implementation and closeout, quality control during production process, effective quality planning for affordable housing, design housing for changing needs throughout the life of the occupants and not just for immediate needs, and consistent commitment to quality by all stakeholders were the factors discovered that impact quality housing delivery. The most

Table 6.31: Descriptive statistics of critical factors for achieving quality sustainable housing

Coding	The critical factors for achieving quality sustainable housing delivery	Minimum	Maximum	Mean	Std. Deviation	Variance	Rank
CAQH8	Quality assurance at implementation and closeout	2.00	4.00	3.3772	.58583	.58583	1
CAQH7	Quality control during production process	1.00	4.00	3.3509	.70375	.70375	2
CAQH9	Effective quality planning for affordable housing	2.00	4.00	3.3333	.60480	.60480	3
CAQH18	Design housing for changing needs throughout the life of the occupants and not just for immediate needs	2.00	4.00	3.3158	.62847	.62847	4
CAQH14	Consistent commitment to quality by all stakeholders	1.00	4.00	3.3158	.65602	.65602	5
CAQH5	Quality sampling during production	1.00	4.00	3.3158	.65602	.65602	6
CAQH13	Adequate design for provision of a safe, secure and healthy environment for the resident	2.00	4.00	3.3070	.59685	.59685	7
CAQH1	Design and construction of housing to support services and amenities for the need of the people	1.00	4.00	3.2982	.67745	.67745	8
CAQH15	Focus on quality sustainability throughout production process	1.00	4.00	3.2719	.66897	.66897	9
CAQH16	Designing for comfort, cost efficient and easy maintenance	2.00	4.00	3.2544	.71410	.71410	10
CAQH11	Design for affordable and maintainable	1.00	4.00	3.2456	.67262	.67262	11
CAQH6	Identify quality requirement	1.00	4.00	3.2456	.72333	.72333	12
CAQH17	Design housing for the use of renewable resources for cost effectiveness	2.00	4.00	3.2368	.66920	.66920	13
CAQH12	Establishment of durability techniques during production	1.00	4.00	3.2368	.68230	.68230	14
CAQH10	Establishment of resources efficient scheme for production	1.00	4.00	3.1842	.68570	.68570	15
CAQH3	Establish accessible and adaptable criteria for all residents	1.00	4.00	3.1579	.78232	.78232	16
CAQH2	Establish architectural scheme appropriate for provide a pleasant living environment	1.00	4.00	3.1228	.71816	.71816	17
CAQH4	Establishment of quality increase	1.00	4.00	3.0789	.73043	.73043	18

important and common relationship among the factors is that all the factors have a mean score above 3, making these factors more relevant. It is paramount that quality should be number one on the agenda at any and every planning stage of production processes, as by the development of this action maintenance cost at usage of any housing will be reduced drastically.

6.8.1 Quality housing delivery frequency statistics analysis

6.8.1.1 Frequency statistical analysis of critical factors of achieving quality housing delivery

Table 6.32 displays frequency statistical analysis of critical factors for achieving quality housing delivery; results obtained from frequency analysis revealed that quality is significant to cost efficient housing delivery. However, more than 90% of the respondents agree

Table 6.32: Frequency statistics analysis of critical factors of achieving quality housing delivery

Factor (Quality assurance at implementation and closeout)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Disagree	6	5.3	5.3	5.3
Agree	59	51.8	5.8	57.0
Strongly agree	49	43.0	43.0	**100.0**
G-Total	**114**	**100**	**100**	
Factor (Quality control during production process)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative percent**
Strongly disagree	2	1.8	1.8.	.1.8
Disagree	9	7.9	7.9	9.6
Agree	50	43.9	43.9	53.5
Strongly agree	53	46.5	46.5	**100.0**
G-Total	**114**	**100**	**100**	
Factor (Effective quality planning for affordable housing)	**Frequency**	**Percentage (%)**	**Valid percent**	**Cumulative Percent**
Disagree	8	7.0	7.0	7.0
Agree	60	52.6	52.6	59.6
Strongly agree	46	40.4	40.4	**100.0**
G-Total	**114**	**100**	**100**	

Table 6.32 continued

Factor (Design housing for changing needs throughout the life of the occupants and not just for immediate needs)	Frequency	Percentage (%)	Valid percent	Cumulative Percent
Disagree	10	8.6	8.8	8.8
Agree	58	50.9	50.9	59.6
Strongly agree	46	40.4	40.4	**100.0**
G-Total	**114**	**100**	**100**	

that adequate application and implementation of these factors will enhance quality housing delivery. Nonetheless, a few respondents disagree with identified factors affecting quality housing delivery. Despite this disagreement, however, the significant facts emerging confirm that design of housing for changing needs throughout the life of the occupants and not just for immediate needs will significantly enhance quality housing delivery and consistently reduce maintenance costs. Nearly all respondents attested to this factor.

6.9 Descriptive statistics analysis of stakeholder influence on sustainable housing delivery during production

For investigation to be conducted into stakeholder influence on sustainable housing delivery during production, questionnaires were administered to respondents, and data collected were analysed through descriptive statistical methods using a Likert scale. Factors were rated according to the level of consensus. The major factors identified by respondents as the furthermost impacting are matching stakeholder interest towards requirements; adequate communication with stakeholders; establishment of stakeholder aim; needs and objectives at planning stage; interaction with stakeholders in a professional and cooperative manner; and adequate handling area of specialisation toward implementation.

The statistical mean scores of these factors are above 3, while conflicting objectives during production among the stakeholders were considered unimportant to stakeholder influence on sustainable housing delivery during production, because the mean score is below 3. All other factors recorded a mean score above 3, indicating a positive impact on stakeholder influence. Considering the data analysis in Table 6.33 below, the needs of every stakeholder involved in a housing production process is crucial to time, cost and quality delivery of housing, and this

Table 6.33: Descriptive statistics analysis of stakeholder influence on affordable sustainable housing delivery during production

Coding	Stakeholders influence on sustainable housing delivery during production	Minimum	Maximum	Mean	Std. Deviation	Variance	Rank
SIH14	Matching stakeholders' interest towards requirements	1.00	34.00	3.4561	2.96630	8.799	1
SIH16	Adequate communication with stakeholders	1.00	4.00	3.2368	.62828	.395	2
SIH12	Establish stakeholders aim, needs, and objectives at planning stage	2.00	4.00	3.1842	.65939	.435	3
SIH9	Interact with stakeholders in a professional and cooperative manner	1.00	4.00	3.1140	.64847	.421	4
SIH11	Adequate handling area of specialisation toward implementation	1.00	4.00	3.0965	.59451	.353	5
SIH10	Impact on requirements	2.00	4.00	3.0965	.59451	.353	6
SIH2	Change course of production	2.00	4.00	3.0965	.60921	.371	7
SIH13	Establish degree of influence on timeline and increase in construction cost substantially	1.00	4.00	3.0789	.62605	.392	8
SIH7	Monitoring and evaluating housing project impact in relative to initial planning	1.00	4.00	3.0789	.75428	.569	9
SIH4	Sponsoring of housing project	1.00	4.00	3.0702	.81707	.668	10
SIH15	Establish criteria to measure success in relative to stakeholders' interest	1.00	4.00	3.0439	.72124	.520	11
SIH1	Has varying levels of responsibility and authority	2.00	4.00	3.0439	.61530	.379	12
SIH3	Assessment of production process	1.00	4.00	3.0263	.68434	.468	13
SIH6	Identifying stakeholder and understanding their relative degree of influence on housing delivery	1.00	4.00	3.0263	.70974	.504	14
SIH5	Provide administrative support	1.00	4.00	3.0088	.75838	.575	15
SIH8	Conflicting of objectives during production	1.00	4.00	2.9386	.69493	.483	16

is most adequately considered at initiating stages and implemented at construction stages of the phases. And negative stakeholder influence can be disastrous for any housing project. If positive and negative influences are not identified and categorised, these must input all housing requirements at design stage.

6.9.1 Stakeholder influence frequency analysis

The frequency statistics analysis of stakeholder influence on sustainable housing delivery during production is depicted in Table 6.34. Surveys were conducted amongst respondents specialising in sustainable housing delivery, with results illustrated as follows: few respondents disagree that matching stakeholder interest with requirements will have an influence on sustainable housing delivery during production.

Table 6.34: Frequency statistics analysis of stakeholder influence on sustainable housing delivery during production

Factor (Matching stakeholder interest towards requirements)	**Frequency**	**Percentage**	**Valid percent**	**Cumulative percent**
Strongly disagree	4	3.5	3.5	3.5
Disagree	9	7.9	7.9	10.5
Agree	65	57.0	57.0	67.5
Strongly agree	36	31.6	31.6	**100.0**
G-Total	**114**	**100**	**100**	
(Factor (Adequate communication with stakeholders)	**Frequency**	**Percentage**	**Valid percent**	**Cumulative percent**
Strongly disagree	2	1.8	1.8	1.8.
Disagree	6	5.3	5.3	7.0
Agree	69	60.5	60.5	67.5
Strongly agree	37	32.5	32.5	**100.0**
G-Total	**114**	**100**	**100**	
Factor (Establish stakeholders aim, needs, and objectives at planning stage)	**Frequency**	**Percentage**	**Valid percent**	**Cumulative Percent**
Disagree	16	14.0	14.0	14
Agree	61	53.5	53.5	67.5
Strongly agree	37	32.5	32.5	**100.0**
G-Total	**114**	**100**	**100**	

Table 6.34 continued

Factor (Interact with stakeholders in a professional and cooperative manner)	Frequency	Percentage	Valid percent	Cumulative percent
Strongly disagree	1	.9	.9	.9
Disagree	15	13.2	13.2	14.0
Agree	68	59.6	59.6	73.7
Strongly agree	30	26.3	26.3	**100.0**
G-Total	**114**	**100**	**100**	

A large number of respondents agree with the fact that matching stakeholder influence on sustainable housing delivery during production will enhance stakeholder encouragement of sustainable housing delivery. Correspondingly, a majority of respondents agree that adequate communication with stakeholders by construction operators will influence sustainable housing delivery successfully. Considering all the available facts obtained from the frequency analysis, it is clear that there are a majority of factors influencing sustainable housing delivery importantly, and each of the identified factors recorded high frequencies of agreement, meaning they have a significant impact on sustainable housing delivery.

6.10 Identifying factors that inflate the cost of sustainable housing delivery over budget through FA and PCA analysis techniques

This section presented factor analysis technique to identify the most significant factors inflating the cost of sustainable housing delivery over budget. The main reason for the use of factor component analysis (PCA) is used interchangeably in this section. The two techniques perform similar functions but produce a smaller number of leaner combinations of variables. Pallant (2013) clarifies, for example, that factor analysis (FA) and principal component analysis (PCA) have similarities: two techniques produce a smaller number of variables from a correlation of original factors in a statistical technique to establish relationships among variables. Pallant (2013) explains that factor analysis (FA) and principal components analysis (PCA) differ in a number of ways, presenting that principal component analysis (PCA) arranges variables of groups into smaller sets of linear combinations; consequently, all variance in the variables is used. In factor analysis, function is estimated using mathematical models as in this case, and the shared variance is analysed. Likewise, Castello and Osborne (2005) suggest that factor analysis is preferable to principal components analysis because principal component analysis only performs data reduction methods.

MacCallum *et al.* (1999) explain the fundamental misconception about the issue of minimum sample size; thereafter, the minimum ratio of sample size to the number of variables has generated arguments in many studies. Consequently, a wide range of recommendations regarding sample size for PCA and PA have been proposed by researchers. However, Gorsuch (1983, cited in MacCallum *et al.,* 1999) recommended that sample size to the number of variables should be at least 100. Similarly, Kline (1979) supported the sample size to the number of variables at 100. Contrarily, Guilford (1954, cited in MacCallum *et al.,* 1999) argues that sample size of the number of variables should exceed at least 200. Therefore, in reference to the information gathered, the conclusion is that there is no acceptable sample size for PCA and FA The sample size for this study is 114 as compared with sample size recommended by Gorsuch (1993); 114 is greater than the 100 advocated.

The processes of PA and PCA analyses include the following as recommended by Pallant (2013): the analysis section on SPSS version 25 is to access dimension-reduction. Then factors are selected, and thereafter, the variables to be analysed are carefully chosen. This is followed by selecting descriptive section, and afterward, the descriptive button to access the initial solution-coefficients KMO and Bartlett's test of Sphericity. Then it is a click to continue, and a click to access the principal component, followed by initial solution-coefficients, KMO and Bartlett's test of Sphericity-correlation matrix-unrotated factor solution-scree plot-based on Eigenvalue is selected. The Eigenvalue greater than 1 is fixed inside the box and maximum Iteration for convergence 25 is fixed. Then a click on the Rotation button to select Direct Oblimin and Delta box inputted to be 0. Then the Rotation solution box is marked, and maximum Iterations for convergence 25 is fixed in a box. After excluding cases of pairwise, small coefficients are selected and Absolute value below 0.3 is inputted for PCA to eventually obtain the listed results.

6.10.1 KMO and Bartlett's Sphericity Test on factors that inflate the cost of sustainable housing delivery

According to Pallant (2013), as it is essential to test adequacy of data collected for subsequent PCA analysis, Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and Bartlett's test of Sphericity were employed for the classified factors that inflate the cost of sustainable housing delivery. Table 6.35 displays the results from Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and Bartlett's test of Sphericity. The attributes associated with KMO are that the KMO indicator ranges from 0-1 maximum, with 0.6 the point recommended at which factor analysis is worthy rated (Pallant, 2013). While Bartlett's test of Sphericity is to access the strength of the connection between variables, the significance is noticed at the point p<0.05 for the PCA to be confirmed suitable (Pallant, 2013; MacCallum *et al.,* 1999). Thus, KMO and Bartlett's Sphericity test results perform on factors that inflate the cost of sustainable housing delivery (Table 6.35) as follows: KMO suitability occurs at point of 0.836 higher than 0.6 and less than 1, as recommended by Pallant (2013) whereas the Bartlett's Sphericity suitability obtained indicated that p=0.000, meaning that p is less than 0.05 (p<0.05) (Pallant, 2013; MacCallum *et al.,* 1999; Jolliffe, 1986). The conclusion can be drawn that the data is adequate and suitable to be used for PCA. The results obtained from KMO and Bartlett's test of Sphericity show test data adequacy and suitability on factors that inflate the cost of sustainable housing delivery over budget.

Table 6.35: KMO and Bartlett's Test of Sphericity

Test		Value and Remark
Kaiser-Meyer-Olkin measure of Sampling adequacy		0.836 Significant and adequate for PCA
Bartlett's Test of Sphericity	Approx. Chi-Square	1333.811
	df	300
	Sig.	0.000 Significant and adequate for PCA

6.10.2 Principal Component Factors fundamental to factors that inflate cost of sustainable housing delivery over budget

To establish the Principal Component Factors fundamental to factors that inflate cost of sustainable housing delivery over budget, it is necessary to consider Pallant's (2013), Jolliffe's (1986) and MacCullum's (1999) principle on number of components to retain. The number of components to be retained hinged on each factor's contribution to concept. To determine which factors to retain, PCA, which includes methods of factor extraction and correlation matrix; unrotated factor solution; scree plot; and Eigenvalues greater than 1. The application of the principle in this case is referenced in Table 6.36, the Eigenvalues of the two components extracted is 8.722 and 1.864. The first component on the Table is proficient for explaining 34.89% of the variance, while the second component on the table is proficient for explaining 7.46% of the variance. Therefore, the combination of the two components will explain 42.35% of the total variance.

Table 6.36: Total variance explained by the components

Component	Initial Eigenvalue			Extraction sum of square loading			Rotations of Square Loadings[a] Total
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	
1	8.722	34.887	34.887	8.722	34.887	34.887	4.675
2	1.864	7.458	42.345	1.864	7.458	42.345	4.630
3	1.460	5.839	48.184				
4	1.422	5.686	53.870				
5	1.323	5.291	59.162				
6	1.171	4.686	63.847				
7	1.000	3.999	67.847				
8	0.817	3.268	71.115				
9	0.746	2.985	74.100				
10	0.718	2.873	76.973				
11	0.695	2.778	79.751				
12	0.620	2.481	82.232				
13	0.547	2.188	84.419				
14	0.535	2.138	86.558				
15	0.480	1.920	88.477				
16	0.441	1.764	90.241				
17	0.419	1.677	91.918				
18	0.393	1.573	93.491				
19	0.319	1.277	94.768				
20	0.304	1.218	95.986				
21	0.291	1.165	97.150				
22	0.218	.872	98.023				
23	0.203	.812	98.835				
24	0.163	.651	99.485				
25	0.129	.515	100.000				

Simultaneously, a scree test was executed on the variables, with the result (Figure 6.1) confirming that two components are retained in reference to 8.722 and 1.864 as indicated in chapter 6.10, however, these two components are at the point which is above the elbow on the scree plot (as indicated in Figure 6.1). In addition, the number of variables to be retained and parallel analysis method will be appropriate through the use of MonteCarloPA software (Pallant, 2013; MacCullum, 1999). Basically, MonteCarloPA is used for the generation of data that will be compared with size of Eigenvalues obtained from PCA. The random Eigenvalues of the two components extracted by PCA were 8.722 and I.864 respectively, whereas the corresponding figures obtained from parallel analysis are 1.9699 and 1.7962, as indicated in Table 6.37 and Table 6.38. Thereafter, Table 6.37 shows the comparison of the two components extracted through PCA and the two components extracted through MonteCarloPA. The result obtained from the comparison of the two components indicated that PCA results of components 1 and 2 extracted is 8.722 and 1.864, greater than random Eigenvalues generated from parallel analysis which are 1.9699 and 1.7962 (8.722>1.9699) (1.864>1.7962); thus 8.722 and 1.864 are accepted.

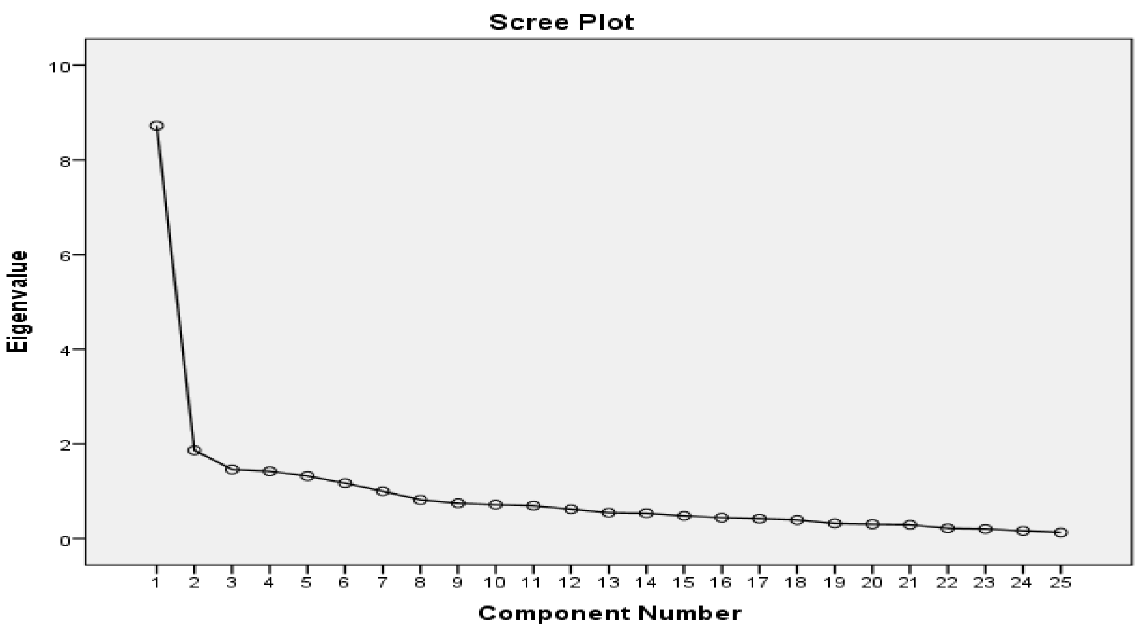

Figure 6.1: Catell’s scree plot for factor inflate cost of sustainable housing delivery

Table 6.37: Comparison of actual Eigenvalues and random Eigenvalues from parallel analysis

Component No.	Actual Eigenvalue from PCA	Random Eigenvalue from parallel analysis	Decision
1	1.869	1.7962	Accept
2	8.722	1.9699	Accept

Monte Carlo PA for parallel analysis version.

The information computed into Monte Carlo PA:

Number of variables = 25

Number of subjects = 114

Number of replications = 100

6.10.3 The synopsis of principal component analysis results (PCA)

Table 6.39 contains the result of principal component analysis on 25 factors and shows pattern matrix and structural matrix for PCA with Oblimin Rotation of FACSH variables. The PCA showed those factors that have strong and weak impact toward inflating cost of sustainable housing delivery. Consequently, the fittingness of data for factor analysis was established through the use of PCA as reported in Chapter 6 subsection 6.10. The KMO value was 0.836, exceeding the 0.6 recommendation by Pallant (2013); similarly, Bartlett's Test of Sphericity was significant at p=0.000 (p<0.5), a result in conformity to the factorability of the correlation matrix.

The principal component analysis results revealed two components with Eigenvalues exceeding 1, giving a vivid explanation on 34.887% and 7.458% of the variance, the similar information in as in sections 6 and 6.9.1. In addition to this information, the scree plot test displayed a break of the second components at the elbow. The parallel analysis revealed two components as having Eigenvalue greater than the randomly generated data matrix by MonteCarloPA; however, the two components are retained for continuation of investigation. Oblimin rotation is used for the interpretation of the two-components retained and used for loading the variables. In reference to Table 6.39 below, due to the large number of variables, the analysis results shows components

Table 6.38: Result of MonteCarloPA analysis

Eigenvalue #	Random Eigenvalue	Standard Dev.
1	1.9699	0.0939
2	1.7962	0.0708
3	1.6740	0.0589
4	1.5824	0.0521
5	1.4914	0.0440
6	1.4028	0.0422
7	1.3216	0.0385
8	1.2506	0.0357
9	1.1792	0.0323
10	1.1165	0.0315
11	1.0492	0.0297
12	0.9945	0.0297
13	0.9358	0.0289
14	0.8757	0.0316
15	0.8264	0.0328
16	0.7755	0.0265
17	0.7234	0.0267
18	0.6755	0.0262
19	0.6252	0.0284
20	0.5786	0.0301
21	0.5328	0.0284
22	0.4331	0.0306
23	0.4331	0.0314
24	0.3841	0.0285
25	0.3203	0.0330

Table 6.39: Pattern matrix and structural matrix for PCA with Oblimin Rotation of FACSH variables

Coding	Variable name	Pattern matrix coefficient		Structural matrix coefficient		Communalities
		1	2	1	2	
FACSH1	Technology advancement	-	.507	-	482	.234
FACSH2	Availability of skill	.469	-	.540	-	.306
FACSH3	Practices of foreign principles on site	.441	-	.497	-	.255
FACSH4	Poor implementation of government policy	.677	-	.578	-	.360
FACSH5	Financial management on housing production	-	.392	-	.517	.309
FACSH6	Frequent changes in design of housing during production	.550	-	.679	-	.505
FACSH7	Cost of housing materials in the market	.360	-	-	.549	.396
FACSH8	High cost of machinery	-	.524	-	.571	.332
FACSH9	Constant additional work without contractual procedure on cost of construction	**.901**	-	.822	-	.693
FACSH10	Inadequate coordination of design phase and construction phase during production	**.806**	-	.745	-	.565
FACSH11	Misunderstanding between design and construction team on site	**.678**	-	.725	-	.531
FACSH12	Economic stability influence	-	**.697**	-	.656	.434
FACSH13	Cost of insurance for housing production process	-	**.667**	-	.606	.377
FACSH14	Government policies on housing	-	**.660**	-	.681	.465
FACSH15	Duration of housing construction	.488	-	.602	-	.398
FACSH16	High cost of labour for production	.374	-	.543	-	.371
FACSH17	Inadequate labour availability on site	**.667**	-	.654	-	429
FACSH18	Absence of construction cost control for production	**.670**	-	.740	-	.560
FACSH19	Currency exchange rate for importation of construction resources	.543	-	.606	-	.378
FACSH20	Inadequate materials for production	.424	-	.544	-	.335
FACSH21	Fluctuation of price of housing materials	-	.464	-	.642	.496
FACSH22	Contract management on site	-	**.713**	-	.707	.500
FACSH23	Contractual procedure for housing delivery	-	.588	-	.664	.456
FACSH24	Adequate planning for production	-	**.640**	-	.683	.471
FACSH25	Competency of government agents on housing development	-	**.601**	-	.650	.429

with strong and weak loadings; the pattern matrix has strong components loadings above 0.6 (highlighted in bold) whereas structure matrix has two components loading above 0.3. The table shows highlighted figures in bold as a strong communality because higher communalities indicate that larger variance in the variables has been extracted by the factor analysis methods. To achieve better analysis of factors, communalities should be greater than 0.4. Considering the highlighted numbers among the communalities, 0.42 is the least recorded; hence, FACSH17 (Inadequate labour availability on site) and FACSH25 (Competency of government agents on housing development) are the two variables contributing the least among the components highlighted, Similarly, considering the loading pattern of FACSH variables, the variables that converge on component 1 referred to inadequate techniques for sustainable housing cost efficiency, and that converge at component 2, are related to unsatisfactory production of sustainable housing over budget.

6.11 Factors that affect design in delivery of affordable housing within budget

To ascertain the basic factors imparting unsustainable design in delivery of affordable housing within budget, principal component analysis (PCA) was employed to reduce the factors to sizable variables for developing a model. The basic reasons for engaging PCA for reduction of the size of the variables was importantly discussed in previous sections, notably chapter 6 and section 6.10.

6.11.1 Use of Kaiser-Meyer-Olkin (KMO) and Bartlett's Sphericity Test

According to the two notable researchers, Pallant (2013) and MacCallum *et al.* (1999), the significance of parallel component analysis (PCA) is to confirm the suitability of research study data for analysis. Kaiser-Meyer-Olkin (KMO) and Bartlett's Sphericity Test are significant to the testing acceptability of data collected, as KMO measure sampling adequacy, whereas Bartlett's test of Sphericity classifies the factors that affect unsustainable design in delivery of affordable housing within budget. Table 6.40 presents results from KMO and Bartlett's test of Sphericity. The characteristics associated with KMO show that KMO indicator ranges from 0-1 maximum, with 0.6 the recommended minimum point at which factor analysis can be acceptable (Pallant, 2013).

Bartlett's test of Sphericity is used to access the strength of the connection between variables, with the implication noticed at a point at which $p<0.05$ meaning that the PCA is confirmed suitable (Pallant, 2013). Thereafter, KMO and Bartlett's Sphericity test perform on factors that affect unsustainable design in delivery affordable housing within budget, as indicated on Table 6.40.

KMO suitability occurs at a point of 0.843 higher than 0.6 and less than 1, as recommended by Pallant (2013) and Jolliffe (1986). Bartlett's Sphericity suitability indicated that p=0.000, meaning that p is less than 0.05 ($p<0.05$) (Pallant, 2013; Jolliffe, 1986). Considering the recommendation of Pallant (2013) and Jolliffe (1986), it is evident that the data is adequate and suitable to be used for PCA.

Table 6.40: KMO and Bartlett's Test of Sphericity

Test		Value and Remark
Kaiser-Meyer-Olkin measure of Sampling adequacy		0.843 Significant and adequate for PCA
Bartlett's Test of Sphericity	Approx. Chi-Square	2622.530
	df	630
	Sig.	0.000 Significant and adequate for PCA

6.11.2 Principal Components factors fundamental to the factors that affect design for affordable housing delivery within budget

To establish the Principal Components Factors fundamental to factors that affect design for affordable housing within budget, it is necessary to consider Pallant's (2013) and MacCullum's (1999) recommendation to retain factors among the principal components factors that affect design of affordable housing delivery within budget. The number of components to be retained hinges on factors meeting the requirements of the concept. To determine factors to be retained, PCA methods of factor extraction are used containing correlation matrix, unrotated factor solution, scree plot and Eigenvalues greater than 1. The application of the principle, in this case, is in reference to Table 6.41. The Eigenvalues of the three components extracted is 12.345, 3.048 and 2.180, respectively. The first component on the table is proficient for explaining 34.290% of the variance, while the second component on the table is proficient for explaining 8.466% of the variance, and the third component on the table is proficient for explaining 6.054 of the variance. Therefore, the combination of the three components will explain 48.811% of the total variance.

Table 6.41: Total variance explained by the components

Component	Initial Eigenvalue			Extraction sum of square loading			Rotations of Square Loadings[a] Total
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	
1	12.345	34.290	34.290	12.345	34.290	34.290	10.227
2	3.048	8.466	42.757	3.048	8.466	42.757	5.385
3	2.180	6.054	48.811	2.180	6.054	48.811	8.019
4	1.698	4.716	53.527				
5	1.532	4.255	57.782				
6	1.417	3.937	61.719				
7	1.159	3.219	64.938				
8	1.107	3.074	68.012				
9	.988	2.744	70.756				
10	.950	2.638	73.394				
11	.918	2.550	75.944				
12	.839	2.331	78.275				
13	.777	2.158	80.433				
14	.668	1.856	82.288				
15	.629	1.748	84.036				
16	.594	1.651	85.687				
17	.546	1.516	87.203				
18	.481	1.335	88.539				
19	.452	1.255	89.793				
20	.420	1.168	90.961				
21	.352	.977	91.938				
22	.331	.920	92.859				
23	.312	.866	93.725				
24	.282	.785	94.510				
25	.262	.729	95.239				

In further consideration of factors to be retained, a scree test was executed on the variables, with results in Figure 6.2 confirming that three components are retained in reference to 12.345, 3.048

Table 6.41 continued**.**

Component	Initial Eigenvalue			Extraction sum of square loading			Rotations of Square Loadings[a] Total
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	
26	.245	.681	95.920				
27	.230	.638	96.558				
28	.212	.588	97.146				
29	.196	.544	97.690				
30	.174	.484	98.174				
31	.156	.435	98.609				
32	.137	.381	98.989				
33	.104	.288	99.278				
34	.095	.264	99.542				
35	.087	.242	99.784				
36	.078	.216	100.000				

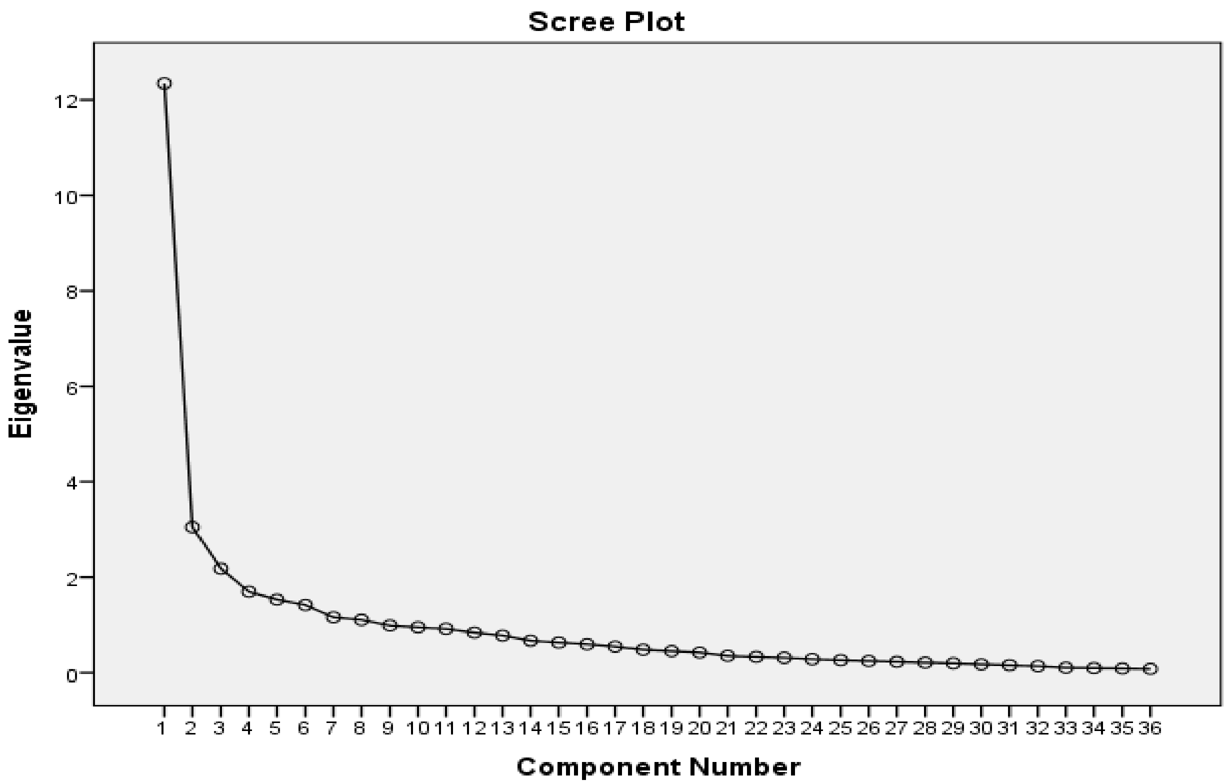

Figure 6.2: Catell's scree plot for factors that affect unsustainable design for affordable housing delivery

and 2.180, as indicated in chapter 6 and section 6.10. These three components are at the point above the elbow on the scree plot, as indicated in Figure 6.2. In addition, to confirm the number of variables to be retained, parallel analysis method will be appropriate through the use of MonteCarloPA software, as this method is recommended by Pallant (2013) and MacCullum (1999).

Fundamentally, MonteCarloPA is used for the generation of data that will be compared with the size of Eigenvalues obtained from PCA. The random Eigenvalues of the three components extracted by PCA were 12.345, 3.048 and 2.180, in that order. The results obtained from corresponding analysis were 2.2596, 2.0902 and 1.9612, as indicated in Table 6.42 and Table 6.43 below. Table 6.44 shows the comparison of the three components extracted through PCA and components extracted through MonteCarloPA. Therefore, the results obtained were compared to the two components indicating that PCA results of components 1, 2 and 3 extracted are 12.345, 3.048 and 2.180, greater than random Eigenvalues generated from parallel analysis which are 2.2596, 2.0902 and 1.9612 (12.345>2.2596) (3.048>2.0902) (2.180>1.9612); thus, 12.345, 3.045 and 2.180 are accepted.

Table 6.42: Comparison of actual Eigenvalues and random Eigenvalues from parallel analysis

Component No.	Actual Eigenvalue from PCA	Random Eigenvalue from parallel analysis	Decision
1	12.345	2.2596	Accept
2	3.048	2.0902	Accept
3	2.180	1.9612	Accept

MonteCarloPA for parallel analysis version.

The information computed into MonteCarloPA:

Number of variables = 36

Number of subjects = 114

Number of replications = 100

6.11.3 Summing up of principal component analysis results (PCA) of EFD variables

The summary of the results of principal component analysis (PCA) on 36 factors is presented

Table 6.43: Result of MonteCarloPA analysis

Eigenvalue#	Random Eigenvalue	Standard Dev.
1	2.2718	.10180
2	2.0965	.0752
3	1.9610	.0623
4	1.8475	.0535
5	1.7537	.0517
6	1.6635	.0457
7	1.5797	.0398
8	1.5120	.0379
9	1.4434	.0364
10	1.3769	.0354
11	1.3041	.0318
12	1.2485	.0360
13	1.1859	.0301
14	1.1315	.0343
15	1.0711	.0340
16	1.0216	.0321
17	0.9740	.0300
18	0.9232	.0331
19	0.8736	.0292
20	0.8283	.0276
21	0.7832	.0284
22	0.7832	.0279
23	0.7016	.0274
24	0.6588	.0230
25	0.6210	.0216

Table 6.43 continued

Eigenvalue#	Random Eigenvalue	Standard Dev.
26	0.5838	.0241
27	0.5465	.0231
28	0.5089	.0223
29	0.4720	.0227
30	0.4371	.0229
31	0.4037	.0218
32	0.3676	.0211
33	0.3355	.0217
34	0.2966	.0227
35	0.2588	.0208
36	0.2183	.0213

Table 6.44: Pattern matrix and structural matrix for PCA with Oblimin Rotation of EFD variables

Coding	Variable name	Pattern matrix coefficient			Structural matrix coefficient			Communalities
		1	2	3	1	2	3	
EFD1	Incorporating sustainable design principles	-	**.676**		-	**.700**	-	.493
EFD2	Discrepancies between drawing and specification impact	-	**.675**	-	-	**.679**	-	.508
EFD3	Design sufficiency and adaptable to meet people demand		**.642**		-	.408	**.680**	.531
EFD4	Replacement of materials during construction affect cost of delivery	-	-	.450	-	.387	.480	.307
EFD5	Government policy on housing design	-	.489		-	.496	-	.281
EFD6	Establish standard design for production	-	**.606**	-		.635	-	.425
EFD7	Design for waste minimisation during production	**.695**	-	-	**.714**	.318	-	.532
EFD8	Design for re-use of materials	**.681**			**.714**	.340	.313	.538
EFD9	Decision taking at planning stage causes changes in housing design	.568	-		**.678**	.348	.460	.517
EFD10	Cost is affected by value engineering at design stage	**.679**	-		**.721**	-	.357	.532
EFD11	Constant promoting high standard design		.515		.355	.558	-	.364
EFD12	Ambiguous design details cause changes in housing design	-	422		.408	.558	.485	.442
EFD13	Coordination of design changes during production	-	-		.341	.407	.386	.262
EFD14	Changes in specification by consultant cause changes in housing design	.472	-	323	**.621**	-	.539	.484
EFD15	Design for the best use of land, infrastructure and services	**.662**	-	-	**.676**	-	.307	.457
EFD16	Inadequately defined scope of work for contractors causes change in housing design during production	-	-	**.779**	-	.318	**.759**	.592
EFD17	Procurement of new materials for housing delivery causes changes in design	-	-	.417	.395	.317	.539	.341
EFD18	Design housing for environmental performance efficiency	-	-	.332	.318	.422	.472	.311
EFD19	Improper design leads to failure in achieving client objectives	-	-	**.689**	-	.390	**.711**	.539
EFD20	Frequent changes to housing design cause variation		-	.416	.356	.453	.557	.402
EFD21	Errors and omission in housing design affects quality	-	-	.587	.335	.388	**.666**	.477
EFD22	Adequate design for new techniques will affect cost effective production	-	.582	-	-	.598	-	.377

Table 6.44 continued

Coding	Variable name	Pattern matrix coefficient			Structural matrix coefficient			Communalities
		1	2	3	1	2	3	
EFD23	Changes in design as a source of waste during production	-	**.682**		.731	-	.400	.546
EFD24	Inadequate design affects cost of delivery	-	302	.510	.509		**.629**	.471
EFD25	Design of first-rate living conditions for a healthy environment	.493			.605	..301	.443	.421
EFD26	Frequent changes of housing design by client affect construction cost	.340		,533	.555	-	**.666**	.538
EFD27	Inadequate consideration for housing location at design stage causes change in design	.355		.408	.535	-	.570	.434
EFD28	Poor communication among design team and contractor at planning stage causes changes in design	-	-	**.741**	.493	-	**.806**	.682
EFD29	Non-involvement of contractors at initiating stage of design planning causes frequent changes in design	-	.369	**.783**	.393	-	**.727**	.658
EFD30	Prolonged procedure for management of design changes causes delay	.427		.438	.577	-	.573	.482
EFD31	Safety consideration for housing delivery causes changes in design	.521	-	-	.588	-	.407	.388
EFD32	Non-compliance of housing design with government regulation causes changes in design at implementation	**.731**	-	-	**.777**	-	.459	.648
EFD33	Complexity of design causes changes in design and affects cost	**.844**			**.796**	-	-	.650
EFD34	Design for better performance	**.837**			**.815**	-	-	.675
EFD35	Sustainability integrated approach for housing delivery	**.855**			**.877**	-	-	.696
EFD36	Design for implementation of new technology	**.742**			**.753**	-	-	.570

Table 6.44. The obtained results clarify that for the factors having strong and weak power mitigating unsustainable design for affordable housing delivery, principal component analysis (PCA) was used to ascertain suitability of data collected for factor analysis as reported in Chapter 6 and subsection 6.10. Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) value 0.843, although the recommended value is 0.6 by Pallant (2013). In spite of that, the value obtained is greater, and the results obtained from Bartlett's Test of Sphericity is 0.000, that is P=0.000 (P<0.5), with the conclusion being that the results are in conformity to the factorability of the correlation matrix, *meaning that the factor is significant and adequate for PCA.* However, the results emerging from principal component analysis show three components with Eigenvalues exceeding 1. The detailed explanation on 34.290%, 8.466% and 6.054% of the variance is shown in Table 6.41, as found in Chapter 6 and subsection 6.10. In continuation of the confirmation of these results, the scree plot test displayed a break of the third component at the elbow, found in Figure 6.2.

The results obtained from parallel analysis revealed three components as having Eigenvalue greater than the randomly generated data matrix by MonteCarloPA. The result is in Table 6.42. Thereafter, three components are retained for continuation of investigation. The Oblimin rotation is used for the interpretation of the three components retained, while simultaneously for loading the variables. Considering the information on Table 6.44, due to the large number of variables, the analysis results exposed components with strong and weak loadings. The pattern matrix have strong component loadings above 0.6 (as highlighted in bold) while the structure matrix has three component loadings above 0.3. Table 6.44 above shows the highlighted figures in bold as strong communalities because to ascertain better analysis of factors, the communalities should be greater than 0.4. In terms of the highlighted number among the communalities, the smallest among them all recorded 0.42. EFD6 (establish standard design for production) has the lowest communalities, which is 0.42 on Table 6.44. Considering the loading pattern of EFD variables, the variables that converge on component-1 are named as *sustainability design and integration to productivity,* and component-2 is referred to as *design for sustainable adaptability and changes in need of amenities,* whereas component-3 is named *inadequate design for needs and scope causes failure.*

6.12 The factor analysis for impact of management of human resources on cost toward sustainable housing delivery

Principal component analyses (PCA) were employed to establish impact of management of human resources on cost toward sustainable housing delivery. This was done purposely to reduce the factor to sizable variables for developing a framework. The primary reason for engaging PCA in the reduction of the variables into sizeable position was discussed in chapter 6 and section 6.10.

6.12.1 KMO and Bartlett's Sphericity Test on factors that influence human resources management on cost toward sustainable housing delivery

The detail of KMO and Bartlett's Sphericity test has been adequately explained in chapter 6 and section 6.10, thus factors that influence human resource management on cost were tested, as indicated in Table 6.45. The results obtained from KMO and Bartlett's test of Sphericity show data adequacy and suitability on factors that influence human resource management on cost toward sustainable housing delivery.

