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STRATEGIC REALIGNMENT OF THE POST-CONTRACT COST CONTROL PROCESS IN THE NIGERIAN CONSTRUCTION INDUSTRY USING KAIZEN

Temitope S. OMOTAYO

Ph.D. Thesis **2017**

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Temitope S. OMOTAYO.

School of the Built Environment

University of Salford, Manchester, UK.

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List of Abbreviations

BPMN - Business Process Model and notation

CMM- Capability maturity model

IDEF0- Icam Definition Fuction Zero

Nigerian Institute of Quantity Surveyors- NIQS

SMSCC - Small and medium scale construction companies

Acknowledgment

I am immense grateful to my creator for giving me this opportunity to reach this level in my career. Dreams come through with action and the right people. I started this journey after my MSc when Dr Kaushal Keraminiyage advised me to try this Ph.D. program. He was my first supervisor and a mentor. I would not have met Dr Udayangani Kulatunga without knowing Dr Keraminiyage.

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My journey of a thousand miles end started with encouragement, was supported by good people and seems to be ending with the beginning of new things.

Dedication

This thesis is dedicated to Yahweh, my creator, for giving me the grace and strength to be a useful soul. I give all the glory to God.

Abstract

Small and medium scale construction companies in Nigeria have many challenges such as management of construction works, employee management, competition in the construction industry and financial management of construction projects. New techniques emanating from lean thinking have helped to reduce cost during manufacturing. Continuous cost reduction or ***kaizen costing*** during the construction phase stems from kaizen, which is a sub-set of lean production. Kaizen is the Japanese word for continuous improvement, which has the proven benefits to reduce construction cost, provide quality products, increase profitability, enhance employee-employer relationship and competitiveness.

The research methodology for this study involved literature review and surveys (quantitative and qualitative). The surveys involved questionnaires and semi-structured interviews. Quantitative data was obtained from one hundred and thirty-five (135) respondents in Small and medium scale construction companies in Nigeria. Eleven (11) executives of small and medium scale construction firms were interviewed. The qualitative data were be analysed using NVIVO 10, while descriptive statistics, pie charts, graphs, Kendall's W test, Spearman rho's correlation, and factor analysis were used to analyse the quantitative data.

The critical success factors for kaizen costing implementation identified management function; operational efficiency; construction business and ethics; and construction cost management as the major implementation factors. The critical success factors, effective post-contract cost controlling techniques and crucial activities for cost reduction during construction were used to produce the kaizen framework. The kaizen framework focused on activities before the construction phase required for effective post-contract control. The kaizen framework was developed using IDEF0, business process model and notation and capability maturity model.

Overall, the validated strategic realignment of the post-contract cost control process in the Nigerian construction industry can be attained within five (5) to (6) years of implementing the framework.

Chapter One

Introduction

1.0 Research background

The successful management of construction projects depends on the cost management systems, methods and techniques (Nasina & Nallam, 2016; Jayaraman, 2016; Haupt & Pillay, 2016; Potts, 2008; Guo et al., 2016). The accuracy of construction cost estimates is vital for organisational financial planning, project financing and viability (Ahiaga-Dagbui & Smith, 2014). Therefore, construction companies thrive on project cost control for financial growth, and this is not dependent on the scale of the construction company. There are a lot of small and medium scale construction companies (SMSCC) around the world, and they are the major drivers of the construction economy (Ugochukwu & Onyekwena, 2014; Bilau & Sholanke, 2015). Some internal and external factors determine project cost. These factors are the involvement of stakeholders, project finance, government regulations, risk, communication, organisational culture, the price of construction materials, and the control of project cost (Ogwueleka & Maritz, 2016; Nasina & Nallam, 2016; Oladapo, 2007; Olatunji, 2008; Treacy et al., 2016). Cost control in construction projects may be influenced by the type of construction industry and the nature of the construction company (Haupt & Pillay, 2016; Jayaraman, 2016; Lee & Migliaccio, 2016; Nasina & Nallam, 2016; Rezania et al., 2016). Regarding cost control, SMSCC have been experiencing poor project performance (Odediran et al., 2012; Odediran et al., 2013). Cost control in projects has been linked to cost overruns (Jayaraman, 2016; Koushki & Kartam, 2004; Le-Hoai & Lee, 2009; Nasina & Nallam, 2016). Studies on cost control have been conducted over the years with very limited practical impact on the performance of SMSCC. One of the other main successful factor for any project is funding and government influence.

Government's funding for SMSCC may stimulate the growth of these companies, but the management of construction companies, organisational culture, and the experienced staff governs the performance of construction companies.

The performance and growth of SMSCC around the world have been a challenge in many construction industries (Abe et al., 2015; Lui and Skerratt, 2014; Rostami et al., 2015). Hence, there has to be focus on improving the performance of SMSCC. Cost overrun has plagued many construction projects. Cost overruns are experienced where there is final construction cost is much higher than the budgeted cost. Cost overruns have also led to construction disputes and litigations. Enhancing cost control processes of construction projects through overhead cost reduction and elimination of waste have been identified to provide further profit and competitiveness for SMSCC (Stålberg & Fundin, 2016; Shang & Pheng, 2013). The need to improve post-contract cost controlling techniques has now become paramount because his requirement is based on the problems facing the traditional costing system for post-contract cost control.

Within the context of Nigeria, SMSCC has a huge market share in the economy (Yahaya et al., 2015; Kehinde, 2016; SMEDAN, 2013; Ezekiel et al., 2016). However, similar to the global context, Nigerian SMSCC is underperforming. Onugu, 2005; Bala et al., 2009; & Agundu et al., 2016 highlighted the factors for the underperformance of SMSCC as being resources, capabilities and management of project cost; these are all related to construction cost management. The traditional construction cost management system in Nigeria has been criticised for its ineffectiveness, due to errors in the traditional cost estimating, cost control, information management and lack of coherence between cost, administration and production management (Dikko, 2002, Olusegun and Alabi, 2011, Sanni and Hashim, 2013). The problem with construction cost controlling in Nigeria has been the involvement of inexperienced construction professionals, quantity surveyors, fluctuation of building material prices, increasing complexity in projects, volatile regulatory system or government policies and lack of innovation and research (Sanni and Hashim, 2013). Innovation in managing construction cost most especially, complex projects is required in developing economies at the moment (Dada, 2014; Emuze et al., 2014). One of such technique is kaizen costing.

Kaizen is a Japanese word for permanent and continuous improvement (Balzer et al., 2015; Azizi & Manoharan, 2015;). Kaizen was developed in Japan after the second world war as a cost management practice; it is also known as “Genka kaizen” in Japanese companies (Higuchi et al., 2015; Kapur et al., 2016). Kaizen costing is a continuous improvement during the production phase (MÍkva et al., 2016; Kumiega &

Vliet, 2008; Higuchi et al., 2015; Singh and Singh, 2015). Kaizen costing has been used in Toyota since 1960 as a cost management technique. The automobile manufacturing industry in Japan has since been using kaizen to improve product cost and profit (Kaur and Kaur, 2013). Kaizen costing benefits have been reflected in the profit margin of most organisations, this is because kaizen costing monitors construction firms' relationship with the supplier's selling price, this becomes a benchmark for cost improvement (kaizen) and the value of product produced (Martin, 1993). Kaizen costing tries to reduce overhead costs and any other areas where waste may arise.

Kaizen costing which is a form of lean construction is beneficial to the construction sector because it will create more value for money, improve project delivery, maximise profit for the contractor, expand construction activities and also improve the economy in the long-run (Kaur and Kaur, 2013; Singh and Singh, 2015; and Vivan et al, 2015). Therefore, the use of kaizen can be identified as a way to improve the competitiveness of Nigerian SMSCC.

1.1 Research Justification

The challenges facing SMSCC in Nigeria has led to the bankruptcy of many construction companies in Nigeria (Polytechnic 2015; Bilau & Sholanke 2015; Ugochukwu & Onyekwena 2014). Ugochukwu & Onyekwena (2014) noted that SMSCC in Nigeria has not been able to compete with large-scale construction companies for government projects. The construction industry in Nigeria is dominated by foreign construction organisations which have suppressed the rise of local firms for several years (Odediran et al., 2012a). Furthermore, Oyedele (2015); Olanrewaju & Anavhe (2014) and Dada (2014) identified the lapses in the cost control methods used in SMSCC in Nigeria. Cost overruns emanated from inaccuracies in the bill of quantities (Oyedele, 2015). Improving the competitiveness of construction projects will influence the growth of SMSCC and also the construction industry in Nigeria (Suárez-Barraza et al. 2011; Choomlucksana et al. 2015). The economy of Nigeria depends on infrastructure development (Inuwa et al., 2014) and the requirement to attain this height depends on the construction industry. Developing economies have to give more priorities and projects to SMSCC to reduce capital flight (Sanni and Hashim, 2013).

In additional to this, the post-contract cost control process requires detailed control and monitoring. Hence, the post-contract cost control phase is vital for project success and performance of construction projects (Please refer to section 2.3 for detailed explanation). SMSCC in Nigeria has been experiencing cost overruns and funding challenges during construction activities (Bala et al. 2009; Bilau & Sholanke 2015; Agundu et al. 2016; Abdullah et al. 2011). The occurrence of cost overrun is usually predominant during the construction phase. Therefore, post-contract cost control goes a long way in determining the performance of SMSCC in Nigeria regarding project delivery, client satisfaction, and competitiveness. As a result of the importance of post-contract cost control during construction projects, certain techniques such as interim valuations, cashflow calculations, monitoring of overheads, monthly financial statements have been employed during construction (Please refer to section 2.1). Post-contract cost controlling techniques may not be effective enough to handle complex projects handled by Nigerian SMSCC.

The complexity of projects in Nigeria requires new post-contract cost controlling methods and techniques. Kaizen costing has the benefit of easy combination with the traditional construction cost management system, and it has a focus on profitability and client satisfaction as opposed to earned value analysis; value engineering; activity based costing; and traditional cost controlling (please refer to Table 2.3). The choice of kaizen costing over other methods such as earned value analysis; life cycle costing; activity based costing; and value engineering has been highlighted in sections 2.4.1 to 2.4.5 and table 2.3. Table 2.3 in section 2 provided a detailed explanation on the merits and demerits of the various post-contract cost controlling methods. The benefits of Kaizen costing were highlighted in section 2.4.5 and in table 2.2 in section 2 specifies the potentials for SMSCC in Nigeria to enhance their performance for improved profitability and competitiveness in the Nigerian construction industry.

The justification for this study depends on the research performance gap in Nigerian SMSCC, low competitive advantage and cost overruns of most construction projects handled by these construction companies. The financial performance of construction projects handled by Nigerian SMSCC may be improved with a new such as kaizen costing. Hence, the research aim and objectives are predicated on the challenges above.

Kaizen costing is used during post-contract cost control for cost reduction and final delivery of quality construction products.

Post-contract cost control is the focus of this study because of the number of complex construction activities which takes place during this phase compared to pre-contract phase. These complex construction activities during the post-contract phase pertain, to the interpretation of construction method statements, bill of quantities and programme of works, which may be subject to inevitable changes. These changes or variations during construction may lead to cost overrun.

1.2 Research Aim and Objectives

The aim of this study is to develop a strategy for conducting post-contract cost control in Nigerian small and medium scale construction companies based on kaizen.

1.2.1 Research Objectives

The research objectives of this investigation are:

a) To critically review the post-contract cost controlling techniques used in the construction industry.
b) To establish and evaluate the techniques used in post-contract cost controlling management in small and medium scale construction companies in Nigeria.
c) To identify and evaluate the critical post-contract cost controlling activities for incremental cost reduction in small and medium scale construction companies in Nigeria.
d) To review and evaluate the critical success factors of adopting kaizen in small and medium scale construction companies in Nigeria.
e) To develop and validate a framework based on kaizen, which can be integrated into the post-contract cost control practices in small and medium scale construction companies in Nigeria.

1.3 Scope and limitations of this research

This study focused on small and medium scale construction contractors Nigeria. This study concentrated on building construction. This study will also be limited to time

overrun. This is because cost factors have more implications on time compared to time on cost. Therefore, if a project has the right financial resources, time overrun will not be an issue. The benefit of cost overruns over time overruns have been proven in studies by (Aibinu and Jagboro, 2002, Odeh and Battaineh, 2002). In a developing economy such as Nigeria, availability of finance is a major issue which has a direct effect on time. Also, since it has been noted by (Sanni and Hashim, 2013) that the major challenge facing most construction companies in Nigeria has to do with cost management. Post-contract cost control is a major focus in this study. This is because cost factors during the estimation process (at the planning face) are faced with errors, design changes, market conditions and other external factors which may lead to cost overrun (Ashworth and Perera, 2015; Oyedele, 2015) Traditional cost management system in construction has a lot of imperfections which can only be managed during construction. The justification for this scope will be discussed further in section 2.3. Kaizen is required in the office before implemented on the site. Therefore, the critical success factors include factors which are associated with the working environment, remuneration and required skill for kaizen framework.

Nigeria is a good example of a developing country and the largest economy in Africa with a gross domestic product of over $500 billion (JIL, 2016; Oteri & Ayeni, 2016). Lagos state is the largest city is Nigeria and this city produces one-quarter of Nigeria's gross domestic product (Oteri & Ayeni 2016). Lagos state is a mega city which accounts for 93.3% of the residential building construction in Nigerian and 4.6% of non-residential buildings (Adelekan, 2013). Construction activities in Lagos state has increased with the development of the Eko Atlantic city in the past five years. This has created opportunities for SMSCC. The prevailing opportunities in Lagos state for SMSCC has created an opportunity for this study to explore the on-going perception of innovation, change and kaizen in Nigerian SMSCC.

1.4 Exclusions

The discussions about the procurement route employed by Nigerian SMSCC was not part of this research because of the scope which is basically on post-contract cost control. In addition to this, the traditional procurement route is the most common type of procurement in Nigerian. Procurement was only mentioned when the factors were

being extracted. This study will not involve the details of building activities on the site. Therefore, a case study was not be applied. New concepts such as BIM is not part of this study because it is not in use in Nigerian construction companies. The estimating methods for quantities will not be considered. Hence, the focus will be on the construction stage. The various types of costs in construction are not parts of this investigation. Consultants will not be parts of the data collection because of the scope which is based on construction companies. The contractor architect and quantity surveyors will be part of the study. The cost of implementing the framework will not be part of this study. Detailed studies about change management for the framework implementation is beyond the scope of this study.

1.5 Reservations

The scarcity of articles on post-contract cost controlling techniques around the world and in Nigeria was recognised. This formed a research gap that this study intends to fill. The dearth of materials on kaizen in Nigerian was also put into considerations. The current publications on kaizen, post-contract cost control and other aspects of this study as small and medium enterprises in the Nigerian construction industry limited the search to what is available. The robustness of literature on the financial performance of SMSCC in Nigeria created an opening for an investigation into their current financial performance.

1.6 Constraints

The constraints encountered in this study pertains to the data collection process. The contractors were not available for data collection, and some of the feedback from the respondents for the questionnaire had an omission. This prompted several revisions. There was a follow-up meeting with the respondents and interviewees. The terminologies used in the data collection instruments were simplified for easy understanding. One of this is kaizen. Continuous improvement (kaizen) and improving the cost continually were used to replace these complex words. During the interview, the researcher has to explain the meaning of the simplified words. The amount of data collected also created analysis constraints. However, they were resolved after several months of studying the appropriate statistical test for the data and research objectives.

1.7 Structure of the thesis

This subjection summarised the eight chapters in this thesis. This is based on the logic of the research objectives and the build-up of the research methodology. The literature review provided grounds for discussing the findings after the analysis. The chapters are summarised as follows.

Chapter 1- Created a background of the study. The justification of the research looked the reason for choosing kaizen costing over other forms of costing techniques such as activity base costing, life cycle costing, earned value analysis and value management. The justification for choosing kaizen is also based on the benefits in other sectors such as automobile manufacturing and in developed countries. The research aims and objectives were coned based on the research background and justification. The scope of the study was also stated.

Chapter 2- This chapter focused on articles related to cost management, the justification for post-contract cost control, latest studies on post-contract cost control, lean construction, kaizen and kaizen costing. The need for kaizen and kaizen costing in Nigeria was well expressed along with the background of SMSCC in Nigeria.

Chapter 3- Designing the research methodology created an opportunity to understand how the research objectives would be resolved. The research onion was chosen because of its meticulous nature. This provided a philosophical basis for the approach, which is mixed, and strategy. The research strategy was chosen based on the needs of the research objectives. Therefore, surveys strategy covered the interviews and quantitative questionnaire. The statistical tests for each of the research objectives were highlighted. The data analysis made use of NVIVO 10 and SPSS 23.

Chapter 4- Qualitative data analysis produced five themes each for objectives two and four. The themes for objective two intended to get the post-contract cost controlling techniques in the Nigerian construction industry, the findings indicated that monitoring building material cost; sub-contractor's activities; cash in-flow and out-flow; interim valuation; and regular site meeting are the core post-contract cost controlling techniques used in the Nigerian construction industry. The critical success factors for the

implementation of kaizen costing in Nigerian construction industry identified organisational culture; communication approach; waste reduction policy; post-contract cost controlling techniques involving kaizen costing; and post-project reviews.

Quantitative findings made use of factor analysis and descriptive statistics for the background of SMSCC in Nigeria. Chi-Square and cross tabulation was used for the background of the respondents and perception towards change and kaizen. Kendall's coefficient of concordance was used to test the findings of the post-contract cost controlling techniques and the crucial activities for incremental cost reduction. Spearman correlation was a testing process for the crucial activities to form links between the factors.

Chapter 5-The discussion of the findings from section 4 and 5 was carried out in this section. The background of SMSCC, respondents and interviewees perception towards improving the existing post-contract system and change were addressed. The post-contract cost is controlling techniques evaluation, critical success factors and activities were discussed using relevant literature.

Chapter 6-The final objective if the framework design. These findings discussed in section 5, were used to create the models based on BPMN, IDEF0 and CMM. The final framework contained the CMM. The framework was validated with four experts in the Nigerian construction industry having over twenty-one years' experience.

Chapter 7-Provided the conclusion, recommendations, and contributions to knowledge and practice. The contribution to knowledge and covered the keywords of kaizen, post-contract cost control and the framework. Recommendations for further research covered some of the exclusions in chapter one such as detailed cost implications and planning phase of construction.

The introduction to this study needs to be justified with relevant literature and for further identification of research gaps. Therefore, an extensive literature review focusing on construction cost management, post-contract cost control, kaizen and the need to adopt kaizen for small and medium scale construction companies is highly imperative.

Chapter Two

Literature review

2.0 Introduction

This chapter includes the comprehensive literature review related to the research objectives in section 1.2.1. Articles related to post-contract cost control techniques; detailed cost controlling systems, methods and techniques; traditional and modern cost controlling approaches, kaizen; and SMSCC organisations culture were discussed. The position of kaizen philosophy and kaizen costing in improving the competitive advantage of small and medium scale construction companies were highlighted. The structure of the literature review by the research objectives has been illustrated in figure 2.1.

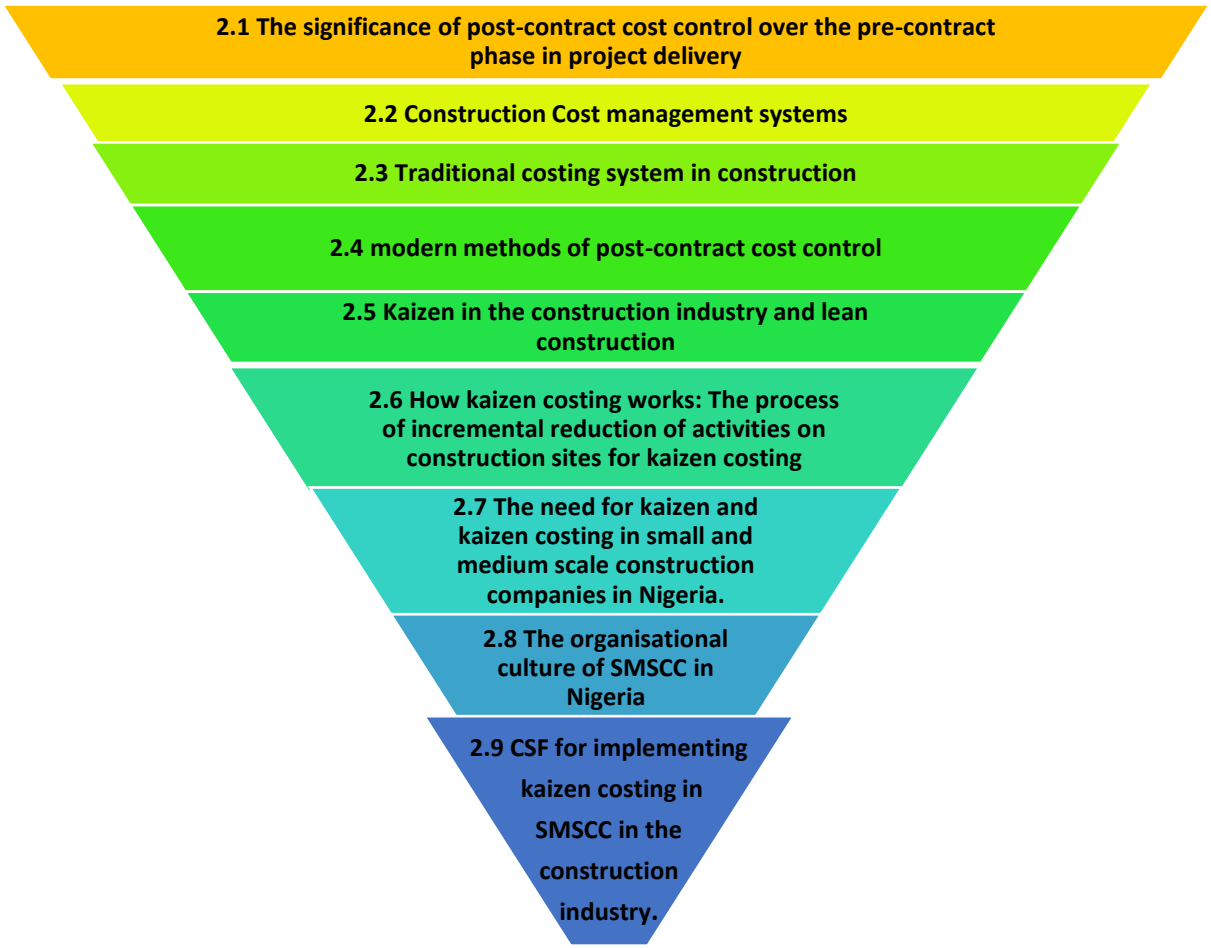

Figure 2.1. Literature review structure

In figure 2.1, the format of the literature review covers the research objectives from section 1.2.1. The research gap is summarised at the end of the literature review providing justification for the choice of kaizen for post-contract cost control in Nigerian SMSCC. Post-contract cost control is the main focus of this study. The structure of the literature review in figure 2.1 has been designed to answer the pertinent question of the choice of post-contract cost control over the planning phase in this study. The detailed discussions of the figure 2.1 begins below in section 2.1.

2.1 The significance of post-contract cost control over the pre-contract phase in project delivery

Post-contract cost control is the subsequent stage after the award of a contract which marks the end of the pre-contract phase. Post-contract cost control refers to the management and monitoring of available resources during construction stage with available methods and techniques for delivery of the project within the budget (Potts, 2008). This stage of construction requires a lot of expertise and management of cost information and data. Managing cost during construction involves making the right decisions at the right time and ensuring the cost of each activity does not go beyond the projected cost.

Cost control of any project starts from inception and ends at the completion with the issuing of final certificates (Ashworth & Perera, 2015). Ashworth & Perera, (2015) noted that the post-contract stage of a project begins from when the contract is signed to the final account and certificate. The process of controlling cost in the post-contract stage according to Ashworth & Perera (2015) is detailed as follows:

a) *"Interim valuations and payment certificate*
b) *Cashflow and forecasts through budgetary control*
c) *Financial statements showing the current and expected final cost for the project*
d) *Final account, the agreement of final certificate and the settlement of claims."*

The choice of a method for controlling the cost of a project during the post-contract stage depends on the contractor's selection method; price determination method for tender and final account; client or contractor control; and the duties of the Quantity Surveyor in managing the budget and account (Ashworth &Perera, 2015). The four main stages highlighted above can vary depending on the type of construction project.

Every construction project and the teams involved in any construction project are unique. Therefore, the method used in controlling cost during a project will also be exclusive.

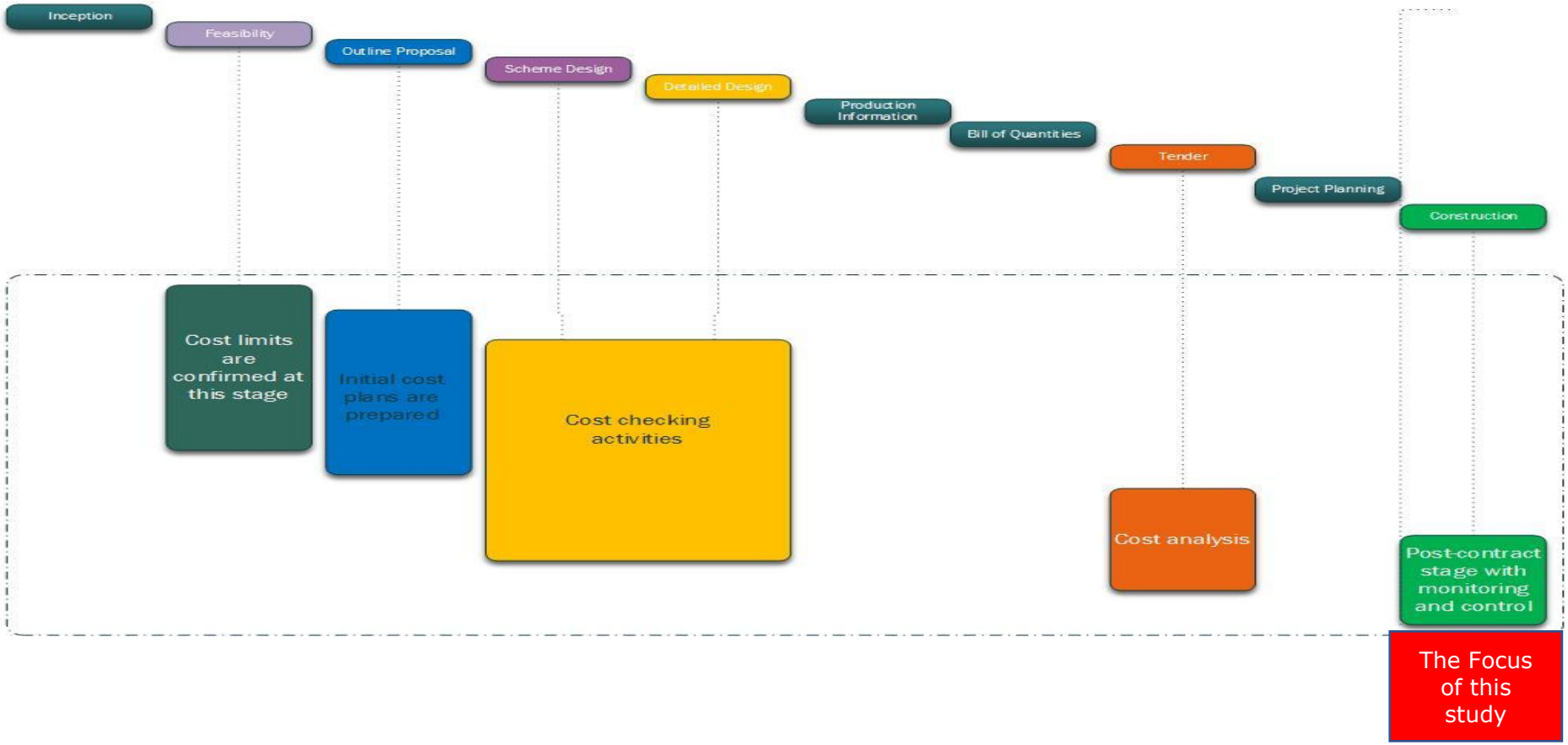

Figure 2.2. stages of cost planning and control

In the UK, the cost control practice during construction was evaluated by Olawale and Sun (2010). Their findings show that design changes, project complexities and performance of sub-contractors are some of the inhibiting factors leading to cost overrun in projects. Olawale and Sun (2010) noted that the inaccurate evaluation of project duration, the conflict between project parties, errors in contract, risk and uncertainty associated with projects are the main inhibitors of projects success during the post-contract stage.