Table 6.45: KMO and Bartlett's Test of Sphericity

Test		Value and Remark
Kaiser-Meyer-Olkin measure of Sampling adequacy		0.877 Significant and adequate for PCA
Bartlett's Test of Sphericity	Approx. Chi-Square	2474.668
	df	435
	Sig.	0.000 Significant and adequate for PCA

6.12.2 Principal components factors that influence human resources management on cost toward sustainable housing delivery

To establish the principal components factors that influence human resource management on cost toward sustainable housing, it is necessary to consider Pallant's (2013), Jolliffe's (1986) and MacCullum's (1999) studies as discussed in Chapter 6 and subsection 6.10. The number of components to be retained has a fundamental linkage with each factor's contribution to concept. To determine which factors to retain, PCA is used, including methods of factor extraction and correlation matrix, unrotated factor solution, scree plot and Eigenvalues greater than 1. The application of the principle in this case is in reference to Table 6.46 below: the Eigenvalues of the two components extracted are 13.123 and 2.227. The first component on the table is proficient

Table 6.46: Total variance explained by the components

Component	Initial Eigenvalue			Extraction sum of square loading			Rotations of Square Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	13.123	43.745	43.745	13.123	43.745	43.745	12.038
2	2.227	7.423	51.168	2.227	7.423	51.168	8.442
3	1.641	5.470	56.638				
4	1.495	4.983	61.621				
5	1.229	4.098	65.719				
6	1.057	3.524	69.244				
7	.970	3.233	72.477				
8	.869	2.898	75.374				
9	.713	2.376	77.751				
10	.681	2.270	80.020				
11	.621	2.070	82.090				
12	.594	1.980	84.071				
13	.562	1.875	85.945				
14	.541	1.803	87.748				
15	.472	1.574	89.322				
16	.420	1.400	90.722				
17	.362	1.206	91.927				
18	.341	1.137	93.065				
19	.306	1.020	94.085				
20	.269	.896	94.981				
21	.231	.771	95.752				
22	.209	.698	96.450				
23	.190	.632	97.082				
24	.172	.575	97.657				
25	.157	.524	98.181				
26	.138	.459	98.640				
27	.124	.415	99.055				
28	.109	.363	99.418				
29	.096	.320	99.738				
30	.079	.262	100.000				

for explaining 43.75% of the variance, while the second component on the table is proficient for explaining 7.42% of the variance. The combination of the two components will explain 51.17% of the total variance.

The detail process compared the size of Eigenvalues obtained from PCA with equivalent analysis obtained through the use of MonteCarloPA, vibrantly explained in chapter 6 and section 6.10. Consequently, the results obtained by comparing the two components to be retained have a fundamental linkage with each factor's contribution to concept. To achieve which factors to be retained, PCA was done which includes methods of factor extraction, correlation matrix, unrotated factor solution, scree plot, and Eigenvalues greater point to the fact that 13.123 and 2.227 are

Table 6.47: Comparison of actual Eigenvalues and random Eigenvalues from parallel analysis

Component No.	Actual Eigenvalue from PCA	Random Eigenvalue from parallel analysis	Decision
1	13.123	2.1101	Accept
2	2.227	1.9428	Accept

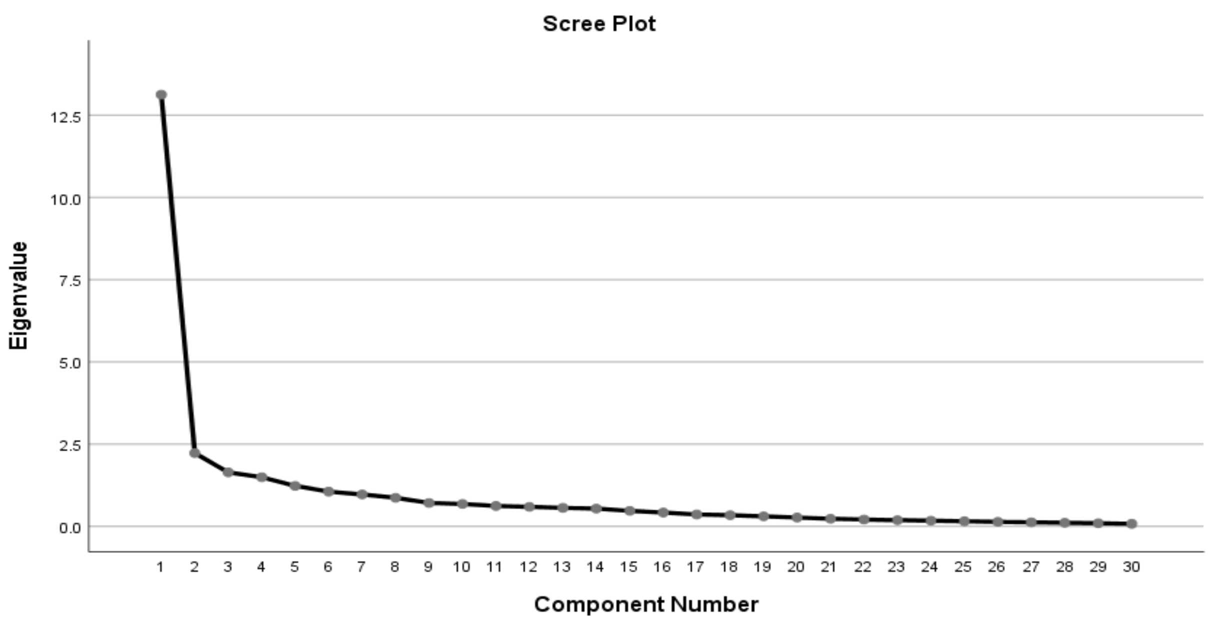

Figure 6.3: Catell's scree plot for factors that affect human resources management toward affordable housing delivery within budget

extracted from components 1 and 2 of the PCA, after comparing the analysis results obtained from MonteCarloPA with PCA result. The PCA results (13.123 and 2.227) are greater than MonteCarloPA results (2.1101 and 1.9428) is shown in Table 6.47 above and Table 6.48 (13.123>2.1101) (2.227>1.9428); hence, 13.123 and 2.227 are accepted.

Monte Carlo PA for parallel analysis version.

The information computed into Monte Carlo PA:

Table 6.48: Results of MonteCarloPA analysis

Eigenvalue#	Random Eigenvalue	Standard Dev.
1	2.1101	.0907
2	1.9428	.0734
3	1.8115	.0690
4	1.7056	.0573
5	1.6950	.0460
6	1.5244	.0440
7	1.4481	.0388
8	1.3718	.0379
9	1.2980	.0346
10	1.2355	.0332
11	1.1707	.0337
12	1.1127	.0329
13	1.0521	.0331
14	0.9956	.0318
15	0.9427	.0248
16	0.8921	.0254
17	0.8412	.0248
18	0.7962	.0285
19	0.7456	.0253
20	0.6979	.0275
21	0.6549	.0276
22	0.6127	.0264
23	0.5748	.0273
24	0.5707	.0240

Table 6.48 continued.

Eigenvalue#	Random Eigenvalue	Standard Dev.
25	0.4917	.0254
26	0.4470	.0278
27	0.4052	.0259
28	0.3659	.0231
29	0.3232	.0230
30	0.2715	.0265

Number of variables = 30

Number of subjects = 114

Number of replications = 100

components to be retained has a fundamental linkage with each factor's contribution to the concept. To determine which factors to retain, PCA was done which includes methods of factor extraction which contains correlation matrix, unrotated factor solution, scree plot, and Eigenvalues greater than 1. The application of the principle, in this case, is referenced in Table 6.46.

6.12.3 Summary of principal component analysis results (PCA

The principal component analysis (PCA) were used to analysis factors that influence human resources management on cost toward sustainable housing delivery, the results are brightly explained in Table 6.49 below. Depicting information from the table shown that 30 factors were analysed, the outcome of the analysis confirm that the factors has strong and weak impact toward human resources management on cost in delivery of sustainable housing. Although, the factors were tested for fittingness for factorial analysis, the process of testing was clearly explained in Chapter 6 and subsection 6.10. However, the Kaiser-Meyer-Olkin measure of Sampling adequacy (KMO) value was 0.877, this figure exceeding the 0.6 recommended by Pallant (2013), while Bartlett's Test of Sphericity was discovered to be significant at p=0.000 (p<.005), therefore the result obtained in conformism to the factorability of the correlation matrix. The results obtained through PCA discovered two components with Eigenvalues exceeding 1, the results of the PCA are 43.745% and 7.458% of the variance, the explanation as regards to this type of results were intensely explained in chapter 6 and sections 6.10.

Table 6.49: Pattern matrix and structural matrix for PCA with Oblimin Rotation of ICMCR variables

Coding	**Variable name**	**Pattern matrix coefficient**		**Structural matrix coefficient**		**Communalities**
		1	**2**	**1**	**2**	
ICMCR1	Involvement of all team members in planning and implementation	**.675**	.507	**.641**	0482	.414
ICMCR2	Develop staffing management plan	**.701**	-	**.651**	-	.431
ICMCR3	Document delivery roles and responsibilities among construction team members	**.713**	-	**.620**	-	.409
ICMCR4	Regular meetings on site for promoting efficient productivity	**.790**	-	**.708**	-	.520
ICMCR5	Define quality accomplishment for housing production	.438	.392	.525	.395	.298
ICMCR6	Time wastage by workforce during production	-	.553	-	.522	.275
ICMCR7	Skill to establish requirements, methods and techniques for housing production	**.669**	-	**.719**	.438	.524
ICMCR8	Constant training of workers for use of techniques	**.674**		**.768**	.528	.615
ICMCR9	A sound knowledge on quality design decisions and implementation	**.671**	-	**.718**	.434	.522
ICMCR10	Team-building strategies for production	**.629**	-	**.716**	.491	.534
ICMCR11	Ability to carry out effective implementation of techniques on housing production	**.671**	**-**	.766	.529	.613
ICMCR12	Emphasis on constant encouraging construction operators on skill advancement and development	**.704**	**.697**	**.713**	.376	.509
ICMCR13	Build trust among construction team members	**.856**	**.667**	**.778**	-	.623
ICMCR14	Reduction in delivery time through proper job allocation to workforce	**.745**	**.660**	**.706**	.303	.502
ICMCR15	Ability to define plan for effective use of resources available for production	**.603**	**-**	**.679**	.457	.478
ICMCR16	Steadfastness in carrying out commitments and obligations	.336	.430	.555	**.601**	.445
ICMCR17	Shortage of experienced workers on site	-	.782	-	**.707**	.516

Table 6.49 continued

Coding	Variable name	Pattern matrix coefficient		Structural matrix coefficient		Communalities
		1	2	1	2	
ICMCR18	Skill in oral and written communication for keeping subordinates, associates, superiors and others adequately informed during production	-	**.662**	.489	**.737**	.563
ICMCR19	Improper planning of workforce activities on site	-	**.776**	.392	**.767**	.589
ICMCR20	Aptitude to work under pressure to meet tight deadlines and adapt to changes affect cost of construction	.413	.421	**.628**	**.632**	.525
ICMCR21	Prompt payment of wages by contractors will enhance productivity	**.700**	-	**.740**	.435	.552
ICMCR22	Ability to safeguard safety consciousness during housing production	.527	**.713**	**.652**	.514	.469
ICMCR23	Workforce productivities affect cost	.332	.515	.595	**.684**	.550
ICMCR24	Skill to apply techniques for reduction in cost of construction during production	.353	.497	**.607**	**.677**	.551
ICMCR25	Wastage of workforce input during production process	-	**.734**	.445	**.770**	.596
ICMCR26	Ability of workforce to develop willingness in sustainability practices	-	**.702**	.476	**.762**	.591
ICMCR27	Knowledge of good safety practices and awareness of personal safety during production	.475	.305	**.631**	.547	.467
ICMCR28	Skill to define effective techniques for achieving objectives	**.679**	-	**.740**	.473	.560
ICMCR29	Flexibility of construction operators in making timely management decisions on production	**.700**	-	**.743**	.442	.558
ICMCR30	Constant emphasis on making maximum usage of local labour force to achieve housing production	.441	.415	**.652**	**.639**	.552

The scree plot test in Figure 6.3 quite clearly shows the break of the second component at the elbow. Similarly, the parallel analysis carried out through the use of MonteCarloPA revealed the two components that were retained, and further analysis was carried out through the use Oblimin rotation to interpret the two component that were retained. At the same time, this was used for loading of variables. The analysis results indicated the components with strong and weak loadings, with the pattern and structure matrix having component loadings above 0.6 and 0.3 (Table 6.49). The figures above 0.6 were highlighted in bold and the figures having strong communalities above 0.4, as recommended, were selected and recorded.

The factor that has the lowest communality is named ICMCR3 (Document delivery roles and responsibilities among construction team members), as the communality recorded is .409. To critically examine the loading pattern of the variables that were converged at component 1 of pattern matrix coefficient is named as *skilful knowledge for management* cost efficient, and the variables that were converged in component 2 of pattern matrix coefficient is referred to as ability to map out strategies for waste reduction and increase in productivity.

6.13 KMO and Bartlett's Sphericity Test on factors that affect material resources management on cost toward sustainable housing delivery

The details of KMO and Bartlett's Sphericity test have been adequately explained in chapter 6 section 6.10. Thus, factors that affect material resource management on cost were tested, as indicated in Table 6.50. The results obtained from KMO and Bartlett's Test of Sphericity show data adequacy and suitability of factors that affect materials resources management on cost toward sustainable housing delivery.

Table 6.50: KMO and Bartlett's Test of Sphericity

Test		Value and Remark
Kaiser-Meyer-Olkin measure of Sampling adequacy		0.793 Significant and adequate for PCA
Bartlett's Test of Sphericity	Approx. Chi-Square	1113.653
	df	276
	Sig.	0.000 Significant and adequate for PCA

The process of comparing the size of Eigenvalues obtained from PCA with equivalent analysis obtained through the use of MonteCarloPA was brilliantly explained in Chapter 6 and subsection

6.10. The results obtained through the comparison of the two components point to the fact that 6.929, 2.267 and 1.773 are extracted from components 1, 2 and 3 of the PCA, after comparing

Table 6.51: Total variance explained by the components

Component	Initial Eigenvalue			Extraction sum of square loading			Rotations of Square Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	6.929	28.870	28.870	6.929	28.870	28.870	5.228
2	2.267	9.444	38.314	2.267	9.444	38.314	4.923
3	1.773	7.387	45.701	1.773	7.387	45.701	3.016
4	1.527	6.364	52.066				
5	1.207	5.029	57.094				
6	1.126	4.691	61.785				
7	1.005	4.189	65.974				
8	.911	3.797	69.771				
9	.826	3.440	73.211				
10	.784	3.268	76.479				
11	.731	3.044	79.523				
12	.653	2.721	82.244				
13	.599	2.494	84.738				
14	.534	2.226	86.964				
15	.496	2.067	89.031				
16	.447	1.864	90.896				
17	.407	1.698	92.593				
18	.368	1.533	94.126				
19	.336	1.399	95.525				
20	.285	1.189	96.714				
21	.250	1.041	97.756				
22	.215	.895	98.650				
23	.190	.793	99.444				
24	.133	.556	100.000				

Table 6.52: Comparison of actual Eigenvalues and random Eigenvalues from parallel analysis

Component No.	Actual Eigenvalue from PCA	Random Eigenvalue from parallel analysis	Decision
1	6.929	1.9448	Accept
2	2.267	1.7747	Accept
3	1.773	1.6606	Accept

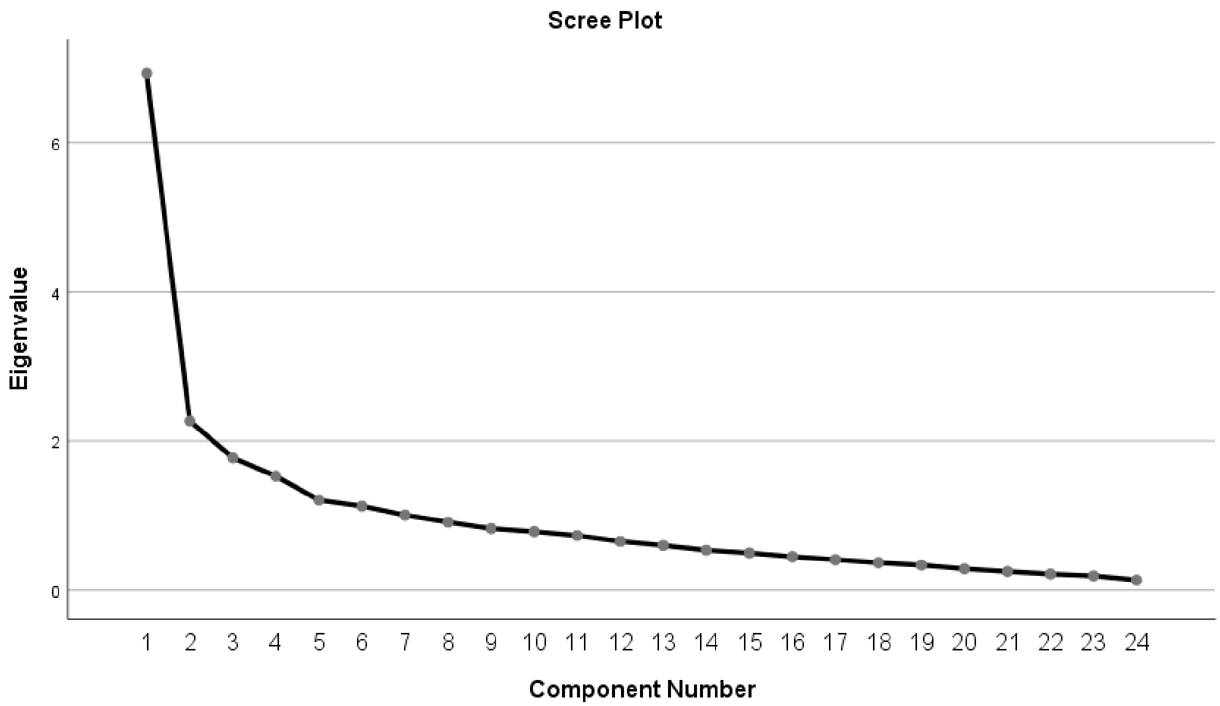

Figure 6.4: Catell's scree plot for factors that affect materials management towards sustainable housing delivery

MonteCarloPA for parallel analysis version.

The information computed into MonteCarloPA:

Number of variables = 24

Number of subjects = 114

Number of replications = 100

the analysis results obtained from MonteCarloPA with PCA result. The PCA results obtained (Table 6.53) is greater than MonteCarloPA result which is 1.9448, 1.7747 and 1.6606 respectively. This is presented in Table 6.51 and Table 6.52 above. (6.929>1.9448) (2.267>1.7747), (1.773>1.6606) therefore, 6.929, 2.267, and 1.773 are accepted.

Table 6.53: Result of MonteCarloPA PA analysis

Eigenvalue #	Random #	Standard Dev.
1	1.9448	.0839
2	1.7747	.0641
3	1.6606	.0549
4	1.5599	.0467
5	1.4665	.0484
6	1.3766	.0367
7	1.2986	.0377
8	1.2209	.0407
9	1.1472	.0360
10	1.0885	.0360
11	1.0282	.0345
12	0.9714	.0283
13	0.9100	.0311
14	0.8537	.0328
15	0.7990	.0311
16	0.7452	.0306
17	0.6938	.0261
18	0.6443	.0252
19	0.5993	.0247
20	0.5432	.0281
21	0.4985	.0282
22	0.4488	.0299
23	0.3958	.0336
24	0.3364	.0357

6.13.1 Summary of principal component analysis results (PCA)

Table 6.54 presents the results obtained from principal component analysis (PCA) engaged to analyse the factors that impact material management toward sustainable housing delivery, with result explained in Table 6.54 confirming that the factors have strong and weak influence on material management in delivery of sustainable housing. Fittingness tests were carried out on the factors through the Kaiser-Meyer-Olkin measure of Sampling adequacy. The outcome of the results confirm that factors are adequate and significant toward factorability of the correlation matrix. The KMO value is 0.793, a figure above the 0.6 recommended by Pallant (2013), while Bartlett's Test of Sphericity was determined as significant at p=0.000 (p<.005); hence, the result is adequate for factorability. The outcome of the results indicates that there are three components with Eigenvalues exceeding 1, discovered through the use of PCA: 28.870, 9.444 and 7.387 of the variances.

The explanation in the uses of PCA was sufficiently covered in chapter 6 and section 6.10. The scree plot test displayed in Figure 6.4 evidently shows the break of the third component at the elbow. Likewise, the MonteCarloPA revealed the three components that were necessary to be retained. Further analyses were carried out through the Oblimin rotation to interpret the three components that were retained and used for the loading of the variables. The results demonstrate that there are strong and weak loadings; the pattern and structure matrix has component loadings above 0.6 and 0.3, as shown in Table 6.53. Therefore, figures above 0.6 were highlighted in bold and figures having strong communalities above 0.4. Consequently, the figures with communalities above 0.4 were selected and recorded.

The factor that recorded the lowest communality is named EBMC3 (Increase in the price of original materials specified causes the use of alternative materials) with communality recorded as .413. By carefully examination, the loading pattern of the variables that converged at component 1 of pattern matrix coefficient is called *fluctuation of material price,* the variable that converges in component 2 of the pattern of matrix coefficient is referred to as *scarcity and cost of materials*, and the variable in component 3 of the pattern matrix coefficient is named *inadequate materials management plan*.

6.13.2 KMO and Bartlett's Sphericity Test on factors that affect management of machinery resources on cost toward sustainable housing delivery

The detail of KMO and Bartlett's Sphericity Test has been adequately explained in chapter 6 section 6.10. Thus, factors that affect management of machinery resources on cost were tested, as indicated in Table 6.54 below. The results obtained from KMO and Bartlett's Test of Sphericity

Table 6.54: Pattern matrix and structural matrix for PCA with Oblimin Rotation of EBMC variables

Coding	**Variable name**	**Pattern matrix coefficient**			**Structural matrix coefficient**			**Communalities**
		1	**2**	**3**	**1**	**2**	**3**	
EBMC1	Use of foreign materials for housing construction has effect on budgeted cost	-	.506		-	.480	.304	.340
EBMC2	Delay in importation of housing construction materials	-	**.626**	-	-		.565	.348
EBMC3	Increase in the price of original materials specified causes the use of alternative materials		**.610**	-	-	.637	.680	.413
EBMC4	Use of materials that are environmentally friendly	-	.401	.408	.302	.535	.528	.465
EBMC5	Increase in price of construction materials	-	.717	-	.436	**.768**	-	.645
EBMC6	Late delivery of construction materials	-	**.620**	-	.447	**.681**	-	.538
EBMC7	Insufficient of construction materials on site	.336	-	-	.484	**.675**	-	.578
EBMC8	Scarcity of housing materials in the country leads to importation of materials with high prices from other nations	-	**690**	-	.328	**.690**	.313	.527
EBMC9	Change in specification of materials during production	-	.455	-	-	.528	.350	.333
EBMC10	Cost of finance construction materials by bank	.427	-	-	.515	.337	.357	.359
EBMC11	Inhibited innovations for housing materials	.516	-	-	.315	**.615**	.410	.462
EBMC12	Quality of workmanship on materials will reduce waste	-	.434	.357	-	.506	.455	.375
EBMC13	Municipal government taxes and charges on materials	.581	-	-	.589	-	-	.350
EBMC14	Sources of estimates on site for calculating cost of materials	.574	-	-	**.600**	-	.363	.434
EBMC15	Management plan for delivery of materials	-	-	**.720**	-	-	**.727**	.532
EBMC16	Site activities plan for cost estimate	-	-	**.588**	.338	.323	**.653**	.490
EBMC17	Project logbooks for records of activities and materials	-	-	**.725**	-	-	**.724**	.551
EBMC18	Seasonal changes in housing construction materials	**.778**	-	.332	**.769**	-	-	.636
EBMC19	Cost of transportation and distribution of materials	**.603**	-	.689	.595	-	-	.394
EBMC20	Exchange rate of dollars affects materials delivery	-	-	-	-	-	-	.046
EBMC21	Increase in price of materials affects time delivery	.585	-	-	**.610**	-	-	.395

Table 6.54 continued.

Coding	Variable name	Pattern matrix coefficient			Structural matrix coefficient			Communalities
		1	2	3	1	2	3	
EBMC22	Government regulations on housing materials usage affect cost	.564	-	-	.635	.311	.388	.487
EBMC23	Currency exchange rate in the country leads to scarcity of materials	.782	-		.817	.344	-	.680
EBMC24	Currency instability in the country affects prices of housing materials	.752	-	-	.765	-	-	.592

Table 6.55: KMO and Bartlett's Test of Sphericity

Test		Value and Remark
Kaiser-Meyer-Olkin measure of Sampling adequacy		0.817 Significant and adequate for PCA
Bartlett's Test of Sphericity	Approx. Chi-Square	891.409
	df	136
	Sig.	0.000 Significant and adequate for PCA

Table 6.56: Total variance explained by the components

Component	Initial Eigenvalue			Extraction sum of square loading			Rotations of Square Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	6.609	38.876	38.876	6.609	38.876	38.876	5.652
2	1.722	10.132	49.008	1.722	10.132	49.008	4.750
3	1.279	7.523	56.531				
4	1.163	6.841	63.371				
5	.882	5.188	68.560				
6	.770	4.527	73.087				
7	.700	4.115	77.202				
8	.683	4.018	81.221				
9	.607	3.570	84.791				
10	.475	2.793	87.584				
11	.455	2.676	90.260				
12	.404	2.378	92.639				
13	.363	2.135	94.774				
14	.279	1.643	96.416				
15	.246	1.447	97.864				
16	.214	1.260	99.124				
17	.149	.876	100.000				

show data adequacy and suitability of factors that affect management of machinery resources on cost toward sustainable housing delivery.

Further to the establishment of facts, a size comparison was carried out between the Eigenvalues obtained from PCA and Eigenvalues analysis obtained through the MonteCarloPA, with results obtained indicating that 6.609 and 1.722 extracted from component 1 and 2 of the PCA is greater than MonteCarloPA result which is 1.7608 and 1.5802, respectively. This information is in Table 6.56 above and Table 6.57: (6.609>1.7608) and (1.722>1.5802); thus 6.609 and 1.5802 are accepted. The similar example of detail analysis is in chapter 6 section 6.10.

Table 6.57: Comparison of actual Eigenvalues and random Eigenvalues from parallel analysis

Component No.	Actual Eigenvalue from PCA	Random Eigenvalue from parallel analysis	Decision
1	6.609	1.7608	Accept
2	1.722	1.5802	Accept

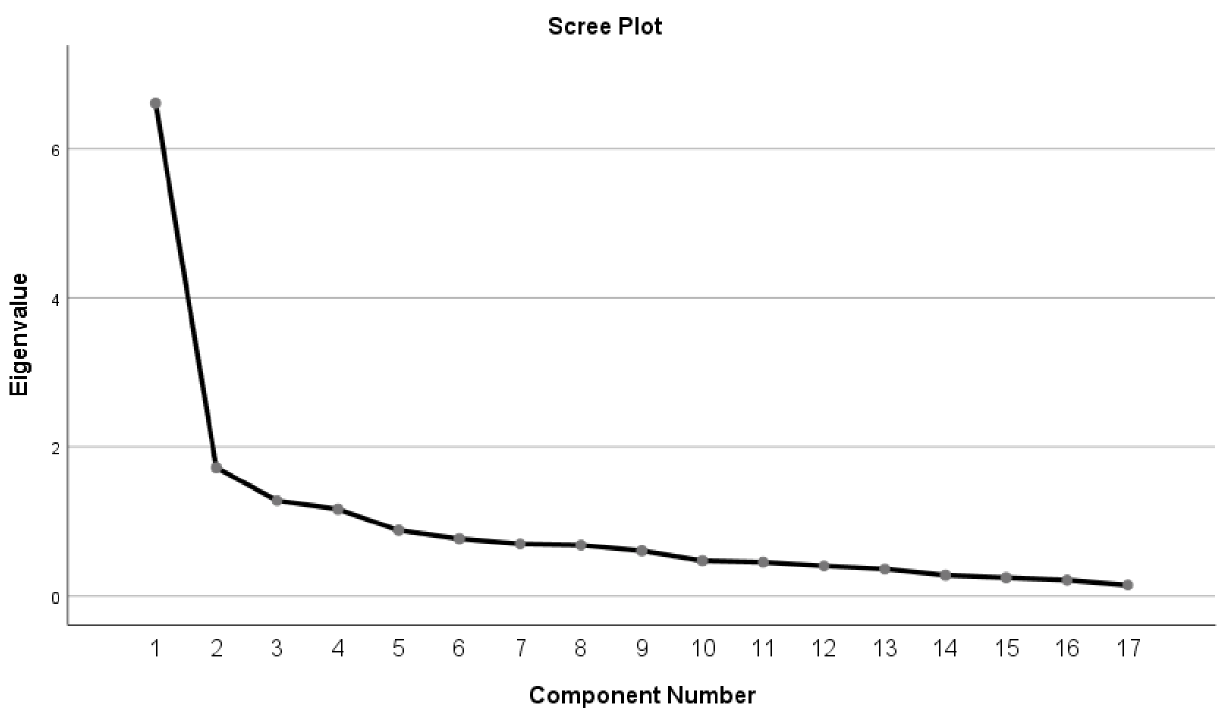

Figure 6.5: Catell's scree plot for factors that affect machinery management toward sustainable housing delivery

MonteCarloPA for parallel analysis version.

The information computed into MonteCarloPA:

Number of variables = 17

Number of subjects = 114

Number of replications = 100

Table 6.58: Result of MonteCarloPA PA analysis

Eigenvalue #	Random Eigenvalue	Standard Dev.
1	1.7608	.0935
2	1.5802	.0564
3	1.4607	.0481
4	1.3441	.0457
5	1.2571	.0449
6	1.1755	.0415
7	1.0986	.0383
8	1.0318	.0340
9	0.9595	.0339
10	0.8919	.0374
11	0.8217	.0318
12	0.7581	.0328
13	0.6954	.0332
14	0.6404	.0319
15	0.5794	.0344
16	0.5084	.0369
17	0.4364	.0405

6.13.3 Summary of principal component analysis results (PCA)

The results obtained from principal component analysis (PCA) are shown in Table 6.58. The similar procedure used to obtain the result is dazzlingly explained in Chapter 6 and subsection 6.10. Table 6.58: Result of MonteCarloPA PA analysis, confirming that the factors have strong and weak influence on machinery management toward sustainable housing delivery within budget. In continuation of the analysis, fittingness tests were performed on the factors through Kaiser-Meyer-Olkin measure of sampling adequacy. The results obtained confirmed the factorability of the correlation matrix. The KMO value is 0.817, so the result obtained is above the

Table 6.59: Pattern matrix and structural matrix for PCA with Oblimin Rotation of EMMC variables

Coding	Variable name	Pattern matrix coefficient		Structural matrix coefficient		Communalities
		1	2	1	2	
EMMC1	Maintenance cost of equipment on site	**.749**	-	**.652**	-	.466
EMMC2	Cost of transportation of equipment to site	**.776**	-	**.701**	-	.516
EMMC3	Equipment delivery time during production process	**.807**	-	**.826**	.392	.683
EMMC4	Cost of equipment and import duties	**.744**	-	**.725**	-	.527
EMMC5	Constant changes in hiring price of equipment	.572	-	**.661**	.452	.471
EMMC6	Specific factory cost attributable to the equipment	-	.513	**.613**	**.639**	.477
EMMC7	Lack of proper planning for the use of equipment	.561	-	**.635**	.414	.427
EMMC8	Idleness of hiring equipment on site	.350	.389	.516	.535	.386
EMMC9	Manufacturer's excise tax on housing equipment	.532	-	**.650**	.504	.484
EMMC10	Constant increase in cost of purchasing equipment	-	.519	.504	**.640**	.473
EMMC11	Different equipment for site soil conditions affect construction cost	.536	-	.605	.391	.387
EMMC12	Overhead cost attributable to the equipment affects cost of construction	.469	.303	**.600**	.506	.434
EMMC13	Procurement of appropriate equipment	.505	-	**.612**	.464	.423
EMMC14	Abnormal profit making from the manufacturers in selling equipment	-	**.717**	.399	**.755**	.577
EMMC15	Faulty equipment on site for production	-	**.644**	-	**.649**	.421
EMMC16	Inadequate management of equipment	-	**.926**	-	**.825**	.725
EMMC17	Planning for the use of equipment on site	-	**.651**	.334	**.673**	.456

0.6 recommended by Pallant (2013). Bartlett's Test of Sphericity demonstrated significance and adequacy of the factor at p=0.000 (p<.005).

The results obtained inveterate that there are two components with Eigenvalues exceeding 1, discovered through the use of PCA, which includes the following 38.876 and 10.132 of the variances. Similarly, the scree plot test displayed in Figure 6.5 clearly shows the break of the second components at the elbow. The MonteCarloPA revealed the two components that were retained. Further analysis through the Oblimin rotation confirmed the two components that were retained and used for the loading of the variables. Results obtained indicated strong and weak loading of the variables: the pattern and structure matrix has component loadings above 0.6 and 0.3, as shown in Table 6.58 above.

Those figures above 0.6 were highlighted in bold; communalities of these figures is above 0.4. Thus, figures that recorded communalities above 0.6 are selected and recorded. The factors recording lowest communalities above 0.4 is named as EMMC15 (Faulty equipment on site for production), with communalities recorded at .421. The variables that converge at component 1 is called *equipment maintenance within the constraint of budget* and the variables that converged at component 2 is referred to as *adequate planning for the use of equipment.*

6.14 Factor analysis of effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery

Principal component analyses (PCA) were employed to establish effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery, done purposely to reduce the factor to sizable variables for developing a model. The basic reason for engaging PCA in the reduction of the variables into sizeable positions was significantly discussed in chapter 6 section 6.10.

6.14.1 The use of Kaiser-Meyer-Olkin (KMO) and Bartlett's Sphericity Test on effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery

Pallant (2013) and MacCallum *et al.* (1999) clarify the need for the use of Kaiser-Meyer-Olkin (KMO) and Bartlett's Sphericity Test, explaining that the importance of parallel component analysis (PCA) is to confirm the suitability of data collected for analysis. Therefore, Kaiser-Meyer-Olkin (KMO) and Bartlett's Sphericity Tests are important to the suitability of the research data collected. KMO measures sampling competence, while Bartlett's Test of Sphericity was engaged for the identification of factors that affect effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery. Table 6.59 presents results obtained from KMO and Bartlett's Test of Sphericity. The major distinguishing aspect associated with KMO is that the KMO indicator ranges from 0.1 to 1 maximum, with 0.6 recommended as point in which factor analysis can be a commendable valued (Pallant, 2013).

Bartlett's Test of Sphericity defines the strength of the connection between variables, with the inference perceived at the point at which $p<0.05$. The interpretation is to confirm that the PCA is suitable (Pallant), linked with Table 6.59. The results of the KMO and Bartlett's Sphericity Test performed on effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery is depicted in Table 6.59. The results found that KMO occurs at a point of 0.889, higher than 0.6 and less than 1, as recommended by Jolliffe (1986) and Pallant (2013), while the Bartlett's Sphericity Test suitability indicated that $p=0.000$, meaning that p is less than 0.05 ($p<0.05$). Thus, adhering to the recommendation of Pallant (2013) and Jolliffe (1986), the conclusion is that data is adequate and suitable to be used for PCA.

Table 6.60: KMO and Bartlett's Test of Sphericity

Test		Value and Remark
Kaiser-Meyer-Olkin measure of Sampling adequacy		0.889 Significant and adequate for PCA
Bartlett's Test of Sphericity	Approx. Chi-Square	2411.661
	df	406
	Sig.	0.000 Significant and adequate for PCA

6.14.2 Principal components of factors fundamental to the effective utilisation of budgeted cost without inflating cost of construction for sustainable housing

The principal component of factors fundamental to the effective utilisation of budgeted cost without inflating cost of construction for sustainable housing is pivoted on the study conducted by MacCullum (1999) and Pallant (2013). However, the number of components to be retained among the principal component factors is fundamental to effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery. The method considered for retaining factors is PCA, which includes factor extraction that contains correlation matrix, unrotated factor solution, scree plot, and Eigenvalues greater than 1, referenced in Table 6.60. The Eigenvalues of the two components extracted is 12.869 and 2.725, correspondingly. Hence, the first component on the table is proficient for explaining 44.396% of the variance, while the second component on Table 6.60 is proficient for explaining 9.396% of the variance, and the combination of the two components will explain 48.811% of the total variance.

Table 6.61: Total variance explained by the components

Component	Initial Eigenvalue			Extraction sum of square loading			Rotations of Square Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	12.869	44.376	44.376	12.869	44.376	44.376	11.553
2	2.725	9.396	53.772	2.725	9.396	53.772	9.123
3	1.517	5.233	59.005				
4	1.381	4.762	63.767				
5	1.054	3.633	67.400				
6	.986	3.399	70.799				
7	.856	2.953	73.752				
8	.772	2.662	76.414				
9	.727	2.506	78.920				
10	.649	2.237	81.156				
11	.612	2.111	83.268				
12	.542	1.868	85.136				
13	.512	1.764	86.900				
14	.452	1.560	88.459				
15	.380	1.310	89.769				
16	.369	1.273	91.043				
17	.343	1.182	92.225				
18	.316	1.091	93.316				
19	.295	1.018	94.334				
20	.276	.953	95.287				
21	.240	.829	96.116				
22	.200	.691	96.806				
23	.177	.610	97.417				
24	.163	.561	97.978				
25	.158	.545	98.523				
26	.131	.452	98.976				
27	.120	.414	99.390				
28	.099	.340	99.730				
29	.078	.270	100.000				

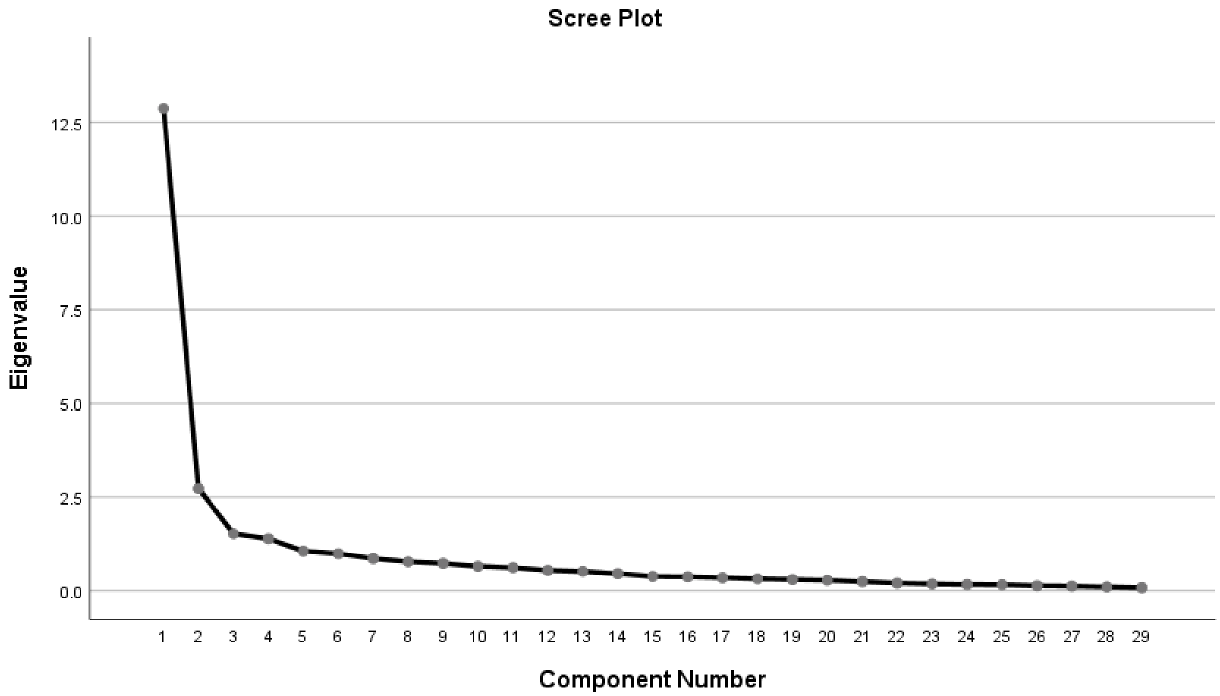

Figure 6.6: Catell's scree plot for effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery

In regard to Figure 6.6, following a scree test performed on the variables, results confirmed that two components are retained, including 12.869 and 2.725. These two components are at the point which is above the elbow on the scree plot, as shown in Figure 6.6, to confirm the number of variables to be retained. Thus the use of parallel analysis methods is essential, with MonteCarloPA software used for this method.

Table 6.62: Comparison of actual Eigenvalues and random Eigenvalues from parallel analysis

Component No.	Actual Eigenvalue from PCA	Random Eigenvalue from parallel analysis	Decision
1	12.869	2.0888	Accept
2	2.725	1.9186	Accept

MonteCarloPA for parallel analysis version.

The information computed into MonteCarloPA:

Number of variables = 29

Table 6.63: Result of MonteCarloPA analysis

Eigenvalue#	Random Eigenvalue	Standard Dev.
1	2.0888	.0943
2	1.9186	.0686
3	1.8021	.0663
4	1.6821	.0516
5	1.5945	.0497
6	1.5014	.0494
7	1.4185	.0413
8	0.3407	.0391
9	0.2703	.0311
10	0.2076	.0296
11	0.1459	.0334
12	0.0853	.0311
13	0.0255	.0307
14	0.9733	.0324
15	0.9193	.0309
16	0.8677	.0337
17	0.8202	.0297
18	0.7721	.0259
19	0.7271	.0310
20	0.6806	.0302
21	0.6349	.0273
22	0.5907	.0246
23	0.5473	.0268
24	0.5037	.0229
25	0.4627	.0242
26	0.4228	.0241
27	0.3777	.0266
28	0.3327	.0254
29	0.2839	.0307

Number of subjects = 114

Number of replications = 100

is suggested by MacCullum (1999) and Pallant (2013). The importance of this method is vital toward the use of MonteCarloPA to generate data that will be compared in size with Eigenvalues obtained from PCA. The information available indicated that random Eigenvalues of two components extracted by PCA are 12.869 and 2.725, while corresponding analysis obtained from parallel analysis is 2.0888 and 1.9186.

Table 6.62 shows the PCA and parallel analysis generated by MonteCarloPA software. The summation of results is as follows: 12.869 is greater than 2.0888 (12.869>2.0888), and 2.725 is greater than 1.9186 (2.725>1.9186); therefore 12.869 and 2.725 are accepted.

6.14.3 Summary of principal component analysis results (PCA) of EUC variables

The essential facts extracted from principal component analysis on 29 factors identified as imparting effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery are presented in Table 6.62.

Table 6.62 above presents findings showing that the factors have both strong and weak power militating the effective utilisation of budgeted cost without inflating cost of sustainable housing delivery. Principal component analysis (PCA) was engaged to establish that the factors are suitable for analysis, as reported in section 6.14.1. Thereafter, the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) value is established as 0.889, even though the recommended value is 0.6 by Pallant (2013). The Bartlett's Test of Sphericity is 0.000, indicating that p=0.000 (p<0.5). The inference is that the results are toeing the line of factorability of the correlation matrix, signifying that the factor is important and adequate for PCA. Conclusively, the results emerged from PCA show two components with Eigenvalues exceeding 1. The detailed interpretation of 44.376% and 9.396% of the variance is on Table 6.62, and the information is in Chapter 6, subsection 6.10.