Post-contract cost control starts from the initial budget that has been planned. Post-contract cost control pertains to controlling changes in cost during construction. Interim valuations are carried out at regular interval during construction. Contractor or client's cashflow is prepared to monitor the project finances to ensure profitability (Sanni and Hashim, 2013). Other techniques used in monitoring construction cost during execution are earned value analysis (Hunter et al., 2014). New techniques involving intranet-based cost controlling system has also been proposed by Abudayyeh et al. (2001). Measuring work on the site can also involve methods such as cost ratio calculation, incremental milestone, units completed and weighted units (CII, 2000). This implies that the available software and tools used in the UK such as Microsoft project professional; earned value analysis calculation; cost record keeping; work programming; material scheduling; variation management; re-measuring of work on site; adjustment of prime cost sums management of inflation; day work accounting and management of claims (Ashworth & Perera, 2015; Potts, 2008, Olawale and Sun, 2010, Otim et al., 2007), has not been sufficient in managing cost overrun. The aforementioned are examples of post-contract cost controlling techniques and tools. The available expertise in the construction industry in the UK has not led to better post-contract cost control practices. The use of post-contract cost controlling techniques in construction requires much evaluation for effectiveness. The evaluation of post-contract cost controlling techniques will provide detailed evidence of the problems with the existing post-contract cost controlling system. An extract of the techniques used for post-contract cost controlling has been explained in Table 2.1

Post-contract cost control is an output of the cost planning phase. Kirkham (2007) noted that cost planning leads to cost control for the development of the design. Kirkham (2007) further stated that cost planning starts with the brief, investigation of satisfactory options and estimation. Hence, cost control is a product of preceding activities by the design and cost planning team to produce cost estimates or bill of quantities, this is illustrated in figure 2.1. Cost planning team sets costtt limits along with the design team and client. This forms the basis

of cost control. Initial cost plans involve estimates. Cost estimation is the bedrock of cost management system. The cost estimate is the amount projected to finish the construction project (Oyedele, 2015). Cost estimating involves developing the cost data for the accomplishment of a construction project through the allocation of resources to various activities (Kern and Formoso, 2004, Owens et al., 2007). The Business dictionary (2013) as cited by Oyedele (2015) also noted that the cost estimated can be planning estimates, budget estimates, companies estimates and not-to-exceed estimates. The estimates are for information purposes only. This is gathered at the early stage of cost planning. The budget estimate is based on well-established budget data which can be historical (this involves taking–off process). Firm estimates are reliable enough for the bidding process, and not-to-exceed estimates are based on firm estimates, and it gives an upper and lower limit for the project cost. Ashworth & Perera (2015) categorised cost estimating into Initial estimate which involves preliminary feasibility and consultations, a firm estimate which assesses the brief for feasibility and viability studies, preliminary cost plan, final cost plan and cost checking stage which uses the working drawing and taking-off techniques to prepare the final budget.

Kern and Formoso (2004) and Samphaongoen (2010) also corroborated this statement by noting that cost estimates are meant to produce a working budget which is used for the tendering process and construction activities. Rad (2002) further highlighted the process of cost estimation as involving historical data, professional expertise, heuristics, and client's requirements to forecast the required financial expenses for the completion of a construction project at the right time. The activities which will be carried out during the execution phase is broken down into work breakdown structures (WBS), this provides a guide for defining the activities, cost estimation, budgeting, scheduling, expenditure, resource allocation, variation management and performance measurement (Rad, 2002). The challenge with these processes is that historical data usually contains errors of previous construction projects which can cause much setback during a new project. Personal experience can also contribute immensely to the success of cost estimation; however, there are innovations in technology coupled with project complexity which can delay the project. In most cases, cost estimates have brought about project cost overruns and delays, and this is as a result of the estimation process. Modern estimating techniques which involves spreadsheets and estimating software are prone to error and are consumes time (Samphaongoen, 2010). The computer aided design technology (CAD) used in designing construction and engineering plans can also be used for estimation. However, if there is a mistake in the design, there will be a mistake in the cost estimation. The computer

aided estimation will also involve the cost estimation of materials, labour, plants or equipment and overheads (Oyedele, 2015). Other factors which can affect cost information for the post-contract phase have were highlighted by Ashworth & Perera (2015) the factors that can influence the accuracy of cost estimates are:

a) Design information which can differ
b) Access to historical cost data which cannot be of the right quality and quantity or related to the project context.
c) The size of the project can influence the number of errors in the cost estimates
d) The number of competitors
e) Market conditions which can arise from the exchange rate, inflation, and import duties and so on.
f) Quantity surveyor's heuristics which can influence the nature of the project, improvements and forecasting skills
g) The experience of the project manager or quantity surveyor can influence the overall cost estimates.

These factors are general factors which affect cost estimates, and they are universal according to Ashworth & Perera (2015). However, in less developed construction industries such as Nigeria's, the factors which affect the accuracy of cost estimates are different. Oyedele (2015) highlighted the various major influencing factors as:

a) Political situation: Most cost estimates are accurate during stable political times.
b) Government policy: Influence of local content investment policies, importation policies, taxes, a method of procurement, the number of foreign contractors or expatriates are some of the policies which can affect the accuracy of cost estimates at a point in time.
c) An Economic condition such as inflation, monetary rate, the interest rate on lending.
d) The construction season such as rainy season and dry season can affect on-going construction work
e) Geographical location of the project can also affect the accuracy of estimates. In places such as the Niger Delta and Northern parts of Nigeria, the accuracy of estimates can be influenced by the topography, swamp or soil conditions

f) Risk emanating from a security can also have a drastic effect on the accuracy of construction cost estimates, especially in the Northern parts of Nigeria where there is a high level of Islamic insurgency. Other types of risk during construction in Nigeria are a financial risk which is related to claims, sub-contractors' cost, disputes and litigations (Lingard et al. 2015).
g) Years which are close to the general elections in Nigeria have much influence on the cost estimates because prices of building materials are lower and there are much procurement activities and award of contracts.
h) Corruption is a factor which affects cost estimates in Nigeria. Most cases of kickback during procurement have led to inflated cost estimates.

The enormity of negative factors influencing cost estimates at the pre-tender phase as stated by Ashworth & Perera (2015); Oyedele (2015) and Samphaongoen (2010), cost estimates will always have latent errors which arise during the construction phase. Zwikael (2009) opined that construction project managers do not critically evaluate project plan development and activity definition. Project plan development determines the overall success of the construction project. This contains the method statement for construction and the activities during construction. Zwikael's statement is very relevant to the Nigerian construction industry. In considering these unavoidable factors which can influence the final construction cost, monitoring and controlling cost during the construction phase is essential. Construction project managers and quantity surveyors during a construction project are imperative because estimating errors and other external and internal influences mentioned above can be monitored. The monitoring process is part of post-contract cost control.

The post-contract cost control techniques used for this process range from interim valuations, to cashflow forecasting and taking corrective actions for the financial statements. In additional to this there are very few articles on post-contract cost control compared to the pre-tender cost control phase (Cunningham, 2015; Potts, 2008; Oyedele, 2015; Watkins, 2014; and Burke, Krynovic and Mance, 2007). Post-contract cost control stems from the traditional system, methods and techniques used for post-contract cost management. The importance of post-contract cost control for project success will be highlighted in the next sub-section.

2.1.1 Importance of post-contract cost control

Based on the articles reviewed in section 2.1, post-contract cost control has a huge importance over pre-contract cost control. Post-contract cost control ensures that the resources of construction projects are kept within the budget for timely delivery of construction projects (Potts, 2008). The resources used during construction projects are plant and equipment, building materials, labour, professional expertise from skilled workers, finance, information technology and finance (Asiedu et al. 2016; Ameyaw et al. 2015; Amoatey et al. 2015; Broft et al. 2016; Emuze et al. 2014). These resources are limited. Therefore, the quantity surveyor who is the quantity surveyor has the prerogative to manage the available resources with the required techniques and expertise. Post-contract cost control is used at this stage. The use of cashflow provides and opportunity for the contractor to assess the cash inflow and expenses (Ashworth and Perera, 2015). Cashflows are used during post-contract cost control to keep the project within budget. Therefore, post-contract cost control determines the profitability of a contractor and also the construction company. If the final account calculated is over the project cost, then the cost overruns and possible delays can occur. The available finances for construction projects have to be managed effectively for the construction company to gain without reducing the quality. Post-contract cost control can affect the growth and sustainability of a construction company. In addition to this, the quality of construction projects delivered by contractors determines the overall level of competitiveness afterwards. The background of post-contract cost control depends on understanding and reviewing the construction cost management system.

2.2 Construction Cost management systems

The significance of post-contract phase over the pre-contract phase has been discussed in section 2.1; this has provided a focus on the processes involved in construction post-contract cost control. For a comprehensive focus on post-contract cost control, there has to be an understanding of the cost management process in construction.

Horngren et al. (1990) as cited by Kern and Formoso (2004) noted that cost management is an integrated cost information charter for a project. Kim (2002) also noted that the cost management system is aimed at ensuring construction projects stays within the highlighted scope of the project budget. Kern and Formoso (2004) supported this by stating that cost management system depends on the managerial roles of the construction company thereby

harnessing the decision making principles, pro-activeness and environmental supra system affecting construction business. Cost management systems are also influenced by the nature of the procurement system. Nonetheless, cost management systems vary and evolve during the course of a construction project.

Construction cost management involves processes which include estimating, budgeting and controlling project cost for effective project delivery within budget (Jainendrakumar, 2015). Construction cost management has been described by the Project Management Body of Knowledge (PMBOK) as a system which allows the quantity surveyor plans, estimate, budget and control the expenditure for a project by preparing a budget (FME, 2014, Owens et al., 2007). Cost management can also be viewed as the process which ensures that the client's requirements for a project are met within a standard quality while reducing the cost of construction (Rad, 2002, Robert and Tichacek, 2005, Venkataraman and Pinto, 2008). Rad (2002) and Venkataraman and Pinto (2008) further noted that cost management is aimed at monitoring the progress of work and juxtaposing the present progress with the planned activities, thereby analysing the differences. This process involves articulating the client's requirements and quality with the available resources. The stakeholders involved in the construction process also safeguard the acceptable cost and delivery date. Cost management in construction is a highly tedious process which begins at the early phase of a construction project (Venkataraman and Pinto, 2008). The challenges faced by quantity surveyors at the initial stages of cost planning can eventually lead to cost and time overruns.

Robert and Tichacek (2005) opined that cost management starts by identifying activities which can generate cost during a construction project. The awareness of limited resources which are necessary for a construction project also influences the cost management. These resources can be material, labour or time. The risks involved in a construction project also influences construction cost. Potts (2008) also noted that cost management evolves throughout the phase of a project as a result of inflation, technological changes, the effect of supply and demand, changes in the construction process. These are risks which affect the entire process of cost management. Notwithstanding these risks are based on the category of cost management. There are three forms of cost management in construction which would be elucidated in the next section.

2.2.1 Forms of construction cost management

The three categories of cost management as noted by Groth and Kinney (1994) are cost containment, cost avoidance and cost reduction. Groth and Kinney (1994), further pointed out that cost containment avoids any further increase in fixed and variable cost, cost avoidance assesses the cost and benefits of each activity by removing any unproductive activity, while cost reduction lowers the fixed and variable cost of necessary activities. These strategies of cost management depend on the type of project, procurement approach, construction approach, client's requirements, the decision of stakeholders in most cases quantity surveyor and project manager. These forms of cost management also depend on the stage of project implementation.

2.2.2 Stages in cost management

The forms of cost management explained in section 2.2.1 depend on the stages. Knowledge about the stages is required because of the existing standards for construction cost management. The Royal Institute of British Architects Plan of Work (RIBA, 2013) has seven stages, the second, third and fourth stages which are concept design, design development and technical design include cost plan, cost information and cost checking (Bill of Quantity and tender analysis). The stages five, six and seven are the construction, handover and in use stages. These stages involve cost control, financial and final account. At second phase the approximate estimates and cost estimation activities begin. This is the cost planning or pre-tender phase. Cost control phase commences in the fifth phase (construction) is the post-tender cost management phase. Therefore, cost management can be categorised into the pre-tender phase and the post tender phase. Nonetheless, cost controlling starts from the pre-tender phase. The various stages in cost management according to RIBA (2013) have to be the same irrespective of the cost management system which the construction company employs. Having explained the forms and stages of cost management, the use of cost management systems, methods and techniques have to be defined for further identification of post-contract cost controlling techniques. There has been a miss-use of words such as systems, methods and techniques in cost management. Hence, the next sub-section will differentiate between systems, method and techniques in construction cost management.

2.2.3. Delineating Systems, method and techniques in construction cost management

Construction cost management is different from cost control and monitoring. Many academics in the built environment confuse cost management system with methods and techniques. This topic has been highlighted wrongly in many cost management textbook and articles. There is a need to understand the meaning of these terminologies to effectively address the challenges facing cost management in the construction industry.

The Business Dictionary (2015) defined the system as *"a set of detailed methods, procedures and routines created to carry out a specific activity, perform a duty or solve a problem".* It further explained that a system has an input, output and feedback mechanism. A system is a set of complex interrelated methods and procedures which have a boundary maintained by processes (Harary and Batell, 1981, Hoyle, 2009, Laszlo and Krippner, 1998). The process involved in the interaction of the methods and the techniques which are used to carry out specific activities in the system. A system encompasses a method and techniques. An example of systems in cost management can be the traditional system, earned value management system (EVMS), or value management.

A method as defined by Free dictionary (2015) is "*a means or manner of procedure, especially a regular and systematic way of accomplishing something or an orderly arrangement of parts or steps to accomplish an end"*. In other words, a method is a group of procedures or an arrangement for specific activities. This definition is also supported by The Business Dictionary (2015) which stated that a method is "*an established habitual, logical or prescribed practice or systematic process of achieving certain ends with accuracy and efficiency, usually in an ordered sequence of fixed steps".* Based on these definitions, examples of methods in cost management are target costing or target value design, kaizen costing; activity based costing, value engineering or analysis and earned value analysis. These methods have internal process structured processes which are used to accomplish their objectives. These processes or activities are known as techniques.

According to The Business Dictionary (2015) technique is *"a systematic procedure, formula, or routine, by which a task is accomplished".* A technique requires skill set acquired through training to achieve an objective (Free Dictionary, 2015 & Oxford dictionary, 2015). Technique demands the ability of the individual carrying out the duty to create a solution. In cost

management the Quantity Surveyor is trained in cost management activities such as preparing cashflow, monitoring and reporting of activities on site, preparing the cost plan and budget. These activities are the techniques which are used based on a prescribed method of doing things. There are various methods and techniques used in traditional cost management, and some of these have various techniques or processes under them. This is illustrated in the below.