Furtherance to the establishment of these results, the scree plot test displayed break of the second component at the elbow, found on Figure 6.3 above. The results obtained from principal component analysis revealed two components having Eigenvalues greater than the randomly generated data matrix by MonteCarloPA: results are in Table 6.48 above. Consequently, the two components are retained for continuation of investigation. Thereafter, Oblimin rotation is used for

Table 6.64: Pattern matrix and structural matrix for PCA with Oblimin Rotation of EUC variables

Coding	Variable name	Pattern matrix coefficient		Structural matrix coefficient		Communalities
		1	2	1	2	
EUC1	Establish stakeholders' interest	-	**.604**	.501	**.701**	.516
EUC2	Improvement on construction operator's productivity		**.718**	.386	**.724**	.525
EUC3	Risk inventory on site for production process	**.627**	-	**.713**	.491	.527
EUC4	Made possible wholesale change in construction technologies	**.630**	-	**.640**	.349	.410
EUC5	Human resources management plan on site	**.344**	.369	.537	.549	.388
EUC6	Determine competencies of construction operators at planning stage	**.737**	-	**.779**	.465	.611
EUC7	Accurate forecasting cost of housing production process at planning stage	**.658**	-	**.788**	.592	.665
EUC8	Adequate establishment of client objectives at briefing	**.727**		**.757**	.436	.575
EUC9	Regulate the true cost at planning stage	**.676**	-	**.673**	.346	.453
EUC10	Contract agreement by law during production	.418	.395	**.625**	**.613**	.504
EUC11	Establish restraint methods toward increased budgeted cost at implementation stage	-	**.627**	.519	**.727**	.555
EUC12	Set requirements before life cycle cost at planning and implementation stages	-	**.624**	.485	**.707**	.518
EUC13	Site activities plan for cost estimate	-	**.792**	-	**.731**	.544
EUC14	Objectivities of financial sustainability	-	**.870**	.317	**.798**	.651
EUC15	Cost control plans for production	-	**.758**	.404	**.762**	.581
EUC16	Determine detrimental effect and viability of housing loan	-	.553	.493	**.660**	.465
EUC17	Establishment of cost control base on site	-	.820	.336	**.772**	.601
EUC18	Determine level of impact of construction constraint at planning stage	.554	-	**.680**	.531	.505
EUC19	Plan for efficiency use of all monetary resources during production	.357	.395	.563	.581	.430
EUC20	Establishment of procedure for funding delivery during production	-	.437	.524	.592	.414
EUC21	Proper design and construction coordination	.580	-	**.677**	.489	.484

Table 6.64 continued.

Coding	Variable name	Pattern matrix coefficient		Structural matrix coefficient		Communalities
		1	**2**	**1**	**2**	
EUC22	Consider varying size and complexity of housing project relative to resources available	**.614**	-	**.703**	.491	.515
EUC23	Work Programme on site	**.830**	-	**.760**	.300	.591
EUC24	Projects schedule/timetable for production	**.831**	-	**.830**	.432	.689
EUC25	Recognises the close relationship between design and construction cost	**.817**	-	**.781**	.370	.622
EUC26	Flexibility integration into housing design to accommodate future demand and changes	**.757**	-	**.745**	.373	.556
EUC27	Teamwork on site for housing production	**.875**	-	**.736**	-	.594
EUC28	General progress report on housing production process	**.778**	-	**.808**	.463	.654
EUC29	Longevity integrated at design stage to achieve reduction in future maintenance	**.666**	-	**.670**	.356	.449

loading the variables. Considering the results in Table 6.64 above and due to the large number of variables, the analysis of results shows components with strong and weak loadings. The pattern matrix in Table 6.64 presents strong component loadings above 0.6, with these components highlighted in bold.

Structure matrix has two component loadings above 0.3. In the same table, components highlighted in bold have strong communalities, confirming better analysis of factors. The communalities should be greater than 0.4. Bearing in mind the available facts, the highlighted numbers fall among communalities greater than 0.4, and the smallest number of communalities recorded by the components (made possible wholesale change in construction technologies) is 0.410, as indicated in Table 6.64. However, considering the loading pattern of EUC variables, the variables that converge on component 1 of pattern matrix coefficient is called *establishment of effective planning*, whereas those variables that converge at component 2 of pattern matrix coefficient is called *management of financial sustainability.*

6.14.4 The critical factors of achieving quality housing delivery

Through the use of principal component analysis (PCA), critical factors for achieving quality housing delivery were established. The primary basic reason for adopting this method is to reduce the identified factors affecting the achievement of quality housing delivery to sizable variables that are more suitable for the development of a model. Chapter 6 and subsection 6.10 vividly discuss those facts concerning PCA.

6.14.5 The Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity on critical factor of achieving quality housing delivery

Pallant's (2013) study makes clear the importance of Kaiser-Meyer-Olkin (KMO) and Bartlett's Sphericity Test, conveying detailed explanation on the importance of parallel component analysis (PCA). Thus, PCA and Bartlett's Sphericity Test are used to ascertain the suitability of data collected for factor analysis. KMO will measure sampling competence whereas Bartlett's Sphericity Test will identify those factors that impact the achievement of quality housing delivery. Table 6.64 presents the results of the analysis obtained from KMO and Bartlett's Test of Sphericity. Although the functions of KMO and Bartlett's Test of Sphericity differ, Chapter 6 subsection 6.10 clearly explains their unique functions.

The results demonstrate that KMO occurs at a point of 0.846 higher than 0.6 and less than 1, as mentioned by Jolliffe (1986) and Pallant (2013). The Bartlett's Sphericity Test confirmed the suitability of the factors at p=0.000, meaning that p is less than 0.05 (p<0.05). Bearing in mind the recommendation of Pallant (2013) and Jolliffe (1986), it can be concluded that the data is adequate and suitable to be used for PCA.

Table 6.65: KMO and Bartlett's Test of Sphericity

Test		Value and Remark
Kaiser-Meyer-Olkin measure of Sampling adequacy		0.846 Significant and adequate for PCA
Bartlett's Test of Sphericity	Approx. Chi-Square	1187.124
	df	153
	Sig.	0.000 Significant and adequate for PCA

6.14.6 Principal components of factors fundamental to the achievement of quality housing delivery

Table 6.63 gives a clear explanation of those factors that will affect the achievement of quality housing delivery. As the similar process has been explained in previous sections, reference can be made to those sections that discussed principal components of factors, notably Chapter 6 and subsection 6.10. The standard method for the retaining of factors is PCA, known as correlation matrix, unrotated factor solution, scree plot and Eigenvalues greater than 1. Table 6.63 above contains results obtained through this application. The Eigenvalue of the two components extracted is 7.557 and 2.429; therefore, the number one component on the table is proficient for explaining 41.986% of the variance; the number two components on the table is proficient for explaining 13.497% of the variance; the summation of the two components will explain 55.483% of the total variance.

Figure 6.7 below describes the result of the scree plot test performed on the variables, with results confirming the two components retained, including 7.557 and 2.429. The two components are at the point above the elbow on the scree plot, as shown in Figure 6.4 above, to ascertain the number of variable to be retained and thereby confirm the usefulness of parallel analysis methods. The details on how MonteCarloPA software functions were explained in Chapter 6, subsection 6.10, with a similar example in section 6.14.2. Therefore, considering the information in Table 6.51, Table 6.52, and Figure 6.4, the summation is that 7.557 is greater than 1.7653 (7.557>1.7653) and 2.429 is greater than 1.6032 (2.429>1.6032); conclusively, 7.557 and 2.725 are accepted.

Table 6.66: Total variance explained by the components

Component	Initial Eigenvalue			Extraction sum of square loading			Rotations of Square Loadings[a] Total
	Total	%of Variance	Cumulative %	Total	% of Variance	Cumulative %	
1	7.557	41.986	41.986	7.557	41.986	41.986	6.290
2	2.429	13.497	55.483	2.429	13.497	55.483	5.930
3	1.177	6.536	62.019				
4	.978	5.436	67.454				
5	.911	5.062	72.516				
6	.726	4.034	76.551				
7	.608	3.377	79.928				
8	.536	2.975	82.904				
9	.495	2.750	85.654				
10	.473	2.630	88.284				
11	.406	2.254	90.538				
12	.371	2.059	92.598				
13	.312	1.734	94.331				
14	.284	1.577	95.908				
15	.254	1.412	97.320				
16	.193	1.072	98.392				
17	.176	.976	99.369				
18	.114	.631	100.000				

Table 6.67: Comparison of actual Eigenvalues and random Eigenvalues from parallel analysis

Component No.	Actual Eigenvalue from PCA	Random Eigenvalue from parallel analysis	Decision
1	7.557	1.7653	Accept
2	2.429	1.6032	Accept

MonteCarloPA for parallel analysis version.

The information computed into MonteCarloPA:

Number of variables = 18

Number of subjects = 114

Number of replications = 100

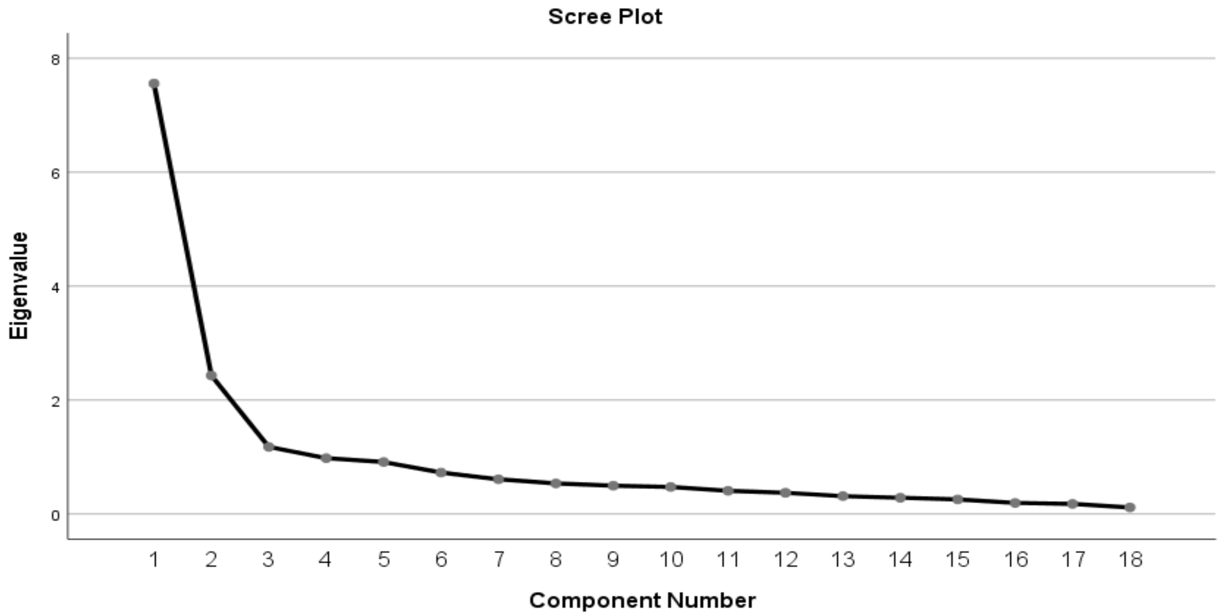

Figure 6.7: Catell's scree plot for evaluation of critical factors for achieving quality housing delivery

6.14.7 Summary of principal component analysis results (PCA) of CAQH variables

Principal component analysis was performed on 18 factors, thereby clarifying the critical factors for achieving quality housing delivery, with information depicted in Table 6.69. The information gathered revealed that the factors have strong and weak power to affect the achievement of quality housing delivery. The significant reason for using PCA is to confirm if the identified factors are suitable for analysis, but the detailed explanation of the importance of using PCA and KMO is adequately discussed in previous sections, notably chapter 6 section 6.10. The results collated indicate that the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) value is 0.846, meaning that the factorability correlation matrix is adequate, and the results of Bartlett's Test of Sphericity is p= 0.000 implying that the factor is significant and adequate for PCA. The results emerged from PCA showing two components with Eigenvalues exceeding 1, with results displayed in Table 6.65. The scree plot test in Figure 6.7 displays a clear break of the second component at the elbow.

Table 6.68: Result of MonteCarloPA analysis

Eigenvalue#	Random Eigenvalue	Standard Dev.
1	1.7653	.0824
2	1.6032	.0635
3	1.4888	.0512
4	1.3832	.0470
5	1.2958	.0412
6	1.2108	.0390
7	1.1304	.0367
8	1.0599	.0324
9	0.9902	.0315
10	0.9261	.0321
11	0.8593	.0333
12	0.7943	,0358
13	0.7351	.0342
14	0.6732	.0294
15	0.6152	.0329
16	0.5565	.0311
17	0.4934	.0310

Table 6.69: Pattern matrix and structural matrix for PCA with Oblimin Rotation of CAQH variables

Coding	Variable name	Pattern matrix coefficient		Structural matrix coefficient		Communalities
		1	2	1	2	
CAQH1	Design and construction of housing to support services and amenities for the needs of the people	**.886**		**.813**	-	.683
CAQH2	Establish architectural scheme appropriate for a pleasant living environment	**.700**		**.701**	.307	.491
CAQH3	Establish accessible and adaptable criteria for all residents	**.716**	-	**.792**	.487	.651
CAQH4	Establishment of quality increases	**.505**	-	.528	-	.282
CAQH5	Quality sampling during production	**.780**	.	**.724**	-	.538
CAQH6	Identify quality requirement at initiating stage process	**.817**	-	**.828**	.382	.687
CAQH7	Quality control during production process	**.856**	-	**.833**	.322	.697
CAQH8	Quality assurance at implementation and closed-out stages	**.639**		**.731**	.488	.569
CAQH9	Effective quality planning for affordable housing	.463	-	.549	.399	.332
CAQH10	Establishment of resources efficient scheme for production	.393		**.603**	**.652**	.550
CAQH11	Design for affordable and maintainable	.322	.564	.569	**.705**	.581
CAQH12	Establishment of durability techniques during production	.	**.684**	.407	**.731**	.544
CAQH13	Adequate design for provision of a safe, secure and healthy environment for the residents	-	**.735**	-	**.723**	.523
CAQH14	Consistent commitment to quality by all stakeholders	-	**.736**	.331	**.740**	.547
CAQH15	Focus on quality sustainability throughout production process	-	**.565**	.464	**.660**	.474
CAQH16	Designing for comfort, cost efficient and easy maintenance	-	**.823**	-	**.794**	.635
CAQH17	Design housing for the use of renewable resources for cost effectiveness	-	**.827**	.303	**.802**	.647
CAQH18	Design housing for changing needs throughout the life of the occupants and not just for immediate needs		**-790**	-	-	.556

Table 6.68 information reveals that pattern matrix has strong component loadings above 0.6, with components displayed in bold, and structure matrix loading above 0.3, also highlighted in bold, having a strong communality greater than 0.4. However, the smallest number of the communalities recorded by the components in bold is 0.474, as displayed in Table 6.69. The variable name is *Focus on quality sustainability throughout production process*. Considering the loading pattern of quality housing delivery, “the variables that converge on component 1 of pattern matrix coefficient will be named *establishment of quality planning and implementation”*, and those “variables that converge at component 2 of pattern matrix coefficient will be named *Design for safe, secure and healthy environment”.* The components are formed on the recommendation made by Pallant’s (2013) and Jolliffe’s (1986) on factors analyses.

6.15 Discussion of findings obtained

6.15.1 Factors that inflate the cost of sustainable housing delivery over budget

The constraint experienced in delivery of housing within budget is a critical issue in construction industry, as most housing projects are delivered above budget with sustainability hindered. This is the major reason to evaluate those factors that inflate cost of sustainable housing delivery over budget. Based on these available facts, literature related to the challenges was reviewed to ascertain those factors that inflate the cost of sustainable housing delivery. The information gathered from the interviews, archives and literature relevant to the study revealed the following factors, in descending order of influence: availability of skilled workers on site; financial management on housing production; adequate planning for production; cost of housing materials in the market; technology advancement; constant addition of work without contractual procedure on cost of constructing; high cost of machinery; contract management on site; contractual procedure for housing delivery; and frequent changes in design of housing during production. These are the top ten factors discovered to inflate cost of construction, and all factors recorded 3-mean scores, implying they all make a strong impact. Those factors that have 2-means scores do not have an impact on cost of construction and therefore do not inflate the budgeted cost.

The availability of skilled workers on site is essential for planning cost effectiveness for sustainable housing production processes and enhancing efficient implementation of aim and objectives entrenched at the initiating stage of production. Thus, successful delivery cost-efficient housing hinges on the availability of skilled workers on site. Financial management and adequate planning for production is highly significant for effective housing production processes. Material cost in delivery of housing is above 50% of the total cost; consequently, cost of materials must be adequately investigated before production.

Procurement planning must be entrenched into material delivery, and this must be implemented at *every* phases of production processes. The study of Patel and Vyas (2011) explains that operational procurement of materials for sustainable housing delivery exemplifies yet another precarious invention of the success of housing production processes. The characteristics that cause waste in human resources are inadequate identification of actual materials in need, poor planning for material delivery and poor storage; in addition to protracted delay, these factors lead to cost increase. Moreover, Patil and Pataskar (2011) argue that effective management of materials and control of register during housing production will significantly impact delivery housing at affordable cost.

This trend in the construction industry results in high cost of construction in delivery of affordable housing in African nations in particular, engendering social, economic and cultural issues such as poverty and unemployment among the people (Omolabi & Adebayo, 2014). The adequate application of these factors during production will significantly reduce cost of production while simultaneously enhancing sustainable housing delivery.

6.15.2 Factors that affect unsustainable design in delivery of affordable housing within budget

The exploratory study and literature review confirmed unsustainable design practices by construction operator toward sustainable housing delivery. This implies the reason to investigate factors that affect unsustainable design in delivery of affordable housing within budget. The major factors identified through the investigation include the following: improper design leads to failure in achieving client objectives; establish standard designs for production reduces cost; design of first-rate living condition for a healthier environment; frequent changes of housing design by client affect construction cost; inadequate design affects cost of delivery; and changes in design are a source of waste during production. These factors recorded a mean score-3 denoting significant impact in delivery of affordable housing within budget.

The incompetency of construction operators in the establishment of aims and objectives at the planning stage, and the manifestation of this at design stage through to the implementation stage, causes constant failure in achieving client objectives; simultaneously, incompetency affects the establishment of standard design for production. Therefore, design of first-rate living condition for a healthy environment will reduce maintenance costs that usually emerge through environmental impact on housing usage. Delineating the aim and objectives of the client is a necessity at the inception of housing production process, and must be well documented to avoid frequent changes to housing design by the client.

One of the major factors to be considered by construction operators at the inception of housing production is the incorporation of sustainable design principles to achieve cost-efficient housing. Sudden changes to new technology during production processes always attract cost increases. Soft planning for the integration of new technology encourages the avoidance of major changes in design that cause wastage during production. Thus, the architect should design cost-efficient materials that are adaptable in meeting client and user needs.

In addition, if improper design leads to failure in achieving client objectives, this implies that client needs and desires are not linked with the aim and objectives entrenched into production processes, a source of high cost of construction and delay in housing delivery. Thus, each client has an influence in a project and their influence constantly causes changes in design on site, frequently leading to demolition and breakage during construction process. Without prior intellectual reasoning, there is the possibility that delay and variation will become the norm rather than the exception on site. According to Jong-jin Kim and Brenda (1998), as adequate design influences the aesthetic of a housing project, successful incorporation of adequate design into housing production requires careful intuition for potential conflicting goals among the clients and construction operators for sustainable housing delivery at its inception stage. This process will enhance delivery of sustainable housing at cost specified. Similarly, Conte and Manno (2012) explain that effective operation of sustainable housing requires acceptable designs that have clear objectives and a balanced collective approach that is aesthetically pleasing, assessable, cost efficient, safe and secure. Therefore, planning at the design stage is essential as it involves plans for the constituent of materials to be used during production for achieving sustainable housing delivery. However, to achieve sustainable housing, it is essential that the architect design for better performance because, among other things, this enhances efficiency of resources (Roy, 2000).

6.15.3 The impact of cost on management of construction resources in delivery of sustainable housing by construction operators

This section is divided into three subsections: human resources have an effect on cost in delivery of sustainable housing; the effect of building material on budgeted cost during a production process toward delivery a sustainable housing; and management of machinery has effect on cost in delivery of sustainable housing.

6.15.4 Human resources have an effect on cost in delivery of sustainable housing

Data analysis results revealed the major factors affecting cost through human resource management: workforce productivity affects cost; involvement of all team members in planning and implementation; regular meeting on site for promoting efficient productivity; team building strategies for production; prompt payment of wages by contractors to enhance productivity; developing staffing management plan; flexibility of construction operators in making timely management decision on production; and skill to define effective techniques for achieving objectives. Other impacting factors include skill to apply techniques for reduction in cost of construction during production; knowledge of safety practices; awareness of personal safety during production; and continuous emphasis on making maximum usage of local labour force to achieve housing production. These are the ten most highly rated factors that will influence the delivery of sustainable housing within budget; all ten factors record a mean score of 4, suggesting that all these factors are highly significant, and must be considered at the inception of production and must be documented.

As workforce productivity has significant effect on cost, a competent project manager must be employed on site who has the skill to plan and manage workers for increases in productivity and enhancement of sustainable housing delivery within budget. Every member involved in housing production processes must have sense of belonging and positive influence, and all team members must hold to a common aim and objectives for sustainable housing delivery within budget. Regular meetings on site are vital because a meeting is a point where existing issues and problems among staff can be voiced and resolved amicably. Doing this will flourish effective sustainable housing delivery within accepted cost.

Another important that factor warrants consideration is prompt payment of wages by the contractor, an incentive that will enhance productivity and thereby improve cost-efficient housing. Timely management in the use of resources is essential and must be adequately considered at every phase of production: adherence to timely delivery at every phase of production will deliver sustainable housing within budget.

While the application of effective techniques on site is subjected to the skill acquired by construction operators, skills will enhance proper identification of aim and objectives entrenched at the planning stage of production. Adequate planning for the use of resources at the beginning of housing production will more reasonably deliver sustainable housing within budget. Therefore, constant emphasis on making maximum usage of local labour will reduce cost and enhance delivery of inexpensive housing. Table 6.23 contains factors with a mean score of 3 and above, signifying that these factors have a significant effect on sustainable housing delivery. While there are 30 factors in total in Table 6.23, all factors have a mean score of 3 or above, including document delivery roles and responsibility among construction team members; ability of workforce to develop willingness in sustainable practices; building trust among construction team members; and wastage of workforce input during production. Adequate application of these factors will promote efficient production and influence sustainable housing delivery significantly.

Essentially, as workforce productivity affects cost, if there is an incentive for the workers, this will undeniably improve productivity, impact cost of construction and affect sustainable housing delivery successfully. Edun-Fotwe and McCaffer (2000) argue that it is essential for all construction firms to organise training and seminars for staff to improve workforce skill for productivity: a knowledgeable worker on site will increase output sufficiently and enhance productivity, imparting sustainable housing delivery within a reasonable budget. Nubler (2000) explains that increase in productivity essentially pivots on efficient utilisation of workers allowing effective housing production processes to be carried out at cost and time postulated.

6.15.5 Effect of building materials on budgeted cost during a production process toward delivery a sustainable housing

Literature reviewed establishes that building material management will affect budgeted cost during a production process toward delivery a sustainable housing. Effective material management is important for housing production, and the cost of materials has serious implications in delivery of cost-effective housing. The major factors identified that influence building material on budgeted cost are as follows: quality of workmanship on materials to reduce waste; late delivery of construction materials; increase in price of original materials specified causes the use of alternative materials; insufficiency of construction materials on site; dollar exchange rate affects timely delivery; scarcity of housing materials in the country leads to importation of expensive materials from another nation; increase in price of construction materials; use of foreign materials for housing construction has an effect on budgeted cost; use of materials that are environmentally friendly; and management of plan for delivery of materials.

These are the first ten factors that affect material management on cost toward sustainable housing delivery. These factors have a mean score of 3 and above, meaning that the factors are significant to material management which affects the delivery of sustainable housing within the budgeted cost specified. To the contrary, the other factors, having no impact on material cost, recorded a mean score of 2. These factors are as follows: cost to finance construction materials by bank; seasonal changes in housing construction materials; increase in price of materials affecting time delivery; and municipal government taxes and charges on materials. Construction operators should understand that quality of workmanship on materials will reduce constant wastage which results from inadequate specification and handling of materials. Therefore, the value of wastage will result in cost increase and affect the cost of housing production meaningfully.

Adequate planning for the use of materials on site is essential to avoid late delivery of construction materials to the site, affecting productivity through time wastage and cost of sustainable housing delivery. However, the avoidance of insufficiency of construction materials on site needs effective storage policies. Delivery control management is essential for sustainable housing delivery. The continuous economic crises in most African nations pose a challenge to affordable housing delivery, especially because of fluctuations in the exchange rate of dollar with local currency. Most essential materials are scarce in Africa, requiring that expensive materials be imported from more advanced nations, relinquishing control of construction cost of sustainable housing. Consequently, the use of these imported materials has a substantial effect on the cost of construction in Africa. Clearly, housing materials for sustainable housing delivery are best if sorted out locally, in order to achieve constant housing delivery within budgeted cost.

According to Gulghane and Khandve (2015), material use is indisputably important in the delivery of sustainable housing: the percentage of material cost is substantial, representing major expenses in housing delivery for achieving reduction in cost of sustainable housing delivery. Effective management of material procurement, then, is essential. Likewise, Gransberg, Popescu and Ryan (2006) confirm that activities regarding material management and usage must be adequately incorporated into the initial planning and project schedule to enhance constant availability and free flow of materials within site premises to improve affordable housing delivery within budget. Madhavi, Mathew and Sasidharan (2013) present that effective material management can be achieved through adequate planning for the use of supply techniques which include quotations, requisitions and adequate use of invoices for material supply, and local means of material supply. Proper documentation of supply should be encouraged for the purpose of sustainability in housing delivery within budget.

6.15.6 Management of machinery has effect on cost in delivery of sustainable housing

The investigation for this study revealed that machinery management is significant to the efficiency of production processes. Therefore, machines must be adequately managed to have efficient production processes within the orbit of affordability and availability. Sustainable housing delivery is importantly attached to efficient machines on site and competent operators. This necessitates the major reason to conduct investigation on the effect of management of machinery on cost toward sustainable housing delivery within budget. Several major factors identified affect the management of machine for affordable housing delivery within the budget specified: cost of transporting equipment to the site; maintenance cost of equipment on site; lack of proper planning for the use of equipment on site; planning for the use of equipment on site; equipment delivery time during production processes; idleness of hiring equipment on site; overhead cost attributable to the equipment; constant increase in cost of purchasing equipment; inadequate management of equipment; and cost of equipment and import duties. These are the top ten rated factors that impact the management of machinery toward sustainable housing delivery within budgeted cost. These factors had mean score of 3 and above, implying significant influence on inexpensive housing. Only one factor was identified as insignificant for cost of construction: manufacturer exercise tax on housing equipment.

In addition, findings revealed that cost of transportation of equipment to site is continuously challenging efficient housing production processes, because there is a need for adequate planning for the management of equipment delivery to the site. However, as equipment management is overseen by untrained workers in construction companies, equipment is often delivered late to the site as a result of incompetency. This causes delay and wastage of human resources, thereby affecting sustainable housing delivery. Another major factor that affects sustainable housing delivery through management of machines is lack of proper planning for the use of equipment on site.

Effective planning at the initial stage of production for each machine will subsequently improve sustainable housing delivery within budget. Each site working schedule must be linked with the particular hour in which a machine is needed on site, and time of delivery must be adequately considered to avoid idleness or hiring equipment on site. The project manager must check the overhead cost of every piece of equipment before purchasing, as this will aid in prohibiting cost increase in construction. Similarly, cost of equipment and import duties must be adequately considered by the project manager to achieve cost-efficiency of housing projects, and the government must also partake in cost reduction for sustainable housing by cutting down import duties. Alternatively, governments could make import duties free for construction equipment to enhance inexpensive housing delivery. Tatari and Skibniewski (2006) explain that sustainable housing delivery depends on type of equipment available for use and cost implications in hiring.

6.15.7 Effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery

As literature related to this study was reviewed, information gathered indicated that the construction cost of housing projects is way above budgeted cost. This necessitates the foremost reason to investigate effective utilisation of budgeted cost without inflating cost of construction for sustainable housing delivery. The ten major factors that impact effective utilisation of budgeted cost without inflating cost of construction are discussed as follows: teamwork on site for housing production; project schedule/time table for production; general progress report on housing process; flexibility integration into housing design to accommodate future demand and changes; durability integration at design stage to achieve reduction in future maintenance; recognising the close relationship between design and construction cost; work programme on site; regulating the true cost at planning stage, accurate forecasting of cost of housing production process at planning stage and adequate establishment of client objectives at briefing. These factors have mean score of 3 and above, signifying that the factors influence the effective utilisation of budgeted cost. There are 29 factors in Table 6.29, and all factors have a mean score of 3 or above. This suggests that all the factors influence budgeted cost and affect sustainable housing delivery significantly.

The inference drawn from all the factors collated points out that teamwork among the construction operators is a yardstick upon which effective productivity can be achieved for sustainable housing delivery, as teamwork promotes efficiency and enhances collaboration to achieve targets during production processes. Thus, a programme of work according to the project schedule can only be achieved through teamwork. To achieve effective production of sustainable housing, general progress reports on housing production are required at every stage of production so lessons learned are documented before moving on to another phase of production. In this way, recurrence of mistakes in the first phase is avoided in the second phase.

It is established that demand for new housing and changes in the use of housing is constant; therefore, it is essential to allow for flexibility integration into housing design to accommodate future demands and changes that the users of such housing will likely put forward for implementation. To avoid continuous future maintenance in housing, it is indispensable that longevity be built into design at the planning stage to achieve reduction in the cost of future maintenance of housing. In addition to reduction in future maintenance of housing, it is of paramount importance to recognise the close relationship between design and construction cost. Acknowledging this at the planning stage will make inexpensive housing more plausible. Constant planning is essential; this should be ongoing at every phase of production, thereby enhancing work programmes on site.

At every stage of production, it is necessary to regulate cost of construction in reference to the aim and objectives established for affordable housing delivery. Adequate planning will assist in achieving sustainable housing delivery. Similarly, it is imperative to accurately forecast cost of housing, not only at the planning stage, but throughout every phase of production. This will enhance adequate establishment of client objectives for housing delivery at every stage of a production process.

According to Olotuah and Aiyetan (2006), cost is the substratum for sustainable housing production processes, provided it is properly managed by construction operators. Thus, effective cost management is essential for the running the orbit of production processes. Cost requires constant monitoring. Desai and Desale (2013) clarify that adequate monitoring and controlling of cost is essential for achieving sustainable housing delivery. Thus, adequate cost monitoring should be integrated at every phase of production, in tune with the stated requirements. Essentially, *cost* can be referred to as the coordinator of construction resources, considering its influence in purchasing and payment of wages. Clearly, effective cost management is required for sustainable housing delivery (Azhar *et al.,* 2008).

6.15.8 The critical factors of achieving quality housing delivery

Quality of a project, critically important, cannot be compromised. The certainty of quality in project delivery is real. Literature related to quality was reviewed, and similarly, magazines and speeches regarding quality and construction documents were studied to ascertain the significance of quality in a project. The information available revealed that quality is important and if properly considered at the inception of housing project, will reduce the maintenance cost of housing delivered. This necessitates the main reason to assess critical factors for achieving quality housing delivery.

The first ten major factors identified as impacting achievement of quality housing delivery are as follows: quality assurance at implementation and closeout stages; quality control during production processes; effective quality planning for affordable housing; design housing for change needs throughout the life of the occupants and not just for immediate need; consistent commitment to quality by all stakeholders; quality sampling during production; adequate design for provision of a safe, secure, and healthy environment for residents; design and construction of housing to support services and amenities for the needs of the people; focus on quality sustainability throughout production processes; and designing for comfort, cost efficient, and easy maintenance. The amazing information concerning the 18 factors is that all these factors record a mean score of 3 and above, implying that they all affect quality of sustainable housing delivery significantly.

Furthermore, one of the major factors identified, referred to as *quality assurance at implementation and closeout,* is a practical active factor, so compliance with this statement by all construction operators will guarantee client interest, quality planning and quality control during housing production processes. Since *housing* means a dwelling place with necessary social amenities, it should be designed for changing needs throughout the life of the occupants, rather than just for immediate needs. Such housing must be comfortable and gorgeous in nature with cost efficiency. Considering cost efficiency of housing delivery, all stakeholders involved in production must ensure consistent commitment to quality at project conception, planning, coordinating, executing and closeout stages of housing production. Quality sampling during production should be the watch word for every construction operator and stakeholder.

Quality and cost efficient housing should be adequately design for the provision of a safe, secure and healthy environment for the residents. As consistent comfortability of residents in housing is essential, designers and project managers should bear this in mind when designing and constructing housing that will support the provision of services and amenities for the needs of the people, with stakeholders focusing on quality sustainability throughout production processes.

Maliene and Malys (2009) explain that cities in both developing and developed nations have been subject to severe social and economic pressures in the recent decade, resulting in an uneven spatial impact on the urban environment and giving rise to a concentration of the most deprived households in urban neighbourhoods. The objective of African governments can be construed as an attempt to implement revival of sustainable housing to create a sustainable community, improving the quality of life. Hence, quality management for the achievement of sustainable housing delivery is essential, embracing quality policies, objectives and responsibilities in an effort to satisfy the need for which the housing was undertaken. Meredith and Mantel (2011) confirm that planning quality sustainable housing deliveries, performing quality assurance for sustainable housing delivery, and performing quality control for sustainable housing delivery is the task for construction operators and stakeholders to achieve comfortability in the sustainable housing.

6.15.9 Stakeholder influence on sustainable housing delivery during production

Much literature related to the management of stakeholder influence during production were reviewed, site investigations were conducted on stakeholder influence, and interviews with construction stakeholders were also carried out to ascertain both positive and negative influences of stakeholders in project delivery. The assembled information confirmed that construction stakeholders have a great deal of influence on project production. This is a major reason to establish stakeholder influence on affordable sustainable housing delivery during production processes.

The ten most significant factors impacting stakeholder needs and decisions on sustainable housing delivery during production are as follows: matching stakeholder interest to requirements; adequate communication with stakeholders; establishing stakeholder aim, needs and objectives at planning stage; interacting with stakeholders in a professional and cooperative manner; adequate handling of specialisation toward implementation; impact on requirements; changing course of production; establishing the degree of influence on timeline and increasing construction cost substantially; monitoring and evaluating housing project impact in relation to initial planning; and the sponsoring of a housing project. Of the 15 factors identified that impact stakeholder needs and interest, all factors recorded has a mean score of 3 and above, suggesting that all the factors are essential for stakeholder influence in sustainable housing delivery. There was only is one factor among the 16 factors that appears to not influence stakeholder needs and interest, termed as *conflicting of stakeholders objectives during production* with a mean score of only 2.

Stakeholders are referred to as a group of persons or organisations that are involved in a project production process who influence the project processes and inject their needs and interests into the project. This must be considered to have successful production processes, as one of the major factors is 'matching stakeholders interest towards requirements'. All stakeholder interests and needs must be adequately considered at each phase of production and integrated into the aim and objectives of sustainable housing. Communication is essential to achieve stakeholder interest and demand, so free flow of communication among stakeholders allows settlement of rift and rancour, closing gaps created by diverse interests, adequately addressing demands. Adequate consideration of this issue will close the gap through effective communication; thereafter, successful production processes are achieved.

There are various ways to handle effective communication among the stakeholders, including the following: classify stakeholder information interest toward housing delivery; design effective communication channel for stakeholders to achieve affordable housing; circulate effective information among construction operators; and employ effective communication to manage stakeholder interest for affordable housing delivery. The establishment of stakeholder needs and objectives at the planning stage of production is pivotal for free flow of communication among stakeholders. Moreover, interaction with stakeholders in a professional and cooperative manner by the construction operators can be achieved through effective communication. This enhances adequate handling of areas of specialisation of each stakeholder for affordable housing. Since every stakeholder has some influence on requirements and the changing course of production, free flow of information will harmonise diverse interests on the requirements. Therefore, interest of every stakeholder must be adequately considered and monitored to discourage unnecessary influences causing delay and increasing cost of construction and likelihood of project abandonment.

According to Meredith and Mentel (2011), communicating with stakeholders will help meet needs and interest as every issue raised by the stakeholder will be addressed adequately, checking against potential negative influence of stakeholders at every phase of production. In so doing, sustainable and cost-efficient housing is more likely. Similarly, stakeholder interest and needs will be be attended to if status report and progress measurements are communicated to stakeholders on daily basis. With this, a significant and effectual effect will be achieved on sustainable housing delivery (Cooke-Davies, 2002).

6.15.10 Validation of the research outcome

Validation is important in this study to ascertain that instruments used in this study measured what they were supposed to measure. So testing the validity of the results obtained is essential. Winter (2000, cited in Golafshani, 2003) explains that *validity* is a process to ensure that instruments used establish the real facts and measure what is required. The below steps were considered in establishing that the research outcome is reliable and effective:

1. The Cronbach's alpha co-efficient was used to test the reliability of 11 scale questions in this study. The scale questions have total 209 factors confirmed as reliable, and the total average of Cronbach's alpha co-efficient of the 11 scale questions is 0.9 (section 6.2.14).
2. The sampling of population used for the collection of data for this study was comprised of construction operators specialising in housing project delivery. These construction operators were drawn in all nine provinces of South Africa (section 5.4.2.1; 5.4.2.2; 5.4.2.3).
3. The most experienced construction operators and stakeholders were engaged, and a chain sampling approach used to draw all the construction operators and stakeholders in all nine provinces of South Africa (section 5.4.2.4).
4. The duration set aside for data collection was reasonable and adequately scheduled, as data were collected within six months.
5. Mixed method techniques (quantitative and qualitative) were employed to ascertain that the most accurate methods are engaged for the collection of quality data to achieve the aim and objectives of this study (sections 5.4.1.5 and 5.5.1.4).
6. An exploratory study was conducted purposely to ascertain the methods and population that will be adequate and enhance the achievement of stated objectives (sections 5.4.1.7 and 5.6.3).
7. The Instrument used for voice recording of the respondents was a stylo phone powered by android, with a high frequency camera for images and recording of voices.

6.16 Summary of Chapter 6

As this chapter contains the results of descriptive statistics analysis, and principal component analysis, results obtained from the analysis reveal the major factors affecting sustainable housing delivery within budgeted cost, through cost of construct, design, construction resources and cost management processes on site. The study aim is to establish factors that influence and develop a framework for effective management of cost toward sustainable housing delivery for construction cost to remain within the limit of budget. Consequently, these factors have been identified and established as discussed in Chapter 1. The PCA techniques are used to reduce the factors to the most major and establish the impact of the factors toward sustainable housing delivery. The component factors that inflate construction cost above budgeted cost have been established, and similarly, component factors that affect design, resources and cost-efficient management have been established. This chapter is structured based on information provided in Chapters 4 and 5. On this basis, a comprehensive analysis of information in response to the aim and objective of the study is adequately considered for discussion. Thus, this chapter is the forerunner to Chapter 7. Chapter 7 bases discussion on the information made available through Chapter 6. The next chapter will discuss techniques and actions used to validate the findings obtained through descriptive statistical and principal component analysis. Moreover, the outcome of the validation will be presented in Chapter 7.

CHAPTER SEVEN

7. QUALITATIVE DATA ANALYSIS

7.1 Introduction

This chapter discusses validation of the results obtained from descriptive statistics and principal component analysis. Qualitative data collected from the respondents were analysed through content analysis and reported accordingly. The validation is carried out according to the aim and objectives of the study. Qualitative techniques used in this study aim to provide clearer information pertaining to the conceptual framework in Chapter 3 in relation to the study aim and objectives. Qualitative data were collected using four case studies involving interviews as the respondent are stakeholders working in the construction industry registered under Construction Institute Development Board (CIDB) South Africa.

7.2 Qualitative data analysis

Qualitative data analysis involves a range of procedures, whereby data collected are transcribe into forms for explanation or interpretation of the people and situations under investigation (Creswell, 2013). This process usually involves writing and identifying themes, qualitative research aids in development of concepts to understand social phenomena in natural settings, and giving due emphasis to the views of respondents (Creswell *et al.,* 2008). The assumption of a qualitative researcher is that the empirical evidence gathered is related to both theoretical ideas and structure that lies beneath observable reality, and the process of qualitative data collection usually involves focus groups, individual interviews, audio and field notes. Most of the data collected are related to individual opinions and concepts (Lewins, Taylor & Gibbs, 2010).

Life (1994) explains that basic qualitative data analysis begins with a transcript of an unstructured interview, field note, documents. Before the commencement of analysis, the researcher opens a new diary to record ideas, results obtained, and the problem associated with the analysis. As it is impossible to analyse all data collected through qualitative methods from the field, there is a need for the selection of text to receive special attention for more important ones, allowing checking for consistency of respondents in answering the questions (Creswell, 2008). The qualitative aspect of this study used the above techniques and principles to establish major facts in support of the aim and objectives entrenched in this study, and information is adequately discussed in this study.

7.2.1 Qualitative content analysis

Content analysis is a widely used qualitative research technique and significant in mixed method approach. The content analysis has three distinct approaches: directed, conventional and summative approach. All the three approaches are used to interpret meaning from the content of text data collected. Content analysis describes ordinary speaker habits and helps the researcher to understand the conversational skill strategies of the respondents (Koltler & Swartz, 1993 cited in Neuendorf, 2016). Content analysis does not apply to every analysis of conversation or message, but is for only those investigations that meet a particular definition. Through content analysis, the researcher was able to examine a large volume of data obtained in Chapter 6 and ease methodical enquiry about those factors affecting effective sustainable housing delivery. The researcher was able to describe the focus of individuals and groups in the discussion of sustainable housing delivery within budget (Weber, 1990; Gao, 1996, cited in Stember, 2001). The interviews were conducted among the construction organisations, namely GHKQ; the construction organisations were selected from among the construction industries registered under Construction Industry Development Board (CIDB) with grade level 3, 5 and 9. These selected construction industries are general building contractors (GB). Consequently, the outcomes of the content analysis was discussed and presented for conclusions and recommendations.

7.3 Construction organisations GHKQ in South Africa

The construction organisations investigated in this study were given anonymous names in order to conduct qualitative interviews that are true and specific. The names are given as follows: Construction organisation G; Construction organisation H; Construction organisation K; and Construction organisation Q. Each construction organisation has respondents that can specifically answer structured and unstructured interview questions, and each of the construction organisations were referred to as case study 1, 2, 3, and 4 in these sections for clarity of description discussion of analysis.

7.3.1 Construction organisation G-Case study analysis-1

Construction techniques and management principles and practices:

Construction organisation G, a reputable company registered under the Construction Industry Development Board (CIDB) with grade level 9 (GB), has a site office in more than half of the nine provinces, officially based in South Africa. The project manager working with construction company G, registered with Construction Industry Development Board (CIDB) under grade level 9 (GB) was asked to explain the impact of availability of skilled workers toward sustainable housing delivery over budget, considering construction techniques and management principles. The project manager from construction company G explained that availability of skilled workers on site is a vital issue, dealt with appropriately when there is a visible need.

7.3.1.1 Sustainable construction cost management techniques

A project manager was quoted as saying; “I will say that whatever any techniques and practices put in place will not override the availability of skilled workers on site; at every stages of production, skilled worker influence is vital positively, since the skilled worker will manage the housing project successfully through to development and implementation phases. These two indices of production processes are divided into subsections on our site, that include project definition, planning, organising, controlling and closing. We make sure that skilled worker on site must be involved at each segment and apply the techniques required. Then I will say one funny thing: skilled workers on site know the techniques needed on site. Techniques cannot work for itself and skilled workers on site will use the techniques to achieve cost efficient housing project delivery anticipated”.

When asked, the project manager commented about the effect of the shortage of skilled workers on site toward sustainable housing delivery: “simple answer to your question is that continuous availability of housing for the low income earners will be denied because quality and quantity will also be a challenge; therefore, the availability of skilled workers on site will enhance effective productivity at affordable cost”. The project manager also commented on the consequence of financial management on housing production: “Let me say or confirm that efficient financial management is the engine room for cost-effectiveness toward project production processes. To achieve cost reduction in housing delivery, the project team must have sound knowledge of costing and implementation by considering requirements of the client and the implications on quality and continuous delivery of such housing in large quantities. This is essential because adequate implementation of financial management must be planned at briefing and considered for design and thereafter draw out if cost imparts a relationship with available construction resources. If so, available and affordable housing will be determined”.

7.3.1.2 *Sustainable design management technique*

Improper design leads to failure of achieving client objectives and affects sustainable housing delivery, commenting on the implication of these factors during production. The project manager was quoted as saying, " I will say that Improper design occurs at a point where errors and omission causes constant changes in design; however, client interests, needs and requirements cannot be achieved in such a situation. Accomplishing client objectives in project delivery is significant. Sustainable design principles mean designs for comfort, value, quality, convenience of the occupants, provision of necessary housing amenities to determine the longevity, and housing design for maintenance freedom. All these indices are parameters we use as a design-team to achieve client satisfaction. Therefore, incorporating maintainable design principles into housing production processes hinges on our quality design planning at the design phase. Prior to that, we talk on the requirements of the client at site meeting to infused quality planning, with implementation at the design stage. We consider cost implications during design meeting and we implement cost efficient housing production within the budget on our site.

Drawings and specification differences impact delivery of affordable housing within budget. The project manager stated that "Certainly, I agree with you that discrepancies between drawings and specifications are a common phenomenon in project production processes. These occurrences generated constant argument on our site between the design team and construction team. The aftermath of these actions led to unnecessary delay in delivery of housing project to our client. We all understand that short delay can be accommodated on site, but prolonged delay causes nuisance to cost-effective production. Maintenance of construction resources on site is a must and continually keeping the cost of maintenance of these resources is a challenge to us and cost efficient production. I suggested that design team and construction team must marry ideals together to avoid errors which constantly lead to frequent changes in design at the implementation stage".

7.3.1.3 *Social satisfaction management technique for construction resources usage*

One of the major factors identified that impacts effective production is *workforce productivity that affects cost of sustainable housing delivery*. With regard to the factor, the PM stated that "I will say that efficiency of the workforce on site increases output. We manage construction resources effectively on our site, especially the human resource aspect, to efficiently use other resources to the maximum. Redundancy of workforce on site means inefficiency in the use of materials and equipment on site, although, we usually discourage this practices. From this simple ideology, my conclusion is that workforce is the driver of materials and machinery for effective housing production processes. Therefore, effective management of workforce will cause reduction in wastage of materials on site, and idleness of machinery on site will be prohibited by workforce actions. What it means is that effectiveness of workforce on site is totally pivoted around incentives on site. As project manager, I know the principle of how to use incentive to no-win situation to increase workforce productivity. Increase in productivity on site will constantly reduce cost of housing project delivery".

Management of quality workmanship on materials will reduce waste toward delivery of sustainable housing. The project manager lamented, "My opinion is that material handling by workforce for efficient production processes is vital for reduction in wastage. Poor workmanship and handling of materials on site is a common practice, and knowledge and experience demanding the matching of appropriate workforce to the available materials on site is necessary. Resources wastage is discourage on our site, and we make sure that wastage is reduced to minimal position from this angle achievement of housing project delivery. The process of engaging an experienced skilled worker on site will enhance quality and reduction in material waste which is the source of cost increase. With constant reduction of waste at each phase of production will enhance cost efficient housing delivery".

Concerning the cost of transporting equipment to site affecting sustainable housing delivery, the project manager harangued: "I do not buy the idea of moving all our equipment to site from the equipment yard. As project manager, I was able to understand this fact in the Northern Cape where the cost of transporting equipment to site is higher than the cost of hiring equipment. Equipment movement to site is always my concern because of the cost of transportation and storage yard affecting construction costs of production. In saying why, the answer is that equipment movement from the yard is costly compared with hiring of equipment from the nearby equipment hiring company, I am saying this because of my experience. Let's say, for example, we have a new project in Durban; hence, we need to move our excavator in Cape Town to Durban. It will be too costly to move such equipment considering the cost of fuelling and maintenance cost of the driver. I hired equipment preferably to moving equipment; most of the project managers do not consider this in their management of a project, but this action has a great influence in cost of housing project. Let me confirm to you that cost of transportation of equipment to site will increase cost of construction significantly if distance of transportation of equipment is far from the new site location. On such occasions, housing project delivery cost will increase substantially".

7.3.1.4 Sustainable quality delivery management technique

Quality assurance at implementation and closeout are critical factors for achieving quality housing delivery. The project manager spoke: “Well, I have sound and solid reply. Quality assurance at implementation and closeout is a good procedure for effective project delivery. Before then, there is a need to establish client and user requirement at the briefing stage and incorporate these into housing planning for production, we practice this on site. Quality is ascertained when all the necessary needs in the house are built into the planning and implemented at each phase of transit to another phase of production. I suggest that this practices must be adequately considered at the initial stage through to planning, implementation and closeout of production processes. Constantly practicing this act will ensure quality housing delivery at moderate and inexpensive cost”.

7.3.1.5 Stakeholder satisfaction management technique

Matching stakeholder interest toward requirements influences sustainable housing delivery during production processes. The project manager presented that, “I want you to know that stakeholders and users have their requirements and interest in project production processes. Basically, the interest of each stakeholder is paramount and is a challenge to every project manager. On my site, I always make sure that all the interests of stakeholders and users are identified and documented at planning. This must be addressed before an efficient housing production process can be guaranteed. At every stage of housing production, stakeholder interest obstructs progress development because of demand and satisfaction, so I will suggest that this must be considered at every phase of production, integrated into planning and implemented accordingly. But this action hinges on the free flow of information among the construction operators and stakeholders present on site. The initial consideration of the stakeholder and household satisfaction at briefing, planning and design stage will augment successful completion of housing production, when all interest is fully considered and implemented, cost efficient housing delivery is certainly”.

On the subject of adequate communication with stakeholders, this has an impact on sustainable housing production processes. The project manager conversed, “ I say that communication is vital in achieving effective project production processes. Communication is a powerful tool that enhances mutual relationships among the construction stakeholders. On my site every interest is considered and implemented, as free communication allows the free flow of ideas, and every stakeholder is fully involved in decisions taken to have a sense of belonging. I wish to confirm that if every stakeholder in a project was allowed to participate fully, his influence will be positive. Constant arguments causing delay and abandonment of housing projects will be drastically reduced. Maintainable housing delivery within budgeted cost is centred on effective communication among the construction operators and stakeholders at every stage of production".

7.3.1.6 Economic constraint management techniques for affordable housing delivery

Teamwork on site will be effectively utilised for management of budgeted cost without inflating cost of construction for sustainable housing delivery. The project manager informs, "I have been working in the construction industry now for over two decades, and I have never seen any technique as perfect as teamwork on site among the construction operators. I believed that team work enhances unity, reconciliation and harmony among the stakeholders on site; it allows settlement of rift and discord which cause nuisance or impediment toward effective project production. As residence project manager I disallow unnecessary arguments and discord among workers on site, because I have identified this challenge as a source of delay, since five years ago in one of our site. Practice of this action will restrain construction cost within the limit of the budget. Moreover, the hiring price of equipment on site must be restrained within budget available. On our site, we make sure that all material prices are constrained within time of delivery; we do not welcome abnormal or inflated prices of material and equipment delivery from the suppliers. The challenges we are presently battling on our site are incessant worker industrial action and demand for increases in wages. Sometime last year, for example, the junior workers lay down their tools twice, an action that slowed work and increased construction cost substantially. Thus, teamwork on site is an efficient technique that will keep costs of construction within budget, since teamwork has been identified as the basis for settling discord and rift among workers. All cases of constant change in design, variations, delay in payment will be resolved amicably if there is teamwork on site, as teamwork on site is a determinant factor for cost efficient housing delivery within budget".

General progress reports on housing will be effectively utilised for management of budgeted cost without inflating cost of construction for sustainable housing delivery. The project manager narrates, "My answer it that progress reports on housing projects are indispensable. Constant progress reports on site keep every stakeholder abreast of construction activities; because, each stakeholder will contribute meaningfully toward happenings on a construction site. At every phase of a production process, it is important to keep every construction operator informed about cost efficient production. Practicing this action will improve monitoring and keep unnecessary inflation of construction cost at anchorage. We practice this system on our site. We call this ‘monthly reconciliation of resource control with available capital’ and at this juncture, the construction operators keep records of available capital and the boundary of construction operation in reference to cost. The conclusion I wish to draw is that general progress reports on site will enhance cost efficient housing production and keep construction of housing within the affordable level. May I confirm to you that cost constraint challenges which have dominated the construction industry will be addressed with unity and sincerity when all stakeholders are adequately informed about the happenings on site”.

7.3.2 Construction organisation H-case study analysis-2

Construction techniques and management principles and practices are important. The construction organisation H is a general building of contractors registered under the Construction Industry Development Board (CIDB) with grade level 5 (GB). This organisation specialises in the construction of social housing. It has a collaboration with the national, provincial and municipal governments for the provision of social housing for low-income earners. The organisation has been in construction for over two decades. A date was fixed for an interview with a quantity surveyor working in construction organisation H in Johannesburg to enquire about the impact of availability of skilled workers on site for sustainable housing delivery within budget in view of construction techniques and management principles. Availability of skilled workers on site impacts the cost of sustainable housing delivery within budget, according to the quantity surveyor.

7.3.2.1.1 Sustainable construction cost management techniques

The quantity surveyor working at construction site H clarifies, “I am employed as skilled workers on site, my duty is to ensure cost efficient project delivery, as skilled workers on site plays a significant role in planning and management of techniques for effective project production. Let me give a brief description of a skilled worker: this is a well-educated person, trained, experienced and devoted to his profession, and capable of doing any given job in an efficient way. Thus, he carries out the development of site work properly by utilising the available capital and resources in an efficient way to fulfil the need of the client and users of sustainable housing, helping to plan for sustainable use of budgeted cost and resources, while carrying out the development and construction work for sustainable housing delivery. Skilled workers on site are responsible to check production processes and promote the achievement of stakeholder interest and help fulfil the objectives of the user for sustainable housing, while at the same time, preventing increase in cost of construction".

7.3.2.1.2 Sustainable design management technique

Improper design leads to failure to achieve client objectives and affects sustainable housing delivery within budget. The quantity surveyor discoursed, "I believed that the aim and objectives of the client will be achieved if improper design are considered at planning stage of design. The client briefing must be integrated into the planning stage of design to achieve cost efficient housing, and to avoid argument and litigations as a result of claims. I realise that cost efficient techniques practices on site is significant toward social housing delivery. Permit me to reveal to you that sustainable design is a strategic design to establish environmentally friendly innovated housing, and it is considered a specific design to fulfil client and user demands for affordable housing. Gentleman, let me confirm to you that housing can only be affordable when the proposed housing is designed to meet people's diverse needs and social cohesion. Sustainable design can be achieved when client and user objectives are well-defined at the design stage to stimulate affordable housing. Social satisfaction management techniques for construction resources usage is imperative".

Workforce productivity affects human resource management toward achieving cost effective sustainable housing delivery. The quantity surveyor gives an account and say that, "Human resources are important among the construction resources, the driver of the two other resources for project production processes. Human resources must be given special attention, as they are the most difficult resources to manage on site because workers react easily to every state of affairs. The welfare of workers on site is a concern, and should be adequately addressed as the project production progresses. As a quantity surveyor, I always make sure that welfare of the workers are adequately taken care of during the preparation of the bill of quantity. The welfare package includes salary, overtime charges, hourly charges, safety and health related issues, and incentives and bonuses. These are the basic things I do for well-being of site workers, and I make sure these are adequately entrenched into the bill of quantity. Thus, effective implementation of workers well-being on site is a yardstick to increase workforce productivity on site. The increase in workforce productivity is an equivalent diminishing to the increase in cost of construction; therefore, management of workforce productivity is significant at planning and in the implementation phases of production; it will enhance reduction in cost of construction for sustainable housing delivery substantially".

Quality of workmanship for materials will reduce waste for sustainable housing delivery. The quantity surveyor speaks out, “Matching quality workmanship with available materials on site is a process of imparting quality into housing, as the quality of workmanship engaged with on site will determine the sustainability of housing produced. The skill possessed by every worker on site will determine quality assembling of materials during production: adequate assembling of materials to form a structure will standardise the longevity, quality, maintenance costs, reduction in errors, and aesthetic of the housing. I wish to let you know that as our company adheres to the policy of quality delivery, quality workmanship is incorporated into the bill of quantity. This is strictly followed at planning, implementation, and through the closeout stage of the production process. Thus, quality workmanship is a determinant factor for waste reduction, enhancing construction cost reduction to achieve sustainable housing delivery”.

Cost of transportation of equipment to site affects cost of sustainable housing delivery. The quantity surveyor pronounces, “Cost of transportation of equipment to the site does not frequently affect cost of construction. It all depends on construction management techniques put in place by the construction operators. The cost of maintenance of site equipment has been incorporated into the bill of quantity. The extraction and the uses depend on the policy of the company, but every project manager has the prerogative right to choose whichever method that will enhance construction cost reduction and benefit sustainable housing delivery. May I confirm to you that the ability to manage equipment usage on site is a plus to construction operators because lack of planning for equipment usage is a challenge which results in redundancy and idleness of the equipment operator on site. The cost of transportation of equipment to site must be properly investigated before steps are taken to bring equipment to site: distance of transportation must be considered in preference to hiring equipment at a close distance to the site. I believed that transportation cost has little influence on cost of construction, if properly managed”.

7.3.2.1.3 Sustainable quality delivery management techniques

Quality assurance at implementation and closeout are considered critical factors for achieving quality housing delivery. The quantity surveyor pronounces, “Quality must start at the client briefing and develop into planning with clarity of aim and objectives as a guide for effective production. As a quantity surveyor, I always prepare quality schedules for site work, and this makes ‘quality’ our watchword in my company. Quality cannot be compromised as it is subjected to maintenance costs. Every construction operator should see quality assurance at implementation to closeout stage as a must. In order to achieve quality housing delivery, there must be adequate planning and frequent enlightenment of construction operators about the importance of quality improvement. Quality assurance and upgrading should commence at the design stage integrated into project drawings to avoid constant errors which usually characterise project production. My summation is that sustainable housing can be achieved if the construction operators consider quality as a bedrock challenge to affordability, construction cost reduction, cost efficiency and maintenance cost free. The ability to consider these constraints and put it into practice as a technique is a must that needs to be instilled in the minds of the construction operators on a daily basis".

7.3.2.1.4 Stakeholder satisfaction management technique

Matching stakeholder interest toward requirements has an influence on sustainable housing delivery during production; the quantity surveyor explains, "In every project production, stakeholder interests are diverse. This generates different opinions at every phase of housing production and creates arguments which breed contempt and rift among construction operators, influencing delay, changes in design, and breaking and pulling down of an already completed job. I foresee a need to document all stakeholder and household interest at design planning stage and implement accordingly to their satisfaction. Consequently, it is of paramount importance for every construction operator to identifying stakeholders and understanding their relative degree of influence on project production processes. In so doing, the measurement of success criteria are established for affordable housing delivery".

7.3.2.1.5 Economic constraint management techniques for affordable housing delivery

Teamwork on site will be effectively utilised for management of budgeted cost without inflating cost of construction for sustainable housing delivery. In discussing the significance of this practice for efficiency, the quantity surveyor opined, "Teamwork is a technique that has been in practice for a long time in project production. The absence of teamwork on site leads to chaos, and stakeholders do whatever they want which is not conducive for successful delivery of sustainable housing as anticipated. As a quantity surveyor on site, I make sure that free communication of information on site flows freely without hindrance; every stakeholder is given the opportunity to express their interest and disagreement with the practices on site. Changes in company policies are communicated timely to those who need this information. Teamwork is essential when cost efficient housing is required; virtually every stage of production needs teamwork to actualise successful completion of project production. Teamwork occurs when a group of construction operators have the same common goals and belief in one another for successful completion of cost-efficient housing within the quality and time specified, thereby keeping construction cost within the frame of budgeted cost established at the planning stage. Teamwork reduces cost constraint challenges which many projects are subjected to. Through teamwork, efficiency is promoted and productivity is improved to achieve cost efficient production".

General progress reports on housing processes will be effectively utilised for management of budgeted cost without inflating the cost of construction for sustainable housing delivery. The quantity surveyor said, "It is essential that constant reporting on housing production processes will keep all construction operators informed; therefore, every hand must be on deck to deliberate issues that challenge cost constraint. After identification of a challenge, the method of managing construction resources will be defined, and the techniques must be applied appropriately without allowing the cost of resources to exceed budgeted cost specified. Consequently, cost constraint challenges that often occur through increases in price of construction resources should be adequately monitored at every stage of housing production processes. My company has different methods for reporting the progress of work on site. It can either be through letter, telephone call, email, meetings or internal seminars. This is done periodically for the sake of monitoring and controlling incessant increases in the cost of construction".

7.3.3 Construction organisation K-case study analysis-3

7.3.3.1 Construction techniques and management principles & practices

The construction organisation K is on grade level 3 (GB), registered under the Construction Industry Development Board (CIDB). This organisation is a small construction company with a collaboration with a municipal government for the provision of social housing on a small scale. The organisation has been into construction jobs and provision of housing for the community for over 15 years, but there is a limit to the value of contracts the organisation can involve, despite the organisation securing various general building contracts. And the organisation claimed to have experienced skilled workers working in the organisation since the inception of the company. Consequently, a date was fixed for interview with an architect working in the organisation situated in Johannesburg to find out from him the influence of availability of skilled workers on site toward sustainable housing delivery over budget, considering construction techniques. The architect also answered other leading questions.

7.3.3.2 Sustainable construction cost management techniques

“Availability of skilled workers on site is a perquisite for an efficient project production process. Having skilled workers on site enhances the chances of achieving cost effective project delivery. I am an architect, and I wish to confirm to you that while beautiful drawings may come from the consultant architect, such drawings need a skilled worker to perfect and implement the practicality of such drawing on site. A working drawing must be fashioned from original drawings to bring out details to the understanding level of the bricklayer/artisans on site. The skilled workers on site will prepare the work schedule and ascertain that what was on the drawing is well represented on the ground. The applicability of what is on the paper to the ground needs special attention of an expert: any error and omission in the drawings can be easily detected by the skilled worker.

Let me reveal to you a costly mistake committed by a group of consultant architects on a drawing, occurring about six years ago, which should have resulted to complete demolition of a structure if the error was not detected in the early stage of the project production processes. The client interests were wrongly presented on the drawing, which would have cost the client a lot of money. What saved the situation was the client’s representative who had the opportunity to brief the contractor group verbally in regard to the requirements of the client. From this, we are able to understand the client’s intension; hence, the drawing was rejected for a more adequate detail drawing with better clarity.

My conclusion is that availability of skilled workers on a site is essential. They must be involved in client briefings, design planning, implementation of client requirements at design stage, and review of the design to ascertain that the client aim and objectives are adequately implemented in the sustainable housing design. Constant practice of this procedure will reduce errors and omissions that seem to infiltrate housing design causing frequent changes of design by the client which is the main source of abnormal increase in construction cost. Therefore, sustainable housing delivery is more likely at fair cost effectiveness”.

7.3.3.3 Sustainable design management techniques

Improper design leads to failure in achieving client objectives and affects sustainable housing delivery within budget: “Let me say that suitable design will include client and users aim and objectives established at the briefing stage and improper design limiting the chances of affordable housing delivery. I understand that sustainable design principles are accomplished when all the necessary comforts required by the client and users are adequately installed into a building. As an architect, I appreciate my involvement in housing design from the client briefing, as this enhances my chance of mirroring the needs and interests of the client accurately on paper and interpreting this idea into reality. Consequently, adequate planning for housing design was considered to incorporate client aim and objectives as a good technique to achieve quality and cost efficiency required. Design planning reduces errors, omissions and frequent changes in design. Please note that design planning increases the chances of accurate review of drawing to match what was intended at the briefing stage. My advice toward achieving sustainable design is that all construction stakeholders be involved in the design stage of the housing project, so that every opinion is documented and incorporated accordingly. I will say that sustainable housing delivery hinges on sustainable design techniques".

7.3.3.4 Social satisfaction management techniques for construction resources usage

Workforce productivity is identified as one of the major factors affecting management of human resources for sustainable housing delivery within budget: "Workforce is the manager of the other construction resources. Workforce efficiency determines the productivity of other resources, as the efficient management of human resources enhances production processes and company productivity. Thus, workforce productivity of human resources in a company is equivalent to the company productivity. Effective productivity can be achieved on site when the programme of work can be adequately matched with the available workforce. Efficiency in housing production becomes more definite. As an architect on site, I always ensure that the majority of labour needed on my site is recruited from the environs of the construction site and trained for enhancement. The economy of the community where the site is situated can only be promoted when the human resources within that vicinity are adequately engaged in project production. If economy of the individual within a community is improved on, their social satisfaction is guaranteed, and correspondingly, the workforce productivity increases".

"In addition to workforce productivity, adequate provision of an incentive for the workforce enhances their chances of effective productivity; if workforce productivity is efficient, similarly, management of cost of construction will be effective as well. Hence, sustainable housing delivery is achieved".

Quality of workmanship for materials will reduce waste for sustainable housing delivery. The architect opined, "Waste is a nuisance effect on cost efficiency. Waste, an unwanted syndrome that affects cost of construction, occurs through human resource redundancy on site. It also occurs via idleness of equipment and operators. To achieve perfection in the use of construction resources, waste must be avoided. Quality workmanship is needed with construction materials, as this will reduce waste in achieving sustainable housing delivery. Whenever I am on the drawing board, I always make sure that accurate measurements are done to avoid unnecessary material cutting which brings waste on site. Planning for material use on site is a step to reducing materials wastage and thereby decreasing construction cost. This enhances the achievement of housing project delivery within budget".

Cost of transportation of equipment to site affects cost of sustainable housing delivery. The architect disclosed,: "As an architect, I am not sure if cost of transportation of equipment to site will affect cost of sustainable housing delivery, but I do know that lack of proper planning for the use of equipment will affect construction cost via delays and idleness of equipment on site. The remedy to the impact of cost of transportation of equipment on my site is that I always design for the use of local materials available near the site vicinity to avoid unnecessary increases in cost of transportation of materials; likewise in the use of equipment to avoid transportation of equipment from far distances which adversely affects cost of project delivery".

7.3.3.5 Sustainable quality delivery management techniques

As quality assurance at implementation and closeout are critical factors for achieving quality housing delivery, the architect reveals, "Quality is essential in project delivery; it cannot be compromised. Quality cuts across all phases of production processes. Based on this fact, I always ensure that quality materials are designed for the construction of housing, and the cost of such material must be inexpensive to achieve both cost effectiveness and quality assurance. Quality planning must be entrenched into housing design in compliance with the planning. To ensure this, constant checking must be conducted at every stage of production processes to achieve continuous quality housing delivery within budget".

7.3.3.6 Stakeholder satisfaction management techniques

Matching stakeholder interest toward requirements has an influence on sustainable housing delivery during production. The architect clarified, "Interest of every stakeholder is significant and therefore can never be compromised. Otherwise arguments ensue among the construction operators and between the client and users. My first assignment as a member of a design team is to document all necessary interests of every stakeholder who is involved in housing production processes, and ensure that every interest is integrated into design. Therefore, delay, variation, litigation and abandonment of housing project will become thing of the past; the adequate care of stakeholder interest will engender peace, harmony and cooperation among the stakeholders for successful delivery of affordable housing".

7.3.3.7 Economy management techniques for affordable housing delivery

Teamwork on site will be effectively utilised for management of budgeted cost without inflating costs of construction for sustainable housing delivery, explaining, "Teamwork is essential in virtually every stage of housing production processes, as teamwork is an antidote for management of cost efficiency and enhances the division of labour among the construction operators and free communication. Teamwork encourages cooperation among construction team members toward achieving the aim and objectives of the client. Adequate planning for the use of construction resources can only be realised if there is an effective collaboration among design, construction, monitoring, controlling and the quality assurance group. Consequently, affordable housing delivery is sustained within the budgeted cost".

7.3.4 Construction organisation Q-case study analysis-4

For construction techniques and management principles and practices, the establishment of the construction organisation Q started immediately after the first democratic election. The construction organisation Q has its national headquarters in Gauteng with branches in all nine provinces of South Africa. The concern of the construction organisation Q is to ensure adequate provision of housing, and to ensure that the needs, development and activities of the inhabitants living in the settlement are adequately cared for. Simultaneously, it is important to make certain that there are abundant opportunities for the citizens of South Africa to achieve their full potential. Yet another function performed, then, by the construction organisation is to promote the establishment of physically, economically, socially, emotionally, and sustainable housing environments. A project coordinator at construction organisation A&B was interviewed, considering that the organisations are involved in the implementation of governmental policies on housing delivery. Although the construction organisation Q has branches in all nine provinces, it operates with *one* policy, so one interview will be reported. One of the coordinators of general planning of construction organisation was interviewed, with the report as follows.

7.3.4.1 *Sustainable construction cost management techniques*

As the availability of skilled workers on site toward sustainable housing delivery over budget is accepted as an efficient construction technique, in what way does your organisation incorporate this construction technique into sustainable housing delivery?

“Our function is to deliver houses to people regardless of their income; so we engage the services of the contractors and individual owners who are competent to handle the construction of their own house under our supervision. We always ensure that competent and skilled workers are involved in the housing production processes. Often, we face challenges pertaining to skilled workers on the site. Because of our policy of community based project, the step we consider for combating the challenges is through organising skilled worker training for the community based workers, but this is also for contractors on site. We practice this action continuously to ensure that the people have sense of belonging and economic development. Having skilled workers on site is essential; it cannot be neglected as the absence of skill workers on site results in shady construction and unprofessional practices, resulting further in delay, wastage of materials, high costs of construction and unjustifiable housing delivery. As one of the coordinators of project planning and management on site, one of my duties is to ensure that the established technique of efficient housing delivery is adhered to by the contractors, and this includes having skilled workers on site for effective housing production processes”.

7.3.4.2 *Sustainable design management techniques*

Improper design leads to failure of achieving client objectives, affecting sustainable housing delivery within budget. “Our organisation has adequate design principles consistent and helpful to the community. Adequately adhering to client objectives will enhance quality housing delivery. The variety of houses we design range from a self-contained room, two-bedroom apartments and three-bedroom detached apartments. The apartments are designed with adequacy and all necessary amenities are sufficiently included in the drawings. We ensure that all amenities are implemented at the construction stage through to the handing over of houses to the users. The housing we design is maintenance free, supports the lifestyle of the people and ensures longevity, quality and cost efficiency in use. The inclusion of all of these facilities makes our housing sustainable and interesting”.

7.3.4.3 Social satisfaction management techniques for construction resources usage

Workforce productivity affects human resource management toward cost effective sustainable housing delivery. “Workforce productivity enhances the smooth running of housing production processes; productivity is a medium of measuring efficient use of human resources. The planning for effective housing production processes on site starts from a drawing board in the office to a working drawing on site; we plan our work from the office and implement it on the ground. Adequate planning is essential toward efficient productivity. Our organisation was able to succeed with housing production processes based on the fact that we have formidable construction team. This team has ground-breaking ideas for planning, implementation, controlling and monitoring delivery of housing to users who are in urgent need of accommodation. The abilities and experiences possessed by this team enhance the workforce productivity we are experiencing in our organisation. However, workforce motivation brings about productivity, with incentives for the workers on site sufficiently provided by our organisation. This is the brain behind our productivity on site – incentives, such as good salary, bonuses, payment of hourly rate as and when due, overtime payment, and provision of good health and safety facility on site. These incentives enhance productivity and social satisfaction”.

As quality of workmanship for materials will reduce wastage for sustainable housing delivery, how possible is the application of this technique in your organisation? “Material usage on site consumes the largest percentage of the total cost of construction, therefore it requires excellence of workmanship to install the materials to avoid wastage of resources. Our staff is specially trained with material handling and installation; likewise, the contractors we engage with in supply and construction are competent in material handling and installation, and most of the materials we use in the housing production processes are sourced locally to enhance the local community economy and reduce cost of construction. These materials are handled and installed by the local community, as they are produced by the local people, thereby drastically reducing wastage of materials on site. It is essential to reduce material wastage on site because construction costs increase through materials wastage. Adequate attention to this issue will improve affordable housing delivery consistently with cost effectiveness”.

Cost of transportation of equipment to site affects cost of sustainable housing delivery. In what way does this factor impact effectiveness of housing delivery in your site? “Most of the equipment we use on our site are pay loaders, excavators, concrete mixers, wheelbarrows and hand tools. As the uses are essential on our site, we make adequate planning for the use of equipment before we move to the site. The transportation of equipment to site is organised in a sequence of orderliness for delivery by the time it is needed on site. Most of the time, we hire equipment for use on our site from the nearby equipment hiring company. Whenever we determine that cost of transportation of equipment from one site to another will increase cost of construction, we decide to hire equipment. To achieve this procedure successfully, it must adequately planned from the initial stage of housing production processes. I wish to confirm emphatically that equipment transportation will increase the cost of construction of sustainable housing delivery, if the distance of conveying it is far from the site where it is needed. In this instance, the cost of maintaining the transportation will not be reasonable as compared with the hiring cost of equipment".

7.3.4.4 Sustainable quality delivery management techniques

Quality assurance at implementation and closeout is a critical factor for achieving quality housing delivery: "Quality is an important issue and must be addressed sufficiently to acknowledge client and user needs. Before quality assurance at implementation can be guaranteed, it must first plan adequately at the initial stage of housing production process, and then this must be perfected at the design stage. The interest and requirement of the housing user must be identified and integrated into the design while considering cost efficient procedures. Then quality assurance at implementation and closeout can be ascertained. The process of guaranteeing quality assurance at implementation and closeout is imperative for adequate planning for entrenchment of quality into the design stage, monitored at every stage through to assurance, so that planned quality is adequately inputted into the housing. Thereafter our quality assurance team moves to site to ensure all necessary requirements of the users as recorded in the planning stage are complied with. This is done in observance of cost efficient management toward sustainable housing delivery".

7.3.4.5 Stakeholder satisfaction management techniques

Matching stakeholder interest to requirements has an influence on sustainable housing delivery during production: "Stakeholders on site include those people having an influence on housing production processes. Our organisation has stages for involving stakeholders in the housing production processes. The comfortability of users is our major concern because their interest is paramount, so it must be critically enquired and inputted into every stage of a housing production process. The major anxiety of the user is that the housing must be comfortable, with all necessary amenities entrenched into the housing. In so doing, we are adherent to free maintenance cost,

Table 7.1: Summary of qualitative research study conducted with reference to each construction organisation case study analysis

Content	**Construction organisation G-case study**	**Construction organisation H-case study**	**Construction organisation K-case study**
Availability of skilled workers on site	I wish to confirm that whatever any technique and management principle and practice put in place will not override the availability of skilled worker on site, because skilled worker on site enhance effective productivity at affordable cost for housing delivery	Let me give a brief description of skilled worker, skilled worker is a well-educated person, trained, experience, and devoted to his profession and capable of doing a given job in an efficient way. Thus, he carries out development of site work properly by utilizing the available capital and resources in a well-organised way to fulfil the need of the client and users of sustainable housing within cost efficient approach. Thus, availability of skilled worker on site is essential	Availability of skilled worker on site is a perquisite for efficient project production process, skilled worker on site enhances the chances of achieving cost effective project delivery. The function of skilled worker on site is essential, and skilled worker must involve in client briefing, design planning and implementation to achieve sustainable housing delivery within budget
Improper design leads to failure in achieving client objectives	May I say that sustainable design principle means design for comfort, value, quality, convenience of the occupants, provision of necessary amenities needed in housing, longevity, and design for maintenance cost free is also an essential need	I will say is a measure of integrating cultural identity, economic stability, value, economic opportunity of the users into design process to achieve cost efficient housing delivery within client budget	Sustainable design is accomplished when all necessary comfort is integrated into housing within the budget, permit me to say that suitable design must include the client and users, aim and objectives established at briefing stage, is a good skill for designers to integrate client objectives into housing production

Table 7.1 continued

Content	Construction organisation G-case study	Construction organisation H-case study	Construction organisation K-case study
Workforce productivity affect cost	A project manager should understand the principle of how to use incentive to no-win situation to increase workforce productivity, increase in productivity on site will constantly reduce cost of sustainable housing delivery, hence, affordability of housing will constantly be enhanced	Human resources are important among construction resources. Thus, effective implementation of workers well-being on site is a yardstick to increase workforce productivity on site. The increase in workforce productivity is an equivalent diminishing in the increase in the cost of construction, therefore, management of workforce productivity is very significant for sustainable housing delivery	Workforce is the user of the other resources, the workforce efficiency determines the productivity of other resources, the efficient management of human resources enhances production process and company productivity increases. Thus, the increase in workforce productivity of human resources, and is an equivalent to company productivity, as a result, management efficient is a top score for sustainable housing delivery within budget
Quality workmanship on materials will reduce wastage	The process of engaging an experience skilled worker on site will enhance quality, and reduction in materials wastage which is the source of constant cost increase in the reduction of waste at each phase of production, thus, sustainable housing delivery is achieved perfectly	Matching quality workmanship with available materials on site, it is a process of imparting quality into housing, the quality of workmanship engaged into on site will determine sustainable housing to be produced. The skill possessed by every worker on site will determine quality assembling of materials during production, adequate assemble of these materials to form a structure will standardize the longevity, quality, and reduction in changes in design and errors which cause wastage, thus sustainable housing is delivered	Waste is a nuisance effect on cost efficiency; waste is unwanted syndrome which affect cost of construction, waste occurs through human redundancy on site, similarly, via idleness of equipment and the operators. To achieve perfection in the use of construction resources waste must be avoided, thus, quality workmanship is needed on construction materials, hence, waste will be reduced to achieve sustainable housing delivery within a reasonable cost

Table 7.1 continued

Content	Construction organisation G-case study	Construction organisation H-case study	Construction organisation K-case study
Cost of transportation of equipment to site	Let me confirm to you that cost of transportation of equipment to site will increase cost of construction significantly, if distance of transporting of equipment is far away from the new site.	Cost of transportation of equipment to the site does not frequent affect cost of construction, it all depends on construction management technique put in place by the construction operators. The cost of transporting of equipment to site must be properly investigated before ordering steps are taken to bring equipment to site and compare with hiring cost. I believed that transportation cost has little influence on cost of construction if properly managed.	As an architect I am not sure if cost of transportation of equipment to site will affect cost of sustainable housing delivery, but I know that lack of proper planning for the use of equipment will affect construction cost, hiring of equipment may be considered as alternative to moving equipment to new site.
Quality assurance at implementation and closeout	Quality is ascertained when all the necessary needs in the housing are built into planning and implemented at each phase of transit to another phase of production, thus, identification of housing durability, maintenance cost free and technique of assemble quality materials is determined. Constantly practicing this act will ensure quality housing delivery at moderate and inexpensive cost.	Quality must first start at client briefing and develop into planning with clarity of aim and objectives, and the action is a guide for effective production, as a quantity surveyor, I always prepare quality schedule for site work, and this make quality as our watch word in my company, quality cannot be compromised, thus every construction operator should see quality assurance from side to side to closeout stage as a must, in order to achieve sustainable housing delivery within budget.	Quality is essential in project delivery, and it cannot be compromised. It cuts across all phases of production. Based on this information, I always ensure that quality materials are designed for the construction of housing, constantly checking for the use of quality materials and practices to enhance sustainable housing delivery within budget.

Table 7.1 continued

Content	Construction organisation G-case study	Construction organisation H-case study	Construction organisation K-case study
Matching stakeholder interest toward requirements	The initial consideration of stakeholder satisfaction at briefing, planning, and design stage will argument successful completion of housing production, when all interest is fully considered and implemented, thereafter, continuous, consistence, and affordable housing are achieved.	In every project production stakeholder's interest are in diverse condition, this generate different opinions at every phases of housing production, and create argument which breed contempt, rift and changes in design at construction stage. Thus, there is a need to document every stakeholder and users' interest, in order to achieve sustainable housing delivery.	Interest of every stakeholder is significant, and can never be compromised, otherwise argument ensues among the construction operators between the client and users. My first assignment as a member of design team is to document all necessary interest of the stakeholders, therefore, delay, variations, litigations and adornments of project will become things of the past, adequate care for the interest of stakeholders will create peace and harmony on site for successful delivery of housing within budget.
Teamwork on site	I have been working in construction industry for more than two decades, and I have never seen any technique that are as perfect as teamwork on site among the construction operators, teamwork allow settlement of rift and discord which causes nuisance or impediment toward effective project production, thus, teamwork on site will allow efficient use of cost on construction resources within the limit of the budget for sustainable housing delivery.	Teamwork is a technique that has been in practice for a long time in project production. The absence of teamwork on site will lead to chaos, with every stakeholder doing whatever he wants. This is not conducive to successful sustainable housing delivery.	Teamwork is essential in virtually every stage of housing production processes. Teamwork is an antidote toward management of cost efficiency and sustainable housing delivery.

availability, affordability, and consistence and continuous delivery, but this is done on the basis of individual income and background information recorded for each user. However, our achievement is basically built on cost effectiveness in housing delivery".

7.3.4.6 Economy management techniques for affordable housing delivery

Teamwork on site will be effectively utilised for management of budgeted cost without inflating cost of construction for sustainable housing delivery: "Teamwork on site is a step taken by construction operators working together in unity for cost efficient production to achieve sustainable housing delivery. A team like manner among the construction operators usually enhances a cordial relationship, and peace, allowing the workers to think straight and reduce different influences on housing production. Delays causing variation are drastically diminished to minimal with free communication among the workers. These identified factors, if allowed to exist on site, will enhance the combination of efforts to propel efficiency toward sustainable housing delivery. Drawing inference from this condition, I will confirm to you that our organisation operates with these factors for effective management, based on the practice that user needs and interests are adequately discussed in an organised meeting. The interests and requirements are married together and documented for design and implementation on site for cost efficient housing delivery".

7.4 General summary of findings

Interviews were conducted among all professionals working in the housing construction industry. All the professionals interviewed made good suggestions in support of the findings obtained through descriptive statistics analysis. The information collected is transcribed through content analysis and reported. Summaries from the quantitative process are as follows:

1. Sustainable construction cost management technique: Availability of skilled workers on site

A sustainable construction technique requires the availability of skilled workers on site. Experienced, skilled workers on site is essential for the implementation of sustainable construction techniques for achieving sustainable housing delivery. A skilled worker will manage the available capital sufficiently by incorporating client and users aim and requirements established at the initial stage into design planning as well as consider all practical implications for production to achieve sustainable housing delivery within construction cost acceptable to the client and users.

2. Sustainable design management technique: Improper design leads to failure in achieving client objectives

A sustainable design technique can only be achieved when incorporating design principles at the initial planning of housing production processes. Enhancing design for comfort, quality, cost free maintenance and longevity are all essential ingredients for delivering sustainable housing within the acceptable demand of the client and occupants.

3. Social satisfaction management technique for construction resources usage: Workforce productivity affects cost, quality of workmanship on materials will reduce wastage, and cost of transportation of equipment to site

Social satisfaction techniques can be achieved with adequate integration of workforce productivity, quality workmanship on material for wastage reduction, and cost of equipment transportation within budget. The achievement is pivoted on establishing an incentive to a ‘no-win situation’ to increase workforce productivity, engaging an experienced, skilled worker on site, and adopting the principle of sequential ordering for delivery of equipment at the time required on site to reduce redundancy and time wastage. As the implementation of worker well-being on site is a yardstick to increase workforce productivity, management efficiency will achieve top scores for sustainable housing delivery within budget. Adequate implementation of these indices will continually and consistently enhance sustainable housing delivery at cost efficient practices.

4. Sustainable quality management technique: Quality assurance at implementation and closeout

A sustainable quality technique is enhanced through quality assurance at implementation and closeout stage. Quality of housing can be ensured at a point when all requested needs and amenities in housing are sequentially built into planning and implemented at each phase of transit to another phase of production. Similarly, the development of client and user aim and objectives established at planning stage into sustainable production will entrench quality into housing delivery within cost efficient procedures, thereby enhancing sustainable housing.

5. Stakeholder satisfaction management technique: Matching stakeholder interest toward requirements

A stakeholder satisfaction technique will be achieved by matching stakeholder interest toward requirements. Adequate consideration for client and user needs at briefing, planning and design stages is a step toward combating the negative influence of stakeholders which can cause hot arguments, disunity, lack of teamwork on site, litigations and frequent changes in design which trigger delays and cost variations. The aftermath of these actions leads to high construction cost of housing delivery, which is inimical to sustainable housing delivery. However, stakeholder interests are diversionary conditions, so adequate communication among stakeholders will identify differing opinions and integrate them together, sorting out the most important issues and documenting these for adequate implementation at the planning stage of each phase of production. The most essential fact that enhances sustainable housing delivery is to know and understand that stakeholder interest is a significant factor and cannot be compromised in an effort to avoid contention which is a nuisance to effective sustainable housing delivery activities.

6. Economy management techniques for affordable housing delivery: Teamwork on site

An economy management technique will be achieved through teamwork on site. This is a perfect technique for effective housing production processes, because teamwork on construction site affords easy settlement of rift and discord resulting in the smooth running of a housing production process. Teamwork enhances production of sustainable housing within construction cost that is acceptable to the client and users, particularly when adequate consideration has been given to construction resource usage. The conclusion is that a team-like manner among the construction operators enhances cordial relationships and peace, and allows workers to think straight and operate under a clear mission and vision for cost efficient sustainable housing delivery.

7.5 Chapter summary

This chapter comprises the validation of findings obtained in Chapter 6; hence, qualitative methods were used to validate the findings and to ascertain practical implications of the findings. Thus, interviews were conducted among four construction firms. In each construction company, one experienced construction operator was selected for an interview. The findings obtained were classified as follows: sustainable construction technique on site required the *availability of skilled worker on site;* sustainable design technique can only be achieved through *incorporating sustainable design principles;* social satisfaction technique can be achieved by means of *adequate integration of workforce productivity, quality workmanship on material, cost of transportation of equipment within budge*t; sustainable quality technique is enhanced through *quality assurance at implementation and closeout stage;* stakeholder satisfaction technique will be achieved through *matching stakeholder interest toward requirements;* economy constraint construction technique will be achieved through *teamwork on site*. The summary of the findings are availability of skilled workers on site, incorporating sustainable design principles, adequate integration of workforce productivity, quality workmanship on materials, cost of transportation of equipment within budget, quality assurance at implementation and closeout stages, matching stakeholder interest toward requirements; and teamwork on site – all these influences are agreed upon by the respondents as the basic procedures to be considered at initial planning and implementation toward sustainable housing delivery within accepted satisfactory level of the client and users in need of such housing. The subsequent chapter will discuss the miscellany of factors impacting sustainability and techniques of housing delivery, and establishment of operational management for cost of construction

CHAPTER EIGHT

8. ESTABLISHMENT OF EFFECTIVE FRAMEWORK FOR MANAGEMENT OF COST TOWARD SUSTAINABLE HOUSING DELIVERY

8.1 Introduction

The preceding, notably in Chapters 6 and 7, has presented the descriptive and inferential statistical analysis of the data collected. Validity of the findings obtained were carried out using a qualitative method. Consequently, the analysis results obtained in Chapters 6 and 7 have established the underlining factors affecting each of the concepts/paradigms in the conceptual framework for the study, as explained in Chapter 3. The chapter presented the miscellany of factors impacting sustainability and techniques of housing delivery, and establishment of operational management for cost of construction. Thus, framework for management of cost toward sustainable housing delivery was designed through regression analysis to validate predictive ability of the model. The principal component analysis was used to reduce the factors to a sizeable form for establishing the relationship between the variables, and influence of predictor variables on dependent variables to establish the framework.