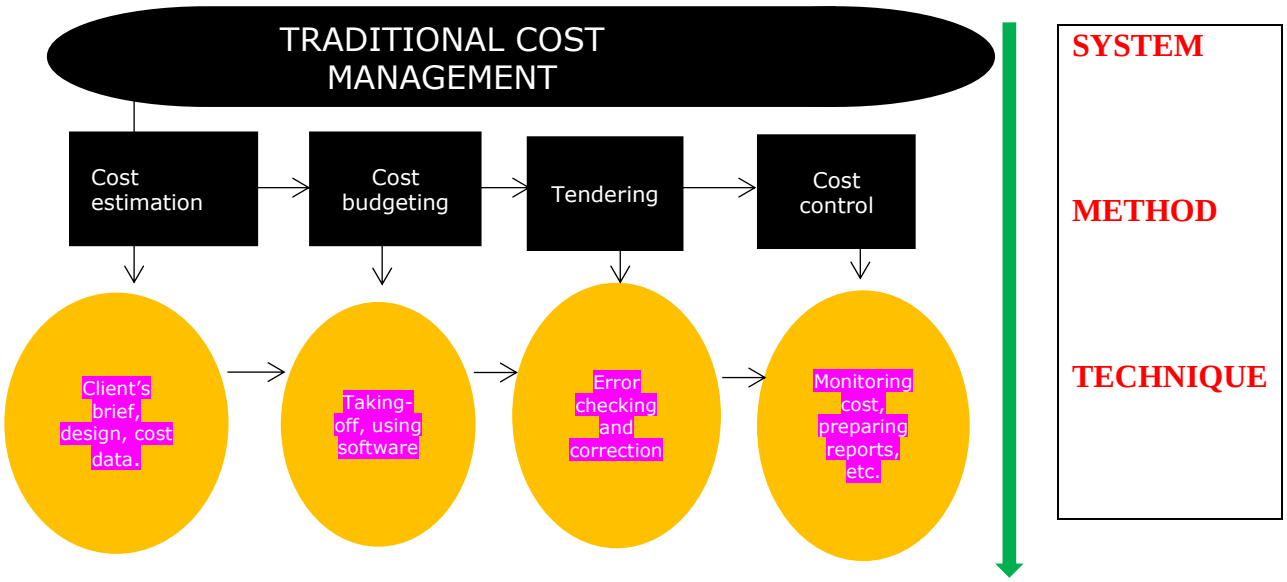

Figure 2.3. The traditional cost management system, methods and techniques

The illustration above represents a possible structure of traditional cost management. The main model can not accurately depict how the construction companies and the quantity surveyor carry out cost planning and control process, but it provides an understanding of what cost management system, methods and techniques are. The traditional system of cost management in figure 2.3 above is also widely used. The difference will be the stakeholders who will be involved in the planning phases.

The cost management systems, methods and techniques used in the construction industry around the world have been reviewed in the table below. Some of these systems, methods and techniques appear to have been categorised wrongly by most researchers and academics in many articles and books. With a proper understanding of cost management, systems, methods and techniques, it is, therefore, paramount to identify the various forms of construction cost management systems, methods and techniques.

In table 2.1, the systems, methods and techniques have been summarised in the figure below. The figure below

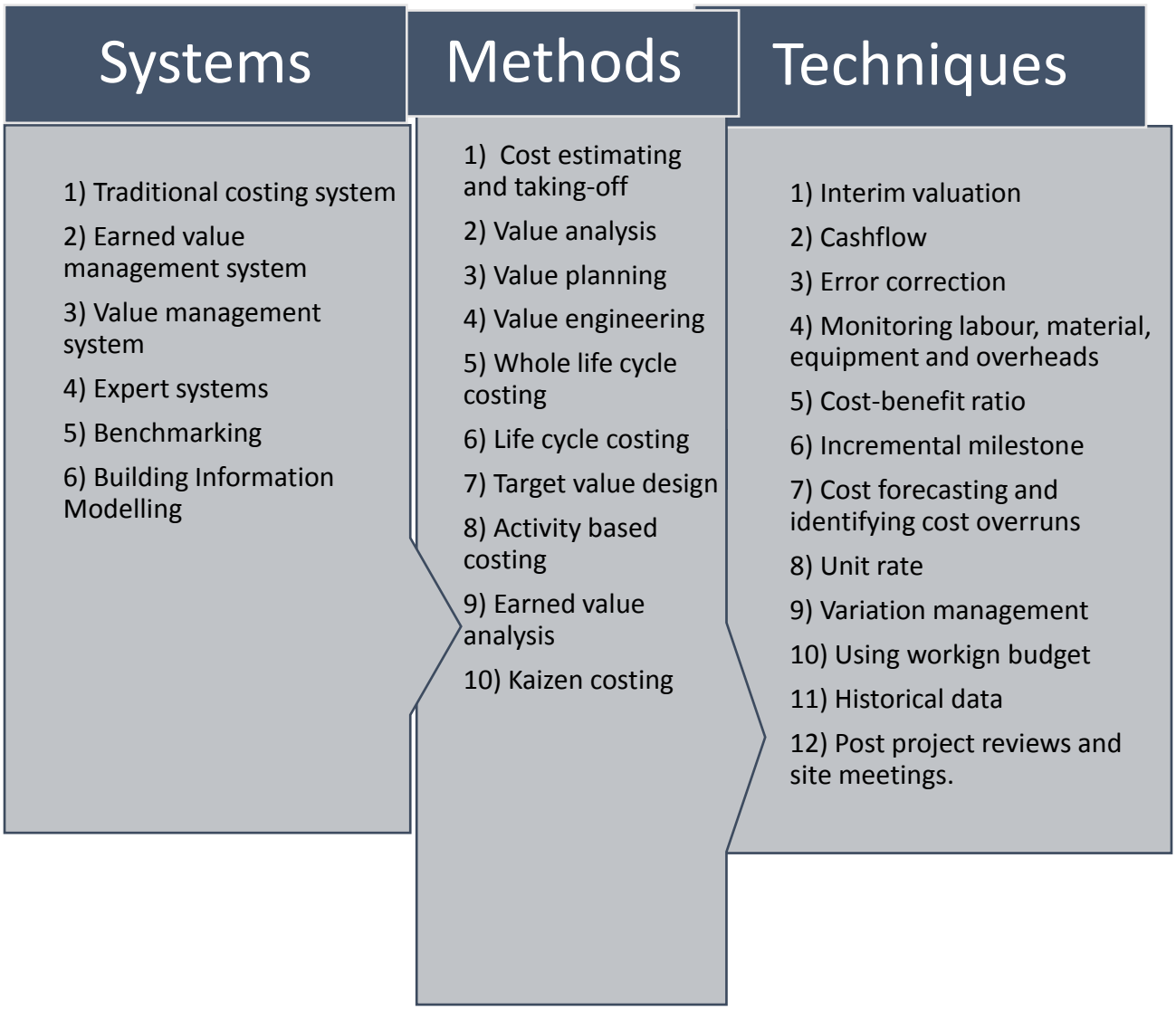

Figure 2.4. Summary of Cost management, systems, methods and techniques.

Table 2.1 below also highlights the merits and challenges of the cost management systems, methods and techniques. The cost management systems, methods and techniques identified in this study were also categorised according to the usage on the path of the consultant quantity surveyor and contractor.

Table 2.1. Cost control systems, methods and techniques

COST MANAGEMENT		DESCRIPTION	STRENGTH	WEAKNESS	REFERENCE
SYSTEM	Traditional costing system in construction (used by consultants quantity surveyors)	The conventional system which has been used by quantity surveyors since the 1920s for managing construction cost. It is widely used in the construction process around the world.	Cost planning cost monitoring and control.	Cost and time overrun, inaccurate costs are provided, challenges with the estimating system.	Ashworth & Perera 2015; Kern and Formoso 2006; Koskela 2002;Eshofonie 2008;Mansfield et al. 1994
	Earned value management system (used by consultant quantity surveyors and contractors)	Introduced by the U.S department of defence in 1963. Uses Earned value analysis method to measure the performance of a project in terms of cost, time and scope against a baseline.	Starts from the planning phase throughout the project, used for forecasting, integrates time, cost and scope, Gives more accurate estimates for complex projects	Involve a lot of calculations from a large amount of data. Depends on available knowledge of software packages.	Sagar and Gayatri 2012; Virle and Mhaske 2013; Ankur and Pathak 2014; Leu and Lin 2008

	Value management system (Used by consultant quantity surveyors and contractors)	Originated in the US after World War II but became popular in the 1990s. Based on the benefits of value systems on a project as defined by client and stakeholders' requirements. Include value analysis, engineering and planning.	Starts from the planning phase of the project up until the completion. Involve stakeholders in reducing cost, improved value and better resource allocation.	The cost of the study, involve broad representation of stakeholders in the study, has to be combined with other cost management systems such as life-cycle costing. The scope can change often.	Ashworth & Perera 2015; Kelly et al. 2004; Coetzee 2009; Mlybari 2011; Rangelova and Traykova 2014
	Expert systems (Used by contractors and non-estimators)	Also known as expert judgement. This involves algorithm and non-algorithm cost models.	Used by non-cost estimators	They are usually inaccurate	Rush and Roy 2001; Rosqvist 2003
	Benchmarking (Used by consultant quantity surveyorsand contractors)	It became popular in the early 2000s The system involves adopting a general approach for measuring construction cost and value by gathering cost data from previous projects and comparing the present performance to the industry's best practices in terms of cost.	More value for money, improved quality. Waste reduction during the construction process is also achieved.	Requires huge database which has to be updated regularly and adequate industry analysis to establish key performance indicators KPIs.	Michel and Naomi 2004;Love et al. 1999; Suresh and Jayavel 2004
	Building information modelling (Used by consultants	Building information modelling is a system which has become more relevant in recent times. The system integrates construction professionals	Improved communication, easier cost management from the design, improved profit, quality, and client	Expensive for most construction companies in developing countries because of the cost of software. Requires training and retraining of staff.	Volk et al. 2014; Takim et al. 2013;Lee and Ha 2013; Mahdjoubi et al. 2013

	quantity surveyors and contractors)	involved in a project in multi-facet computer software which complies the construction data (design, cost and other relevant information) in a single platform thereby making the project easier.	satisfaction. BIM also ensures sustainability in construction.		
METHODS	Cost estimating and taking-off (Used by consultant quantity surveyors)	This method has been in existence ever since cost management started. The method is under the traditional system of cost management. It involves processes which identify the quantity of the work to be done on site from the drawings and multiplying it by the cost of individual rates.	Gives the required cost data to prepare the bill of quantities.	Easily subject to cost and time overrun. This method can have latent errors in them.	Samphaongoen 2010; Ashworth & Perera 2015; Oyedele 2015.
	Value analysis (Used by contractors)	This is a method from the value management system. This method is used for existing building. The main object is	Value analysis is also used in cost reduction activities. This also affects the value	The basic challenge with value analysis is that has to depend on the whole-life cycle costing data and	Maznan et al. 2012; Xu et al. 2012

		trying to improve the value of the project to make it functional.	of the building in the long run.	other stakeholders for the research. This consumes time.	
	Value Planning (Used by consultant quantity surveyors)	Value Planning is a method undervalue management, and it is the first phase of value management. It involves making plans which affect the project and stakeholders economically, socially and environmentally. The output of value planning is strategic policies which can influence the project cost.	Policies are created during the value planning phase to reduce cost and have a positive impact on the construction companies as a whole.	Just like the value management system, value planning is time and cost consuming	Coetzee 2009; Töytäri 2015; Ellen, 2000
	Value engineering (Used by consultant quantity surveyors and contractors)	Value engineering is the construction phase in value management which involve the creation of various options which are within the construction budget thereby reducing the cost and creating more value.	Waste reduction, improved profit for the company, improved competitiveness.	The cost and time of investigating various options for improved value can lead to cost and time overrun if not adequately planned.	Coetzee 2009; Töytäri 2015; Ellen 2000; Maznan et al. 2012;
	Whole life cycle costing (Used by consultant quantity surveyors and contractors)	This method compares the opportunity cost and future cost of a building, this involve the investment cost and also the flow of income as a result of the project. Modern methods of	Very useful for investment appraisal.	Mostly confused with life-cycle costing. There is an early struggle for profitability, and there is a drop in productivity. Pay back the loans for the investment can be a challenge	Kazunobu 2003; Sagar and Gayatri 2012; Eric and Timo 2008

		whole-life cycle costing have been developed in the 2000s.			
	Life-Cycle costing (Used by contractors)	The overall cost of a project is considered including additional cost which will be incurred during operation and maintenance.	Include preliminary item of works during construction and also the running cost, energy bills, etc. Used before, during and after construction.	It can be expensive to use, and it has to be combined with value management for it to be effective	Coetzee, 2009; Kelly et al., 2004; Rangelova & Traykova, 2014
	Target value design (Used by consultant quantity surveyors and contractors)	A useful method in value management which combines the value and design during the pre-tender phase.	Combined target costing and value engineering during design for easier cost control during construction.	Cannot be used alone. It has to be combined with value management. Cannot be used during the construction phase.	Pishdad-Bozorgi et al., 2013; Pennanen et al., 2011; Wu, 2003.
	Activity based costing (Used by contractors)	Calculated individual cost and assigns cost to activities related to products and services.	Used during construction. The Very effect in reducing overhead and services cost.	Has to be combined with traditional costing and or target costing	Lin et al. 2001; Mansury, 2002
	Earned value analysis (Used by contractors)	Measure the performance of a project cost or scheduled. Utilises baseline indicating the planned cost and actual cost.	A modern and effective method for project cost control.	Can be misused for forecasting.	Ankur & Pathak, 2014; Leu & Lin, 2008; Czarnigowska, 2008.
	Kaizen costing (Used by contractors)	An incremental cost reduction method used during construction by identifying.	Creates more profit for the contractor, improved.	Cannot be used alone during construction, it has to be combined	Granja et al., 2005; Kaur and Kaur 2013; Singh and Singh, 2012.

		waste and eliminating them before they occur.	quality and client satisfaction.	with target costing or traditional costing	
TECHNIQUE	Interim Valuation (Used by contractors)	Completed work on site is measured, and the contractor is paid based on this.	Interim certificates can be issued for payment. Allows the client to make payment based on work done gradually.	Claims and delays on the site could mar the payment to contractors. It depends on the financial stability of the client and the satisfaction with the work done. Depends on the type of contract	Ashworth & Perera, 2015.
	Cashflow (Used by contractors)	Flows of cash for day to day activities for relevant activities on site.	Allows the contractor to calculate the profit and other expenditure.	Nil	Ashworth & Perera, 2015;
	Error correction in tendering (Used by contractors and consultant quantity surveyors)	Errors are corrected in the tender figures as part of the tender documentation process.	This depends on the type of contract or project.	Nil	Sanni and Durodola, 2012;

	Monitoring labour, material, equipment and overheads (Used by contractors)	Materials, labour, plants and equipment expenditure in the preliminary item of works are monitored regularly to ensure it does not go beyond the estimates.	The Monitoring process is usually a very effective technique in project cost control.		Sanni and Durodola, 2012; Ashworth &Perera, 2015.
	Cost-benefit ratio (Used by contractors)	A cost-benefit analysis which can be used to evaluate the value of the project during valuation.	This is a technique which can be used in value engineering.	It has to be combined with monitoring of overheads	CII, 2000
	Incremental milestone (Used by contractors)	This is a technique for earned value analysis. It is used to measure completed work and outline the cost and during for further calculations.	This technique identifies the work which has to be done and it useful for performance measurement.	Nil	CII, 2000; Leu & Lin, 2008;
	Cost forecasting and identifying cost overruns (Used by contractors)	A technique used to evaluate the cost needed to complete the project, his can be carried out using earned value analysis.	Used during construction to monitor project cost. Cost overrun is detected early.	Not always accurate	Sanni and Durodola, 2012
	Unit rate (Used by contractors)	Single rate cost estimating method using during and before construction. Cost estimating o the various building elements	Identifies individual rates for each construction element. Direct labour cost is also identified.	Nil	Olawale and Sun, 2010;

		are calculated using this method.	Used as part of the interim valuation.		
	Variation management (Used by contractors)	All activities involving making changes after a design change during construction.	This is required in some cases where the project has experienced sudden change.	Can lead to time and cost overrun	Olawale and Sun, 2010; Ashworth &Perera, 2015; Sanni and Durodola, 2012
	Use of established working budget (Used by contractors)	Bill of quantities are used during construction activities for managing construction cost.	Used during construction to monitor and control project cost.	Can contain errors which can affect project delivery	Sanni and Durodola, 2012
	Historical data and profit and loss summary (Used by contractors)	Data from previous similar projects are used during construction cost control.	Provides quick data for the cost and project manager during construction. Used as a technique in expert judgement.	Can be influenced by inflation and market forces. Not always accurate	Sanni and Durodola, 2012
	Post project reviews and site meetings (Used by contractors)	Final site meeting is documented to evaluate the performance of the project, in this instance cost, expenditure and profit are evaluated	Very useful tool for managing current and future projects. Ensures previous errors are not transferred to new projects.	Subject to regular review.	Puvanasvaran et al. (2010); Berger (1997); Chukwubuikem et al. (2013)

In Table 2.1, the identified systems, methods and techniques in the construction sector have explained the strengths and weaknesses of the aforementioned. In addition to this, the widely used system (traditional cost management system) covers other systems, methods and techniques. The traditional system of cost management is the foundation of construction cost management. The focus on post-contract cost control phase of construction also depends on what goes on during the traditional cost management phases. Furthermore, post-contract cost controlling techniques identified in this study from section 2.1 is based on the traditional cost management system. The next sub-section discusses the traditional cost management system.