8.2 Miscellany of factors that impact formation of framework for sustainable housing delivery

These sections contain various factors that influence sustainable housing delivery and production techniques, discussed in reference to Chapters 6 and 7. To establish the framework for sustainable housing delivery for the smooth operation of housing production processes, and to achieve sustainable housing delivery for the people irrespective of income steadily, continuously and cost efficiently. In so doing, availability and affordability will be guaranteed. Hassan *et al.* (2010) have established critical success factors for sustainable housing and a framework for project management, explaining that housing is the critical issue in global development which has an incredible impact on the environment through planning, implementation and closeout stages of project production processes. According to Oyebanji *et al*. (2017), also establishing critical success factors for achieving sustainable social housing, the all-encompassing objective of social housing is to meet housing needs, particularly those of vulnerable households, low- and middle-

Table 8.1: To evaluate factors that inflate cost of sustainable housing delivery over budget

Concept	Issue addressed	Findings attained
To identify and establish factors that inflate cost of construction for sustainable housing delivery during production processes	Identified and established factors that causes increase in cost of construction above client budget	1. Availability of skilled workers on site (FACSH2)
		2. Financial management on housing production (FACSH5)
		3. Adequate planning for production (FACSH24)
		4. Cost of housing materials in the market (FACSH7)
		5. Technology advancement (FACSH1)
		6. Constant additional work without contractual procedure on cost of construction (FACSH9)
		7. High cost of machinery (FACSH8)
		8. Contract management on site (FACSH22)
		9. Contractual procedure for housing delivery (FACSH23)
		10. Frequent changes in design of housing during production (FACSH6)
		11. High cost of labour for production (FACSH16)
		12. Duration of housing construction (FACSH15)
		13. Fluctuation of price of housing materials (FACSH21)
		14. Economic stability influence (FACSH12)
		15. Inadequate coordination of design phase and construction phase during production (FACSH10)

income earners. The aim of the study conducted by Oyebanji *et al.* (2017) is to determine the critical success factors for achieving sustainable social housing from economic, social and environmental perspectives for meeting housing needs. To further clarify the significance of a framework of factors and techniques for sustainable housing delivery, Ibem and Aduwo (2015) established a framework for understanding sustainable housing for policy development and practical actions, explaining that despite the increasing knowledge surrounding sustainable development globally, one critical aspect of urban housing problems is that sustainable housing delivery is yet to gain wide acknowledgement as significant in developing nations, especially African nations.

The collection of factors from the findings in Chapters 6 and 7 are classified according to the objectives of the research study in Chapter 1 toward the establishment of a framework. The objectives are stated as follows: identify and evaluate factors that inflate cost of sustainable housing delivery over budget; identify and establish the factors that affect unsustainable design in delivery of sustainable housing within budget; evaluate and establish the impact of cost on management of construction resources in delivery of sustainable housing by construction operators; identify how budgeted cost could be effectively utilised without detrimentally impacting sustainable housing delivery, and; establish a framework for effective management of cost toward sustainable housing delivery for construction costs to remain within the limit of budgeted cost.

8.2.1 Objective one

The objective was to identify the major factors that inflate cost of sustainable housing delivery over budget. From the analysis in Chapters 6 and 7, the factors that inflate cost of sustainable housing delivery over budget were established, as indicated in Table 8.1 above.

8.2.2 Objective two

The objective was to establish the foremost factors that affect unsustainable design in delivery of sustainable housing within budget. The findings presented in Chapters 6 and 7 show the factors that affect unsustainable design in delivery of housing within budget, as shown in Table 8.2 below.

Table 8.2: To establish factors that affect unsustainable design in delivery of sustainable housing within budget

Concept	Issue addressed	Findings attained
To identify and establish factors that affect unsustainable design that usually causes frequent changes in design at construction stage	Identified and established the design factors that cause constant increase in cost of construction of sustainable housing delivery above client budget as a result of errors and omissions, and to achieve comfort, quality and cost-efficient housing	1. Improper design leads to failure in achieving client objectives (EFD19)
		2. Establish standard design for production (EFD6)
		3. Design of first-rate living conditions for a healthy environment (EFD25)
		4. Frequent changes of housing design by client affect construction cost (EFD26)
		5. Incorporating sustainable design principles (EFD1)
		6. Inadequate design affects cost of delivery (EFD24)
		7. Frequent changes to housing design cause variation (EFD20)
		8. Adequate design for new techniques will affect cost effective production (EFD22)
		9. Changes in design as a source of waste during production (EFD23)
		10. Design sufficiency and adaptable to meet people demand (EFD3)
		11. Constant promoting high standard design (EFD11)
		12. Design for better performance (EFD34)
		13. Complexity of design causes changes in design and affects cost (EFD33)
		14. Design for waste minimisation during production (EFD7)
		15. Design for implementation of new technology (EFD36)

8.2.3 Objective three

The objective was to establish the impact of cost on management of construction resources in delivery of sustainable housing by construction operators, with findings drawn from Chapters 6 and 7. In these sections, three issues were addressed – human, materials and equipment management – impacting management of construction resources on budgeted cost, as presented in Table 8.3 below.

Table 8.3: To identify the impact of cost on management of human, material and equipment resource in delivery of sustainable housing by construction operators

Human		
Concept	**Issue addressed**	**Findings attained**
To identify and establish factors that affect human resources in the management of construction cost toward sustainable housing delivery, to achieve cost efficiency, quality, affordable housing delivery, and increase productivity to achieve reduction in cost of construction	Identified and established the factors that affect human resources in the management of construction cost toward sustainable housing delivery; to achieve availability and affordability and continuous delivery of housing for people inexpensively.	1. Workforce productivities affect cost (ICMCR23) 2. Involvement of all team members in planning and implementation (ICMCR1) 3. Regular meetings on site for promoting efficient productivity (ICMCR4) 4. Team-building strategies for production (ICMCR10) 5. Prompt payment of wages by contractors will enhance productivity (ICMCR21) 6. Develop staffing management plan (ICMCR2) 7. Flexibility of construction operators in making timely management decisions on production (ICMCR29) 8. Skill to define effective techniques for achieving objectives (ICMCR28) 9. Skill to apply techniques for reduction in cost of construction during production (ICMCR24) 10. A sound knowledge on quality design decisions and implementation (ICMCR9) 11. Knowledge of good safety practices and awareness of personal safety during production (ICMCR27) 12. Constant emphasis on making maximum usage of local labour force to achieve housing production (ICMCR30) 13. Document delivery roles and responsibilities among construction team members (ICMCR3) 14. Ability of workforce to develop willingness in sustainability practices (ICMCR26) 15. Build trust among construction team members (ICMCR13)

Table 8.3 continued.

Materials		
Concept	**Issue addressed**	**Findings attained**
To identify and establish factors that affect materials resources in the management of construction cost toward sustainable housing delivery	Identified and established the factors that affect material resources in the management of housing production processes to avoid wastage and delays which increase cost of construction for affordable housing delivery	1. Quality of workmanship on materials will reduce waste (EMBC12)
		2. Late delivery of construction materials (EBMC6)
		3. Increase in the price of original materials specified causes the use of alternative materials (EBMC3)
		4. Insufficient of construction materials on site (EBMC7)
		5. Exchange rate of dollar affects time delivery (EMBC20)
		6. Scarcity of housing materials in the country lead to importation of materials with high price from another nations (EMBC8)
		7. Increase in price of construction materials (EBMC5)
		8. Use of foreign materials for housing construction has effect on budgeted cost (EBMC1)
		9. Use of materials that are environmentally friendly (EBMC4)
		10. Management plan for delivery of materials (EMBC15)
		11. Currency instability in the country affects prices of housing materials (EMBC24)
		12. Delay in importation of housing materials (EBMC2)
		13. Government regulation on housing materials usage affect (EMBC22)
		14. Project logbooks for records of activities and materials (EMBC17)
		15. Change in specification of materials during production (EMBC9)

Table 8.3 continued.

Equipment management		
Concept	**Issue addressed**	**Findings obtained**
To identify and establish factors that affect equipment management resources in the management of construction cost toward sustainable housing delivery for affordability and consistency in delivery.	Identified and established factors that affect equipment resources in the management of efficient housing production for enhancement of construction cost to avoid resources wastage, redundancy and idleness of operators on site, as these increase the cost of construction and have negative influences on sustainable housing delivery at cost efficiency.	1. Cost of transportation of equipment to site (EMMC2)
		2. Maintenance cost of equipment on site (EMMC1)
		3. Lack of proper planning for use of equipment (EMMC7)
		4. Planning for the use of equipment on site (EMMC17)
		5. Equipment delivery time during production process (EMMC3)
		6. Idleness of hiring equipment on site (EMMC8)
		7. Overhead cost attributable to the equipment, affect cost of construction (EMMC12)
		8. Constant increase in cost of purchasing equipment (EMMC10)
		9. Inadequate management of equipment (EMMC16)
		10. Cost of equipment and import duties (EMMC4)
		11. Site soil condition attracts the use of different equipment affect construction cost (EMMC11)
		12. Specific factory cost attributable to the equipment (EMMC6)
		13. Constant changes in hiring price of equipment (EMMC5)
		14. Faulty equipment on site for production (EMMC15)
		15. Procurement of appropriate equipment (EMMC13)

8.2.4 Objective four

The objective was to identify how budgeted cost could be effectively utilised without detrimentally impacting sustainable housing delivery, with findings extracted from Chapters 6 and 7. The factors that enhances effective utilisation of budgeted cost toward sustainable housing delivery were established, as indicated in Table 8.4 below.

Table 8.4: To ascertain how budgeted cost could be effectively utilised without detrimentally affecting sustainable housing delivery

Concept	Issue addressed	Findings attained
To identify and ascertain how budgeted cost could be effectively utilised without detrimentally impacting sustainable housing delivery in order to achieve quality; cost maintenance free; consistency and affordable housing	Identified and ascertained how budgeted cost could be effectively utilised without detrimentally impacting sustainable housing delivery; to achieve cost efficient housing, availability and affordability; and to maintain construction cost within constraint of the client budget	1. Teamwork on site for housing production (UEC27)
		2. Project schedule/timetable for production (EUC24)
		3. General progress report on housing process (UEC28)
		4. Flexibility integration into housing design to accommodate future demand and changes (EUC26)
		5. Longevity integrated at design stage to achieve reduction in future maintenance (UEC29)
		6. Recognise the close relationship between design and construction cost (EUC25)
		7. Work programme on site (EUC23)
		8. Regulate the true cost at planning stage (EUC9)
		9. Accurate furcating cost of housing production process at planning stage (EUC7)
		10. Adequate establishment of client objectives at briefing (EUC8)
		11. Determine level of impact of construction constraint at planning stage (EUC18)
		12. Proper design and construction coordination (EUC21)
		13. Establishment of procedure for funding delivery during production (EUC20)
		14. Consider vary in size and complexity of housing and construction cost (EUC22)
		15. Contract agreement by law during production (EUC10)

8.2.5 Objective five

The objective was to establish a framework for effective management of cost toward sustainable housing delivery in order for construction costs to remain within the limit of budgeted cost. The findings from objectives one, two, three and four, as indicated in Table 8.5, are the fundamental factors answerable for the effective management of cost at every stage of production processes toward achieving sustainable housing delivery. However, the subject matter of the findings obtained clearly point out the key facts of techniques and administration that will enhance continuous provision of sustainable housing within affordability, consistently within the constraint of budgeted cost of the client. This achievement will create housing for the people, irrespective of their source or size of income.

Table 8.5: Combination of fundamental factors that could be used to establish a framework for effective management of cost toward sustainable housing delivery for construction costs to remain within the limit of budgeted cost

Concept	Issue addressed	Findings attained
To establish a framework for effective management of cost toward sustainable housing delivery in order for construction cost to remain within the limit of budgeted cost.	Established a framework for effective management of cost toward sustainable housing delivery and key techniques and administration that will enhance effective production was entrenched in the findings obtained for availability and affordability of housing with cost efficient delivery, at accepted aim of the client and users	Collated findings
		Objective 1 findings (FACSH) Table 6.19
		Objective 2 findings (EFD) Table 6.21
		Objective 3 findings (ICMCR, EMBC, EMMC) Table 6.23,6,25 &6.27
		Objective 4 findings (UEC) Table 6. 29

8.3 Additional issues studied for the enhancement of sustainable housing delivery

8.3.1 Housing quality factors

The foremost factors impacting quality of sustainable housing delivery were established in order to complement the research study objectives and achieve comfort, longevity, quality, cost free maintenance, and worthy housing within the budget of the client. These findings are extracted from Chapters 6 and 7 of the study, as indicated in Table 8.6.

Table 8.6: Evaluate and establish critical factors of achieving quality sustainable housing delivery

Concept	Issue addressed	Findings attained
To evaluate and establish the critical factors of achieving quality sustainable housing delivery	Evaluated and established the critical factors of achieving quality sustainable housing delivery, and sustainable quality techniques for development of client and users aim and objectives, planned at briefing stage toward quality housing delivery	1. Quality assurance at implementation and closeout (CAQH8)
		2. Quality control during production process (CAQH7)
		3. Effective quality planning for affordable housing (CAQH9)
		4. Design housing for changing needs throughout the life of the occupants and not just for immediate needs (CAQH18)
		5. Consistent commitment to quality by all stakeholders (CAQH14)
		6. Quality sampling during production (CAQH5)
		7. Adequate design for provision of a safe, secure and healthy environment for the resident (CAQH13)
		8. Design and construction of housing to support services and amenities for the need of the people (CAQH1)
		9. Focus on quality sustainability throughout production process (CAQH15)
		10. Designing for comfort, cost efficient and easy maintenance (CAQH16)
		11. Design for affordable and maintainable (CAQH11)
		12. Identify quality requirement (CAQH6)
		13. Design housing for the use of renewable resources for cost effectiveness (CAQH17)
		14. Establishment of durability techniques during production (CAQH12)
		15. Establishment of resources efficient scheme for production (CAQH10)

8.3.2 Stakeholder influence on sustainable housing delivery

The principal factors impacting stakeholder needs and interest toward sustainable housing delivery were established. The practices of achieving the needs and the interest of client and users are adequately entrenched in those influencing factors; thus, techniques for implementing comfort, quality, quantity, cost efficiency, availability and affordability into housing production processes are clearly inputted into the findings. The findings are presented in Chapters 6 and 7 of the study for achieving sustainable housing delivery within an acceptable demand of the client and users.

Table 8.7: Evaluate and establish stakeholder influences on sustainable housing delivery

Concept	Issue addressed	Findings attained
To identify and establish stakeholder influences on sustainable housing delivery during production processes. To achieve teamwork, adequate consideration of needs and interest, allow free communication to close the gaps that causes rift and discord among the stakeholders and the construction operators.	Identified and Established the stakeholder's influences on sustainable housing delivery during production processes. To avoid litigation, argument, disunity, and enhances opinion integration into planning through effective communication on site. Hence, sustainable housing delivery will be achieved.	Matching stakeholders' interest towards requirements (SIH14)
		Adequate communication with stakeholders (SIH16)
		Establish stakeholders aim, needs, and objectives at planning stage (SIH12)
		Interact with stakeholders in a professional and cooperative manner (SIH9)
		Adequate handling area of specialisation toward implementation (SIH11)
		Impact on requirements (SIH10)
		Change course of production (SIH2)
		Establish degree of influence on timeline and increase in construction cost substantially (SIH13)
		Monitoring and evaluating housing project impact in relative to initial planning (SIH7)
		Sponsoring of housing project (SIH4)
		Establish a criterion to measure success in relative to stakeholders' interest (SIH15)
		Has varying levels of responsibility and authority (SIH1)
		Assessment of production process (SIH3)
		Identifying stakeholder and understanding their relative degree of influence on housing delivery (SIH6)
		Provide administrative support (SIH5)

8.4 Summary of key findings and relationship with aim and objectives of the research study

This section briefly explains the summary of findings and their relationship with the aim and objectives of the research study. Descriptive statistical analysis was carried out on the data as discussed in Chapter 6 and findings obtained were recorded according to each objective. Consequently, qualitative techniques were used to validate the findings obtained to determine with certainty if the instrument used measured what it was supposed to measure. Interviews were conducted among selected respondents drawn from construction companies registered under Construction Industry Development Board (CIDB) of South Africa under grade 3, 5 and 9, and operating as general building contractors (GB).

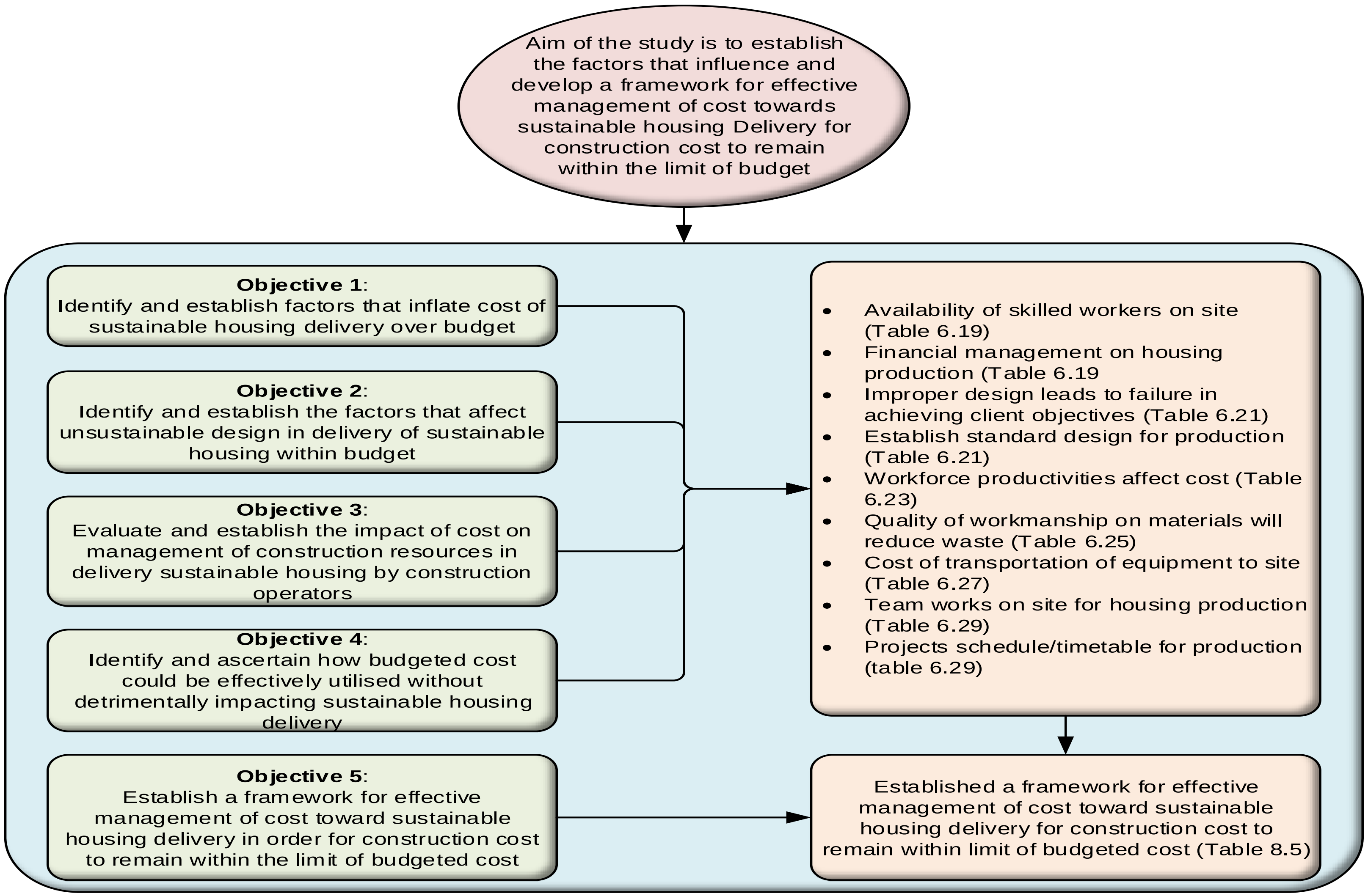

Figure 8.1: Summary of key findings in relationship with aim and objectives of the research study

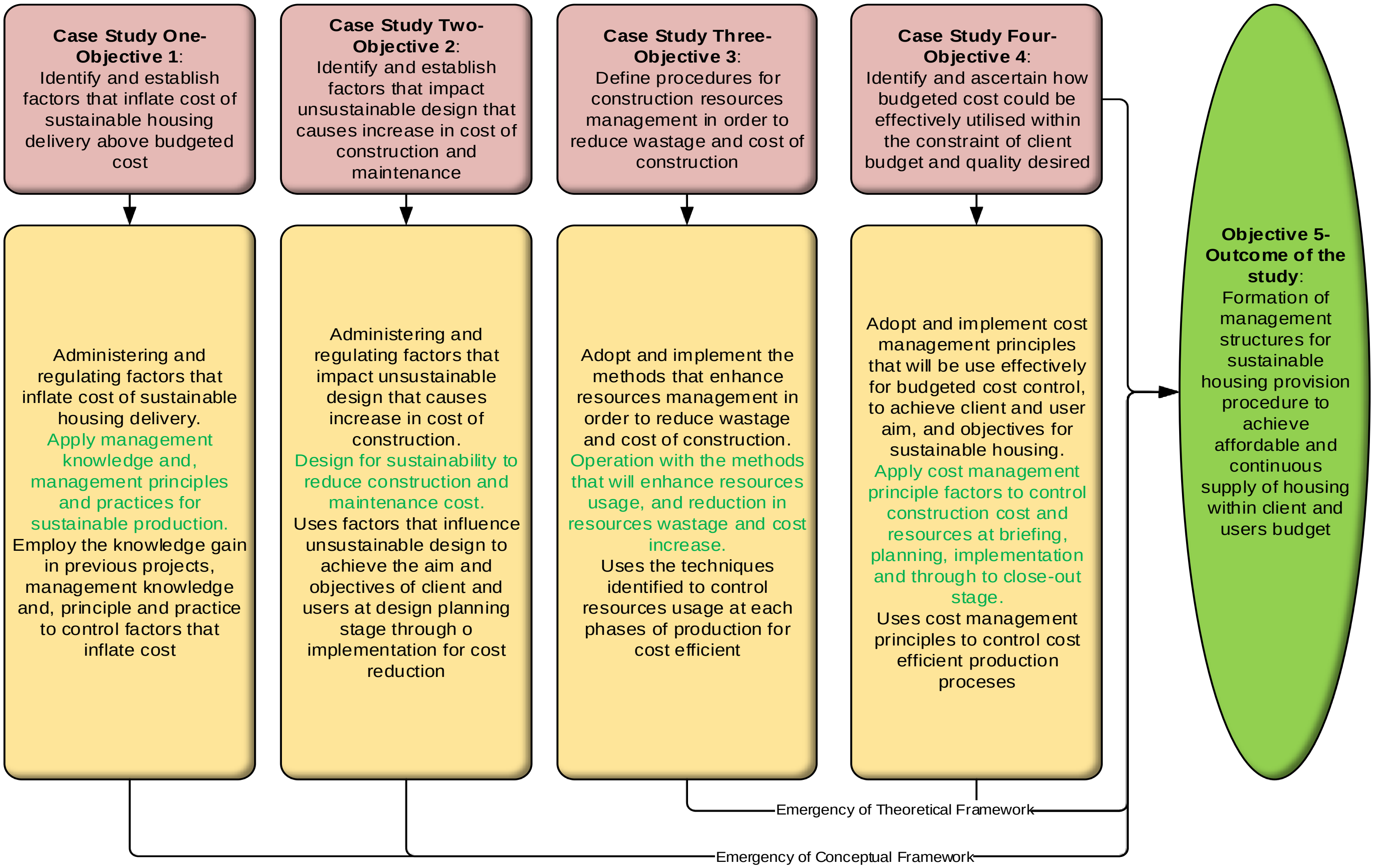

Figure 8.2: Establishment of operational techniques for the provision of sustainable housing within budget

Similarly, a representative of the Department of Human Settlement was interviewed to determine the validity of the findings obtained, because this is the government organisation responsible for the provision of affordable housing for the people. The outcomes of the interview were vividly explained in Chapter 7 of this study. The aim of this study is “to establish factors that influence and develop a framework for effective management of cost toward sustainable housing delivery for construction cost to remain within the limit of budget”. Following the establishing of five objectives from the literature reviewed, each objective helped achieve the aim of the research study, as depicted in Figure 8.1 and Figure 8.2. Figure 8.1 clearly explains how the objectives were used to achieve the aim of the study, and their corresponding relationships, while Figure 8.2 established effective operational techniques for the provision of sustainable housing delivery. Each objective instituted factors and techniques for the running and controlling the management of cost efficiency in order to provide sustainable housing within the budget of the client and users unceasingly and consistently.

8.5 Uses of factor and PCA analysis, correlation and logistic regression analysis

The basic reason for the use of these techniques has been discussed intensely in Chapter 5 of this study, section 5.6.7; justification for the use of PCA, correlation and logistic regression analysis is to establish a framework for effective management of cost toward sustainable housing delivery, to correlate the relationships among dependent variables, and to establish the predictors that influence the dependent variables.

8.5.1 Correlation among independent and dependent variables

Correlation analysis was carried out purposely to ascertain which variables are connected and define a relationship between two variables, thereby establishing a relationship among independent and dependent variables. This process was carried out purposely to determine which variables will be inputted into logistic regression for the establishment of a framework for sustainable housing delivery. Mukaka (2012) explains that *correlation* is a statistical method used to assess a possible linear relationship between two continuous variables; it is used to calculate and interpret any association of variables. In other words, correlation coefficients are used to assess the strength and direction of linear relationships between pairs of variables. There two correlation coefficients and known as Pearson’s correlation coefficient and Spearman’s correlation coefficient. Pearson’s correlation coefficient is used for the calculation of variables that are normally distributed. Whereas, Spearson’s correlation coefficient is more robust to outliers than Pearson’s correlation coefficient, one major concern about a correlation coefficient is that it does not communicate information about whether one variable moves in response to another. Therefore, there is no attempt to establish one variable as dependent and the other as independent; hence, correlation coefficients determine the relationships of two variables and facts about association of variables.

8.5.2 Logistic regression analysis

The basic significance of logistic regression is that it allows a researcher to test models to predict definite outcomes with two or more groups: the predictor (independent) variables can be either categorical or continuous or a mix of both in one model. However, the family of logistic regression techniques allow a researcher to explore the prediction ability of sets or block of variables, and to specify the entry of variables. Assumptions that need to be considered before logistic regression techniques can be used efficiently concern sample size, multicollinearity and outliers. Consequently, the assumption has been considered for this study as suggested by Pallant (2013) in order to achieve effective development of the framework. Pearce and Ferrier (2000) explain that though the use of statistical modelling techniques such as logistic regression is increasing, relatively little attention has been devoted to the development and application of appropriate evaluation techniques for assessing the predictive performance of a model. The evaluation of the predictive performance of model is a vital step in model development.

8.5.3 Independent and dependent variables used in this study

The independent and dependent variables used in this study are shown in Table 8.8.

Table 8.8: Dependent and independent variables

Dependent variables	**Independent (predictors) variables**
Cost increase as a result of variation in the housing project	Inadequate technique for sustainable housing cost -efficiency (FACSH9, FACSH10, FACSH11, FACSH17, FACSH18)
Timeframe for housing project delivery	Effective production of sustainable housing within budget (FACSH12, FACSH13, FACSH14, FACSH22, FACSH24, FACSH25)
	Sustainability design and integration to productivity (EFD7, EFD8, EFD10, EFD15, EFD15, EFD32, EFD33, EFD34, EFD35, EFD36)
	Design for sustainable adaptability and changes in needs of amenities (EFD1, EFD2, EFD3, EFD6, EFD23)

Table 8.8 continued.

Dependent variables	Independent (predictors) variables
	Adequate design for needs and within scope (EFD16, EFD19, EFD28, EFD29)
	Skilful knowledge for management of resources for cost efficient production (ICMCR1, ICMCR2, ICMCR3, ICMCR4, ICMCR7, ICMCR8, ICMCR9, ICMCR10, ICMCR11, ICMCR12, ICMCR13, ICMCR14, and ICMCR15)
	Ability to map out strategies for waste reduction and increase in productivity (ICMCR12, ICMCR13, ICMCR14, ICMCR17, and ICMCR18)
	Adequate planning for materials storage toward monitoring fluctuation in currency exchange rate (EBMC18, EBMC19, EBMC23, and EBMC24)
	Effective monitoring materials delivery strategies to avoid human resources wastage (EBMC2, EBMC3, EBMC5, EBMC6 and EBMC)
	Efficient materials transportation to site within time and inexpensive manner (EBMC15, EBMC17, and EBMC19
	Equipment maintenance within the constraint of budget (EMMC1, EMMC2, EMMC3, EMMC4)
	Adequate planning for the use of equipment on site to achieve effective productivity (EMMC14, EMMC15, EMMC16, EMMC17)
	Establishment of effective planning for cost efficient housing production (EUC3, EUC4, EUC6, EUC6, EUC7, EUC8, EUC9, EUC22, EUC23, EUC24, EUC25, EUC26, EUC27, EUC28, EUC29)
	Management of financial sustainability to achieve housing requirements specified (EUC1, EUC2, EUC11, EUC12, EUC13, EUC14, EUC15, EUC17)
	Establishment of quality planning and implementation for resources efficient for production processes (CAQH1, CAQH2, CAQH3, CAQH3, CAQH5, CAQH6, CAQH7, CAQH8)
	Design for safe, secure and health environment to achieve comfort of life of the occupants. (CAQH12, CAQH13, CAQH14, CAQH16, CAQH17, CAQH18)
	Type of housing (New housing project; Renovation of housing)

8.5.4 Presenting the results from correlation analysis between demographic characteristic and dependent variables

The correlation analysis between demographic characteristics and dependent variables (cost increase as a result of variations; housing project completion time) are checked, with results obtained shown in Table 8.9 indicating that ‘type of housing’ correlated with ‘housing project completion time’: the rho value is -0.207* and p value is 0.027, implying that the correlation has weak rho -0.207* while the p value 0.027 is highly significant. The other demographics, which can also be referred to as independent variables, did not correlate with cost increase as a result of variations and housing project completion time. Consequently, 'types of housing' is pulled into the model.

Pallant (2013) explains that correlation analysis is used to define the strength and dimension of the linear relationship between two variables. There are a number of different statistics available from SPSS, but the uses hinged on level of measurement.

Table 8.9: Correlation analysis between demographic characteristic and dependent variables

Spearman's rho		Cost increase as a result of variations		Housing project completion time	
Demographic		**rho**	**p value**	**rho**	**p value**
Years of working experience	Correlation coefficient	-0.119	0.208	-0.161	0.087
Respondent position	Correlation coefficient	-0.016	0.867	0.129	0.171
Years in current position	Correlation coefficient	-0.040	0.671	0.051	0.588
Type of housing	Correlation coefficient	-0.118	0.211	-0.207*	0.027
Housing usage	Correlation coefficient	-0.165	0.079	0.070	0.459
Contracting procedure used	Correlation coefficient	0.155	0.099	-0.060	0.528
Total AMR scores	Correlation coefficient	-0.091	0.336	-0.069	0.469

8.5.5 Multicollinearity test among the independent variables or checking correlation among the predictors

The correlation analysis was performed on the independent variables. The main purpose of carrying out the analysis is to check the correlation among the independent variables. The results, presented in Table 8.10, indicate that the independent variables are not highly correlated, but in fact, they all recorded weak correlations, implying that all the independent variables can be pulled into the model. According to Grewal *et al.* (2004), multicollinearity can cause problems under certain precise conditions. Multicollinearity can be extreme and unacceptable if higher between 0.6 and 0.8, as error rates can be substantial (greater than 50% and frequently above 80%). The error rate becomes negligible when multicollinearity is between 0.4 and 0.5, respectively. Consequently, the results in Table 8.10 indicate that independent variables (predictors) of multicollinearity range between 0.243 and 0.498, implying that error rate is negligible.

Table 8.10: Multicollinearity among the independent variables

		Cp1 cost	Cp2 cost	Cp1 design	Cp2 design	Cp3 design	Cp1 human	Cp2 human	Cp1 matral	Cp2 matral	Cp3 matral	Cp1 mahry	Cp2 mahry	Cp1 effint	Cp2 effint	Cp1 qulity	Cp2 qulity
Cp1 cost	Pearson corr	1															
Cp2 cost	Pearson corr	.406*** *															
Cp1 Design	Pearson corr	.194*	.462*** *														
Cp2 Design	Pearson corr	.518**	.308**	.397*** *													
Cp3 Design	Pearson corr	.431**	.342**	.516**	.382*** *												
Cp1 Human	Pearson corr	.328**	.406**	.400**	.362**	.786***											
Cp2 Human	Pearson corr	.305**	.348**	.318**	.307**	.290**	.334*** *										
Cp1 Material	Pearson corr	.332**	.285**	.446**	.346**	.432**	.333**	.406*** *									

Table 8.10 continued

		Cp1 cost	Cp2 cost	Cp1 design	Cp2 design	Cp3 design	Cp1 human	Cp2 human	Cp1 matral	Cp2 matral	Cp3 matral	Cp1 mahry	Cp2 mahry	Cp1 effint	Cp2 effint	Cp1 qulity	Cp2 qulity
Cp2 Material	Pearson corr	.386**	.192*	.237*	.246**	.277**	.306**	.568**	.296***								
Cp3 Material	Pearson corr	.288**	.244**	.320**	.274**	.409**	.247**	.311**	.436**	.317***							
Cp1 Macinery	Pearson corr	0.123	.197*	.394**	.456**	.325**	.356**	.391**	.365**	.201*	.333***						
Cp2 Macinery	Pearson corr	.532**	.418**	.211*	0.117	.416**	.404**	.351**	.505**	.351**	0.173	.248***					
Cp1 Effective	Pearson corr	.307**	0.123	0.174	.259**	.289**	.207*	.226*	.475**	.363**	.248**	.284**	.466***				
Cp2 Effective	Pearson corr	.247**	.239*	.376**	.338**	.487**	.518**	.530**	.375**	.327**	.342**	.328**	.498**	.243***			
Cp1 Quality	Pearson corr	.352**	.285**	.404**	.243**	.392**	.466**	.280**	0.169	0.155	0.152	.294**	.300**	0.104	.427***		
Cp2 Quallity	Pearson corr	.372**	.407**	.397**	.382**	.786**	.334**	.406**	.296**	.317**	.333**	.248**	.466**	.243**	.427***		

Key to table:

As the names of the variables are coded/abbreviated purposely for analysis, the full name of the variables are given as follows: Cp1 cost = *Inadequate technique for sustainable housing cost - efficiency*; Cp2 cost = (*unsatisfactory production of sustainable housing over budget*); Cp1 design = *Sustainability design and integration to productivity*; Cp2 design = *Design for sustainable adaptability and changes in needs of amenities*; Cp3 design = *Adequate design for needs and within scope* ; Cp1 human = *Skilful knowledge for management of resources for cost efficient production*; Cp2 human = *Ability to map out strategies for waste reduction and increase in productivity*; Cp1 materials = *Fluctuation of materials price*; Cp2 materials = *Scarcity and cost of materials*; Cp3 materials = *Inadequate materials management plan* Cp1 machinery = *Equipment maintenance within the constraint of budget*; Cp2 machinery = Adequate planning for the use of equipment; Cp1 effective = Establishment of effective planning for budgeted cost usage; Cp2 effective = *Management of financial sustainability*; Cp1 quality = Establishment of quality planning and implementation; Cp2 quality = Design for safe, secure health environment.

8.6 Presenting results obtained from regression analysis (testing the predictive ability of the predictors on dependent variables ‘cost increase as a result of the variations’ & ‘housing project completion time’)

8.6.1 Case processing summary

Table 8.11 presents the details of the sample size used in this study, as the number of selected cases involved is 114, analysed and recorded at 100%.

Table 8.11: Case processing summary

Unweighted cases		**N**	**Percent**
Selected cases	Included in analysis	114	100
	Missing cases	0	0
	Total	114	100
Unselected cases		0	0
Total		**114**	**114**

8.6.2 Depending variables encoding

Table 8.12 shows how SPSS has dealt with the coding of the dependent variable (cost increase as a result of variations); to achieve adequate results, the Yes and No used in the questionnaire section D was recorded, as suggested by Pallant (2013), newly coded using 0 and 1. Table 8.12 shows that Yes represents 1, and No represents 0. The interpretation of this coding is that Yes indicates that the respondents confirmed that there is cost increase as a result of variations in delivery of sustainable housing on their sites. The No is a confirmation by the respondents that there was no cost increase as a result of variations in delivery of sustainable housing on their sites.

Table 8.12: Dependent variables encoding

Original value	Internal value
No	0
Yes	1

8.6.3 Classification table [a,b]

Table 8.13 displays the overall percentage of cases that were correctly classified, 86.8%, implying that all the respondents working in housing project sites will have challenges of cost increase as a result of variation because of the high percentage indicated in Table 8.13.

Predicted.

Cost increase as a result of variation.

Table 8.13: Classification table [a,b]

Observed	No	Yes	Percentage correct
Step of cost increase as a result variation	0	15	0
	0	99	100.0
Overall percentage			**86.8**

8.6.4 Omnibus test of model coefficients

The Omnibus test in this study gives an overall indication of how the intended framework will perform, with results shown in Table 8.14 termed as ‘goodness of fit test’ because the significant value is .013 which is less than .05, hence, $p<0.013$. This implies that the model which the variable used as predictors is far better than the SPSS original guess, which assumed cost increase as a result of variation. The chi-square value as recorded in Table 8.14 is 13.059 with 16 degrees of cost increase as a result of variation.

Table 8.14: Omnibus test of model coefficients

		Chi-square	df	Sig
Step1	Step	31.059	16	.013
	Block	31.059	16	.013
	Model	31.059	16	.013

8.6.5 Hosmer and Lemeshow test

The Hosmer and Lemeshow test used in the study supported the model as valuable; SPSS clarified the test as the most reliable test for discovery of the fitness of model. However, Pallant (2013) explains that the Hosmer Lemeshow goodness of fit must be above .05 to support a model. The results of the Hosmer Lemeshow goodness of fit test performed in this study is 10.043, with a significance level of .262. The inference drawn from the results in Table 8.14 show the value is greater than .05 thereby confirming support of the model.

Table 8.15: Hosmer and Lemeshow test

Step	Chi-square	Df	Sig
	10.043	8	.262

8.6.6 Model summary

Table 8.16 shows facts about the usefulness of the model, thus the Cox & Snell R Square and the Nagelkerke R Square values provide an indication of the number of variations in the dependent variables explained by the model (from a minimum value of 0 to a maximum of approximately 1), describing the Pseudo R Square statistics. The value of Cox & Snell R Square and Nagelkerke R Square is .238 and .44, respectively, implying that between 23.8% and 44.1% the variability is explained by the set of variables.

Table 8.16: Model summary

Step	-2 Log Likelihood	Cox & Snell R Square	Negelkerke R Square
1	57.719	.238	.441

8.6.7 Classification table [a] – output

Table 8.17 shows how well the model is able to predict the correct category of cost increase as a result of variation, and no cost increase as a result of variation. The results shown in Table 8.16 can be compared with the classification of table [a,b] (Table 8.12) to confirm how much improvement was achieved when the predictor variables are included in the model. Results in Table 8.16 show that the model correctly classified 92.1% (referred to as Percentage as in Classification PAC), confirming an improvement over the 86.8% in Table 8.12.

Predicted.

Cost increase as a (result of Variation).

Table 8.17: Classification table [a,b]

Observed	No	Yes	Percentage correct
Step 0 cost increase as a result variation	7	8	46.7
	1	98	99.0
Overall percentage			**92.1**

8.6.8 Predictive ability of the model

Table 8.18 displays information about the predictive ability of the model. Each of the predictor variables must be checked. Moreover, the Sig value that is less than .05 must be checked for. This will confirm the variables that contribute significantly to the predictive ability of the model. Consequently, two significant variables were identified, including *inadequate materials management plan* and *establishment of effective planning for budgeted cost usage.* The two predictors have p<.044 and p<.037, respectively, as these are the major variables that impact cost increase as a result of a variation for sustainable housing project delivery within budgeted cost.

Considering the B value, Exp(B) and 95.0%CI for Exp (B), the B value in the table recorded .917 against p<.044 and .195 against p<.037. The two B values have a positive value, implying that the respondents say Yes there is cost increase as a result of variation toward sustainable housing delivery.

Table 8.18: Predictive ability of the model (cost increase as a result of variations)

Predictor Variables (abbreviated)	B	SE	Wald	df	Sig	Exp(B)	95% C.I for Exp(B)	
							Lower	Upper
Step[a] Inadequate technique for sustainable housing cost efficiency (cost)	-.313	.211	2.212	1	.137	.731	.484	1.105
Unsatisfactory production of sustainable housing over budget (cost)	-.364	.293	1.542	1	.214	.695	.391	1.234
Sustainable design and integration to productivity (Design)	.080	.097	.676	1	.411	1.083	.896	1.310
Design for sustainable adaptability and change in need of amenities	.459	.265	2.990	1	.084	1.582	.941	2.661
Inadequate design for needs and scope causes failures (Design)	-.243	.284	.735	1	.391	.784	.450	1.367
Skilful knowledge for management cost efficient (Human Resources)	.168	.150	1.252	1	.263	1.183	.881	1.589
Ability to map out strategies for waste reduction and increase in productivity (Human Resources)	-.493	.822	.359	1	.549	.611	.122	3.060
Fluctuation of materials price (Material resources)	-.036	.277	.017	1	.897	.965	.561	1.660
Scarcity and cost of materials (Material Resources)	.306	.260	1.388	1	.239	1.358	.816	2.258
Inadequate materials management plan (Material Resources)	.917	.455	4.067	1	**.044**	2.503	1.026	6.104
Equipment maintenance within the constraint of budget (Resource Equipment)	.022	.199	.012	1	.911	1.022	.693	1.509
Adequate planning for the use of equipment (Resource Equipment)	-.151	.278	.294	1	.588	.860	.499	1.483
Management of financial sustainability (Effective Utilisation)	-.364	.189	3.718	1	.054	.695	.480	1.006
Establishment of effective planning for budgeted cost usage (Effective Utilisation)	.195	.093	4.350	1	**.037**	1.215	1.012	1.459
Establishment of quality planning and implementation (Quality Control)	-.190	.179	1.128	1	.288	.827	.582	1.174
Design for safe, secure health environment (Quality Control)	.061	.158	.146	1	.702	1.062	.779	1.449
Constant	3.955	3.428	1.331	1	.249	.019	.484	1.105

As the Exp(B) column talks about the odds ratio for each of the independent variables in this study, the odds of a respondents answering Yes to cost increase as a result of variation is 2.503 and 1.215, respectively higher for the respondents who say No, there is no cost increase as a result of variations toward sustainable housing delivery within budget.

Table 8.18 shows a 95% confidence interval, 95.0%CI for Exp (B) having Lower and Upper values, the confidence interval for variables of cost increase as a result of variation (*establishment of effective planning for budgeted cost usage*-OR 1.215). The *Confidence Interval* of the two independent variables ranges between 1.026 to 6.104 and 1.012 to 1.459, respectively. With p value of p<.044 and p<.037 for-OR=2.503 and Management FSHRS-Effective utilisation-OR=1.215, cost increase as a result of variations in housing delivery was predicted by *inadequate materials management plan*-OR 2.503 and *establishment of effective planning for budgeted cost usage*-OR1.215. Consequently, on this basis of cost increase as a result of variations in housing delivery predicted by independent variables in bold letters in Table 8.18, that framework for effective management of cost toward sustainable housing delivery was established (as shown in Figure 8.3). A logistic regression test analysis on the predictors' variables ascertained its predictive power on dependent variables (completion time) toward sustainable housing delivery within budget

The similar details case processing summary has been discussed in descriptive statistics in section 6.2.2.1, but for the purpose of clarity, it will be discussed briefly here.

8.7.1 Case processing summary

Table 8.19 presents the differing time that the respondents completed housing project delivery on site. The respondents who completed projects within timeframe, above time specified, were clearly depicted in the table; likewise, those respondents not yet completing their housing projects were made known in the table, with similar details of explanation in section 6.2.1.1.

Table 8.19: Case processing summary

		N	Marginal percentage
Project completion time	Within timeframe	59	51.8%
	Above time specify	20	17.5%
	Below time specify	11	9.6%
	Not yet completed	24	21.1%
Type of housing	New housing project	93	81.6%
	Renovation of housing	21	18.4%
Valid		114	100.0%
Missing		0	
Total		**114**	

8.7.2 Model fitting information

Table 8.20 presents model fitting criteria, -2log likelihood, and Likelihood Ratio test, with results obtained as follows: 2log likelihood is 273.574, 129.967 and the Chi-square value result is 143.61. With 51 degrees of completion within time frame, the p<.005 implies the model fitting suitably.

Table 8.20: Modelling fitting information

Model	Model Fitting Criteria -2Log Likelihood	Likelihood Ratio Test		
		Chi-Square	df	Sig
Intercept only	273.574			
Final	129.967	143.607	51	000

8.7.3 Goodness-of-Fit-Hosmer-Lemeshow Test

With the Hosmer-Lemeshow Test for the Goodness of Fit, the results obtained, presented in Table 8.21, indicate the Chi-square as 198.66 with a significance level .276, and 129.97 with a significance level .276 of completion within time sustainable housing project, p=1, greater than .05, signifying that the model is well supported and fitting.

Table 8.21: Goodness of fit

	Chi-Square	df	Sig
Pearson	198.655	276	1.000
Deviance	129.967	276	1.000

8.7.4 Predictive ability of the model (project completion within time)

Table 8.22 shows the Bvalue, Wald. Exp(B) and 95% confidence intervals in Exp(B) for regression analysis between completion time and independent variables. The results obtained are as follows: Bvalue is -.517 negative, pointing toward the fact that the more the respondent practices the implementation of effective housing production, this will enhance delivery of sustainable housing within time. Another Bvalue is .420 positive, denoting that the respondents claim that sustainable housing is delivered within timeframe. In addition, Bvalue -4.181 negative, implies that type of housing will influence delivery within time.

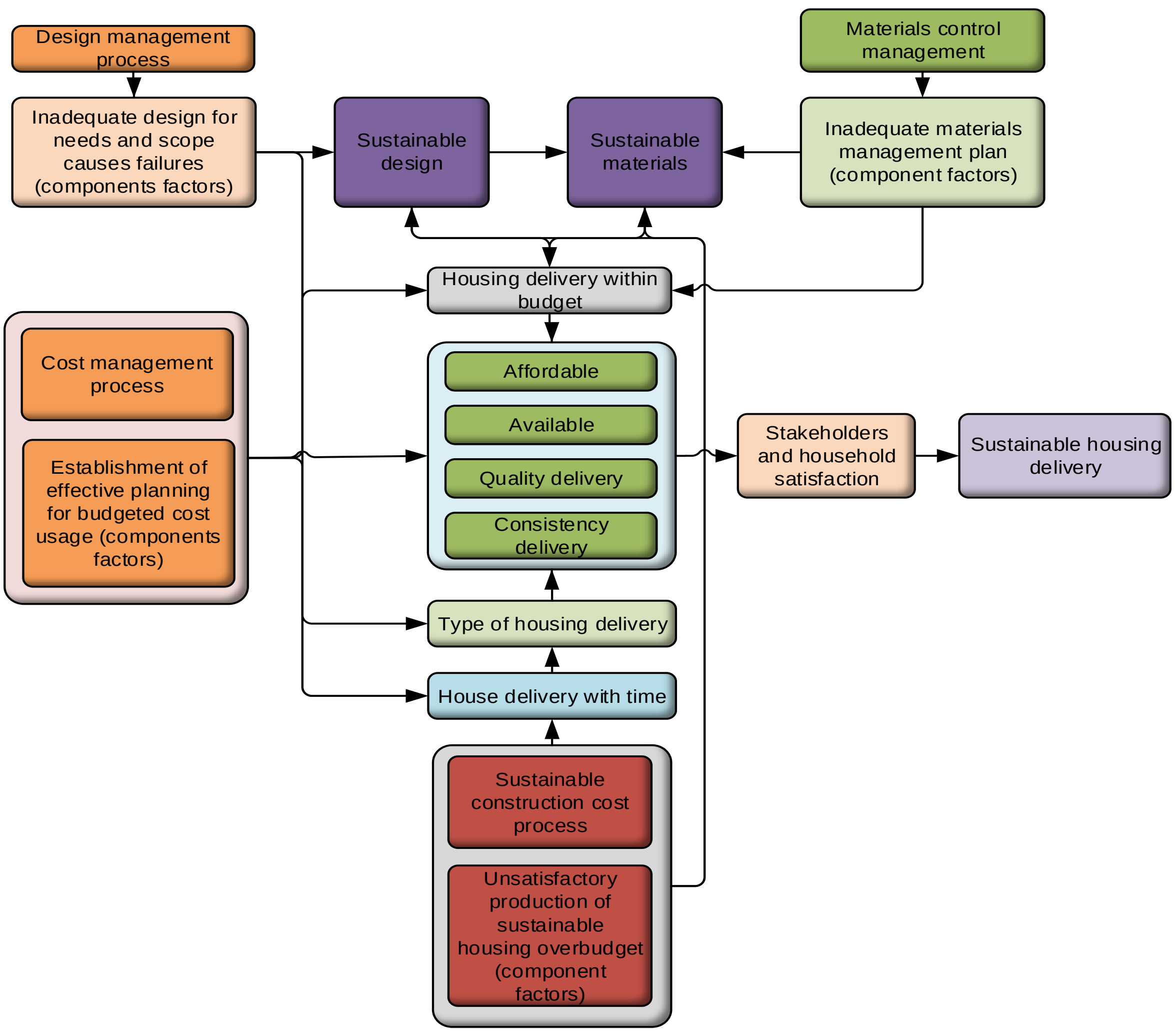

Figure 8.3: Framework for effective management of cost toward sustainable housing delivery (objectives linked to research concept)

Table 8.22: Predictive ability of the model (project completion within time)

Predictor variables (abbreviated)	**B**	**Std. error**	**Wald**	**df**	**Sig**	**Exp(B)**	**95% C.I for Exp(B)**	
							Lower Bound	**Upper Bound**
Within Timeframe Intercept	3.179	3.672	.750	1	. 387			
Step[a] Inadequate technique for sustainable housing cost efficiency (cost)	.252	.147	2.912	1	.088	1.286	.963	1.717
Unsatisfactory production of sustainable housing over budget (cost)	-.517	.226	5.250	1	**.022**	.596	.383	.928
Sustainable design and integration to productivity (Design)	-.021	.104	.041	1	.839	.979	.798	1.201
Design for sustainable adaptability and change in need of amenities	-.209	.208	1.018	1	.313	.811	.540	1.218
Inadequate design for needs and scope causes failures (Design)	.420	.178	5.555	1	**.018**	1.522	1.073	2.157
Skilful knowledge for management cost efficient (Human Resources)	-.099	.162	.371	1	.543	.906	.659	1.245
Ability to map out strategies for waste reduction and increase in productivity (Human Resources)	-.753	.725	1.080	1	.299	.471	.114	1.949
Fluctuation of materials price (Material Resources)	.345	.236	2.134	1	.144	1.412	.889	2.244
Scarcity and cost of materials (Material Resources)	-.219	.198	1.214	1	.271	.804	.545	1.186
Inadequate materials management plan (Material Resources)	.084	.321	.069	1	.793	1.088	.580	2.040
Equipment maintenance within the constraint of budget (Resource Equipment)	-.248	.223	1.245	1	.264	.780	.504	1.207
Adequate planning for the use of equipment (Resource Equipment)	.401	.219	3.367	1	.067	1.493	.973	2.292
Management of financial sustainability (Effective Utilisation)	-.212	.144	2.163	1	.141	.809	.610	1.073
Establishment of effective planning for budgeted cost utilisation (Effective Utilisation)	.107	.072	2.184	1	.139	1.112	.966	1.281
Establishment of quality planning and implementation (Quality Control)	.159	.131	1.488	1	.222	1.173	.908	1.515
Design for safe, secure health environment (Quality Control)	.032	.145	.049	1	.825	1.033	.777	1.372
Type of housing	-4.181	1.600	6.826		.009	.015	.001	.352
Type of housing	0[b]	.	.		.	.	.	.

Table 8.23: Predictive ability of the model (project completion above time)

Predictor variables (abbreviated)	B	Std. error	Wald	df	Sig	Exp(B)	95%C.I.for Exp(B)	
							Lower Bound	Upper Bound
Above Timeframe Intercept	8.138	4.535	3.220	1	.073			
Inadequate technique for sustainable housing cost efficiency (cost)	-.012	.186	.004	1	.949	.988	.686	1.423
Unsatisfactory production of sustainable housing over budget (cost)	.004	.288	.000	1	.988	1.004	.571	1.766
Sustainable design and integration to productivity (Design)	-.392	.138	8.096	1	.004	.676	.516	.885
Design for sustainable adaptability and change in need of amenities	-.058	.255	.053	1	.819	.943	.572	1.554
Inadequate design for needs and scope causes failures (Design)	.235	.218	1.162	1	.281	1.266	.825	1.942
Skilful knowledge for management cost efficient (Human Resources)	-.020	.222	.008	1	.927	.980	.634	1.515
Ability to map out strategies for waste reduction and increase in productivity (Human Resources)	-.458	.902	.258	1	.612	.632	.108	3.707
Fluctuation of materials price (Material Resources)	-.230	.242	.904	1	.342	.794	.494	1.277
Scarcity and cost of materials (Material Resources)	.383	.278	1.908	1	.167	1.467	.852	2.528
Inadequate materials management plan (Material Resources)	.234	.390	.362	1	.548	1.264	.589	2.713
Equipment maintenance within the constraint of budget (Resource Equipment)	.135	.263	.265	1	.606	1.145	.684	1.917
Adequate planning for the use of equipment (Resource Equipment)	-.232	.242	.920	1	.337	.793	.494	1.273
Management of financial sustainability (Effective Utilisation)	-.312	.217	2.073	1	.150	.732	.478	1.120
Establishment of effective planning for budgeted cost usage (Effective Utilisation)	.140	.103	1.854	1	.173	1.151	.940	1.409
Establishment of quality planning and implementation (Quality Control)	.003	.141	.000	1	.984	1.003	.760	1.323
Design for safe, secure health environment (Quality Control)	.075	.160	.222	1	.638	1.078	.788	1.476
Type of housing	-1.634	1.821	.805		.370	.195	.006	6.925
Type of housing	0[b]	.	.		.	.	.	.

Table 8.24: Predictive ability of the model (project completion below time)

Predictor variables (abbreviated)	B	Std. error	Wald	df	Sig	Exp(B)	95%C.I.for Exp(B)	
							Lower Bound	Upper Bound
Below Time Frame Intercept	-894.731	.000	.	1	.			
Step[a] Inadequate technique for sustainable housing cost efficiency (cost)	67.370	18100.396	.000	1	.997	181288783148024530000000000000.000	.000	.c
Unsatisfactory production of sustainable housing over budget (cost)	21.864	25218.844	.000	1	.999	3128466290.843	.000	.c
Sustainable design and integration to productivity (Design)	28.817	27121.847	.000	1	.999	3273750110425.515	.000	.c
Design for sustainable adaptability and change in need of amenities (Design)	-25.074	29813.535	.000	1	.999	1.289E-11	.000	.c
Inadequate design for needs and scope causes failures (Design)	-3.921	20433.095	.000	1	1.000	.020	.000	.c
Skilful knowledge for management cost efficient (Human Resources)	-22.868	24220.380	.000	1	.999	1.171E-10	.000	.c
Ability to map out strategies for waste reduction and increase in productivity (Human Resources)	-78.171	81120.277	.000	1	.999	1.124E-34	.000	.c
Fluctuation of materials price (Material resources)	70.519	41284.061	.000	1	.999	4224886354919216000000000000000.000	.000	.c
Scarcity and cost of materials (Material Resources)	-4.660	19215.806	.000	1	1.000	.009	.000	.c
Inadequate materials management plan (Material Resources)	-181.196	50199.963	.000	1	.997	2.029E-79	.000	.c

Table 8.24 continued

Predictor variables (abbreviated)	B	Std. error	Wald	df	Sig	Exp(B)	95%C.I.for Exp(B)	
							Lower Bound	Upper Bound
Equipment maintenance within the constraint of budget (Resource Equipment)	5.896	9727.781	.000	1	1.000	363.702	.000	.c
Adequate planning for the use of equipment (Resource Equipment)	15.209	27402.043	.000	1	1.000	4029097.107	.000	.c
Management of financial sustainability (Effective Utilisation)	34.382	21213.514	.000	1	.999	855163416119228.500	.000	.c
Establishment of effective planning for budgeted cost usage (Effective Utilisation)	18.933	8855.685	.000	1	.998	166867714.047	.000	.c
Establishment of quality planning and implementation (Quality Control)	32.873	13749.488	.000	1	.998	189046625506170.060	.000	.c
Design for safe, secure health environment (Quality Control)	-70.170	32150.341	.000	1	.998	3.354E-31	.000	.c
Type of housing	-213.593	.000	.		.	1.730E-93	1.730E-93	1.730E-93
Type of housing	0b	.	.		.	.	.	.

The Exp(B) values are the odds ratio (OR) for independent variables, the odd ratio for the three independent variables are .596, 1.522. and .015 (Table 8.21) displays 95% confidence interval (95.0% C.I. for Exp(B) given lower bound and upper bound; therefore, results in Table 8.21 reveal a confidence interval in which sustainable housing completed within time frame as (Unsatisfactory production of sustainable housing over budget-cost OR -.596) ranges from .383 to .928 and (Inadequate design for needs and scope causes failures-Design OR 1.522) ranges from 1.073 to 2.157, and (type of housing OR .015) ranges from .001 to .352, p<.022, p<.018 and p<.009, respectively. Hence, sustainable housing delivery and completion within time was predicted by 'unsatisfactory' production of sustainable housing over budget-cost OR-596*,* Inadequate design for need and scope causes failure (Design) OR 1.522 = *type of housing* OR .015 = *New housing project* and *Renovation of housing.* On the basis of housing delivery within time predicted by independent variables in bold letters (Table 8.21) that framework for effective management of cost toward sustainable housing delivery was established, as shown in Figure 8.3 above.

8.7.5 Predictive ability of the model housing project completion above and below time

Table 8.22 and Table 8.23 show that predictive ability of the model project completion above and below time, with results confirming that all predictors have a p value above 0.05, implying that project completion above and below time were not predicted by the predictors.

Key to Figure 8.3.

The list of component factors that predicted cost increase as a result of variation and housing delivery within timeframe:

<u>Unsatisfactory production of sustainable housing over budget – component factors:</u>

FACSH12: Economic stability influence

FACSH13: Cost of insurance for housing production process

FACSH14: Government policies on housing

FACSH24: Adequate planning for production

FACSH25: Competency of government agents on housing development

Inadequate design for needs and scope causes failures – component factors:

EFD16: Inadequately defined scope of work for contractors causes change in housing design during production

EFD19: Improper design leads to failure in achieving client objectives

EFD28: Poor communication among design team and contractor at planning stage causes changes in design

EFD29: Non-involvement of contractors at initiating stage of design planning causes frequent changes in design

Inadequate materials management plan – component factors:

EBMC15: Management plan for delivery of materials

EBMC17: Project log books for records of activities and materials delivery

EBMC19: Cost of transportation and distribution of materials to site

Establishment of effective planning for budgeted cost usage – component factors:

EUC1: Establishment of stakeholder interest

EUC2: Improvement on construction operator productivity

EUC11: Establish restraint methods toward increased budgeted cost at implementation stage

EUC12: Set requirements before life cycle cost at planning and implementation stages

EUC13: Site activities plan for cost estimate

EUC14: Objectivities of financial sustainability

EUC15: Cost control plans for production

EUC17: Establishment of cost control base on site

8.7 Chapter summary

The chapter presents the establishment of an effective framework for management of cost toward sustainable housing delivery, by assessing factors that impact formation of framework for sustainable housing delivery. The chapter also explains how the objectives of the research study were achieved, itemising those factors significant to each objective the under the concept, with issues addressed and findings obtained. Consequently, the chapter explains how the main objectives of the study were achieved through a number of figures.

The use of correlation analysis to determine correlation between dependent variables was clearly stated and the result obtained through the correlation were also explained. Similarly, a logistic regression analysis result was depicted clearly in this chapter. The factors under dependent and independent variables are discussed, and factors that predict cost increase and time delivery of housing projects was explained in the chapter. This chapter discussed the information provided throughout Chapter 6, and on this basis, the outcome of descriptive statistics was established in relationship with the objectives of the study. A summary of key findings in relationship with the aim and objectives of the research study was presented in this chapter; similarly, operational techniques for the provision of sustainable housing within budget were talked over in this chapter. Furthermore, this chapter discoursed about the management code for enhancement of construction operator performance, including a guide toward planning and implementation of requirements. As a forerunner to Chapter 9, and on the basis of information made available in Chapter 8, conclusions and recommendations are established in Chapter 9 for achieving stainable housing delivery.

CHAPTER NINE

9. CONCLUSIONS AND RECOMMENDATIONS

9.1 Introduction

This chapter is comprised of the summary of research findings, after all necessary techniques of researching were observed. Relevant literature was consulted and reviewed, with some principles and ideas abstracted from the literature and included in the study. The comprehensive literature review provided a better understanding of sustainable housing delivery techniques, and the significance of techniques to construction operators. Based on this available facts and research findings, a framework for sustainable housing delivery within budget was established. The concluding aspects of the research study are presented and recommendations made in reference to the findings obtained. Thereafter, the contributions of the study to the existent body of knowledge were adequately presented, and the limitations of the study clearly explained.

9.2 Revision of the research intent in reference to the research objectives

Chapter 1 of this study contains the main research question, which states: *How can affordable housing be delivered within budgeted cost through sustainable design, methods and practices during production processes*? In order to provide a solution to this research question, five objectives identified in this study were adequately studied, and findings presented accordingly. These objectives are as follows:

- to identify factors that inflate cost of sustainable housing delivery over budget;
- to establish the factors that affect unsustainable design in delivery of sustainable housing within budget;
- to found the impact of cost on management of construction resources in delivery of sustainable housing by construction operators;
- to ascertain how budgeted cost could be effectively utilised without detrimentally impacting sustainable housing delivery; and
- to establish a framework for effective management of cost toward sustainable housing delivery with construction cost remaining within the limit of budgeted cost.

The achievement of these research objectives is pivoted on an extensive review of literature, with the purpose of gaining insightful knowledge of the challenges affecting affordable housing delivery. Through the process, methods applied by previous researchers were adapted to determine the problems that degrade the effective production of sustainable housing delivery. Hence, this thesis focuses on the investigation of construction cost issues, unsustainable design, construction resource management issues, construction constraint issues and sustainability integration techniques for effective affordable housing production processes within budget. This investigation was initiated to determine the best way to deliver affordable housing for all people, irrespective of their income.

The process adopted for achieving the research objectives is sequential mixed method, which includes quantitative and qualitative methods. Data collected through these techniques were thoroughly evaluated and analysed with statistical tools such as descriptive and frequency statistics analysis, PCA, correlation and logical regression analysis. Findings deduced from these methods were used to attain the objectives of this study.

9.2.1 Factors that inflate cost of sustainable housing delivery over budget (objective one)

Objective one of this study was achieved through the investigation of factors that inflate cost of sustainable housing delivery over budget. Relevant literature was studied to guide the approach required to attain the first objective of the study and arrive at an appropriate conclusion. The relevant information is in chapter 6 and 8. However, twenty-five factors were determined as major causes of cost inflation in sustainable housing delivery over budget in South Africa. The factors were rated by the respondents and analysed through descriptive statistical analysis and principal component analysis (PCA). Results obtained from the application of the PCA determined the list of factors that inflate cost of sustainable housing delivery. These factors were grouped into two component factors under the *inadequate techniques for sustainable housing cost efficiency* and *unsatisfactory production of sustainable housing over budget.* Correlation and logistic regression analysis was applied to predict the component factors that influence housing project completion within time under *unsatisfactory production of sustainable housing over budget* with predictive ability of a sig value .022 of the model; the framework was established on this basis. These established factors are significant toward cost-efficient production and enhancing construction operator performance in controlling construction cost inflation within budgeted cost in South Africa.

9.2.2 Factors that affect design in delivery of sustainable housing within budget (objective two)

Objective two of this study was significantly achieved through identified factors causing unsustainable design in the housing delivery in South Africa. This was determined through a review of literature related to unsustainable design practices and the application of descriptive statistics and principal component analysis (PCA). Thirty-six factors were determined and categorised into three component factors by the PCA. The variables were grouped into three components and classified into component factors under *sustainable design integration to productivity, design for sustainable adaptability,* and *change in need of amenities, and inadequate design for needs and scope causes failures*. Correlation and logistic regression analysis method was used to predict the component factor that predicts the factors affecting unsustainable design in delivery of sustainable housing within budget. The component factor, *inadequate design for needs and scope causes failure,* has a predictive ability of sig value .018 of the model that predicts housing project delivery within time, so that construction costs will remain within budgeted cost. The significance of establishing these factors is to augment sustainable practices of stakeholder working in the South African construction industry for effective production of housing within cost constraint, and reducing high construction costs. The framework was, therefore, established on this basis, and the relevant information as regards the achievement of this objective is in chapter 6 and 8 of this study.

9.2.3 Impact of cost on management of construction resources in delivery of sustainable housing by construction operators (objective three)

Objective three was established on the adequate review of literature concerning construction resource management, followed by data collection from the respondents and data analysis through descriptive statistical methods. And the impact of cost on management of construction resources in delivery of sustainable housing by construction operators was established. Based on the methods adopted, construction resources were classified into three subheadings: human resource management, material resource management, and equipment resource management. Findings obtained validate the factors affecting the cost management of construction resources toward sustainable housing delivery. From this process, it was deduced that 30 construction techniques affected human resource management toward cost efficient housing delivery. Alternatively, the material management on cost was impacted by 24 construction techniques in achieving sustainable housing delivery within the client budget. Another finding showed that 17 construction techniques were determined as major issues affecting equipment management toward cost efficiency sustainable housing delivery.

The findings obtained through the use of descriptive statistical analysis and principal component analysis (PCA) produced seven component factors which were then determined and categorised into two, three and two component factors by the PCA as human, material and machinery. The seven factors determined are *skilful knowledge for management of cost efficient, ability to map out strategies for waste reduction and increase in productivity, fluctuation of materials price, scarcity and cost of materials, inadequate materials management plan, equipment maintenance within the constraint of budget, and adequate planning for the use of equipment.* These factors have an effect on cost management of sustainable housing delivery within budget. Correlation and logistic regression analysis was used to predict the component factors that predicted the factors that cause cost increase as a result of variation under *inadequate material management plan,* with the predictive ability of sig value .044 of the model. The identified factors are significant toward efficient techniques for the management of resources by construction operators to control construction cost within budgeted cost in delivery of affordable housing in South Africa. Through this process a framework was established, and significant information as regards to achievement of this objective is in chapter 6 and 8.

9.2.4 How budgeted cost could be effectively utilised without detrimentally impacting sustainable housing delivery (objective four)

Objective four was established with regard to the comprehensive review of literature. Survey questionnaires were distributed to collect relevant data from elected respondents to determine factors that affect effective utilisation of cost. Findings revealed that twenty-nine factors impact effective utilisation of cost toward sustainable housing delivery within limit of budgeted cost. The variables are grouped into two components through the use of PCA under the *establishment of effective planning for budgeted cost usage* and *management of financial sustainability.* A correlation and logistic regression analysis method was used to predict the factors that influence effective utilisation of cost toward sustainable housing delivery. The *establishment of effective planning for budgeted cost usage* is comprised of factors that predict cost increase as a result of variation, with a predictive ability of sig value .037 of the model. The component factor established will enhance construction operation management techniques toward cost efficient housing delivery to remain within the constraint of the budgeted cost. Thus, affordable housing will be available for low income earners of South Africa; the framework was established through this process, and the achievement of this objective clearly explained in chapter 6 and 8

9.2.5 Establishment of a framework (objective five)

Objective five was achieved by establishing a framework through the findings obtained from objectives one to four. The component factors obtained from the objectives are correlated and used logistic regression analysis to ascertain the factors that have predictive ability for cost efficient sustainable housing delivery. The component factors that have predictive ability are *unsatisfactory production of sustainable housing over budget (*with a predictive ability of a sig value .022), *inadequate design for needs and scope causes failure (*with a predictive ability of sig value .018), *inadequate material management plan (*with a predictive ability of a sig value .044), and the *establishment of effective planning for budgeted cost usage* (with a predictive ability of sig value .037). On this basis, the variables that predict cost increase as a result of variation and housing project completion within time frame were instituted, with these variables used to establish a framework for effective management of cost toward sustainable housing delivery for construction cost to remain within the limit of the budgeted cost. This information as regard to achievement of objective-5 is clearly reported in chapter 6 and 8.

9.3 Contribution of the study to knowledge

The rationale for conducting this research pivots on affordable, cost efficient, quality, available, and uninterrupted housing delivery. The achievement of these indicators of sustainable housing is centred on the aim and objectives of the research study entrenched in Chapter 1 and chapter 3 that consists framework of theoretical and conceptual. Thus, the research study has achieved the intended aim and five objectives, and the contributions of the study to the existent body of knowledge as indicated through the results attained:

- Developed framework on sustainable techniques for construction operators toward achieving affordable housing production process. This will alter the conventional practices of housing delivery in South Africa. Thus, housing will be available and affordable for all people irrespective of income.
- Established the component factors that inflate cost of sustainable housing delivery over budget, with predictive ability of a sig value .022.
- Instituted the component factors that affect the design of delivery sustainable housing within budget, with a predictive ability of a sig value .018.

- Established the impact of cost on the management of construction resources in delivery of sustainable housing by construction operators, with a predictive ability of a sig value .044.
- Ascertained how budgeted cost could be effectively utilised without detrimentally impacting sustainable housing delivery, with a predictive ability of sig value .037 of the model.
- Established the critical factors of achieving quality sustainable housing delivery. This will augment construction operator quality performance toward sustainable housing delivery within acceptable quality.
- Instituted stakeholder influence on sustainable housing delivery, and satisfaction of stakeholder needs and interests. This will guide construction operators for involving all stakeholders in housing project production, documenting their opinions to satisfy stated requirements.
- Established the predictor variables (independent variables) obtained from the first objective to the fourth objective. This will aid the prediction of the management of dependent variables (cost increase as a result of variations and project delivery within time, budget and quality). Affordable housing will then be delivered at construction cost within budgeted cost.
- The developed and validated framework for effective management of cost toward sustainable housing delivery in order for construction cost to remain within the limit of budgeted cost for government agencies, the construction industry and the stakeholders. As a result, inexpensive housing will be available at a low cost for citizen of South Africa.

The framework will enhance construction techniques by instituting adequate knowledge for the application of management knowledge areas, principles and practices. Social satisfaction of the people toward affordable housing will be enhanced via effective management of interests and requirements of stakeholders. Stakeholder influence issues that cause high construction cost will be resolved.

The construction constraint challenges affecting cost, delivery time, and quality expected were halted through the establishment of management techniques and recognition of factors that influence cost of construction issues (MCCI-objective one & four). With the same approach, the unsustainable design challenges were resolved by instituting these management techniques with the factors that affect design and frequent changes in design issues (MFCDI-objective two). In addition, construction resource management disorderliness, clearly a challenge to sustainable housing delivery, has been halted by the assessment approach, instituting criteria for management of the construction resources syndrome (MCRS-objective three). This technique will reduce wastage and optimise efficiencies in resource utilisation and operational performance that influence productivity on site. Likewise, a framework was established for effective management of cost toward sustainable housing delivery to retain construction cost within the limit of budgeted cost, denoted as EMSHD-objective five. The comprehensive interpretation of the achievement of EMSHD-objective five is as follows:

MCCI signifies the management of construction constraint issues, and these issues have been solved via objectives one and four (sections 6.4, 6.7, 6.8, 6.9, 6.10, and subsections 6.10.2, 6.14.2, 6.14.3 and 6.14.4; with Table 6.19, Table 6.29, Table 6.31, Table 6.33, Table 6.39, Table 6.64 & Table 6.69) in conjunction with established critical factors for achieving quality housing and stakeholder influence on sustainable housing delivery. MFCDI symbolises, management of frequent changes in design issues. These issues have been laid to rest by objective two (subsections 6.5.1.1, 6.11, 6.11.2, & 6.11.3; with Table 6.21 & Table 6.44).

MCRS, on the other hand, implies management of construction resource syndrome; this disorderliness has been halted through objective three (sections 6.6, 6.6.3.1, 6.6.5.1, 6.12.2, & 6.13.1; with Table 6.23, Table 6.25, Table 6.27, Table 6.49 & Table 6.54). The framework is established through objective five, implying EMSHD=MCCI+MFCDI+MCRS or MCCI+MFCDI+MCRS=EMSHD.

Considering the results obtained through descriptive statistics, PCA and logistic regression analysis, **EMSHD**=MCCI+MFCDI+MCRS will be construed as **EMSHD**=FACSH12, FACSH13, FACSH14, EUC1, EUC2, EUC11, EUC12, EUC13, EUC14, EUC15, EUC17**+**EFD16, EFD19, EFD28, EFD29**+**EBMC15, EBMC17, EBMC19.

9.4 Summary of the research study

This research study focuses on sustainable integration of housing production processes with the establishment of sustainable management techniques and sustainable factors that impact cost of construction, unsustainable design, and effective utilisation of budgeted cost, coupled with the establishment of criteria for management of construction resources. The significance of the critical factors used in achieving quality and stakeholder influence was considered in developing a framework for the effective management of cost toward sustainable housing delivery. The framework combines environmental, social and economic sustainability to stimulate housing production, with the purpose of enhancing sustainable housing delivery. Furthermore, there are construction techniques, a social satisfaction approach, construction constraint, and a resource usage mechanism create for the continuous affordability and availability of housing within budget for all people regardless of level of income.

One of the purposes of the research is to institute effective management techniques for construction operators by establishing sustainable construction cost processes, design management processes, material control management processes and cost management processes to accomplish affordable housing delivery and reduce cost of housing maintenance. The study develops a concept of planning and designing, with the integration of a sustainable design and construction cost reduction, to mitigate the shortage of affordable housing in developing nations.

The framework developed in this study promotes cost effective housing production that is within client and user budget. The framework is a construction management technique that facilitates the application of management knowledge areas – management principles and practices; management of needs and requirements; management of materials and labour activities; and management of machinery use on site – for cost efficiency in production to achieve sustainable housing delivery. This was possible with thorough understanding garnered from various literature on sustainable housing delivery in South Africa as well as the rest of the world.

The findings deduced from previous research generated the basis for executing an exploratory study which determined the challenges facing the delivery of housing above the budgeted cost of clients. The methodology employed in the study is a sequential mixed methods approach. Data collected through these methods were analysed through the use of a descriptive statistical method, and reliability tests were performed on the instruments used. And likewise, the validity of the findings was measured through an interview to ascertain the correctness of the results. Component principal analysis (PCA) was performed on the data to compress the factors into manageable ones by establishing the independent variables. Consequently, correlation and logistic regression were used to perform test the dependent and independent variables. This process ascertains the predictors that drive the dependent variables toward sustainable housing delivery within budgeted cost.

Goodness of Fit was carried out to ascertain the realism of the model in sustainable housing delivery within budget and to perform the variability test. According to the facts obtained through the model fitting criteria, -2Log Likelihood and Likelihood Ratio test are sufficient evidence for the possibility of increasing sustainable housing delivery within client budget and time given.

9.5 Conclusions

The aim and objectives of this study are achieved through the framework developed for effective management of cost toward sustainable housing delivery to peg construction cost within the limit of budgeted cost. Findings indicate that effective production of sustainable housing within budget will enhance affordable housing delivery for low income earners. Additionally, the adequate management of financial sustainability in achieving housing requirements specified augments reduction in maintenance cost of housing. This propels adequate design for needs and scope toward satisfying client and users interest in housing usage, together with efficient material transportation to site within time. Therefore, based on this, the availability of materials is improved to deflate the price fluctuation in material supply.

The practicing of constant additional work without contractual procedure on cost of construction is reduced through the implementation of the techniques determined for briefing and planning and the implementation of requirements. This influences the adequate coordination of design and construction phase during production, simply because errors, omissions and irregularities continuously experienced in sketches will be corrected at the planning stage of design. The onward transfer of faults to the construction stage diminishes budget to a manageable standard, thereby deflating construction cost of affordable housing delivery.

As part of the set objectives, improvement of the sustainable design for affordable housing delivery was attained by implementing sustainable design management techniques at the planning stage of housing production processes. In due course, this will enhance the incorporation of sustainable design principles into construction activities by guiding the construction operators in the efficient use of the materials at construction stage, in accordance with design initiatives at the planning stage. The adequate implementation of techniques will assist in the reduction of discrepancies between drawing and specification experienced regularly at the construction stage, which could halt constant changes in housing design. Therefore, client interest will be satisfied and cost efficient housing is attained.

In the process, economic management techniques for affordable housing delivery are created through operational techniques. This consolidates the involvement of the stakeholder interest at briefing and planning stage to lessen negative influence of the client and users during housing production processes. This improves the association between the client, users and construction operators to encourage cost efficient housing delivery in South Africa. Another improved area is construction operator productivity from adequate budget planning to efficient design planning and extending to efficient use of materials to reduce waste. In effect, this satisfies the aim and requirements of the client and concurrently reduces or eliminates delay in production. Further deductions demonstrate the importance of the framework developed to support services and amenities for the needs of the people through the techniques used for the design and construction of housing. In that case, it is noteworthy to create architectural scheme suitable for designing befitting houses in a pleasant environment for the users. Other considerable factors are friendly environment, adequate ventilation, natural aesthetic, comfortability and cost-efficient maintenance, each integrated into the framework

The implementation of the framework will enhance cost efficient housing delivery through adequate planning to avoid mismanagement issues in the area of construction costs, frequent changes in design issues, and construction resource syndrome.

9.6 Pragmatic implications and recommendations

Housing in a quality home is an important asset for people of various status or categories. Affordable housing is inadequate among low-income earners, even though it has been promised by government. Therefore, sustainable housing delivery and procedure was considered as a proffered solution to these challenges, especially since the delivery of housing must be consistent, continuous, available, affordable and durable with quality. Efficient production and productivity is initiated through the framework developed. In addition, the framework will guide client and the government over cost efficiency through effective design process, thereby influencing the accomplishment of usage of construction resources. Efficiency in resource management was established through the implementation of the framework to determine the appropriate way of handling material procurement, storage and effective control of supply.

In reference to the findings obtained from the research study, the following are recommended:

1. Integrating the local people into community projects	The government must allow community participation in the housing production scheme from the inception of the project to the delivery of the housing. This can be achieved by organising relevant and comprehensive training to guide community involvement in the inspection of the project, to ward off any unnecessary delay and to

		encourage utilisation of local materials with employment of the local skilled workers.
2.	Strengthening the association of the stakeholders	Stakeholders involved in the housing project are expected to work together in harmony to encourage a pleasant business atmosphere towards efficient and timely housing delivery. By doing so, they will be able to develop sustainable housing delivery techniques that suit the briefing, planning, implementation and handing over of a sustainable housing project.
3.	Implementation of framework	The framework developed should be implemented to discourage inappropriate use of budget, to foster effective utilisation of resources to the optimal level for adequate housing delivery. This will raise the hopes of low-income earners for acquiring their own assets.
4.	Proper handling of design, cost, materials and labour	Appropriate handling of design, cost, materials and labour should be subjected to adequate monitoring to propel fast and sustainable housing delivery at affordable price within the budgeted cost for end-users.

9.7 Research limitation

The limitations encountered on site by the researcher is the obstruction of free access to construction site. In addition, only few construction company permitted me to inspect materials and drawings on sites. In the South African context, sustainable housing delivery managers scarcity and their busy schedule made them inaccessible on site. Thus, data collection on site remain difficult. To retrieve questionnaires from construction managers take several months, therefore completion of questionnaires within time frame is hampered.

. Future research

Further research should be conducted in the areas highlighted below:

- Investigating the maintainable housing materials that influence sustainable design toward delivery of affordable housing in each province in South Africa concerning the physical environment.
- Researching the need to prioritise the involvement of community workers in any proposed sustainable housing production, to boost public project participation and discourage

community violence between stakeholders and residents, to dampen unnecessary rises in construction cost and delays in delivery of affordable housing.

REFERENCES

Abdul Rahman, I., Memon, A. H., Karim, A. & Tarmizi, A. (2013). Relationship between factors of construction resources affecting project cost. *Modern Applied Science*, *7*(1).

Abdullah, A.A. & Rahman, H.A. (2012). Identification of relevant risks in abandoned housing projects in Malaysia: A qualitative study. *Procedia-Social and Behavioral Sciences*, *62:* 1281-1285.

Abdullahi, B. C. & Aziz, W. N. A. W. A. (2011). The role of private sector participation in achieving anticipated outcomes for low-income group: A comparative analysis of housing sector between Malaysia and Nigeria. *African Journal of Business Management*, *5*(16): 6859.

Abisuga, A. O., & Oyekanmi, O. O. (2014). Organisational factors affecting the usage of sustainable building materials in the Nigerian construction industry. *Journal of Emerging Trends in Economics and Management Sciences*, *5*(2):113-119.

Abubakar, I. R. & Doan, P. L. (2010). New towns in Africa: Modernity and/or decentralization. In *53rd Annual Meeting, African Studies Association. San Francisco, USA*.

Abubakar, I.R. (2014). Abuja city profile Volume 41, Part A December 2014 *Cities*, page 81-91

Adebayo, A. A. (2002). Sustainable construction in Africa: agenda 21 for sustainable construction in developing countries. *Africa Position Paper*.

Adebayo, A., & Adebayo, P. (2001). Sustainable Housing Policy and Practice: Reducing Constraints and Expanding Horizons within Housing Delivery. *Safundi: The Journal of South African and American Comparative Studies*, *2*(3):1-14.

Adedeji, Y. M. D. & Olotuah, A. O. (2012). An evaluation of accessibility of low-income earners to housing finance in Nigeria. *European Scientific Journal*, *8*(12).

Adedeji, Y. M. D. (2012). Sustainable housing provision: preference for the use of interlocking masonry in housing delivery in Nigeria. *Architecture Research*, *2*(5), 81-86.

Ademiluyi, I. A. (2010). Public housing delivery strategies in Nigeria: A historical perspective of policies and programmes. *Journal of sustainable development in Africa*, *12*(6): 153-161.

Ahmad, R. & Bujang, S. (2013). Issues and Challenges in the practice of Performance Appraisal Activities in the 21st Century. *International Journal of Education and research*, *1*(4): 1-8.

Ahmad, S. & Choi, M. J. (2011). The context of uncontrolled urban settlements in Delhi. *Asien*, *118:* 75-90.

Ahmad, S., Choi, M. J. & Ko, J. (2013). Quantitative and qualitative demand for slum and non-slum housing in Delhi: empirical evidences from household data. *Habitat International*, *38*, 90-99.

Aibinu, A. A. & Odeyinka, H. A. (2006). Construction delays and their causative factors in Nigeria. *Journal of construction engineering and management*, *132*(7:667-677.

Ajayi, J.R. (2012). Strategies for sustainable housing cooperatives in South Africa. Doctor of Philosophy (Construction Management)), Nelson Mandela Metropolitan University, Port Elizabeth.

Akadiri, P. O., Chinyio, E. A. & Olomolaiye, P. O. (2012). Design of a sustainable building: A conceptual framework for implementing sustainability in the building sector. *Buildings*, *2*(2): 126-152.

Akingbade, A., Navarra, D., Zevenbergen, J. & Georgiadou, Y. (2012). The impact of electronic land administration on urban housing development: The case study of the Federal Capital Territory of Nigeria. *Habitat International*, *36*(2), 324-332.

Akinmoladun, O. I. & Oluwoye, J. (2007). An assessment of why the problems of housing shortages persist in developing countries: A case of study of Lagos Metropolis, Nigeria. *Pakistan Journal of Social Science*, *4*(4), 589-598.

Ali, H. H. & Al Nsairat, S. F. (2009). Developing a green building assessment tool for developing countries–Case of Jordan. *Building and Environment*, *44*(5):1053-1064.

Amaeshi, K. M. & Crane, A. (2006). Stakeholder engagement: a mechanism for sustainable aviation. *Corporate Social Responsibility and Environmental Management*, *13*(5), 245-260.

Amao, F. L. (2012). Housing quality in informal settlements and urban upgrading in Ibadan, Nigeria (A case study of Apete in Ibadan). *Developing Country Studies*, *2*(10).

Amaratunga, D., Baldry, D., Sarshar, M. & Newton, R. (2002). Quantitative and qualitative research in the built environment: application of “mixed” research approach. *Work study*, *51*(1): 17-31.

Amba, K. (2010). The need for popular participation in Abuja: a Nigerian story of informal settlements. *Journal of Place Management and Development*, *3*(2): 149-159.

Angus, G. Y., Flett, P. D. & Bowers, J. A. (2005). Developing a value-centred proposal for assessing project success. *International Journal of Project Management*, *23*(6): 428-436.

Arayici, Y., Egbu, C.O. & Coates, S.P. (2012). Building information modelling (BIM) implementation and remote construction projects: issues, challenges, and critiques. *Journal of Information Technology in Construction*, *17:* 75-92.

Archer, M., Bhaskar, R., Collier, A., Lawson, T. & Norrie, A. (2013). *Critical realism: Essential readings*. Routledge.

Aribigbola, A. (2008). Housing policy formulation in developing countries: Evidences of programme implementation from Akure, Ondo State Nigeria. *Journal of Human Ecology*, *23*(2), 125-134.

Ashworth, A. & Skitmore, M. (2005). Accuracy in estimating *cost modelling*. published in the USA and Canada by Routledge 29 West 35th Street, New York,

Atkinson, R. (1999). Project management: cost, time and quality, two best guesses and a phenomenon, it is time to accept other success criteria. *International Journal Of Project Management*, *17*(6), 337-342.