2.3 Traditional costing system in construction

Traditional costing system in construction represents the overall process of pre-contract phase of construction, tendering and post-contract cost control (Please refer to section 2.1 and figure 2.2).

In Table 2.1, traditional cost management system because it has been used over the years and modern cost management systems have replaced cost planning and cost control activities. The traditional cost management system in construction has been in use in many countries around the world. The main features of traditional costing system are evident in the cost management system, methods and techniques in figure 2.3. The methods involve cost estimating, cost budgeting, tendering and cost control, while the techniques used in traditional costing system in construction are client's brief taking-off quantities, error checking and monitoring costs during construction.

The rapid increase in technology and project complexity has not brought any changes in cost management systems in many construction industries. Johnson and Kaplan, (1993) as cited by Kern and Formoso (2006) stated that the same cost management system which has been used in the 1920s in many construction companies. Kim (2002) opined that traditional management system has become hazardous and archaic for managerial use. Koskela (2002) corroborated this by noting that traditional system of construction become unproductive when the production process is not taken into consideration. Kern and Formoso (2006) also supported this argument by noting that traditional cost management cannot provide the precise product cost and the system cost estimation does not include managerial decision-making approach which will

eventually bring a positive impact on the project. The authors indicated that traditional cost management system encourages quantity surveyors to make short-term goals to reduce cost and ignore the additional inventory cost in the process. Kern and Formoso (2006) suggested an integrated approach for the 21st-century construction process. The model integrates operational estimating with S-curves and target costing to create a more up-to-date and proactive system for managing construction cost.

2.4 Modern methods of post-contract cost control

Modern cost management systems such as earned value management system, experts' system value management, life-cycle costing, added value in building and design and benchmarking have been developed from the 1960s to early 2000s (Ashworth & Perera, 2015). Other modern methods of cost management are lean construction system (Alarcón, 1997, Chiarini, 2012, Howell, 1999) and the kaizen system (Granja et al., 2005, Kaur and Kaur, 2013, Smadi, 2009b). Some of these systems have begun to emerge in construction companies around the world. Nonetheless, systems such as earned value analysis are now being used as a result of the development of construction project management software such as Microsoft office project. These systems are discussed to lay bare the various contributions to the advancement of cost management in construction. There is need to clarify the difference between cost management systems, from methods and techniques.

Some modern methods of post-contract cost control were highlighted in table 2.1 Modern methods of post-contract cost control stems from the pre-contract phase where target value design, value management system and earned value management system. Modern methods of conducting post-contract cost control are new methods from the early 1990s which are usually combined with the traditional method of conducting post-contract cost control as elucidated in section 2.1. Although, traditional method as described in figure 2.2 is still widely used, modern methods have been developed from the value and earned value management system. The post-cost control techniques emanating from the aforementioned system are discussed in the sections below.

2.4.1 Target value design

Target value design is a modern method of cost management. According to Ballard, 2012 and Zimina, 2012 as cited by Pishdad-Bozorgi et al. (2013) target value design (TVD) "*was first implemented by Boldt construction in St. Olaf's Tostrud Fieldhouse and Thedacare's Shawano Clinic Projects and then by Sutter Health in the USA in association with their supply chain*". Target value design integrates target costing and target value design as a value management techniques which involve the collaboration of stakeholders such as project managers, architects, cost managers to create design and construction options for cost estimation and value engineering activities as the project design changes (Pishdad-Bozorgi et al., 2013). Therefore, target costing and value engineering are combined during the design phase for easier cost control during the construction phase. Target costing is mainly adopted as means of creating more value during the planning phase.

Target costing is not only relevant to the manufacturing sector but also the construction industry. Target costing is a Japanese word for *"Genka Kikaku"* (Everaert et al., 2006). Target costing began in Japanese corporation, and it has been adopted by the United States, United Kingdom and other developed nations of the world. More than 80 percent of companies in Japanese assembly industries make use of target costing (Kato, 1993). Kato (1993) observed that in some early articles, "cost planning" and "cost projection systems" have been used to connote target costing. "Manufacturing cost reduction", "basic net price", "direct cost feasibility study" and "pre-calculations" are other names used instead of target costing (Dekker and Smidt, 2003 as cited by Everaert et al., 2006). Target costing is also known as design to cost which is dependent on the internal financial strength of the organisation, design to cost was traced to the United States Department of Defence in weapons production (Everaert et al., 2006). This process involves setting a concrete cost for the production of a product. The different names which can be manufacturing cost reduction, basic net price, pre-calculations, direct cost feasibility study and cost planning proves that target costing is done at the initial stages before design. This process incorporates a quantity surveyor or an accountant in manufacturing to design a product according to the finances available.

Target costing is used in various Japanese companies (Wu, 2003), its application in construction give the cost of a project or building at the design stage. Therefore, it is dependent on the Architects' design (Pennanen et al., 2011). The design of a building structure has to be

tailored to the available cost, this process as described by (Pennanen et al., 2011) cannot be achievable and cannot be easily monitored because of the traditional cost estimating system and Computer Aided Design in construction. However (Pennanen et al., 2011), decided to introduce Building Information Modelling (BIM) to attain the design steering concept. The design steering concept has already been used in many construction companies to manage cost with design and achieve cost targets however this process cannot have been used in many developing countries such as Nigeria where BIM is just emerging. Gagne and Discenza (1995), noted that an effective cost management technique must meet customer demands at the cheapest cost at the same time reduce waste and cost. The main necessity of managing cost in production is targeted at reducing cost, waste and also meeting clients' needs to ensure profitability.

Most cost targets which are done initially are not realised at the end of the production. Most cost targets which fail to meet expectation or lead to overruns, Eshofonie (2008) highlighted price fluctuations, poor contract management which leads to claims and poor estimating methods which include errors are some of the factors which negatively influence cost targets in Nigeria construction projects. The impact of improper risk assessment during the feasibility stage of construction projects in Nigeria is one of the factors responsible for cost overruns (Dada and Jagboro, 2007). The factors mentioned by Eshofonie (2008) and Dada & Jagboro (2007) are the limiting factors affecting target costing in Nigeria. This has led to cost overruns in Nigeria even after applying the strategic principles of design to cost. Apart from this most projects also follow "costing to design" approach where the Architect designs the plan and the Quantity Surveyor prepares the estimates. In this case, proper technique for project cost control during execution stage would be required, therefore, kaizen costing can be combined with target costing or target value design. The output of target value design aids the cost management of various activities on construction sites via the reduction of overhead cost.

2.4.2 Activity based costing

Activity-based costing (ABC) has been in existence after the World War II. However, this system of accounting came into prominence in the 1990s as a technique for making costing decisions in many corporations (Harrison and Sullivan 1995, cited by Lin et al., 2001). Activity based costing is defined as a system of "*calculating the cost of individual activities and assigning these costs to cost objects such as products and services on the basis of activities*

undertaken to produce each product or service" (Horngren et al., 2001 cited by Lin et al. 2001). ABC is very different from the traditional costing system because of the cost tracers used in identifying the cost drivers which are overheads (Jong No and Kleiner, 1997). ABC was originally based on cost accounting principles (Mansuy, 2002). This process is not only based on costing products and services alone but also integrated with the supply chain management.

According to Lin et al. (2001), the cost of the supply chain has to be measured for the supply chain management to attain its goals. Therefore, the cost of the supplier has also been identified as a significant cost in ABC. However, many projects have not been able to implement ABC because of lack of identification and implementation of activity-based costing (Jaya, 2013). Moreover, ABC cannot be effective alone; it has to adopt some cost management tools in the pot-contract cost control phase (Jong No and Kleiner, 1997). This can involve milestone setting and interim valuations.

If ABC is combined with methods such as kaizen costing in a detailed framework, this can enhance the management of project overheads. The concept of activity based costing in construction. The value of the project can be considered as a form of control system.

2.4.3 Value Engineering

Value engineering is a method of the value management system. Value management system is an integrated framework led by a major facilitator to explore alternatives for creating more value during the phase of a construction project without reducing construction cost (Coetzee, 2009, Kelly et al., 2004, Rangelova and Traykova, 2014). Value management can be broken down into value planning for the planning phase, value engineering for the construction phase and value analysis for established projects (Coetzee, 2009). Value engineering creates solutions as options for initial activities which is existing within the budget, some of these activities are studied to produce more value during the execution stage (Kelly et al., 2004). Value engineering is also carried out with life cycle costing to assess various alternatives during construction projects. This method is new in the construction industry, and it is not used because it consumes a lot of time and resources in the implementation process. Value engineering also requires a skilled value engineer to partake in the study. Value engineering is not so common in many developing countries because of its demanding nature (Coetzee, 2009). However, in large construction companies with robust financial resources, value

engineering is a very effective method for project cost control. The economic cost of construction is very important to monitor and control during construction.

2.4.4 Life cycle costing

Life cycle costing is a method for evaluating the overall economic cost of a project taking into account cost which is incurred during and after construction. Some of these include site cost, capital cost, professional fees, energy cost, all preliminary items of work which are needed for construction and afterwards (Coetzee, 2009, Kelly et al., 2004, Rangelova and Traykova, 2014). Life cycle costing involves the calculation of net present value, internal rate of return or annual equivalent of the value construction project. This assessment is used as a tool in value management; nonetheless, the overall aim of life cycle costing intends to find out the cost which will be incurred and the initial investment by the client. Life cycle costing can also be used as a method of controlling cost during the construction stage by ensuring that all preliminary items used during the construction phase is well documented and kept within budget. Life cycle costing cannot stand alone; it has to be combined with traditional cost controlling method or any other method in use.

2.4.5 Earned value analysis

Earned value analysis is a part of earned value management which is used to measure work in progress during the execution phase (Ankur and Pathak, 2014, Leu and Lin, 2008). The measurement is between the planned value and actual value giving a final value which is the cost variance (Ankur and Pathak, 2014). Earned value analysis does not only measure the cost but the schedule, this is also used to forecast indicators of what will happen in the future in terms of cost and schedule (Sagar and Gayatri, 2012). Parameters such as cost variance, schedule variance, the cost of the performance index, schedule performance index, estimate and completion, estimate to completion, variance at completion are used to measure the overall performance of construction projects (Sagar and Gayatri, 2012, Virle and Mhaske, 2013). These activities are carried out with the aid of software packages such as Microsoft Project Professional, visual studio and Primavera. The finding gathered in using earned value analysis also gives adequate opportunities for reducing cost. Earned value analysis is widely used in many construction companies around the world, but the drawback is that it requires professional expertise to make use of the software packages. Czarnigowska (2008) warned that earned value analysis is not to be used for forecasting but for performance measurement,

which has been adopted wrongly in some cases. Earned value analysis does not consider a waste reduction; this is one of the drawbacks of this method. Having considered the various modern methods of controlling and monitoring construction cost from activity based costing, earned value analysis, life cycle costing and value engineering, the only method available is kaizen costing for cost control.

2.4.6 Kaizen costing

The word "*kaizen*" is a combination of two Japanese words "*kai"* and *"zen"* which means change for the better or continuous improvement (Puvanasvaran et al., 2010, Shang and Pheng, 2013b, Suárez-Barraza and Lingham, 2008). Kaizen costing is an application of kaizen in the production phase to reduce cost by minimising waste. The application of kaizen costing in the construction industry has not been well documented as there are few studies related to this topic. Some of the studies and literature reviews on kaizen costing in the construction industry is based on Granja et al. (2005) analysis of target and kaizen costing in the construction industry. Granja et al. (2005) noted that continuous cost improvement is necessary at the construction stage not only to maintain the cost of the project but also to target more profit and eliminate waste.