Aurich, J. C., Fuchs, C. & Wagenknecht, C. (2006). Life cycle oriented design of technical Product-Service Systems. *Journal of Cleaner Production*, *14*(17): 1480-1494.

Ayoola, A. & Amole, D. (2014). The value of housing among the poor in Ilesa, Osun State Nigeria. *Architecture Research*, *4*(1A): 45-54.

Azhar, S., Nadeem, A., Mok, J. Y. & Leung, B. H. (August 2008). Building Information Modelling (BIM): A new paradigm for visual interactive modelling and simulation for construction projects. In *Proc., First International Conference on Construction in Developing Countries,* 435-446.

Baar, T., Marković, S., Fondement, F. & Strohmeier, A. (2006). Definition and correct refinement of operation specifications. In *Dependable Systems: Software, Computing, Networks* (pp. 127-144). Springer, Berlin, Heidelberg.

Bakar, A.H.A., Razak, A.A., Abdullah, S., Awang, A. & Perumal, V. (2010). Critical success factors for sustainable housing: a framework from the project: management view. *Asian journal of management research*, *1*(1): 66-80.

Bartlett, E. & Howard, N. (2000). Informing the decision makers on the cost and value of green building. *Building Research & Information*, *28*(5-6): 315-324.

Basiago, A.D. (1998). Economic, social, and environmental sustainability in development theory and urban planning practice. *Environmentalist*, *19*(2):145-161.

Begum, R.A., Siwar, C., Pereira, J.J. & Jaafar, A.H. (2009). Attitude and behavioral factors in waste management in the construction industry of Malaysia. *Resources, Conservation and Recycling*, *53*(6):.321-328.

Bertoldi, A. (2010) Infrastructure Stimulus Package Development Outcomes Setting the Scene, Presentation to the Infrastructure Dialogue 18 November 2010

Bhaskar, R. (2014). The possibility of naturalism: A philosophical critique of the contemporary human sciences. Routledge.

Billson, A. (2010). An estimator's lack of knowledge regarding the use of resources to calculate a rate; specifically focusing on Civil Engineering construction procedures.

Blaikie, N. (2009). *Designing social research*. Polity published in the USA by Blackwell publishers Inc. Commerce Place 350 Main Street Malden, MA02148. USA

Blismas, N., Pasquire, C. & Gibb, A. (2006). Benefit evaluation for off-site production in construction. *Construction Management and Economics*, *24*(2): 21-130.

Bolnick, J. & Bradlow, B. (2011). Rather a better shack now than wait twenty years for a formal house. *Shack Dwellers International and Informal Settlement Upgrading in South Africa, Trialog*, *104*(1).

Bon-Gang Hwang, Xianbo Zhao & SI, YiNg (2013). Identifying the critical factors affecting schedule performance of public housing project, Habitat international, (3): 214-221.

Bontenbal, M.C. (2009). Strengthening urban governance in the South through city-to-city cooperation: Towards an analytical framework. *Habitat International*, *33*(2): 181-189.

Bossel, H. (1999). *Indicators for sustainable development: theory, method, applications* (pp. 1-124). Winnipeg: International Institute for Sustainable Development.

Boswell, P. & Walker, L. (2004). *Procurement and Process Design.* FIDIC and Lorna Walker Consulting Ltd, Geneva, London.

Boussauw, K. (2014). City profile: Ghent, Belgium. Volume 40 part *Cities*, *40: page* 32-43.

Brace, I. (2008). Questionnaire design: How to plan, structure and write survey material for effective market research. Kogan Page Publishers.

Bradlow, B., Bolnick, J. & Shearing, C. (2011). Housing, institutions, money: the failures and promise of human settlements policy and practice in South Africa. *Environment and Urbanization*, *23*(1):.267-275.

Breheny, M. (1997). Urban compaction: feasible and acceptable? *Cities*, *14*(4): 209-217.

Brown, C. (2011). The social dimension of sustainable development: Defining urban social sustainability. *Sustainable Development*, *19*(5): 289-300.

Brown-Luthango, M., Reyes, E. & Gubevu, M. (2017). *Informal settlement upgrading and safety: experiences from Cape Town, South Africa.* Journal of Housing and the Built Environment, 32(3):.471-493.

Bruff, G.E. & Wood, A.P. (2000). Local sustainable development: land-use planning's contribution to modern local government. *Journal of Environmental Planning and Management*, *43*(4):.519-539.

Brugmann, J. (1996). Planning for sustainability at the local government level. *Environmental Impact Assessment Review*, *16*(4-6):.363-379.

Brundtland, G.H. (1985). World commission on environment and development. *Environmental policy and law*, *14*(1):.26-30.

Bryde, D., Broquetas, M. & Volm, J.M. (2013). The project benefits of building information modelling (BIM). *International journal of project management*, *31*(7):.971-980.

Bugaje, I.M. (2006). Renewable energy for sustainable development in Africa: a review. *Renewable and Sustainable Energy Reviews*, *10*(6):.603-612.

Burnett, J. (2007). City buildings—Eco-labels and shades of green! *Landscape and Urban planning*, *83*(1): 29-38.

Cameron, R., & Molina-Azorin, J. F. (2011). The acceptance of mixed methods in business and management research. *International Journal of Organisational Analysis*, *19*(3): 256-271.

Campbell, S. (1996). Green cities, growing cities, just cities? Urban planning and the contradictions of sustainable development. *Journal of the American Planning Association*, *62*(3) 296-312.

Carter, C. R. & Rogers, D. S. (2008). A framework of sustainable supply chain management: moving toward new theory. *International Journal of Physical Distribution & Logistics Management*, *38*(5): 360-387.

Carter, E. (2006). Making Money from Sustainable Homes: A Developer's Guide. Chartered Institute of Building.

Carter, K. & Fortune, C. (2007). Sustainable development policy perceptions and practice in the UK social housing sector. *Construction Management and Economics*, *25*(4), 399-408.

Chaarawi, Z., Khalifa, M., Maarouf, D. & Abdellatif, M. (2016). Evaluation of Stakeholders' Relationship in Housing Provision Process in Egypt: Case Study of 6th October City. *Procedia Environmental Sciences*, *34*: 618-630.

Chan, A. P., & Chan, A. P. (2004). Key performance indicators for measuring construction success. *Benchmarking: An International Journal*, *11*(2): 203-221.

Chen, Y., Okudan, G.E. & Riley, D.R. (2010). Sustainable performance criteria for construction method selection in concrete buildings. *Automation in construction*, *19*(2):.235-244.

Chow, M. Y. K., Quine, S. & Li, M. (2010). The benefits of using a mixed methods approach–quantitative with qualitative–to identify client satisfaction and unmet needs in an HIV healthcare centre. *AIDS care*, *22*(4): 491-498.

Chritamara, S., Ogunlana, S. O. & Bach, N. L. (2002). System dynamics modeling of design and build construction projects. *Construction Innovation*, *2*(4)L 269-295.

Claes Fornell & David F. Larcker (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error Journal of Marketing Research, 18(1): 39-50 Published by: American Marketing Association.

Clark, V. L. P., Creswell, J. W., Green, D. O. N. & Shope, R. J. (2008). Mixing quantitative and qualitative approaches. *Handbook of emergent methods*, *363*.

Clarke, L. & Herrmann, G. (2004). Cost vs. production: disparities in social housing construction in Britain and Germany. *Construction management and economics*, *22*(5): 521-532.

Cohen, B. (2006). Urbanization in developing countries: Current trends, future projections, and key challenges for sustainability. *Technology in society*, *28*(1): 63-80.

Cole, R. J. (2005). Building environmental assessment methods: redefining intentions and roles. *Building Research & Information*, *33*(5): 455-467.

Collins, D. (2003). Pretesting survey instruments: an overview of cognitive methods. *Quality of life research*, *12*(3): 229-238.

Conte, E. & Manno, V. (2012). Beyond the building centric approach: A vision for an integrated evaluation of sustainable building environmental. *Impact Assessment Review,* 34: 31-40.

Cooke-Davies, T. (2002). The “real” success factors on projects. *International Journal of Project Management*, *20*(3): 185-190.

Costello, A.B. & Osborne, J.W. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical assessment, research & evaluation*, *10*(7), pp.1-9.

Crawley, D. & Aho, I. (1999). Building environmental assessment methods: applications and development trends. *Building Research & Information*, *27*(4-5), 300-308.

Creswell J. W., 2009 Mapping the field of mixed methods research Journal of mixed methods research volume 3 number 2 April 2009 95-108 © 2009 Sage publications

Creswell, J. W. & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory into practice*, *39*(3):124-130.

Creswell, J. W. & Poth, C. N. (2017). Qualitative inquiry and research design: Choosing among five approaches. Sage publications.

Creswell, J. W. (1999). Mixed-method research: Introduction and application. *Handbook of educational policy*, 455-472.

Creswell, J. W. (2011). Controversies in mixed methods research. *The Sage handbook of qualitative research*, *4:* 269-284.

Creswell, J. W. (2013). Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications.

Creswell, J. W., Clark, V. L. P. & Garrett, A. L. (2008). Advances in mixed methods research.

Creswell, J. W., Fetters, M. D. & Ivankova, N. V. (2004). Designing a mixed methods study in primary care. *The Annals of Family Medicine*, *2*(1): 7-12.

Crook, A. T. D. & Whitehead, C. M. (2002). Social housing and planning gain: is this an appropriate way of providing affordable housing?. *Environment and Planning A*, *34*(7): 1259-1279.

Dada, M. O. & Oladokun, G. B. (2008). Critical success factors in public-private-partnership projects in Nigeria: A perceptual Survey. *Transformation through construction: Joint*, 1-10.

Daly, H. E. (1990). Toward some operational principles of sustainable development. *Ecological economics*, *2*(1): 1-6.

Davila, T. & Wouters, M. (2005). Managing budget emphasis through the explicit design of conditional budgetary slack. *Accounting, Organizations and Society*, *30*(7): 587-608.

Davis, L. L. (1992). Instrument review: Getting the most from a panel of experts. *Applied nursing research*, *5*(4): 194-197.

Declaration, R., 1992. Rio declaration on environment and development from agenda 21 United Nations conference on environmental and development (1992)-the Earth Summit

Demaid, A. & Quintas, P. (2006). Knowledge across cultures in the construction industry: sustainability, innovation and design. *Technovation*, *26*(5): 603-610.

DeNavas-Walt, C. (2010). Income, poverty, and health insurance coverage in the United States (2005). Diane Publishing.

Derban, W. K., Derban, D. K., Ibrahim, G. & Rufasha, K. (2002, July). Microfinance for Housing for Low/Moderate-income Households in Ghana. In *Conference on Housing and Urban Development for Low Income Groups in Sub Saharan Africa, Accra* (pp. 22-26).

Desai, M. C. & Desale, S. V. (2013). Study Factors Affecting of Delay in Residential Construction Project for Nashik city. *International Journal of Latest Trends in Engineering and Technology (IJLTET), (2):*115-124.

Devers, K. J. & Frankel, R. M. (2000). Study design in qualitative research--2: Sampling and data collection strategies. *Education for health*, *13*(2): 263.

Dey, I. (2003). *Qualitative data analysis: A user friendly guide for social scientists.* Routledge.

Ding, G. K. (2008). Sustainable construction—The role of environmental assessment tools. *Journal of environmental management*, *86*(3): 451-464.

Doppelt, B. (2009). Leading Change Toward Sustainability-: A Change-Management Guide for Business, Government and Civil Society. Greenleaf Publishing.

Duncan, W.R., 1996. PMBOK–A Guide to the Project Management Body of Knowledge. *Zda: Project management institute (pmi)*.

Duranton, G. & Puga, D. (2013) the growth of cities, www.sciencedirect.com/science/article/pii

Dyllick, T. & Hockerts, K. (2002). Beyond the business case for corporate sustainability. *Business strategy and the environment*, *11*(2): 130-141.

Dziekoński, K. (2017). Project managers' competencies model for construction industry in Poland. *Procedia Engineering*, *182:* 174-181.

Edum-Fotwe, F. T. & McCaffer, R. (2000). Developing project management competency: perspectives from the construction industry. *International Journal of Project Management*, *18*(2): 111-124.

Egger, M., Juni, P., Bartlett, C., Holenstein, F. & Sterne, J. (2003). How important are comprehensive literature searches and the assessment of trial quality in systematic reviews? Empirical study.

Ekins, P., Simon, S., Deutsch, L., Folke, C. & De Groot, R. (2003). A framework for the practical application of the concepts of critical natural capital and strong sustainability. *Ecological economics*, *44*(2): 165-185.

Ekpenyong, N. S., Lasisi, R. A. I. M. I. & Ekpenyong, A. S. (2012). Urban Poverty and Juvenile Delinquency in Nigeria: Through the Lens of Port Harcourt Remand Home Inmates. *Research on Humanities and Social Sciences*, *2*(8): 127-132.

El-Haram, M. A. & Horner, M. W. (2002). Factors affecting housing maintenance cost. *Journal of Quality in maintenance Engineering*, *8*(2:, 115-123.

Fabrigar, L.R., Wegener, D.T., MacCallum, R.C. & Strahan, E.J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological methods*, *4*(3):.272.

Fagbenle, O., Phillip, L. and Omuh, I., 2012. The Influence of training on Bricklayers' productivity in Nigeria. *International Journal of Management Sciences and Business Research*, *1*(7).

Fajana, S., Owoyemi, O., Elegbede, T. & Gbajumo-Sheriff, M. (2011). Human resource management practices in Nigeria. *Journal of Management and Strategy*, *2*(2):.57.

Faniran, O. O., & Caban, G. (1998). Minimizing waste on construction project sites. *Engineering, Construction and Architectural Management*, *5*(2): 182-188.

Fapohunda, J. A. (2010). Operational Framework for Optimal Utilisation of Construction Resources during the Production Process. Unpublished Doctoral Dissertation, Sheffield Hallam University.

Faugier, J. & Sargeant, M. (1997). Sampling hard to reach populations. *Journal of Advanced Nursing*, *26*(4): 790-797.

Flores-Colen, I. & de Brito, J. (2010). A systematic approach for maintenance budgeting of buildings façades based on predictive and preventive strategies. *Construction and Building Materials*, *24*(9): 1718-1729.

Formoso, C. T., Isatto, E. L. & Hirota, E. H. (1999, July). Method for waste control in the building industry. In *Proceedings IGLC* (7): 325..

Fraenkel, J. R., Wallen, N. E. & Hyun, H. H. (1993). *How to design and evaluate research in education* (Vol. 7). New York: McGraw-Hill.

Gan, Q. & Hill, R. J. (2009). Measuring housing affordability: Looking beyond the median. *Journal of Housing economics*, *18*(2): 115-125.

Gan, X., Zuo, J., Wu, P., Wang, J., Chang, R. & Wen, T. (2017). How affordable housing becomes more sustainable? A stakeholder study. *Journal of cleaner production*, *162:* 427-437.

Ganiyu, B. O. & Zubairu, I. K. (2010). Project Cost Prediction Model using Principal Component Regression for Public Building Projects in Nigeria. *Journal of Building Performance ISSN*, *1*(1).

Ganiyu, B.O. (2016). *Strategy to enhance sustainability in affordable housing construction in South Africa* (Doctoral dissertation, Cape Peninsula University of Technology).

Garip, S. Banu & Hasan Şener. (2012), Analysing environmental satisfaction in gated housing settlements: A case study in İstanbul. *A| Z ITU Journal of the Faculty of Architecture*: 120-133.

Gibson, R. B. (2006). Beyond the pillars: sustainability assessment as a framework for effective integration of social, economic and ecological considerations in significant decision-making. *Journal of Environmental Assessment Policy and Management*, *8*(03): 259-280.

Goddard, W. & Melville, S. (2004). *Research methodology: An introduction*. Juta & Company Ltd.

Goebel, A. (2007). Sustainable urban development? Low-cost housing challenges in South Africa. *Habitat International*, *31*(3): 291-302.

Goertzen, J. R. (2010). Dialectical pluralism: a theoretical conceptualization of pluralism in psychology. *New Ideas in Psychology*, *28*(2): 201-209.

Golafshani, N. (2003). Understanding reliability and validity in qualitative research. *The qualitative report*, *8*(4): 597-606.

Goodier, C. & Gibb, A. (2007). Future opportunities for offsite in the UK. *Construction Management and Economics*, *25*(6): 585-595.

Gordillo, F. & Hernández , N (2006). *Sustainable urban housing. Strategies for implementation in Bogotá.*

Gransberg, D.D., Popescu, C.M. & Ryan, R. (2006). *Construction equipment management for engineers, estimators, and owners*. CRC Press.

Gravetter FJ, Wallnau LB. (2000). 5th ed. Belmont: Wadsworth – Thomson Learning; Statistics for the behavioral sciences.

Greenwood, M. (2007). Stakeholder engagement: Beyond the myth of corporate responsibility. *Journal of Business Ethics*, *74*(4):.315-327.

Grewal, R., Cote, J.A. & Baumgartner, H. (2004). Multicollinearity and measurement error in structural equation models: Implications for theory testing. *Marketing science*, *23*(4):.519-529.

Guest, G., Bunce, A. & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field methods*, *18*(1): 59-82.

Guide, A. (2001). Project Management Body of Knowledge (PMBOK® GUIDE). In *Project Management Institute*.

Gülden Demet, O. R. U. Ç., & GİRİTLİOĞLU, C. (2008). The evaluation of urban quality and vitality of the Istanbul historical peninsula-Eminönü district. *evaluation*, *5*(1): 97-117.

Gulghane, A.A. & Khandve, P.V. (2015). Management for Construction Materials and Control of Construction Waste in Construction Industry: A Review. *Int. Journal of Engineering Research and Applications*, *5*(4):.59-64.

Gunder, M. (2006). Sustainability: Planning’s saving grace or road to perdition?. *Journal of Planning Education and Research*, *26*(2): 208-221.

Gyourko, J. & Saiz, A. (2006). Construction costs and the supply of housing structure. *Journal of regional Science*, *46*(4): 661-680.

Habitat, U.N. (2011). Cities and climate change: *Global Report on Human Settlements 2011.* London, Royaume-Uni, Etats-Unis: UN-Habitat.

Habitat, U.N. (2013). *State of the world's cities 2012/2013: Prosperity of cities.* Routledge.

Han, M.Y., Chen, G.Q., Shao, L., Li, J.S., Alsaedi, A., Ahmad, B., Guo, S., Jiang, M.M. & Ji, X. (2013). Embodied energy consumption of building construction engineering: case study in E-town, Beijing. *Energy and Buildings*, *64:*.62-72.

Hart, S. L. (1997). Beyond greening: strategies for a sustainable world. *Harvard business review*, *75*(1): 66.

Hashim, Z. A. (2010). House price and affordability in housing in Malaysia. *Akademika*, *78:* 37-46.

Hassan A, Bakar A, Razak AA, Abdullah S, Awang A & Perumal V. (2010). Critical success factors for sustainable housing: A framework from the project. Asian Journal of Management Research. 66-80.

Hassan, G. F. (2011). The enabling approach for housing supply: Drawbacks & prerequisites–Egyptian experiences. *Alexandria Engineering Journal*, *50*(4): 421-429.

Hassen, E.K. (2000). Infrastructure Delivery and Employment Creation in South Africa. In *TIPS Conference" 2000 Annual Forum*.

Hegazy, T. (1999). Optimization of construction time-cost trade-off analysis using genetic algorithms. *Canadian Journal of Civil Engineering*, *26*(6): 685-697.

Hendrickson, C., Hendrickson, C.T. and Au, T., 1989. *Project management for construction: Fundamental concepts for owners, engineers, architects, and builders*. Chris Hendrickson.

Hill, R. C. & Bowen, P. A. (1997). Sustainable construction: principles and a framework for attainment. *Construction Management & Economics*, *15*(3): 223-239.

Hill, R.J. & Magnani, E. (2002). An exploration of the conceptual and empirical basis of the environmental Kuznets curve. *Australian Economic Papers*, *41*(2):.239-254.

Hinde, A. (2014). *Demographic methods*, published by Taylor & Francis Group 12 May 2014 London Routledge 320 pages ISBN 9780203784273

Hossain, N., Shah, N., Shah, T. & Lateef, S.B. (2016). Physicians' migration: perceptions of Pakistani medical students. *Journal of the College of Physicians and Surgeons Pakistan*, *26*(8):.696-701.

Hox, J. J. & Boeije, H. R. (2005). Data collection, primary vs. secondary. *Encyclopedia of social measurement*, *1*(1): 593-599.

Huchzermeyer, M. (2001). Housing for the poor? Negotiated housing policy in South Africa. *Habitat International*, *25*(3): 303-331.

Huchzermeyer, M. (2003). A legacy of control? The capital subsidy for housing, and informal settlement intervention in South Africa. *International Journal of Urban and Regional Research*, *27*(3): 591-612.

Hussein, A., 2009. The use of triangulation in social sciences research: Can qualitative and quantitative methods be combined. *Journal of comparative social work*, *1*(8), pp.1-12.

Hutchings, M. & Christofferson, J. P. (2005). Factors leading to construction company success: perceptions of small-volume residential contractors'. *International Journal of Construction Education and Research*, *1*(2): 102-11.

Huynh, K. T., Castro, I. T., Barros, A. & Berenguer, C. (2012). Modeling age-based maintenance strategies with minimal repairs for systems subject to competing failure modes due to degradation and shocks. *European journal of operational research*, *218*(1): 140-151.

Hwang, B. G. & Ng, W. J. (2013). Project management knowledge and skills for green construction: Overcoming challenges. *International Journal of Project Management*, *31*(2): 272-284.

Hwang, B. G., Thomas, S. R., Haas, C. T. & Caldas, C. H. (2009). Measuring the impact of rework on construction cost performance. *Journal of Construction Engineering and Management*, *135*(3): 187-198.

Ibem, E. O. & Amole, O. O. (2010). Evaluation of public housing programmes in Nigeria: A theoretical and conceptual approach. *The Built & Human Environment Review, 3:* 88-117.

Ibem, E. O. (2011). The contribution of Public–Private Partnerships (PPPs) to improving accessibility of low-income earners to housing in southern Nigeria. *Journal of Housing and the Built Environment*, *26*(2): 201-217.

Ibem, E.O. & Aduwo, B.E. (2015). A framework for understanding sustainable housing for policy development and practical actions.

Ibem, E.O., Anosike, M.N. & Azuh, D.E. (2011). Challenges in public housing provision in the post-independence era in Nigeria. *Journal of Human Sciences*, *8*(2):.421-443.

Idrus, N. & Ho, C. S. (2008, June). Affordable and quality housing through the low cost housing provision in Malaysia. In *Seminar of Sustainable development and Governance*.

Iheme, J. O., Effiong, J. B. & Ekung, S. B. (2015). The Effect of Government Policy on Housing Delivery in Nigeria: A Case Study of Port Harcourt Low Income Housing Programme. *International Letters of Social and Humanistic Sciences*, *61:* 87-98.

Ihuah, P.W. & Eaton, D. (2013). The pragmatic research approach: a framework for sustainable management of public housing estates in Nigeria. *Journal of US-China Public Administration*, *10*(10):.933-944.

Ikejiofor, U. (1999). The God that Failed: A Critique of Public Housing in Nigeria, 1975–1995. *Habitat international*, *23*(2): 177-188.

Ikerd, J. E. (1997). Toward an economics of sustainability. *Retrieved November*, *12*, 2010.

Iwaro, J. & Mwasha, A. (2013).The impact of sustainable building envelope design on building sustainability using Integrated Performance Model. *International Journal of Sustainable Built Environment*, *2*(2):153-171.

Iwaro, J., Mwasha, A., Williams, R. G. & Zico, R. (2014). An Integrated Criteria Weighting Framework for the sustainable performance assessment and design of building envelope. *Renewable and Sustainable Energy Reviews*, *29:* 417-434.

Jaillon, L. & Poon, C. S. (2008). Sustainable construction aspects of using prefabrication in dense urban environment: a Hong Kong case study. *Construction Management and Economics*, *26*(9), 953-966.

Jenkins, P. (1999). Difficulties encountered in community involvement in delivery under the new South African housing policy. *Habitat International*, *23*(4): 431-446.

Jenkins, W. (2010). Sustainability theory. Berkshire Encyclopaedia of Sustainability: The Spirit of Sustainability, 1: 380-384.

Jenks, M. Dempsey, N. (2005). Future forms and design for sustainable cities. Routledge, Architecture imprint of Elsevier Linacre house Jordan hill oxford OX28DP 30 Corporate drive Burlington MA 01803

Jiboye, A. D. (2010). The correlates of public housing satisfaction in Lagos, Nigeria. *Journal of Geography and Regional Planning*, *3*(2): 17.

Jiboye, A. D. (2011). Achieving sustainable housing development in Nigeria: A Critical challenge to governance. *International Journal of Humanities and social science*, *1*(9): 121-127.

Jiboye, A. D. (2011). Urbanization challenges and housing delivery in Nigeria: The need for an effective Policy framework for Sustainable Development. *International Review of Social Sciences and Humanities*, *2*(1): 176-185.

Johnson, R.B., Onwuegbuzie, A.J. and Turner, L.A., 2007. Toward a definition of mixed methods research. *Journal of mixed methods research*, *1*(2), pp.112-133.

Jolliffe, I.T. (1986). principal component analysis and factor analysis published by Springer-verley publishing company New-York Inc.

Jong-Jin, K. (1998). *Sustainable architectures modules question use and examples of sustainable building materials,* National Pollution Prevention Centre for Higher Education.

Jordaan, A. C., Drost, B. E. & Makgata, M. A. (2004). Land value as a function of distance from the CBD: the case of the eastern suburbs of Pretoria. *South African Journal of Economic and Management Sciences*, *7*(3): 532-541.

Kain, J. F. & Quigley, J. M. (1975). A Theory of Urban Housing Markets and Spatial Structure. In *Housing Markets and Racial Discrimination: A Microeconomic Analysis* (9-55). NBER.

Kazadi, K., Lievens, A. & Mahr, D. (2016). Stakeholder co-creation during the innovation process: Identifying capabilities for knowledge creation among multiple stakeholders. *Journal of Business Research*, *69*(2): 525-540.

Kelly, R. & Moles, R. (2002). The development of Local Agenda 21 in the mid-west region of Ireland: a case study in interactive research and indicator development. *Journal of Environmental Planning and Management*, *45*(6): 889-912.

Kerzner, H. R. (2013). Project management: a systems approach to planning, scheduling, and controlling. John Wiley & Sons.

Kindig, D. & Stoddart, G. (2003). What is population health? *American Journal of Public Health*, *93*(3): 380-383.

King, R., Orloff, M., Virsilas, T. & Pande, T. (2017). *Confronting the urban housing crisis in the global south: adequate, secure, and affordable housing.* World Resources Institute Working Paper.

Klassen, A.C., Creswell, J., Clark, V.L.P., Smith, K.C. and Meissner, H.I., 2012. Best practices in mixed methods for quality of life research. *Quality of Life Research*, *21*(3), pp.377-380.

Kline, R.B., 2015. *Principles and practice of structural equation modelling*, published by Guilford publications New York.

Kofoworola, O. F. & Gheewala, S. H. (2009). Estimation of construction waste generation and management in Thailand. *Waste management*, *29*(2): 731-738.

Kolltveit, B. J. & Grønhaug, K. (2004). The importance of the early phase: the case of construction and building projects. *International Journal of Project Management*, *22*(7): 545-551.

Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International.

Kuroshi, P.A., Anigbogu, N.A. & Bala, K. (2007). Building research for sustainable housing development in Nigeria. *International Journal for Housing Science and Its Applications*, *31*(3): 195.

Kwon, S. H., Chun, C. & Kwak, R. Y. (2011). Relationship between quality of building maintenance management services for indoor environmental quality and occupant satisfaction. *Building and Environment*, *46*(11): 2179-2185.

Lalloo, K. (1998). Arenas of contested citizenship: housing policy in South Africa. *Habitat International*, *23*(1): 35-47.

Langeweg, F. (1998). The implementation of Agenda 21 our common failure? *Science of the total environment*, *218*(2): 227-238.

Laryea, S. & Ibem, E. O. (2014). 8th CIDB Postgraduate Conference Proceedings 10-11 February 2014 University of the Witwatersrand, Johnnesburg, South Africa.

Laurel, B. (2003). Design research: methods and perspectives. MIT press Cambridge Mucsachusetts London England

Laurian, L., Crawford, J., Day, M., Kouwenhoven, P., Mason, G., Ericksen, N. & Beattie, L. (2010). Evaluating the outcomes of plans: theory, practice, and methodology. *Environment and Planning B: Planning and Design*, *37*(4):.740-757.

Lauritzen, E. K. & Hahn, N. J. (1992). Building waste generation and recycling. *International solid waste management association year book 1991–1992*, 48-58.

Lauritzen, E. K. (1998). Emergency construction waste management. *Safety Science*, *30*(1): 45-53.

Le Roux, F. E. (2011). The provision of low-cost housing in South Africa: a wicked problem with a systems theory solution (Doctoral dissertation, Stellenbosch: Stellenbosch University).

Lee, J. H. & Kim, Y. G. (2001). A stage model of organisational knowledge management: a latent content analysis. *Expert Systems with Applications*, *20*(4): 299-311.

Lee, L. M., Lim, Y. M. & Nor'Aini, Y. (2008). Strategies for urban conservation: A case example of George Town, Penang. *Habitat International*, *32*(3): 293-304.

Lehmann, S. 2006. Towards a sustainable city centre: integrating ecologically sustainable development (ESD) principles into urban renewal. *Journal of green building*, *1*(3):.83-104.

Lewins, A., Taylor, C. & Gibbs, G.R. (2010). What is qualitative data analysis (QDA)? Retrieved April 15, 2013.

Li, T.H., Ng, S. T. & Skitmore, M. (2013). Evaluating stakeholder satisfaction during public participation in major infrastructure and construction projects: A fuzzy approach. *Automation in construction*, *29:* 123-135.

Li, T.H., Ng, S.T. & Skitmore, M. (2012). Conflict or consensus: An investigation of stakeholder concerns during the participation process of major infrastructure and construction projects in Hong Kong. *Habitat international*, *36*(2):.333-342.

Love, P. E., Holt, G. D., Shen, L. Y., Li, H. & Irani, Z. (2002). Using systems dynamics to better understand change and rework in construction project management systems. *International journal of project management*, *20*(6): 425-436.

Lucia, S., Herrmann, L. & Killias, M. (2007). How important are interview methods and questionnaire designs in research on self-reported juvenile delinquency? An experimental comparison of Internet vs paper-and-pencil questionnaires and different definitions of the reference period. *Journal of Experimental Criminology*, *3*(1): 39-64.

Luo, R. & Wang, D. (2008). A study on the difference of social integration of the different floating population aggregation types in Shanghai. In *Urban Planning Forum* 6: 92-99.

Lusthaus, C., Adrien, M. H. & Perstinger, M. (1999). Capacity development: definitions, issues and implications for planning, monitoring and evaluation. *Universalia Occasional Paper*, *35:* 1-21.

MacCallum, R.C., Widaman, K.F., Zhang, S. & Hong, S. (1999). Sample size in factor analysis. *Psychological methods*, *4*(1):.84.

Madhavi, T.P., Mathew, S.V. & Sasidharan, R. (2013). Material management in construction: A case study. *International journal of research in engineering and technology*, *2*(1):.400-403.

Mafukidze, J.K. & Hoosen, F. (2009). November. Housing shortages in South Africa: A discussion of the after-effects of community participation in housing provision in Diepkloof. In *Urban Forum,* 20(4): 379. Springer Netherlands.

Mahadik, U. A (2015) cost reduction in construction project, An International Journal of Engineering Technology Management and Applied Sciences, September 2015, Volume 3, Special Issue, ISSN 2349-4476

Maina, J. J. (2013). Uncomfortable prototypes: Rethinking socio-cultural factors for the design of public housing in Billiri, north east Nigeria. *Frontiers of Architectural Research*, *2*(3): 310-321.

Makinde, O. O. (2014). Housing delivery system, need and demand. *Environment, development and sustainability*, *16*(1): 49-69.

Maliene, V., & Malys, N. (2009). High-quality housing—A key issue in delivering sustainable communities. *Building and Environment*, *44*(2): 426-430.

Manikandan, S. (2011). Measures of central tendency; the mean, *Journal of Pharmacology and Phamacotherapentic,* Mumbai 2.2: 140-142

Manzini, E. & Vezzoli, C. (2003). A strategic design approach to develop sustainable product service systems: examples taken from the ‘environmentally friendly innovation’ Italian prize. *Journal of Cleaner Production*, *11*(8): 851-857.

Marais, L. (2005). *Housing in former homeland areas of South Africa: Delivery, issues, and policy in the Free State province* of South Africa

Marchionini, G. (2006). Exploratory search: from finding to understanding. *Communications of the ACM*, *49*(4): 41-46.

Marshall, M. N. (1996). Sampling for qualitative research. *Family practice*, *13*(6): 522-526.

McGaffin, R., Spiropoulous, J. & Boyle, L. (2019, June). *Micro-developers in South Africa: a Case Study of Micro-property Developers in Delft South and Ilitha Park, Cape Town.* In Urban Forum, 30(2): 153-169. Springer Netherlands.

Meijers, E., Hoogerbrugge, M., Louw, E., Priemus, H. & Spaans, M. (2014). City profile: The Hague. *Cities*, *41:* 92-100.

Melchert, L. (2007). The Dutch sustainable building policy: A model for developing countries. *Building and Environment*, *42*(2):893-901.

Memon, A. H., Rahman, I. A., Abdullah, M. R., & Azis, A. A. A. (2011). Factors affecting construction cost in Mara large construction project: perspective of project management consultant. *International Journal of Sustainable Construction Engineering and Technology*, *1*(2): 41-54.

Meredith, J. R. & Mantel Jr, S. J. (2011). *Project management: a managerial approach*. John Wiley & Sons.

Meredith, J., 1993. Theory building through conceptual methods. *International Journal of Operations & Production Management*, *13*(5), pp.3-11.

Merriam, S.B. and Grenier, R.S. eds., 2019. *Qualitative research in practice examples for discussion and analysis*. John Wiley & Sons.

Migiro, S. MSMEs and Black Economic Empowerment in the Construction Industry: the Case of Gauteng Provincial Housing Department South Africa

Mingers, J., Mutch, A. & Willcocks, L. (2013). Introduction [special issue: Critical realism in information systems research]. *MIS quarterly*, *37*(3):.795-802.

Mingers, J., Mutch, A. and Willcocks, L., 2013. Critical realism in information systems research. *MIS quarterly*, *37*(3), pp.795-802.

Miraftab, F. (2003). The perils of participatory discourse: Housing policy in post-apartheid South Africa. *Journal of Planning Education and Research*, *22*(3): 226-239.

Mnisi-Mudunungu, G. D. (2011). Implementation of government housing delivery programme in the Gravellotte area of Ba-Phalaborwa Municipality, Limpopo (Doctoral dissertation, University of Limpopo (Turfloop Campus)).

Mont, O. K. (2002). Clarifying the concept of product–service system. *Journal of Cleaner Production*, *10*(3): 237-245.

Morelli, N. (2006). Developing new product service systems (PSS): methodologies and operational tools. *Journal of Cleaner Production*, *14*(17): 1495-1501.

Morris, P. (2007). What does green really cost? *PREA Quarterly*, Summer: 55-60.

Morrison, N. (1984). The accuracy of quantity surveyors' cost estimating. *Construction Management and Economics*, *2*(1):.57-75.

Morse, J. M. (2000). Determining sample size. Qualitative Health Research, vol. 10, 3–5 Sage publications

Morse, J. M. (2016). *Mixed method design: Principles and procedures.* published by Routledge 2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN 711 Third Avenue, New York, NY 10017, USAS

Morse, J. M., Barrett, M., Mayan, M., Olson, K. & Spiers, J. (2002). Verification strategies for establishing reliability and validity in qualitative research. *International journal of qualitative methods*, *1*(2): 13-22.

Moselhi, O. & Lorterapong, P. (1993). Least impact algorithm for resource allocation. *Canadian journal of civil engineering*, *20*(2): 180-188.

Moser, C. A. & Kalton, G. (2017). *Survey methods in social investigation*. Routledge.

Muhammad, Z., Johar, F., Sabri, S. & Jonathan, Z. U. (2015). A review of housing provision and the challenges of sustainable housing delivery in the federal capital territory Abuja, Nigeria. *Jurnal Teknologi*, *77*(14).

Mukaka, M.M. (2012). A guide to appropriate use of correlation coefficient in medical research. *Malawi Medical Journal*, *24*(3):.69-71.

Mulliner, E., Smallbone, K. & Maliene, V. (2013). An assessment of sustainable housing affordability using a multiple criteria decision making method. *Omega*, *41*(2):.270-279.

Munasinghe, M. (1993). *Environmental economics and sustainable development* (Vol. 3). World Bank Publications (elibrary.Worldbank.com).

Musabayana, J. (2013). Small enterprise growth: the critical role of the owner-manager a case study of the construction sector in Gauteng, South Africa (Doctoral dissertation).

Nakada, K. (1997). Kansei engineering research on the design of construction machinery. *International Journal of Industrial Ergonomics*, *19*(2): 129-146.

Nakajima, M. (1998). Knowledge-Based Generation of the Activity Process in Wooden Construction Systems. *Computer-Aided Civil and Infrastructure Engineering*, *13*(3): 163-177.

Nakweenda, Twiitedululeni Lukas. (2014). "An investigation into housing finance schemes in Namibia: a case study of otjomuise, Windhoek" (Unpublished PhD dissertation., University of Namibia).

Nega, F. (2008). Causes and Effects of Cost Overrun on Public Building Construction Projects in Ethiopia. (Unpublished Doctoral Dissertation, Addis Ababa University).

Nelms, C. E., Russell, A. D. & Lence, B. J. (2007). Assessing the performance of sustainable technologies: a framework and its application. *Building Research & Information*, *35*(3): 237-251.

Nengwekhulu, R. H. (2009). Public service delivery challenges facing the South African public service. *Journal of public administration*, *44*(2): 341-363.

Neuendorf, K.A. (2016). *The content analysis guidebook* published by Sage publication Inc 2455 Teller Road thousand Oaks California 91320

Neutze, M., Sanders, W., & Jones, R. (2000). Estimating Indigenous housing need for public funding allocation: a multi-measure approach.

Newbold, R. C. (1998). *Project management in the fast lane: applying the theory of constraints.* CRC Press

Newman, I. & Benz, C. R. (1998). *Qualitative research methodology quantitative exploring the interactive continuum.* USA: Southern Illinois University .

Ng, S.T., Skitmore, M., Tam, K.Y. & Li, T.H. (2014). Public engagement in major projects: the Hong Kong experience. *Proceedings of the Institution of Civil Engineers*, *167*(1):.22.

Nijkamp, P. & Soeteman, F. (1988). Land use, economy and ecology: Needs and prospects for co-evolutionary development. *Futures*, *20*(6): 621-634.

Norberg, J. & Cumming, G. S. (2013). *Complexity theory for a sustainable future*. Columbia University Press.

Nubi, T.O. (2000). Housing finance in Nigeria: Need for re-engineering. *Ideal Habitat Cooperative Initiative*.

Nübler, I. (2000). Human Resources Development and Utilisation in Demobilization and Reintegration Programmes. In *Demobilization in Sub-Saharan Africa* (45-77). Palgrave Macmillan, UK.

O'connor, B.P. (2000). SPSS and SAS programmes for determining the number of components using parallel analysis and Velicer's MAP test. *Behavior research methods, instruments, & computers*, *32*(3):.396-402.

Oberlender, G. D. & Trost, S. M. (2001). Predicting accuracy of early cost estimates based on estimate quality. *Journal of Construction Engineering and Management*, *127*(3): 173-182.

Odediran, S. J. & Windapo, A. O. (2014, February). Systematic Review of Factors Influencing the Cost Performance of Building Projects. In *Postgraduate Conference* (p. 501).

Odediran, S.J., Morakinyo, K.O. & Adeyinka, B.F. (2013). An assessment of facilities and materials specification of residential buildings in Nigeria. *Journal of Building Performance*, *4*(1).

Ofori, G. (2007). Construction in developing countries. *Construction management and economics*, *25*(1):.1-6.

Ofori, G., Hindle, R. and Hugo, F., 1996. Improving the construction industry of South Africa: A strategy. *Habitat International*, *20*(2), pp.203-220.

O'Gorman, K. D. & Macintosh, R. (2014). *Research methods for business and management*. Goodfellow Publishers Limited.

Ogunbiyi, O., Goulding, J. S. & Oladapo, A. (2014). An empirical study of the impact of lean construction techniques on sustainable construction in the UK. *Construction innovation*, *14*(1): 88-107.

Ogunbiyi, O., Goulding, J. S. & Oladapo, A. 2014. An empirical study of the impact of lean construction techniques on sustainable construction in the UK. *Construction innovation*,

Ogwueleka, T.C. (2013). Survey of household waste composition and quantities in Abuja, Nigeria. *Resources, Conservation and Recycling*, *77:*.52-60.

Ojonemi, P. S. (2013). Rural development policies and the challenges of realizing the Millennium Development Goals in Nigeria. *Mediterranean Journal of Social Sciences*, *4*(2): 643.

Okafor, F. C. (1988). Resettlement and ecological disruption in Abuja, Nigeria. *Land Use Policy*, *5*(2): 170-174.

Okon, D.E. & Ukwayi, J.K. (2012). Challenges and Prospects of the Millennium Development Goals (MDGS) in Nigeria. *Global Journal of Social Sciences*, *11*(2):.119.

Okonjo-Iweala, N. (2014). Unleashing the housing sector in Nigeria and in Africa. In *6th Global Housing Finance Conference*.

Olagunju, O. A. (2014). The Development of a framework for sustainable housing delivery in Lagos, Nigeria (Doctoral dissertation).

Olander, S. & Landin, A. (2005). Evaluation of stakeholder influence in the implementation of construction projects. *International journal of project management*, *23*(4): 321-328.

Olayiwola, L. M., Adeleye, O. & Ogunshakin, L. (2005). *Public housing delivery in Nigeria: Problems and challenges,* paper presented at the XXXIII IAHS World Congress on housing 27-30 September 2005 transforming housing environment through design University of Pretoria

Olotuah, A. O. & Aiyetan, A. O. (September 2006). Sustainable Low-Cost Housing Provision in Nigeria: a bottom-up, participatory approach. In *Proceedings of 22nd Annual ARCOM Conference,* 4-6.

Olotuah, A. O. & Bobadoye, S. A. (2009). Sustainable housing provision for the urban poor: a review of public sector intervention in Nigeria. *The Built and Human Environment Review*, *2*: 51-63.

Omolabi, A. & Adebayo, O. (2014). An Assessment of Problems of Public Low Income Housing Provision and the Role of Social Housing in Creating a Great Residential Neighbourhood in Lagos, Nigeria. *Planning Africa 2014*, 399.

Omoregie, A. & Radford, D. (2006, April). Infrastructure delays and cost escalation: Causes and effects in Nigeria. In *Proceeding of sixth international postgraduate research conference* (79-93).

Onwuegbuzie, A.J. and Leech, N.L., 2004. Enhancing the interpretation of significant findings: The role of mixed methods research. *The qualitative report*, *9*(4), pp.770-792.

Onyekachi, Adiukwu Fidelis.(2014). *Effects of Governance and Policy Reforms on Affordable Housing in Nigeria. International Journal of Innovation and Scientific Research* ISSN 2351-8014 Vol. 11 No. 2 Nov. 2014, pp. 413-419

Orgen, N. K., Ayarkwa, J., Ahadzie, D. K., & Badu, E. (2015). Effect of Construction Business Relationship Situation on Design Service Delivery in Ghana. *Engineering Management Research*, *4*(1): 13.