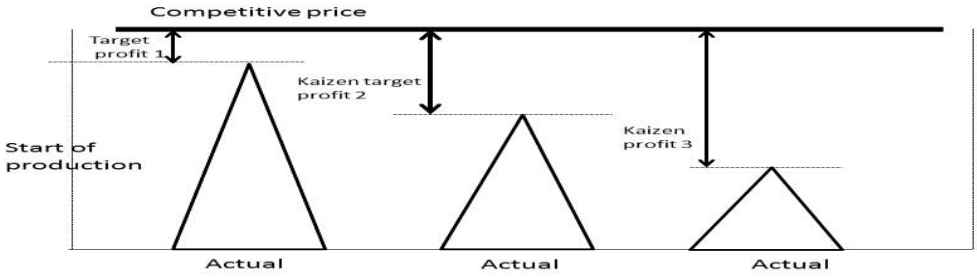

Figure 2.5. Improving cost management progressively during the construction phase (Granja et al., 2005)

The case studies conducted in a metal industry, a large construction and concrete company by Savolainen (1999), discussed the understanding and adoption of kaizen processes empirically. The findings reveal that kaizen adoption process is iterative and the speed of implementation differs in the two companies. Kaizen involves continual incremental improvement of the product cost and waste reduction during the execution stage (Kaur and Kaur, 2013). Singh and

Singh (2012) documented a comprehensive literature of the how and where kaizen has been studied and utilized. Singh and Singh (2012) collected a number of case studies, surveys and key components of kaizen in the manufacturing and construction sectors in various countries. Singh and Singh (2012) also noted that kaizen costing focuses on the profit and value a product will give at the manufacturing stage. This process should be part of the management function aimed at improving the product and service delivery. In this case, kaizen costing process will involve the employees and employers' inputs in improving their organisation's performance and handling of financial and non-financial aspects of manufacturing. Kaizen costing is aimed at reducing cost and creating greater valuable products with the influence of every stakeholder. The use of kaizen costing in these organisations studied by Ellram (2006) is not only limited to the manufacturing process but also the supply chain. Cost reduction in the supply chain will also reduce the unit cost of the product. Therefore, kaizen costing is not only within the organisation alone but within other external factors or stakeholders have to be managed along with the performance of the company in reducing cost. Cheser (1994) stated that Kaizen costing had been implemented in an organisation where the product cost has been monitored and reduced to improve the companies' profit. The use of kaizen costing in an organisation will improve the profit margin yearly. Also, the continuous improvement of the number of working hours in an organisation along with the budget of the organisation has created more profits in organisations were used (Budugan, & Georgescu, 2009). This involves elimination of non-productive activities which can increase during the working hours. Employee productive has been improved using kaizen costing. Utari (2011) studied the use of kaizen costing in PT. Coca-Cola Bottling Indonesia-Central, Sumatera. The findings shows that eliminated rejected products using kaizen costing significantly increased the profit of the company. This process involves identifying what the consumers what and disregarding any component or product which do not add value.

Based on the proven benefits identified by Ellram (2006) and Singh and Singh (2012) in manufacturing industries, there is a need for an adequate research in the application of kaizen costing in construction. This method of cost reduction during manufacturing has also been expressed as a strategy for cost control during the same phase.

Table 2.2: Benefits of kaizen costing

Benefits of kaizen costing	References
Continuous incremental improvement of the product cost	Singh and Sing (2012)
Incremental reduction of waste during the construction stage	Kaur and Kaur (2013)
Cost reduction is also established in the supply chain	Ellram (2006)
Used to improve companies' profit	Cheser (1994) and Utari (2011)
Kaizen can improve the competitive advantage of a small and medium scale companies	Puvanasvaran et al. (2010)
Can be integrated with a company's budgeting system and reduce non-productive working hours	Budugan, & Georgescu (2009)

The benefits of kaizen costing listed above are from studies carried out by researchers, some of which are case studies on companies which used kaizen costing.

A comparison of the different post-contract cost control methods has been carried out in the table below. The table highlighted the merits and drawbacks of the post-contract cost controlling techniques.

Table 2.3. The Merits and drawback of post-contract cost controlling techniques.

Cost management method	Merit	Reference	Drawbacks	References
Traditional cost controlling measures	Utilizes interim valuation, milestones to monitor and control cost	Ashworth & Perera (2015); Oyedele (2015) and Samphaongoen (2010)	Based on inaccurate estimates in the bill of quantities. Prone to cost and time overrun, does not reduce cost easily	Eshofonie (2008) and Dada & Jagboro (2007)
Activity based costing	Calculated unit cost required at the construction phase Identifies the overheads Can be combined with cost of the supply chain	Lin et al. 2001; Jong No & Kleiner, 1997; Lin et al., 2010.	Cannot be effective alone, needs to be combined with other methods Critical success factors needs to be understood before implementation	Jong No & Kleiner, 1997; Jaya, 2013.
Value Engineering	Creates more alternatives to reduce cost and improve value	Kelly et al., 2004; Coetzee, 2009	Requires a lot of time to study, can delay the project, capital intensive	Coetzee, 2009; Rangelova & Traykova, 2014
Life cycle costing	Takes into account preliminary items of work during construction	Kelly et al., 2004; Coetzee, 2009	Has to be combined with value engineering or traditional method	Coetzee, 2009; Rangelova & Traykova, 2014
Earned value analysis	Measure work in progress, reduces cost after evaluation	Sagar & Gayatri, 2012; Virle & Mhaske, 2013	Requires expertise to use software packages	Czarnigowska (2008)
Kaizen costing	Can be combined with target costing. Profit and value focused	Granja et al., 2005; Singh and Singh, 2012.	It is only applicable to the post-contract stage and cannot be used during the cost planning stages It takes a long process for it to be implemented	Granja et al., 2005. Savolainen, 1999.

In table 2.3, the major issues with the post-contract cost controlling methods are the inaccuracies of estimates and other factors highlighted in section 2.2.4. This does not imply traditional post-contract cost control method should not be used in the construction industry; it has a gap which can be filled with other methods of post-contract cost control such as activity based costing and kaizen costing. Kaizen costing has the advantage of incrementally improving

the cost of construction, and it targets quality and client satisfaction. Additionally, kaizen costing's merits highlighted in table 2.2 can be combined with the traditional approach of post-contract cost control for efficient project cost control during construction.

The choice of kaizen costing has been justified from table 2.2 and 2.3. Kaizen costing provides an opportunity for quantity surveyors to identify problems with the construction process which can cause cost overruns before it occurs. The proactive nature of kaizen can reduce maintain the cost of construction. The overall quality of the project satisfies the client and thereby leads to improved competitiveness, increased profitability and company growth.

From section 2.1 to 2.4, this review has discussed the need to focus on post-contract cost control as a strategic aspect for enhancing the profitability and performance of companies using kaizen and kaizen costing. Hence, details about the potentials of kaizen in the construction and how it can mitigate the challenges posed by errors in estimating and budgeting. Kaizen is a product is a lean production. Therefore kaizen cannot be discussed without including lean in the construction industry. Lean has a lot of aspects which is related to waste eliminations and quality improvement. Consequently, further justification for the choice of kaizen over other aspects of lean will be discussed in the next section.

2.5 Kaizen in the construction industry and lean construction

The basic concept of lean construction which is born out of lean production philosophy. The lean production philosophy has various sub-concepts such as just-in-time, responsiveness to change, effective relationship within the value stream, quality management, waste reduction and continuous improvement (Marhani et al., 2012, Marhani et al., 2013)**.** Marhani et al. (2012) supported this by adding last planner system, concurrent engineering, business process re-engineering, value-based system and teamwork as part of the major concepts of lean construction. The five principles of lean construction by Lean Enterprise Institute (2009) as cited by Marhani et al. (2012) include identifying the value, mapping the value stream, create flow, establish pull and seek perfection. These principles have been aimed at focusing on value over cost by reducing non-value added activities thereby creating more client satisfaction; this is the continuous improvement aspect of lean production.

The word “continuous improvement” or kaizen has become common in many organisations in the world. Contrary to the believe of many authors that kaizen started from the Toyota production system (TPS) along with lean production, Shang and Pheng (2013b) argued that kaizen started from the United States when the government started the “*training within industry”* program during the World War II, before it was brought to Japan. Continuous improvement is not only relevant to performance management but also production management in large corporations and Small and Medium Enterprises (SMEs). Lean thinking and continuous improvement have become a subject which many organisations have harnessed as a tool for improved performances in all divisions. Koskela and Ballard (2012) argued that failure to harness the concept of product in management has led to a lot of challenges in the field of management science for half a century. The use of production techniques such as lean production in construction has been a major subject of discussing in the academia. The concept of lean construction has greatly improved the cost, quality, client satisfaction and construction project delivery (Sacks, Koskela, Dave, & Owen, 2010). Studies in the area of lean production in construction involved case studies of various industries other than the construction industry, therefore the benefits highlighted by Sacks et. al (2010) have cut across these industries.

Lean construction has been developed and applied in many construction activities. Al-Aomar (2012) stated that if lean construction has to be appropriately used a framework has to be established, the author further noted that implementation of lean in construction would be further enhanced with Six Sigma rating. The concept of is a broader approach for improving the production system by reducing waste and adding more value. Implementing lean construction has had its debates in the industry and academia. The outcomes of these debates led to the establishment of lean construction in various countries depending on the organisational culture of the construction industries (Sweis, Hiyassat &Al-Hroub, 2016; Shang & Pheng, 2014). The difference between lean construction and kaizen in the construction industry depends on is acceptability, organisational culture towards, change, construction company policies and the type of system used. In adopting a lean construction in Chinese construction companies, Shang and Pheng (2014) identified the barriers as *"their lack of a long-term philosophy", "the absence of a lean culture in their organisations" and "the use of multi-layer subcontracting"*. These can be the same for kaizen in the construction industry. However, Shang and Pheng (2014) identified *“lack of a supporting culture, compressing schedules,*

limited resources and especially the lack of professionals with sufficient understanding of kaizen" as the major barriers of kaizen in the construction industry.

Although, kaizen has not been used in most construction industries, a kaizen model was developed by Vivan, Ortiz and Paliari (2015) was based on an action research strategy using seventy-six (76) building projects in Brazil. The results showed that the overall cost of the building reduced drastically over the phase of the project. Kaizen costing was applied during construction to reduce cost. Kaizen costing is the cost reduction mechanism of kaizen during production. The model developed by Vivan, et al. (2015) also eliminated the myth of standardisation for production in construction during the action research process. Other authors such as Kaur & Kaur, 2013; Martin, 1993; and Smadi, 1993 identified the use of kaizen and kaizen costing for offsite manufacturing of building components and construction. The case studies conducted in a metal industry, a large construction and concrete company by Savolainen (1999), discussed the understanding and adoption of kaizen processes empirically. The findings reveal that kaizen adoption process is iterative and the speed of implementation differs in these two companies.

From the review above, kaizen is the overall process of continuous improvement, while kaizen costing is the process of continually improving the cost of production. The process of utilising kaizen and kaizen costing during production is cost effective but requires detailed housekeeping and identification of problems. The process of using kaizen involve an incremental identification of activities during production for reduction. In construction, overheads present the available gaps where likely elimination of overheads is required.

2.5.1 Incremental waste reduction process in kaizen costing: Overhead cost reduction of non-value adding activities

Waste management practices in Kaizen costing is viewed from the perspective of production waste. However, the overall concept of kaizen also perceives waste from the administrative aspect. The concept of Kaizen, which is a continuous improvement during production, is one of the derivatives of lean production. Singh and Singh (2012), reviewed the history, evolution and the concept of continuous improvement in organisations over the years. The finding shows that continuous improvement otherwise known as Kaizen has been used to improve organisation's performance over the decades. Kaizen focuses more on reducing waste before

and during construction. The concept of kaizen costing is a method used in reducing waste during construction (Chukwubuikem et al., 2013). This method has been used main in the manufacturing industry in many countries around the world. The concept is relatively new in the construction industry.

In kaizen costing, waste is referred to any human activity which does not add value and consumes resources (Womack and Jones, 2003). These human activities must always add value while resources are used up. Otherwise it would be regarded as a waste. The majority of these waste arise in the use of materials for productions.

Waste management in various construction industries has defined policies. In the UK the waste management policy is well implemented. The UK generates about 90 million tonnes of construction waste annually (Williams and Turner, 2010). It was further noted that these wastes are generated by waste from packaging; leftovers from construction materials; design error or changes; poor storage; pilfering and handling of materials. These causes depend on the nature of the construction industry. In developing construction industries such as in Nigeria, the general causes of construction waste on site include poor allocation of resources; poor recording keeping; vandalism, variation and rework; damage as a result of weather or mishandling; damage as a result of transportation; composite and design of building; material supplied and used on site and site office waste (Wahab and Lawal, 2011). The materials, which generate the waste on site, can be concrete, wood, metals plastic, tiles, insulations, paints, soil and stones, ceramics, glass and bricks. Waste generation on the site can be avoided, but the effect can lead to cost and time overruns. In some cases, it can abruptly end the project. The concept of kaizen costing in construction waste reduction for improved profitability, sustainable construction, improved value and client satisfaction through better quality depends on a number of factors other than waste reduction. The identification of waste for continual reduction purposes using kaizen costing depends on the supply chain, workers on site, payment by the client, purchase orders, and actions are taken on site.

Waste is causing factors as identified by Nagapan et al. (2012) and Nagapan et al. (2011) as being physical and non-physical. The physical wastes are debris from the construction process, while the non-physical waste is non-value adding activities such as material handling, inventory, process and delays. Nagapan et al. (2012) further categorised waste arising from procurement, workers, site conditions, handling, management, and external influencing factors.

In incremental waste reduction for kaizen, activities culminating to post-contract cost reduction are mainly overhead cost reduction. Overhead cost is also non-value adding, non-labour expenses raising the overall cost (Lan Oo et al. 2014; Enshassi et al. 2008; Hetherton & Jennifer 2015). An example of overhead cost is depreciation, the cost of processing payments, administrative charges and costs which are indirectly related to the construction process. Hence, kaizen costing application in post-contract cost control, the focus will be on overhead cost reduction. This is because overhead cost reduction is usually fixed during a time period. Kaizen costing is concerned with activities which can be controlled by the stakeholders involved in the construction process. The construction team needs to focus on the supply chain, handling, equipment hire and preliminary items of work. The table 2.4 below shows the different activities carried out by construction operatives which lead to the accumulation of overhead cost.

Table 2.4. Activities relating to overhead cost

S/N	Overhead cost activities	References
1	Plant and equipment depreciation	Nagapan et al. 2011; Nagapan et al. 2012
2	Equipment setup	Nagapan et al. 2011; Nagapan et al. 2012
3	Drawing reviews from variation	Vivan et al., 2015; Mohamed Hafez 2015; Nagapan et al. 2012
4	Variation during construction	Oyewobi et al. 2016; Lammoglia et al. 2010; Cruz et al. 2009
5	Purchase orders and material delivery	Ellström 2015; Lindén & Josephson 2013; Love et al. 2009; Danese et al. 2012
6	Payment of suppliers, sub-contractors and labourers	Araujo et al. 2016; Selviaridis & Norman 2014; Emuze & Julian Smallwood 2014; Tran & Carmichael 2012
7	Cost of construction cost planning, general planning, resource planning and project reports	Tannock et al. 2007; Lammoglia et al. 2010; Oyewobi et al. 2016
8	Costs associated with preliminary items of work	Granja et al., 2005; Nagapan et al. 2011; Nagapan et al. 2012

The aforementioned activities in table 2.5 above are related to the general overhead cost which can be reduced through the continuous improvement process (kaizen costing). Plant and equipment depreciation cost are usually paid by the contractor during the lifetime of the construction process. With constant negotiation with the equipment supplying company, the overhead cos relating to depreciation of plant and equipment will be reduced. Handling of

equipment (setup) and materials which are supplied as a result of the purchase of building materials have overheads such as administrative charges relating to payment. Preliminary items of work are related to fixed payment for water, electricity, first aid, inventory, security and so on, can be reduced my monitoring usage. Hence, incremental reduction of muda (waste) on construction sites will provide an opportunity with the implementation of kaizen costing.

The incremental reduction process during kaizen costing will be explained further in the next section with an illustration of how kaizen costing can be applied in the construction industry considering the identified activities in table 2.4.

2.6 How kaizen costing works: The process of incremental reduction of activities on construction sites for kaizen costing

kaizen is costing works as a cost reduction mechanism during production. According to IFS (2010), Yashihuro Monden classifies kaizen costing into:

> *"1. Asset and organisation-specific Kaizen Costing activities planned according to the exigencies of each deal.*
> *2. Product-model-specific costing activities carried out in special projects with added emphasis on value analysis (Monden has the automotive industry in mind)".*

IFS (2010) and Shang and Pheng, (2013) explained that kaizen costing could be separated into maintenance and improvement. Maintenance is related to keeping the cost within budget, while improvement identifies gaps which allow for the reduction of cost. The maintenance aspect involves management function which would be narrowed down further to policy guiding waste reduction in the office, rules and regulations, guidelines and procedures for an employee-employer relationship, elimination of waste. This managerial function is essential as a culture within the organisation before the site activities. Reduction of waste which is also known as *Muda* in Japanese involve all non-value adding activities (IFS, 2010). Therefore managing value during production is essential to the realisation of waste reduction during production. The production aspect depends on the work breakdown structure and cost estimates.

Cost estimates must be established in a standardised framework. This framework or system must be established within the organisation for product cost monitoring for a lower cost than the budgeted cost and ensure products are within the budget or target cost, with this process subsequently repeated (IFS, 2010). The plan-do-check-act (PDCA) process is required in this phase.

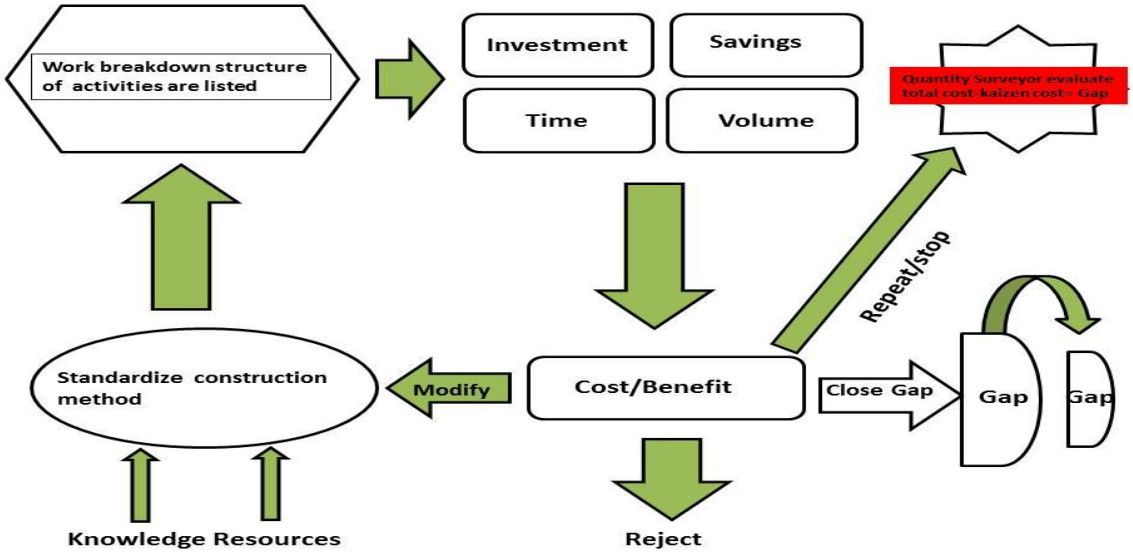

Figure 2.6. Kaizen costing process during construction (Modified from IFS white paper, 2010)

Even though figure 2.4 does not illustrate kaizen in construction, the modification process from the IFS white paper demonstrates how kaizen costing can be used in the construction industry. This was adapted from IFS white paper on the development of an application for kaizen costing. This model recognises the existence of a budget for construction work, which has to be prepared for the construction phase. A standard construction method has to be established in addition to the program of works in the form of a work breakdown structure (WBS). The work breakdown structure would allow the project manager and quantity surveyor to allocate finance, time and labour resources. The Quantity Surveyor would seek alternatives to these resources and cost-saving mechanisms. This evaluation compares the current cost of construction to the target cost in the budget, therefore eliminating more waste. The wastes identified are reduced further and further to create more value and profit. This process involves closing the gap created by waste. The circle is repeated until the best quality is attained.

According to Puvanasvaran et al. (2010), another approach to kaizen costing involves the plan-do-check-action (PDCA) process. This process involves seven stages which are:

a) Defining the plot area or section which requires improvement;
b) Identifying the losses from non-value added activities which are documented in a template;
c) Scheduling the activities to be reviewed for solutions;

d) Organising the project team to brainstorm on likely solutions;
e) Implementing the solutions involving plan-do-check-act. This also involve research, data collection and analysis;
f) Conforming the effectiveness by looking at before and after approach;
g) Following up with the implemented plan involve a checklist sheet, employees, the top management.

These steps highlighted above can be adopted during construction also to reduce cost and time. Nonetheless, there are some strategies or enablers which are required for the successful implementation of kaizen costing in construction companies.

Based on available literature kaizen costing seems to be very alien to SMSCC in Nigeria. There is very few literature about this concept of kaizen relating to the Nigerian construction industry. Therefore, their processes involving kaizen costing in figure 2.4 has to be developed further based on the requirement of SMSCC in Nigeria, the need for kaizen costing and the critical success factors for kaizen implementation in SMSCC. The process of kaizen involves continuous identification and elimination of problems within SMSCC.

The process of incrementally reducing cost during construction for SMSCC depends on activities which are not adding value. Non-value- added activities in construction are the gaps which can be noted in figure 2.4. They are categorised as material delivery(transportation and handling), overhead cost reduction during construction, preliminary cost reduction, supply, variation management, plant and equipment hire (depreciation) and payment of sub-contractors (Inglezakis & Zorpas 2011; Jayamathan & Rameezdeen 2014; Yahya et al. 2016; Yates 2013; Khanh & Kim 2015). The waste category in this study can be physical and non-physical (Sandberg & Bildsten 2011; Chatziaras et al. 2016; Sandhu 2014; Ajayi et al. 2016; Yahya et al. 2016). For instance, waste arising from material handling and transportation are physical, but waste arising from overhead are non-physical. Preliminary items such as the overhead cost of electricity, water, stationery, road, security and so on are also major gaps which can be closed for reduction of cost. Overhead costs relating to preliminaries, payment of contractors (administrative charges), suppliers, equipment and variation management can be minimised throughout the course of the construction project. This process will keep the project within budget and also ensure, reasonable value and project performance.

Section 2.5 and 2.6 have addressed kaizen in the construction industry, and the process kaizen follows to attain cost reduction. The use of kaizen in Nigerian SMSCC depends on the justification identified in section 1.2. Therefore, an overview of the present circumstance of kaizen in Nigerian SMSCC will provide an insight into the organisational culture of the companies and success criteria for implementation.

2.7 The need for kaizen and kaizen costing in small and medium scale construction companies in Nigeria

There is no documented evidence of kaizen in the Nigerian construction industry. There are few studies related to the use of kaizen costing in Nigeria. The only work available at the moment is authored by Olabisi et al. (2012). The paper focused on impact kaizen costing has on the profitability of small and medium-scale manufacturing enterprises in Ogun state, Nigeria. The data and information dearth on the subject is one of the gaps which this research seeks to bridge. A significant adoption of kaizen costing in Nigeria construction industry could go a long way in improving the profitability, competitiveness and overall growth of the sector.

The need for kaizen and kaizen costing for SMSCC in Nigeria is predicated on the existing problems such as cost overrun, low growth and sustainability of SMSCC as a result of diminishing competitive advantage (please refer to section 1.1 and 1.2). These problems identified in section 1.1 are related to the financial performance of Nigerian SMSCC. The role of quantity surveyors in construction organisations in Nigeria has always been related to the financial probity of every project. Quantity surveyor has the duty to ensure that construction cost stays within budget with an excellent profit margin for the contractor and delivery of the final product to the client at a reasonable cost. According to Sanni and Durodola (2012) some cost controlling techniques used in Nigeria as being monitoring labour, equipment and material cost; overhead monitoring; taking corrective action; identifying cost overruns; analysing cost reports; keeping and using historical data; analysing cost variance, forecasting cost of completion; summarising profit and loss.

The post-contract cost control process needs to improve with the new trends in construction such as lean construction and the modern methods of construction. This is because of the high level of competition from foreign construction companies, the complexity of construction projects and needs to improve the performance of SMSCC in Nigeria. The demand for

improvement in cost control of building projects varying complexities compels the adoption of new techniques of managing construction cost. Kaizen and Kaizen costing has been used in construction waste reduction, improved quality of the final product, improved profitability and competitiveness of company (Kaur & Kaur, 2013; Martin, 1993; and Smadi, 1993). The use of kaizen costing in construction can be combined with the traditional costing systems for effectiveness. This cost controlling approach can be improved with kaizen by improving the number of working hours (Budugan & Georgescu, 2009). The study conducted by Budugan & Georgescu (2009) shows that employee working hours improvement can lower variable cost and invariably the total production cost. The number of hours employees give in a construction company has an influence on the overall cost of a project; therefore, teamwork is very vital in kaizen costing.

These key benefits have not been studied by most academics in Nigeria, and the focus has only been on target costing and improved estimating techniques for reducing cost overrun and project abandonment (Sanni and Hashim, 2013, Frimpong et al., 2003, Mansfield et al., 1994).

This study intends to identify the organisational culture workings of SMSCC in Nigeria as a bedrock for post-contract cost control improvement for this category of companies. The next section will discuss the nature of SMSCC in Nigeria for the purpose of integrating kaizen into the construction process in Nigeria.

2.8 The organisational culture of small and medium scale construction companies in Nigeria

Organisational culture describes the opinions of the owners of the company, and it binds the stakeholders within the company together (Issa & Haddad 2008). Organisational culture is a collection of internal and external factors that can lead to the establishment of beliefs, customs morals, knowledge and policies. Therefore, the formation of culture within an organisation depends on several factors, and it is a process leading to the formation of policies. These factors are peculiar to the nature of the environment where the company is situated, government policies, the nature of the economy, the makeup of the company (a type of company) and other internal influences (Alashwal & Abdul-Rahman 2014; Ribeiro 2009; Norma et al. 2010; Kransdorff 1996). This is also related to the main essence of improving the organisation for competitiveness and growth.

The growth of construction companies in Nigeria began in the 1940s and during the oil boom of the 1970s. The Nigerian construction industry created a lot of small and medium scale construction companies (Isa et al., 2013). The construction industry in Nigeria has been growing at a slow pace over the years despite the oil wealth of the country. Nonetheless, massive economic and infrastructural growth has been concentrated mainly in few cities such as Lagos, Port Harcourt, Abuja, Kaduna and Kano. The growth can be because of the presence of small and medium scale construction organisations in these cities.

Eniola (2014) as cited by Eniola et al. (2015) noted that there is no accurate definition for small and medium scale construction companies (SMSCC). At the moment in the Nigerian construction industry, there is no precise number of SMSCC because of the unorganised nature of the sector. Although, Lagos state Ministry of Housing has a database of about one thousand SMSCC, the figures keep changing because of the fraudulent nature of the owners of these companies. Some of the companies are only registered for a single project, after the end of the project, the construction company ceases to exist. Another constraint in defining what SMSCC is in Nigeria is the challenge of having the right parameters. This is because the parameters, which include the size of fixed asset, personnel, technology, production, output, system or management or capital is subjective according to various analysts. Therefore, the definition of small and medium scale enterprises depends on the economic judgement of the country where the company is situated. Eniola et al. (2015), further noted that the Central Bank of Nigeria (CBN) defines SMEs as a company having less than 50 and 100 staff for small and medium respectively, while the asset is between one (1) million naira (£3,293.98)and one hundred and fifty (150) million naira (£494,096.92)for small and medium respectively. These values are used in this study to categorise small and medium scale construction companies.

SMEs has the potential to drive the economy of any nation to greater heights (Afolabi et al., 2013, Abdullah et al., 2011). However, this depends on the intellectual capacity of the personnel, technology and access to funds (Abdullah et al., 2011, Eniola et al., 2015, Fagbohun and Mohammed, 2014). Small and medium construction companies in Nigeria are facing this challenge. Abdullah et al. (2011) opined that the Nigerian small and medium construction companies are faced with the challenge of performing personnel. This has affected the delivery of projects, companies profit level and the company's productivity. Abdullah et al. (2011) further noted that there is a correlation between remuneration and the performance of staff.

Abdullah et al. (2011) concluded that the personnel of SMSCC require more motivation in order to improve the organisation's competitive advantage. SMSCC in Nigeria have been creating employment, but the turnover is relatively low because multinational construction companies have the upper hand (Odediran et al., 2012b). The need to improve certain managerial aspects of SMSCC in Nigeria can necessitate the implementation of kaizen in these industries.

There are aspects of organisational culture that are very visible based on the behaviour of the organisation. Some organisations have behaviours that are latent (Issa & Haddad 2008; Anumba et al. 2008; Anumba et al. 2002). Therefore, there is a need to investigate the behaviour of organisations towards a perspective. This perspective can be towards the style of communication in the workplace or response to change. In investigating communication in organisations, there are various approaches. There is nonverbal communication, meetings, memos, top down approach and bottom up approach (Hoogervorst et al. 2004; Larson & Kleiner 2004; Dawson-Shepherd 1997). Furthermore, communication within organisations can be regarded as implicit and explicit communication. Implicit communications aim to transfer knowledge to the employees, while explicit behaviours can intentionally transfer information to change the behaviour of the employees (Hoogervorst et al. 2004). This can be about the quality and ways of improving identified lapses within the organisation.

Organisational culture also develops into organisational learning. However, this is only when the organisation decides to make use of what they have learned over the year. This can carry out via post-project review. A post-project review is a form of organisation learning whereby the organisation decides to improve the present condition. In the construction industry, some of the important lessons which should have been learnt during the project are compiled as a form of knowledge management for future use (Kululanga & Kuotcha 2008; Singhvi 1986). Post-project reviews lead to improvement of organisations if they are executed and evaluated for further reviews.

The challenge with the construction industry in Nigeria and SMSCC in the country is business ethics. Business ethics here is corruption and quality of cost information, which can bother down to professionalism. The organisational culture of Nigerian SMSCC influence decision making, change management and requirements for implementation of kaizen. Therefore, this section has identified the challenges facing SMSCC which are communication, unethical

practices, difficulty in changing the modus operandi and motivation. The aforementioned barriers are not enough to constitute the critical success factors for kaizen costing implementation. Therefore, further discussions about the strategies and factors for successful implementation of kaizen in Nigerian SMSCC will be extracted from existing literature.