Ortiz, O., Castells, F. & Sonnemann, G. (2009). Sustainability in the construction industry: A review of recent developments based on LCA. *Construction and Building Materials*, *23*(1): 28-39.

Osikena, J., Owen, A., Ugur, D. & Kaberuka, D. (2014). *Employment, enterprise and skills* building business infrastructure for African development

Osmani, M., & O'Reilly, A. (2009). Feasibility of zero carbon homes in England by 2016: A house builder's perspective. *Building and Environment*, *44*(9): 1917-1924.

Owolabi, J. D., Amusan, L. M., Oloke, C. O., Olusanya, O., Tunji-Olayeni, P. F., Dele, O & Omuh, I. O. (2014). Causes and effect of delay on project construction delivery time. *International Journal of Education and Research*, *2*(4): 197-208.

Owolabi-Merus, O. (2015). Infrastructure development and economic growth Nexus in Nigeria. *International Journal of Academic Research in Business and Social Sciences*, *5*(1): 376.

Oyebanji, A.O., Liyanage, C. & Akintoye, A. (2017). Critical Success Factors (CSFs) for achieving sustainable social housing (SSH). *International Journal of Sustainable Built Environment*, *6*(1):.216-227.

Oyeneyin, L., Ayodeji, O., Adewole, S. and Gbala, M., Mothers' Experiences with Postpartum Intrauterine Contraceptive Devices at the Mother and Child Hospital, Ondo, Southwest Nigeria. *Niger Delta Journal Of Medical Sciences*, p.28.

Pallant, J. (2013). *SPSS survival manual*. A step by step guide to data analysis using SPSS for windows (version 10) published by McGraw-Hill Education (UK).

Parker, D. (2001). Economic regulation: a preliminary literature review and summary of research questions arising. In *of Research Questions Arising, Centre on Regulation and Competition, Working Paper No 6*.

Patel, K. (2016). Sowing the seeds of conflict? Low income housing delivery, community participation and inclusive citizenship in South Africa. *Urban Studies*, *53*(13): 2738-2757.

Patel, K.V. & Vyas, C.M. (May, 2011). Construction materials management on project sites. In *National Conference on Recent Trends in Engineering & Technology* (13-14).

Patil, A.R. & Pataskar, S.V. (2013). Analyzing material management techniques on construction project. *International Journal of Engineering and Innovative Technology*, *3*(4):.96-100.

Pattillo, M. (2005). Black middle-class neighborhoods. *Annual review of sociology, vol 31*: pp 305-329.

Pearce, D. (1988). Economics, equity and sustainable development. *Futures*, *20*(6): 598-605.

Pearce, J. & Ferrier, S. (2000). Evaluating the predictive performance of habitat models developed using logistic regression. *Ecological modelling*, *133*(3):.225-245.

Pietrosemoli, L. & Monroy, C. R. (2013). The impact of sustainable construction and knowledge management on sustainability goals. A review of the Venezuelan renewable energy sector. *Renewable and Sustainable Energy Reviews*, *27:* 683-691.

Placing, H. I. C. (2000). epsychology@. *journal of environmental psychology*, *20:* 207-217.

Plano Clark, V. L. (2010). The adoption and practice of mixed methods: US trends in federally funded health-related research. *Qualitative Inquiry*, *16*(6): 428-440.

Pluye, P., Gagnon, M.P., Griffiths, F. and Johnson-Lafleur, J., 2009. A scoring system for appraising mixed methods research, and concomitantly appraising qualitative, quantitative and mixed methods primary studies in mixed studies reviews. *International journal of nursing studies*, *46*(4), pp.529-546.

PMBOK, A. (2008). *Guide to the project management body of knowledge* (PMBOK Guide)-Forth Edition. Published by: Project Management Institute.

Potty, N. S., Irdus, A. B. & Ramanathan, C. T. (2011, September). Case study and survey on time and cost overrun of multiple D&B projects. In *National Postgraduate Conference (NPC),* 1-6. IEEE.

Priemus, H. (2005). How to make housing sustainable? The Dutch experience. *Environment and Planning B: Planning and Design*, *32*(1): 5-19.

Pugh, C. (1986). Housing theory and policy. *International Journal of Social Economics*, *13*(4/5): 3-104.

Pulselli, R. M., Simoncini, E., Pulselli, F. M. & Bastianoni, S. (2007). Energy analysis of building manufacturing, maintenance and use: Em-building indices to evaluate housing sustainability. *Energy and buildings*, *39*(5): 620-628.

Rahardjo, T. (2000). The Semarang Environmental Agenda: a stimulus to targeted capacity building among the stakeholders. *Habitat international*, *24*(4): 443-453.

Rahman, I.A., Memon, A.H., Aziz, A.A.A. & Abdullah, N.H. (2013). Modeling causes of cost overrun in large construction projects with partial least square-SEM approach: contractor's perspective. *Research Journal of Applied Sciences, Engineering and Technology*, *5*(06): 1963-1972.

Rao, A., Jha, K. N. & Misra, S. (2007). Use of aggregates from recycled construction and demolition waste in concrete. *Resources, conservation and Recycling*, *50*(1): 71-81.

Rees, W. E. (1994). Economics, ecology, and the role of environmental assessment in achieving sustainable development. *Learning to Live Drug Free: A Curriculum Model for Prevention*, 123.

Ribeiro, G. L. & Dwyer, T. (2015). Social, Political and Cultural Challenges of the BRICS. Langaa RPCIG.

Robbins, D. K., Pantuosco, L. J., Parker, D. F. & Fuller, B. K. (2000). An empirical assessment of the contribution of small business employment to US State economic performance. *Small Business Economics*, *15*(4): 293-302

Roberts, P. and Hills, P., 2002. Sustainable development: analysis and policy in East and West--the cases of Hong Kong and Scotland. *Sustainable Development*, *10*(3), p.117.

Robichaud, L. B. & Anantatmula, V. S. (2010). Greening project management practices for sustainable construction. *Journal of Management in Engineering*, *27*(1): 48-57.

Roozenburg, N. F. & Eekels, J. (1995). *Product design: fundamentals and methods* (V2). Chichester: Wiley.

Rosenberger, I. K. 2003. Sustainable low-cost housing–a review of three low-cost housing developments in Gauteng province (doctoral dissertation, Rand Afrikaans University).

Rotheroe, N., Keenlyside, M. & Coates, L. (2003). Local agenda 21; articulating the meaning of sustainable development at the level of the individual enterprise. *Journal of Cleaner Production*, *11*(5): 537-548.

Roy, R. (2000). Sustainable product-service systems. *Futures*, Volume, *32*(3): Issue 3-4 page 289-299

Rust, K. (2006). Analysis of South Africa's housing sector performance. *FinMark Trust* making financial market work for the poor South Africa

Sallam, M., Al-Fraihat, E., Dababseh, D., Taim, D., Zabadi, S., Hamdan, A.A., Hassona, Y., Mahafzah, A. and Şahin, G.Ö., 2019. Dental students' awareness and attitudes toward HPV-related oral cancer: a cross sectional study at the University of Jordan. *BMC oral health*, *19*(1), p.171.

Salleh, A. G. (2008). Neighbourhood factors in private low-cost housing in Malaysia. *Habitat International*, *32*(4): 485-493.

Sambasivan, M. & Soon, Y. W. (2007). Causes and effects of delays in Malaysian construction industry. *International Journal of project management*, *25*(5): 517-526.

Sandberg, J. and Alvesson, M., 2011. Ways of constructing research questions: gap-spotting or problematization?. *Organization*, *18*(1), pp.23-44.

Saris, W. E. & Gallhofer, I. N. (2007). *Design, evaluation, and analysis of questionnaires for survey research* (Vol. 548). John Wiley & Sons.

Scherer, A. G., Palazzo, G. & Seidl, D. (2013). Managing legitimacy in complex and heterogeneous environments: Sustainable development in a globalized world. *Journal of Management Studies*, *50*(2): 259-284.

Sebti, M., Alkama, D. & Bouchair, A. (2013). Assessment of the effect of modern transformation on the traditional settlement 'Ksar'of Ouargla in southern Algeria. *Frontiers of Architectural Research*, *2*(3): 322-337.

Sengupta, U., 2006. Government intervention and public–private partnerships in housing delivery in Kolkata. *Habitat International*, *30*(3):.448-461.

Seyfang, G. (2010). Community action for sustainable housing: Building a low-carbon future. *Energy Policy*, *38*(12): 7624-7633.

Shan, C., & Yai, T. (2011). Public involvement requirements for infrastructure planning in China. *Habitat International*, *35*(1), 158-166.

Shao, J. (2013). Sustainable strategies applied on commercial architecture in Australia. *Frontiers of Architectural Research*, *2*(3): 362-372.

Shi, L. & Chew, M. Y. L. (2012). A review on sustainable design of renewable energy systems. *Renewable and Sustainable Energy Reviews*, *16*(1): 192-207.

Shun, L. Y. 2007. A checklist for assessing sustainability performance of construction projects. *Journal of Civil Engineering and Management,* xiii(4):273-281.

Sivam, A. (2002). Constraints affecting the efficiency of the urban residential land market in developing countries: a case study of India. *Habitat International*, *26*(4): 523-537.

Sivam, A. (2003). Housing supply in Delhi. *Cities*, *20*(2): Vol 20 No 2, 135-141. Published by Elsevier Science

Skinner, J. S. (1996). Is housing wealth a sideshow?. In *Advances in the Economics of Aging* (241-272). University of Chicago Press.

Smithin, J. (Ed.). (2002). *What is money?*, how monetary policy work, published by Routledge Taylor and Francis Group

Smythe, W. E. & McKenzie, S. A. (2010). A vision of dialogical pluralism in psychology. *New Ideas in Psychology*, *28*(2): 227-234.

Sohmen, V. S. & Dimitriou, C. K. (2015). Ten Core Competencies of Program Managers: An Empirical Study. *International Journal of Health and Economic Development*, *1*(1): 1.

Song, J., Fagerlund, W. R., Haas, C. T., Tatum, C. B. & Vanegas, J. A. (2005). Considering prework on industrial projects. *Journal of Construction Engineering and Management*, *131*(6): 723-733.

Srirangan, K. (2000). Public land and property development and cross-subsidisation for low-income housing in Delhi. In *Delhi field studies and workshop: Guide to good practice in core area development*.

Steel, W. F. & Andah, D. O. (2008). Rural and Micro Finance Regulation in Ghana: Implications for Development and Performance of the Industry. *The economy of Ghana: analytical perspectives on stability, growth and poverty,* Ernest Aryeetey and Ravi Kanbur, eds., Woeli Publishing Services and James Currey.

Stegman, M. A. (1991). The excessive costs of creative finance: Growing inefficiencies in the production of low-income housing. *Housing Policy Debate*, *2*(2): 357-373.

Stemler, S. (2001). An overview of content analysis. *Practical assessment, research & evaluation*, *7*(17):.137-146.

Stentz, J. E., Clark, V. L. P. & Matkin, G. S. (2012). Applying mixed methods to leadership research: A review of current practices. *The Leadership Quarterly*, *23*(6): 1173-1183.

Sterman, J. D. (1992). System dynamics modeling for project management. *Unpublished manuscript, Cambridge, MA*.

Stetsenko, A. (2008). From relational ontology to transformative activist stance on development and learning: expanding Vygotsky's (CHAT) project. *Cultural Studies of Science Education*, *3*(2): 471-491.

Stone, M. E., Burke, T. & Ralston, L. (2011). *The residual income approach to housing affordability: The theory and the practice,* for the Australian housing and urban research institute, published May 2011 number 139, ISSN 18349250, ISBN 978-1-921610-71-4

Strauss, A., 15. 15 Methods of Data Analysis in Qualitative Research, scholar.google.com/scholar

Strauss, M., Rhodes, B. & George, G. (2015). A qualitative analysis of the barriers and facilitators of HIV counselling and testing perceived by adolescents in South Africa. *BMC health services research*, *15*(1): 250.

Strong, D. M., Lee, Y. W. & Wang, R. Y. (1997). Data quality in context. *Communications of the ACM*, *40*(5): 103-110.

Sullivan, E. & Ward, P. M. (2012). Sustainable housing applications and policies for low-income self-build and housing rehab. *Habitat International*, *36*(2): 312-323.

Sultan, B. & Kajewski, S. 2004. Local problems in the construction industry of Yemen. *Globalisation and Construction*, 369.

Tam, C. M., Tam, V. W. & Tsui, W. S. (2004). Green construction assessment for environmental management in the construction industry of Hong Kong. *International Journal of Project Management*, *22*(7): 563-571.

Tam, V. W., Tam, C. M., Zeng, S. X. & Ng, W. C. (2007). Towards adoption of prefabrication in construction. *Building and environment*, *42*(10): 3642-3654.

Tan, T. H. (2008). Determinants of homeownership in Malaysia. *Habitat International*, *32*(3): 318-335.

Tanko, B. L., Abdullah, F. & Ramly, Z. M. (2017). Stakeholders Assessment of Constraints to Project Delivery in the Nigerian Construction Industry. *International Journal of Built Environment and Sustainability*, *4*(1).

Tashakkori, A. & Teddlie, C. (Eds.). (2010). *Sage handbook of mixed methods in social & behavioral research.* Sage Researchgate.net/profile/Goekhan-Daghan/publication

Tashakkori, A. and Creswell, J.W., 2007. The new era of mixed methods [Editorial]. *Journal of mixed methods research*, *1*(1), pp.3-7.

Tatari, O. & Skibniewski, M. (2006). Integrated agent-based construction equipment management: Conceptual design. *Journal of Civil Engineering and Management*, *12*(3): 231-236.

Taylor R. G. & Normal G. H. M. (1994). Developing procurement system for developing community CIB W92 symposium publication no 175

Taylor, E. W. (2008). Transformative learning theory. *New directions for adult and continuing education*, *2008*(119): 5-15.

Teck-Hong, T. (2012). Housing satisfaction in medium-and high-cost housing: The case of Greater Kuala Lumpur, Malaysia. *Habitat International*, *36*(1): 108-116.

Teddlie, C. & Tashakkori, A. (2003). Major issues and controversies in the use of mixed methods in the social and behavioural sciences. *Handbook of mixed methods in social & behavioural research*, 3-50.

Teddlie, C. & Tashakkori, A. (2006). A general typology of research designs featuring mixed methods. *Research in the Schools*, *13*(1): 12-28.

Teddlie, C. & Tashakkori, A. (2009). *Foundation of Mixed Methods Research Interesting Quantitative and Qualitative Approaches in the Social and Behavioural Sciences.* United Kingdom: Sage.

Tianliang Lin., Qingfeng Wang., Baozan Hu & Wen Gong. (2010). Development of hybrid powered hydraulic construction machinery Automation, *Construction,* 19(1): 11-19.

Tjandradewi, B. I., Marcotullio, P. J. & Kidokoro, T. (2006). Evaluating city-to-city cooperation: a case study of the Penang and Yokohama experience. *Habitat International*, *30*(3): 357-376.

Tomlinson, B. (1998). 15 Access-self materials. *Materials development in language teaching*, p.320. Cambridge University press, the Edinburgh building Cambridge CB28RU UK www.cambridge.org/9780521157049

Tomlinson, M.R. (1998). South Africa's new housing policy: an assessment of the first two years, 1994–96. *International Journal of Urban and Regional Research*, *22*(1):.137-146.

Tomlinson, R. (2014). International best practice, enabling frameworks and the policy process: A South African case study. *Cities of the Global South Reader*, *315*.

Tommelein, Iris D. & Glenn Ballard. (1997). *Coordinating specialists*. Vol. 8. Technical Report No. 97.

Tongco, M. D. C. (2007). Purposive sampling as a tool for informant selection, ethnobotany research & applications, a journal of plant, people and applied research Quezon City 1101 Philippines

Torcellini, P.A. & Crawley, D.B. (2006). Understanding zero-energy buildings. *ASHRAE Journal*, *48*(9): 62.

Trotter, R. T. (2012). Qualitative research sample design and sample size: Resolving and unresolved issues and inferential imperatives. *Preventive medicine*, *55*(5): 398-400.

Tshikhudo, L.M. (2016). Development of construction small, medium and micro enterprise in the South African construction industry (Doctoral dissertation, University of Johannesburg).

Tunji-Olayeni, P.F., Mosaku, T.O., Fagbenle, O.I., Amusan, L.M., Omuh, I.O. & Joshua, O. (2014). Evaluating Construction Project Performance: A Case of Construction SMEs in Lagos, Nigeria.

Ubisi, S.V., Khumalo, P. & Nealer, E.J. (2019). Provision of adequate housing through cooperative government and intergovernmental relations in the Bushbuckridge local municipality. *Gender & Behaviour*, 17(2).

Ugonabo, C. & Emoh, F. (2013). The major challenges to housing development and delivery in Anambra State of Nigeria. *Civil and Environmental Research*, *3*(4): 1-20.

Ugwu, O. O. & Haupt, T. C. (2007). Key performance indicators and assessment methods for infrastructure sustainability—a South African construction industry perspective. *Building and Environment*, *42*(2): 665-680.

Ugwu, O. O., Kumaraswamy, M. M., Wong, A. & Ng, S. T. (2006). Sustainability appraisal in infrastructure projects (SUSAIP): Part 1. Development of indicators and computational methods. *Automation in construction*, *15*(2): 239-251.

UK Essays. November 2013. Labour Management in Construction Projects Management Essay. [online]. Available from: https://www.ukessays.com/essays/management/labour-management-in-construction-projects-management-essay.php?cref=1 [Accessed 25 August 2017].

Ukoje, J.E. & Kanu, K.U. (2014). Implementation and the Challenges of the Mass Housing Scheme in Abuja, Nigeria. *American International Journal of Contemporary Research*, 4(4):209-218.

Un-Habitat, 2012. *Cities in a globalizing world: global report on human settlements.* Routledge.

Un-Habitat, 2013. *Planning and design for sustainable urban mobility: Global report on human settlements 2013.* Routledge.

Van Teijlingen, E. R. & Hundley, V. (2001). The importance of pilot studies, social research University of Surrey

Van Wyk, B. (2012). *Research design and methods Part I.* University of Western Cape.

VanderStoep, S. W. & Johnson, D. D. (2008). *Research methods for everyday life: Blending qualitative and quantitative approaches* (32). John Wiley & Sons.

Vlek, C. & Steg, L. (2007). Human Behavior and Environmental Sustainability: Problems, Driving Forces, and Research Topics. *Journal of social issues*, *63*(1):.1-19.

Wa'el Alaghbari Mohd. Razali A. Kadir Azizah Salim Emawati. (2007). The significant factors causing delay of building construction project in Malaysia, *Engineering Construction and Architectural Management*, 14(2): 192.

Walker, A. & Kwong Wing, C. (1999). The relationship between construction project management theory and transaction cost economics. *Engineering Construction and Architectural Management*, 6(2):166-176.

Walsh-Bowers, R. (2010). Some social-historical issues underlying psychology's fragmentation. *New Ideas in Psychology*, *28*(2): 244-252.

Wang, D. & Li, S. M. (2006). Socio-economic differentials and stated housing preferences in Guangzhou, China. *Habitat International*, *30*(2): 305-326.

Wang, X. & Huang, J. (2006). The relationships between key stakeholders' project performance and project success: Perceptions of Chinese construction supervising engineers. *International Journal of Project Management*, *24*(3): 253-260.

Waziri, A. G., & Roosli, R. (2013). Housing Policies and Programmes in Nigeria: A Review of the Concept and Implementation. *Society for Business and Management Dynamics*, *3*(2): 60-68

WBDG, a programme of the National Institute of Building Science (2017) building resilience excerpted from the 12th edition of architectural graphic standards (wbdg.org/project-management).

Wentworth, L. & Makokera, C.G. (2015). Private sector participation in infrastructure for development. *South African Journal of International Affairs*, *22*(3):.325-341.

Westerveld, E. (2003). The Project Excellence Model®: linking success criteria and critical success factors. *International Journal of project management*, *21*(6): 411-418.

Williams, K. & Dair, C. (2007). What is stopping sustainable building in England? Barriers experienced by stakeholders in delivering sustainable developments. *sustainable development-bradford*, *15*(3): 135.

Williams, K., Jenks, M. & Burton, E. (2000). *Achieving sustainable urban form*. Taylor & Francis.

Windapo, A. (2017). *Determinants of the sustainability and growth of construction contractors*

Windapo, A., Odediran, S., Moghayedi, A., Adediran, A. & Oliphant, D. (2017). Determinants of Building Construction Costs in South Africa. *Journal of Construction Business and Management*, *1*(1): 8-13.

Winston, N. (2010). Regeneration for sustainable communities? Barriers to implementing sustainable housing in urban areas. *Sustainable Development*, *18*(6): 319-330.

Xin, Z. Y. & Rong, L. B. (2004). Sustainable housing and urban construction in China [J].*Energy and Buildings*, 36(12):1287-1297.

Yahya, K. & Halim Boussabaine, A. (2006). Eco-costing of construction waste. *Management of Environmental Quality: An International Journal*, *17*(1): 6-19.

Yakub, A. A., Salawu, A. O. & Gimba, S. D. (2012). Housing Delivery via Housing Cooperatives as a tool towards achieving National Development; An Empirical Study In S. In *Laryea, SA Agyepong, R. Leiringer, and W. Hughes,(Eds.) Procs 4th West Africa Built Environment Research (WABER) Conference* (1427-1441).

Yang, F. (2009). Consumption over the life cycle: How different is housing?. *Review of Economic Dynamics*, *12*(3): 423-443.

Yeung, S. C. W. & Howes, R. (2006). The role of the housing provident fund in financing affordable housing development in China. *Habitat International*, *30*(2): 343-356.

Yin, R. K. (2013). Case study research: Design and methods. Sage publications.

Yu, A., Shen, Q., Kelly, J. & Hunter, K. (2006). Investigation of Critical Success Factors in Construction Project Briefing by Way of Content Analysis. *J. Constr. Eng. Manage.*, 10.1061/(ASCE)0733-9364(2006)132:11, 1178-1186.

Yu, Ann TW, *et al.* (2005). Application of value management in project briefing. *Facilities* 23.7/8: 330-342.

Yu, D. & Yang, J. (2016). Knowledge Management Research in the Construction Industry: a Review. *Journal of the Knowledge Economy*, 1-22.

Zainul Abidin, N. & Pasquire, C. L. (2005). Delivering sustainability through value management: Concept and performance overview. *Engineering, Construction and Architectural Management*, *12*(2): 168-180.

Zhu, Y. & Lin, B. (2004). Sustainable housing and urban construction in China. *Energy and Buildings*, *36*(12): 1287-1297.

Zimmermann, M., Althaus, H. J. & Haas, A. (2005). Benchmarks for sustainable construction: A contribution to develop a standard. *Energy and Buildings*, *37*(11): 1147-1157.

Zou, P. X., Zhang, G. & Wang, J. (2007). Understanding the key risks in construction projects in China. *International Journal of Project Management*, *25*(6): 601-614.

Zwikael, O., Shimizu, K. & Globerson, S. (2005). Cultural differences in project management capabilities: a field study. *International Journal of Project Management*, *23*(6): 454-462.

Appendix A: Quantitative questionnaires

Akinyede Imisioluseyi Julius

Cape Peninsula University of Technology

Department of Civil Engineering and Surveying

Bellville Campus, South Africa

Email: seyiakinyede@yahoo.co.uk.

Mobile: +27 632698555

Dear Sir/ Madam

QUESTIONNAIRE SURVEY

FRAMEWORK FOR EFFECTIVE MANAGEMENT OF COST TOWARD SUSTAINABLE HOUSING DELIVERY

This study is to establish a framework for effective management of cost toward sustainable housing delivery. It is a research study in the Department of Civil Engineering at the Cape Peninsula University of Technology.

Kindly peruse the questionnaire, rating each question appropriately. Names and opinions of respondents will not be disclosed. Completing the questionnaire will only take twenty minutes. The completed questionnaire should be returned to the address above.

Thank you for your friendly assistance and support for innovation.

Akinyede, IJ

(Doctoral Student)

SECTION A: RESPONDENT DETAILS

1. Kindly indicate the nature of practice undertaken by your company?

☐ Architectural firm ☐ Project consultant firm ☐ Structural firm

☐ Construction firm ☐ Quantity surveying firm

2. How long have you worked in the construction industry? 1-5 ☐ 6-10 ☐ 11-15 ☐ 16-20 ☐ 21-25 ☐ 26-30 ☐

SECTION B: PROFESSIONAL AFFILIATION

Kindly indicate your professional affiliation within your company:

3. What position are you in your firm? Architect ☐ Project Manager ☐ QS ☐

Site Engineer ☐ Contract Manager ☐ Contractor ☐ Client ☐ Quality Assurance Manager ☐

4. How long have you been in your current position? 1-5 ☐ 6-10 ☐ 11-15 ☐ 16-20 ☐

21-25 ☐ 26-30 ☐ 31-35 ☐ 36-40

SECTION C: HOUSING DELIVERY DIFFERENTIATING

5. What type of housing project are you involved in? Tick if applicable:

☐ New housing project ☐ Renovation of housing

6. What is the use of the housing project in which you are involved?

Public residential housing ☐

Private residential housing ☐

SECTION D: Kindly relate questions 7-12 to housing delivery with which you have been involved in the past:

7. What is the budgeted cost? R200, 000-R1.0m ☐ R1m-R50m ☐ R51m-R500billion ☐

8. Was there cost increase as a result of variation in the housing project? Ye No

9. Specify the time frame for the housing project 6 month ☐ 1yr ☐ 2yrs ☐ 3yrs ☐ above ☐ 3yrs

10. When was the housing project actually completed? Within time frame ☐ above time specify ☐ below time specified ☐ not yet completed ☐

11. What contracting procedure was used for the housing project?

design and build contract ☐ construction management contract ☐

traditional cost plus ☐ traditional lump sum contract ☐

design and manage contract ☐

12. What is the area occupied by the housing project? 500m2 ☐ 1000m2 ☐ above ☐

SECTION E: ADMINISTRATIVE MANAGEMENT RULES AND PRACTICES FOR HOUSING DELIVERY

1. Kindly rate the level at which of the following practice is applicable to your firm in housing project delivery:

1-Extremely not applicable, 2-Not applicable, 3-Moderately applicable, 4-Applicable, 5-Extremely applicable

Significant factors	**1**	**2**	**3**	**4**	**5**
Ethical consideration on site					
Establishment of cost control criteria on site					
Obedience to international standard organisation rules					
Policy on quality					
Keeping achiever records					
Total quality management procedure for production					
Keeping records of experience learned on project delivery					
Safety practices on site					

2. Kindly indicate which of these learning processes is applicable to your firm in delivery of affordable housing:

1-Extremely not applicable, 2-Not applicable, 3-Moderately applicable, 4-applicable, 5-Extremely applicable

Significant factors	**1**	**2**	**3**	**4**	**5**
Organised skill improvement conference for construction operators					
Learning through teamwork on site					
Learning through workshop training					
Learning through research on housing delivery					
Learning from previous projects					
Seminars organised for housing development					

SECTION F: FACTORS THAT INFLATE THE COST OF SUSTAINABLE HOUSING DELIVERY OVER BUDGET

1. The under listed are the factors that inflate the cost of sustainable housing delivery over budget, indicate the level at which you agree with the factors:

1- Strongly disagree, 2-Disagree, 3- Agree, 4-Strongly agree

Significant factors	**1**	**2**	**3**	**4**
Technology advancement				
Availability of skilled workers on site				
Practices of foreign principles on site				
Poor implementation of government policy				
Financial management on housing production				
Frequent changes in design of housing during production				
Cost of housing materials in the market				
High cost of machinery				
Constant additional work without contractual procedure on cost of construction				
Inadequate coordination of design phase and construction phase during production				

Significant factors	1	2	3	4
Misunderstanding between design and construction team on site				
Economic stability influence				
Cost of insurance for housing production process				
Government policies on housing				
Duration of housing construction				
High cost of labour for production				
Inadequate labour availability on site				
Absence of construction cost control for production				
Currency exchange rate for importation of construction resources				
Inadequate materials for production				
Fluctuation of price of housing materials				
Contract management on site				
Contractual procedure for housing delivery				
Adequate planning for production				
Competency of government agents on housing development				

SECTION G: FACTORS THAT AFFECT UNSUSTAINABLE DESIGN IN DELIVERY OF AFFORDABLE HOUSING WITHIN BUDGET

1. Please indicate the level at which you agree with the factors that affect unsustainable design in delivery of affordable housing within budget:

1- Strongly disagree, 2-Disagree, 3-Agree, 4-Strongly Agree

Significant factors	1	2	3	4
Incorporating sustainable design principles				
Discrepancies between drawing and specification impact				
Design sufficiency and adaptable to meet people demand				
Replacement of materials during construction affect cost of delivery				
Government policy on housing design				
Establish standard design for production				
Design for waste minimisation during production				
Design for re-use of materials				

Significant factors	**1**	**2**	**3**	**4**
Decision taking at planning stage causes changes in housing design				
Cost is affected by value engineering at design stage				
Constant promoting high standard design				
Ambiguous design details cause changes in housing design				
Coordination of design changes during production				
Changes in specification by consultant cause changes in housing design				
Design for the best use of land, infrastructure and services				
Inadequately defined scope of work for contractors causes change in housing design during production				
Procurement of new materials for housing delivery causes changes in design				
Design housing for environmental performance efficiency				
Improper design leads to failure in achieving client objectives				
Frequent changes to housing design cause variation				
Errors and omission in housing design affects quality				
Adequate design for new techniques will affect cost effective production				
Changes in design as a source of waste during production				
Inadequate design affects cost of delivery				
Design of first-rate living conditions for a healthy environment				
Frequent changes of housing design by client affect construction cost				
Inadequate consideration for housing location at design stage causes change in design				
Poor communication among design team and contractor at planning stage causes changes in design				
Non-involvement of contractors at initiating stage of design planning causes frequent changes in design				
Prolonged procedure for management of design changes causes delay				

Significant factors	**1**	**2**	**3**	**4**
Safety consideration for housing delivery causes changes in design				
Non-compliance of housing design with government regulation causes changes in design at implementation				
Complexity of design causes changes in design and affects cost				
Design for better performance				
Sustainability integrated approach for housing delivery				
Design for implementation of new technology				

SECTION H: THE IMPACT OF COST ON MANAGEMENT OF CONSTRUCTION RESOURCES IN DELIVERY OF SUSTAINABLE HOUSING BY CONSTRUCTION OPERATORS

H1. Indicate the level at which you accept how human resources has an effect on cost in delivery of sustainable housing with each of the following under listed statements:

1-Perfectly unacceptable, 2-Unacceptable, 3-Quite acceptable, 4-Acceptable, 5-Perfectly acceptable

Significant factors	**1**	**2**	**3**	**4**	**5**
Involvement of all team members in planning and implementation					
Develop staffing management plan					
Document delivery roles and responsibilities among construction team members					
Regular meetings on site for promoting efficient productivity					
Define quality accomplishment for housing production					
Time wastage by workforce during production					
Skill to establish requirements, methods and techniques for housing production					

Significant factors	**1**	**2**	**3**	**4**	**5**
Constant training of workers for use of techniques					
A sound knowledge on quality design decisions and implementation					
Team-building strategies for production					
Ability to carry out effective implementation of techniques on housing production					
Emphasis on constant encouraging construction operators on skill advancement and development					
Build trust among construction team members					
Reduction in delivery time through proper job allocation to workforce					
Ability to define plan for effective use of resources available for production					
Steadfastness in carrying out commitments and obligations					
Shortage of experienced workers on site					
Skill in oral and written communication for keeping subordinates, associates, superiors and others adequately informed during production					
Improper planning of workforce activities on site					
Aptitude to work under pressure to meet tight deadlines and adapt to changes affect cost of construction					
Prompt payment of wages by contractors will enhance productivity					
Ability to safeguard safety consciousness during housing production					
Workforce productivities affect cost					
Skill to apply techniques for reduction in cost of construction during production					
Wastage of workforce input during production process					

Significant factors	1	2	3	4	5
Ability of workforce to develop willingness in sustainability practices					
Knowledge of good safety practices and awareness of personal safety during production					
Skill to define effective techniques for achieving objectives					
Flexibility of construction operators in making timely management decisions on production					
Constant emphasis on making maximum usage of local labour force to achieve housing production					

H2. Indicate the level at which you agree that management of machinery has an effect on cost in delivery of sustainable housing with each of the following under listed statements:

1-Strongly Disagree, 2-Disagree, 3-Agree, 4-Strongly Agree

Significant factors	1	2	3	4
Maintenance cost of equipment on site				
Cost of transportation of equipment to site				
Equipment delivery time during production process				
Cost of equipment and import duties				
Constant changes in hiring price of equipment				
Specific factory cost attributable to the equipment				
Lack of proper planning for the use of equipment				
Idleness of hiring equipment on site				
Manufacturer’s excise tax on housing equipment				
Constant increase in cost of purchasing equipment				
Different equipment for site soil conditions affect construction cost				
Overhead cost attributable to the equipment affects cost of construction				
Procurement of appropriate equipment				
Abnormal profit making from the manufacturers in selling equipment				

Significant factors	1	2	3	4
Faulty equipment on site for production				
Inadequate management of equipment				
Planning for the use of equipment on site				

H3. Indicate the level at which you agree on the effect of building materials on budgeted cost during housing production process with each of the under listed statements:

1-Strongly Disagree, 2-Disagree, 3-Agree, 4-Strongly Agree

Significant factors	1	2	3	4
Use of foreign materials for housing construction has effect on budgeted cost				
Delay in importation of housing construction materials				
Increase in the price of original materials specified causes the use of alternative materials				
Use of materials that are environmentally friendly				
Increase in price of construction materials				
Late delivery of construction materials				
Insufficient of construction materials on site				
Scarcity of housing materials in the country leads to importation of materials with high prices from other nations				
Change in specification of materials during production				
Cost of finance construction materials by bank				
Inhibited innovations for housing materials				
Quality of workmanship on materials will reduce waste				
Municipal government taxes and charges on materials				
Sources of estimates on site for calculating cost of materials				
Management plan for delivery of materials				
Site activities plan for cost estimate				
Project log books for records of activities and materials				
Seasonal changes in housing construction materials				
Cost of transportation and distribution of materials				
Exchange rate of dollars affects materials delivery				
Increase in price of materials affects time delivery				

Significant factors	1	2	3	4
Government regulations on housing materials usage affect cost				
Currency exchange rate in the country leads to scarcity of materials				
Currency instability in the country affects prices of housing materials				

SECTION I: EFFECTIVE UTILISATION OF BUDGETED COST WITHOUT INFLATING COST OF CONSTRUCTION FOR SUSTAINABLE HOUSING DELIVERY

1. Identify which of the following cost management principles are used in housing production processes with which you are involved. Carefully indicate how effective the step was without inflating cost of construction for sustainable housing delivery:

1-Ineffective, 2-Slightly ineffective, 3-Slightly effective, 4-Effective, 5-Perfectly effective

Significant factors	1	2	3	4	5
Establishment of stakeholders interest					
Improvement on construction operators productivity					
Risk inventory on site for production process					
Made possible wholesale change in construction technologies					
Human resources management plan on site					
Determine competencies of construction operators at planning stage					
Accurate furcating cost of housing production process at planning stage					
Adequate establishment of client objectives at briefing					
Regulate the true cost at planning stage					
Contract agreement by law during production					
Establish restraint methods toward increased budgeted cost at implementation stage					
Set requirements before life cycle cost at planning and implementation stages					

Significant factors	1	2	3	4	5
Site activities plan for cost estimate					
Objectivities of financial sustainability					
Cost control plans for production					
Determine detrimental effect and viability of housing loan					
Establishment of cost control base on site					
Determine level of impact of construction constraint at planning stage					
Plan for efficiency use of all monetary resources during production					
Establishment of procedure for funding delivery during production					
Proper design and construction coordination					
Consider varying size and complexity of housing project relative to resources available					
Work programme on site					
Projects schedule/timetable for production					
Recognise the close relationship between design and construction cost					
Flexibility integration into housing design to accommodate future demand and changes					
Teamwork on site for housing production					
General progress report on housing production process					
Longevity integrated at design stage to achieve reduction in future maintenance					

SECTION J: MODALITY OF ACHIEVING SUSTAINABLE AFFORDABLE HOUSING DELIVERY WITHIN CONSTRAINT OF QUALITY DURING PRODUCTION PROCESS

1. What is the modality of achieving sustainable affordable housing? Confirm the level at which you agree with the following under listed statements in achieving sustainable affordable housing delivery:

1-Strongly disagree, 2-Disagree, 3-Agree, 4-Strongly agree

Significant factors	**1**	**2**	**3**	**4**
Instituting of construction professionals who will actualize client's interest				
Developed consistency availability of housing within quality				
Proper monitoring and controlling of housing delivery at stages of production process				
Adequate planning at initiating stage				
Proper cost estimates for housing production				
Prompt payment to contractors by the client				
Proper management of procurement procedure				
Avoiding mistake during production process				
Adequate preparation for housing financing by client				
Discourage absenteeism among workers for continuity of responsibility during production				
Adequate management of equipment and materials to achieve timely delivery of project				
Establishment of financial control team				
Establishment of teamwork among stakeholders for production				
Allow for free flow of information among construction team				
Strong desire to reduce the construction cost without affecting quality				
Expert desire to reduce the maintenance cost of housing				
Procurement of competent contractors and subcontractors				
Involvement of experienced professionals				
Skilful desire for reduction in operating cost				
Proper briefing of objectives by the client at the planning stage				
Targeting quality for production				
Prompt decision taking at planning and implementation stages				
Establishment of effective communication system on site				
Draw out programme of work for production within time				

SECTION K: WHAT ARE THE CRITICAL FACTORS OF ACHIEVING QUALITY HOUSING DELIVERY?

1. What are the critical factors of achieving quality housing delivery? Confirm the level at which you agree with the following under listed statements in achieving quality housing delivery:

1-Strongly disagree, 2-Disagree, 3-Agree, 4-Strongly agree

Significant factors	**1**	**2**	**3**	**4**
Design and construction of housing to support services and amenities for the needs of the people				
Establish architectural scheme appropriate for a pleasant living environment				
Establish accessible and adaptable criteria for all residents				
Establishment of quality increases				
Quality sampling during production				
Identify quality requirement at initiating stage process				
Quality control during production process				
Quality assurance at implementation and closed-out stages				
Effective quality planning for affordable housing				
Establishment of resources efficient scheme for production				
Design for affordable and maintainable				
Establishment of durability techniques during production				
Adequate design for provision of a safe, secure and healthy environment for the residents				
Consistent commitment to quality by all stakeholders				
Focus on quality sustainability throughout production process				
Designing for comfort, cost efficient and easy maintenance				
Design housing for the use of renewable resources for cost effectiveness				
Design housing for changing needs throughout the life of the occupants and not just for immediate needs				

SECTION L: WHAT ARE THE STAKEHOLDERS' INFLUENCES ON AFFORDABLE SUSTAINABLE HOUSING DELIVERY DURING PRODUCTION?

1. What are the stakeholders' influences on affordable sustainable housing delivery? Confirm the level at which you agree with the following under listed statements in achieving affordable housing delivery:

1-Strongly disagree, 2-Disagree, 3-Agree, 4-Strongly agree

Significant factors	**1**	**2**	**3**	**4**
Has varying levels of responsibility and authority				
Change course of production				
Assessment of production process				
Sponsoring of housing project				
Providing administrative support				
Identifying stakeholder and understanding their relative degree of influence on housing delivery				
Monitoring and evaluating housing project impact in relation to initial planning				
Conflicting objectives during production				
Interact with stakeholders in a professional and cooperative manner				
Impact on requirements				
Adequate handling area of specialisation toward implementation				
Establish stakeholders aims, needs and objectives at planning stage				
Establish degree of influence on timeline and increase in construction cost substantially				
Matching stakeholders interest towards requirements				
Establish a criteria to measure success relative to stakeholder interest				
Adequate communication with stakeholders				

Appendix B: Invitation letter and request to participate in qualitative study

Department of Civil Engineering

Faculty of Engineering

Cape Peninsula University of Technology Bellville Campus

Symphony Way Bellville 7535

South Africa

Email; seyiakinyede@yahoo.co.uk

Date……………………….

Dear Sir/Madam

Letter of request to participate in qualitative study

This is to inform you that you are among of the skilled professional selected as respondents to participate in qualitative interview, and I wish to invite you officially that you will partake in the interview scheduled to take place 27th and 28TH of November 2017, alternatively sir, you can schedule a time that will be convenient for you, so that the interview can be accomplished efficiently. The major reason for the interview is basically hinge on the validation of the result obtained from the quantitative data analysis, and to actually determine if the instruments used accurately measure what it supposed to measure. Thus, your wealth of experience is highly needed toward the realisation of the aim and objectives entrenched in this research study. I will appreciate the acknowledgement and acceptance of this letter by you through the highlighted email above.

Sir, professional ethics will be adequately considered during and after the interview, in view of the facts that information collected will not be divulged to the public and name of participant will not be mentioned.

Thank for your support for innovation at all time.

Yours sincerely,

Akinyede, IJ

(Doctoral Student-CPUT)

Appendix C: Qualitative Interview guide

Qualitative Interview guide; Title; Framework for effective management of cost toward sustainable housing delivery

To achieve cost-efficiency during project production, how could factors that inflate cost of sustainable housing delivery be guided and implemented for effective production, the underlisted are the major factors identified.

- Availability of skilled worker
- Financial management on housing production
- Adequate planning for production

The constant increase in cost of construction of housing is a challenge through unsustainable design, how could factors that affect unsustainable design in delivery of affordable housing be averted at planning and production stages, the underlisted factors are identified.

- Improper design leads to failure in achieving client objectives
- Establish standard design for production
- Design of first-rate living condition for a healthy environment

Construction resources waste is a syndrome, how could the management of construction resources be effectively implemented to achieve delivery of sustainable housing, underlisted factors are identified as imparting sustainable housing delivery

- ❖ Workforce productivity
- ❖ Involvement of all team members in planning and implementation
- ❖ Regular meeting on site for promoting efficient productivity

The management of machinery is a challenge to cost of construction, how possibly will management of machinery be effectively implemented to achieve sustainable housing delivery, underlisted factors are branded as influencing cost of construction

- ❖ Cost of transportation of equipment to site
- ❖ Maintenance cost of equipment on site
- ❖ Lack of proper planning for the use of equipment

Materials management is a dare on sustainable housing delivery, how conceivably wills management of materials be effectively implemented to achieve cost efficiency housing, underlisted factors trademarked as influencing cost of construction

- ❖ Quality workmanship on materials will reduce waste
- ❖ Late delivery of construction materials to site
- ❖ Increase in the price of original materials specified causes the use of alternatives materials

Quality is indispensable toward sustainable housing delivery, how could quality be achieved in spite of critical factors constraint quality housing delivery within budget, the underlisted factors were identified as the critical factors impact quality sustainable housing delivery

- ❖ Quality assurance at implementation and closeout
- ❖ Quality control during production process
- ❖ Effective quality planning for affordable housing

Stakeholders has interest and influence on affordable housing delivery, how prospective will stakeholders interest and influence be guided and implemented for sustainable housing delivery, the underlisted factors impact stakeholders influence

- Matching stakeholders interest towards requirements
- Adequate communication with stakeholders
- Establish stakeholders aim, needs and objectives at planning stage