2.9 Critical success factors for implementing kaizen in SMSCC in the construction industry

The strategies other researchers have suggested for implementing kaizen in countries around the world can be applied to the Nigerian construction industry. These strategies can be categorised as they relate to the various sections of the kaizen process within a construction industry for the company and construction process. Additionally, the critical success factors in this section are from third world countries (such as China, Brazil and India) similar to the Nigerian construction industry. Most third world construction industries have similar challenges such as cost overruns, project financing and SMSCC which are facing stiff competition from multinational construction companies. The challenges faced in third world construction companies are very similar (Ballesteros-Pérez et al. 2015; Dada & Jagboro 2007; Guo et al. 2016; Amoatey et al. 2015). The strategies are therefore transferable.

Shang and Pheng (2013) investigated the challenges facing the implementation of kaizen and kaizen costing in Chinese construction companies by interviewing project managers. The finding shows that most construction organisations do not have the culture of exposing the problems within the business because it can lead to losses. The nature of most organisations in China prefers to perceive major problems and cover up minor problems. Kaizen demands the identification of difficulties which can lead to waste and eliminate them (Suárez-Barraza et al., 2011). Shang and Pheng (2013) further stated that most project managers in China decide to compress the duration of the project even though the projects cannot be completed at such an unrealistic time frame. The author also stated that kaizen could not work in this instance because there will be intense pressure to finish a project without considering the quality. The final challenge involves the inadequacy of construction professionals with the pertinent understanding of how kaizen works. It was noted that Chinese construction companies are facing the challenge of few construction professionals with the understanding of kaizen. Although, most construction companies envy the Japanese production success stories, they do not have the required kaizen skills.

Borrowing from the experiences of Shang and Pheng (2013) in implementing kaizen and kaizen costing for construction companies in China, the critical success factors are related to identified strategies for the implementation of kaizen and kaizen costing in a company. Although, there are no direct identified implementation strategies for the Nigerian context, these basic requirements for kaizen implementation critical success factors in developing countries such as Brazil, China and India.

Shang and Pheng (2013b); Arya and Jain (2014); Puvanasvaran et al. (2010); Berger (1997); Chukwubuikem et al. (2013) and Magnier-Watanabe (2011) have identified several critical success factors required for the implementation of kaizen costing in a company. Some of these strategies are like enablers or critical success factors required for kaizen costing. These critical success factors have been categorised as thus:

a) **Organisation structure:** Magnier-Watanabe (2011) noted that "*kaizen required a horizontal organisation structure and opportunistic knowledge acquisition*", kaizen requires a lot of communication and teamwork and a less bureaucratic management structure. This allows a lot of information to flow within the organisation. This fosters improved relationship between the employer and the employees. There is a need for an ad-hoc, collective and innovative system within the organisation for kaizen costing to be effective.
b) **Construction process standardisation:** There is need to improve the process of construction to a more standardised one if kaizen costing will be used (Shang and Pheng, 2013b). Most construction companies' modus operandi depend on the nature of the project, organisation policy and regulatory bodies.
c) **Government and regulatory bodies**: Government policies, politics and construction regulatory bodies influence various construction industries around the world. If these bodies do not approve kaizen costing as a mean of post-contract cost control, they cannot be used. However, some construction regulatory bodies are very flexible and do not get involved in innovation within construction companies.
d) **Contract documentation and procurement:** The type of procurement process adopted can affect the cost of the project. A design and build system will be different from the traditional procurement system. Therefore, the contractor can have more resources at his disposal to implement kaizen costing during a project and create his

own team. Also, the level of involvement of stakeholders in the project goes a long way during the construction process. Clarity of exclusions and accuracy of estimates can also influence the time available for kaizen activities.

e) **Financial risk management:** Since the quantity surveyor and project managers are mainly involved in managing the financial risk which can arise as a result of price fluctuations, inflation, changes in the building design, variation, claims, theft, fraudulent practices and kickbacks, payment delays, suppliers' and sub-contractors' cost. These factors along with the preliminary items of work can affect the financial position of a construction project thereby affecting the success of kaizen costing.

f) **Communication and teamwork:** Kaizen costing activities on the site can not involve the cost or project managers alone but *kaizen team*. This team will have to work with every stakeholder including the suppliers of building materials, clients and sub-contractors. Communication is essential during the implementation of kaizen costing. Therefore, regular site meeting and post-project review meeting are necessary. In most cases where BIM is implemented during the pre-tender process, communication can be easier with other stakeholders.

g) **Decision making:** The decision made by the cost or project manager during kaizen implementation and follow-up can affect the overall performance of kaizen costing. The contractor or management function in cost management has to be involved in making some final decisions about claims or litigation can affect the implementation process of kaizen costing. Shang and Pheng (2013b) noted that the construction company needs to see "*problems as opportunities"* in order to make the best decisions during kaizen activities.

h) **Relationship management:** In most situations where claims are raised by the subcontractor or contractor, there is a need for relationship management between the stakeholders. The availability of resources to execute kaizen costing during construction depends on the relationship between the contractor quantity surveyor and the client.

The various categories of critical success factors can be broken down into the table below to identify the important drivers of kaizen and kaizen costing implementation.

Table 2.5. The critical success factors for the adoption of kaizen and kaizen costing

Critical success factors	References
Organisation structure	
Flexible organisation policy	Magnier-Watanabe, 2011; Berger, 1997; Arya and Jain, 2014
Existing continuous improvement policy	Olabisi et al., 2012; Arya and Jain, 2014; Puvanasvaran et al., 2010
Organisation structure and communication	Puvanasvaran et al. 2010; Olabisi et al., 2012; ;
Employee empowerment	Arya and Jain 2014; Shang and Pheng, 2013; Olabisi et al., 2012
Experienced Quantity surveyors other staff	Shang and Pheng, 2013; Puvanasvaran et al., 2010
Excellent remuneration and motivation	Olabisi et al., 2012, Shang and Pheng, 2013;
Excellent working conditions	Arya and Jain 2014; Olabisi et al., 2012
Excellent employer/ employee relationship	Puvanasvaran et al., 2010 ; Magnier-Watanabe, 2011
Training of inexperienced employee	Chukwubuikem et al., 2013, Arya and Jain 2014; Olabisi et al., 2012
Availability of software packages	Olabisi et al., 2012; Chukwubuikem et al., 2013 ; Puvanasvaran et al., 2010
Financial status of the construction company	Puvanasvaran et al., 2010; Chukwubuikem et al., 2013 ; Berger, 1997
Contract documentation and procurement	
Procurement method adopted	Sanni and Hashim, 2013, Chukwubuikem et al., 2013
Clarity of exclusions in the contract	Sanni and Hashim, 2013; Chukwubuikem et al., 2013;
Accuracy of estimates	Sanni and Hashim, 2013; Kern and Formoso, 2006
Construction process and technical know-how	

Construction method adopted	Olabisi et al., 2012; Kern and Formoso, 2006
In-depth knowledge of production process	Puvanasvaran et al., 2010 ; Magnier-Watanabe, 2011; Berger, 1997
Standardised production process	Mansfield et al., 1994; Granja et al., 2005; Brunet and New, 2003
Project complexity	Mansfield et al., 1994; Granja et al., 2005
Employee experience	Sanni and Hashim, 2013; Magnier-Watanabe, 2011; Chukwubuikem et al., 2013
Quantity Surveyor site experience	Puvanasvaran et al., 2010; Olabisi et al., 2012
Updating cost information during construction	Mansfield et al., 1994; Ashworth & Perera, 2015; Groth and Kinney, 1994
Variations and rework during construction	Olawale and Sun, 2010; Sanni and Durodola, 2012; Ashworth & Perera, 2015; Mansfield et al., 1994
Government and regulatory influence	
Stability of market conditions	Mansfield et al., 1994; Olawale and Sun, 2010; Oyedele, 2015
Political stability	Oyedele, 2015; Mansfield et al., 1994; Olawale and Sun, 2010
Government regulations	Oyedele, 2015; Mansfield et al., 1994; Olawale and Sun, 2010
Influence of construction professional bodies	Oyedele, 2015; Mansfield et al., 1994; Olawale and Sun, 2010
Financial risk management and litigation	
Price and design risk	Chukwubuikem et al., 2013, Berger, 1997

Quality of cost information	Puvanasvaran et al., 2010 ; Mansfield et al., 1994
Price fluctuations	Puvanasvaran et al., 2010 ; Mansfield et al., 1994
Payment delays	Puvanasvaran et al., 2010 ; Mansfield et al., 1994
Claims	Cheung, Wong, Yiu, & Kwok, 2008; Iwamatsu, Akiyama, & Endo, 2008
Fraudulent practices and kickbacks	Oyedele, 2015; Mansfield et al., 1994 ; Dada and Jagboro, 2007 ; Eshofonie, 2008
Disputes and litigations	Cheung, Wong, Yiu, & Kwok, 2008; Iwamatsu, Akiyama, & Endo, 2008
Suppliers' cost of materials	Oyedele, 2015; Kern and Formoso, 2006
Sub-contractors' cost	Oyedele, 2015; Kern and Formoso, 2006
Communication and teamwork	
Regular site meetings	Olawale and Sun, 2010; Sanni and Durodola, 2012; Ashworth &Perera, 2015; Mansfield et al., 1994;
Management of overheads on site	Arya and Jain 2014; Olawale and Sun, 2010.
Communication among project professionals	Arya and Jain 2014; Magnier-Watanabe, 2011; Berger, 1997
Post-project reviews of cost information	Magnier-Watanabe, 2011; Berger, 1997; Chukwubuikem et al., 2013
Improved teamwork	Puvanasvaran et al., 2010 ; Magnier-Watanabe, 2011
Improved contractor-client communication	Granja et al., 2005; Ashworth & Perera,

	2015; Nakacwa, & Kyakula, 2007; Pott, 2008
Decision making	
Contractor decision-making technique	Chukwubuikem et al., 2013, Berger, 1997; Puvanasvaran et al., 2010;
Architect/project managers' decision	Puvanasvaran et al., 2010; Magnier-Watanabe, 2011; Berger, 1997; Arya and Jain, 2014
Quantity Surveyor's decisions	Puvanasvaran et al., 2010;
Relationship management	
Contractor/suppliers relationship	Magnier-Watanabe, 2011; Berger, 1997; Arya and Jain, 2014
Contractor/subcontractor relationship	Puvanasvaran et al., 2010 ; Magnier-Watanabe, 2011; Berger, 1997; Arya and Jain, 2014
Contractor/Quantity Surveyor relationship	Puvanasvaran et al., 2010 ; Magnier-Watanabe, 2011; Berger, 1997; Arya and Jain, 2014
Architect/Quantity Surveyor relationship	Chukwubuikem et al., 2013 ; Magnier-Watanabe, 2011; Berger, 1997; Arya and Jain, 2014

Each of the sections in table 2.4 has been able to break down the possible drivers for the categories. Hence, the literature review conducted on each of the categories identified the drivers. These known factors from existing literature will not be enough to resolve the research objective in section 1.2.1 number 5; it will be combined with the required the perception of the stakeholders in the Nigerian construction industry for this study. Furthermore, the identified gaps in this section have created an opportunity for detailed research into the possibility of combining kaizen and kaizen costing with traditional costing system for post-contract cost control in Nigerian SMSCC. The key gaps from this literature review are expounded in the next section.

2.10 Summary of identified gaps for post-contract cost control in the Nigerian construction industry and the possible influence of kaizen

This section identified the key cost management systems, methods and techniques used in post-contract cost control, the challenges facing the current post-contract cost control. The need to focus on post-contract cost control is highly imperative based on the certain errors generated during the cost estimation process Kern and Formoso (2004) and Samphaongoen (2010).There is a need for modern methods of controlling cost during the construction stage. Although, earned value analysis, value engineering and activity based costing could be used. However, these methods are expensive to use for most small and medium scale companies in developing economies. Kaizen costing has been identified as a new approach to reducing the cost of construction and creating more value through waste reduction. The benefits of kaizen costing in the manufacturing and construction industry as highlighted by the authors (Singh and Singh, 2012; Kaur and Kaur, 2013; Ellram, 2006; Cheser, 1994 and Utari, 2011) also form the basis of this research. Implementing kaizen costing has its own challenges and requirements; nonetheless, the benefits can go a long way in addressing the major challenges of traditional post-contract cost control. The problems identified in this review include the challenge of cost overruns and project abandonment in most construction projects handled by indigenous contractors (Eshofonie, 2008; and Dada & Jagboro, 2007). The traditional cost control system in Nigeria has been facing challenges of inflation, exchange rate fluctuations, price fluctuations and an increase in import duties (Dikko, 2002). This method is broadly considered not suitable for small and medium scale construction companies in Nigeria.

The research gaps from the literature review are as follows:

a) Cost planning phase is riddled with a lot of errors which are always transferred to the construction phase. These errors are in the estimating and working budget. Hence, there is a need to look at the alternative method of enhancing the post-contract cost controlling techniques.
b) Kaizen provides an opportunity to reduce non-value added activities during construction, deliver quality buildings at the right cost to a satisfied client. A case of seventy-six building in an action research project by Vivan et al. (2015) proved that kaizen costing could be used in construction.
c) There is no documented evidence of kaizen in the Nigerian construction industry. This is a research gap this study intends to fill.

d) The Nigerian manufacturing sector is already using kaizen costing (Olabisi et al., 2010). Therefore, it is possible to adopt kaizen in the Nigerian construction industry.
e) SMSCC in Nigeria are having issues with competitiveness, and they require a new framework for competition. This also depends on the organisational culture of SMSCC in Nigeria.
f) Innovation is required in the post-contract cost control aspect of construction.
g) The concept of kaizen is new to SMSCC in Nigeria. Therefore it is imperative to address their opinion towards change and also evaluate the level of continuous improvement knowledge they can have.
h) There is no available framework for kaizen to be implemented in any construction company in Nigeria. Therefore, it is imperative to explore the possibility of having a framework for kaizen in the Nigerian construction industry.

Having identified the need for research in the post-contract cost control phase of construction in the Nigerian construction sector, the next section discusses the research methodology is required to create a framework for the construction industry.

Chapter Three

Research Methodology

3.0 Introduction

This section discusses the research methodology which was adopted for this investigation. This includes the research philosophy strategy adopted for each objective, approach, sampling techniques tools for data collection and the limitation in data collection.

3.1 Research methodology in the built environment

A number of research frameworks have been designed to provide a detailed understanding of research methodology and the step by step procedures that needs to be followed for a study. For example, the research onion (Saunders, Lewis and Thornhill, 2015) and the nested model (Kaglioglou, Cooper, Aouad, Hinks, Sexton and Sheath, 1998). Saunders et al. (2015) comprise of research philosophy, approach, strategy, choices and time horizon (research onion).

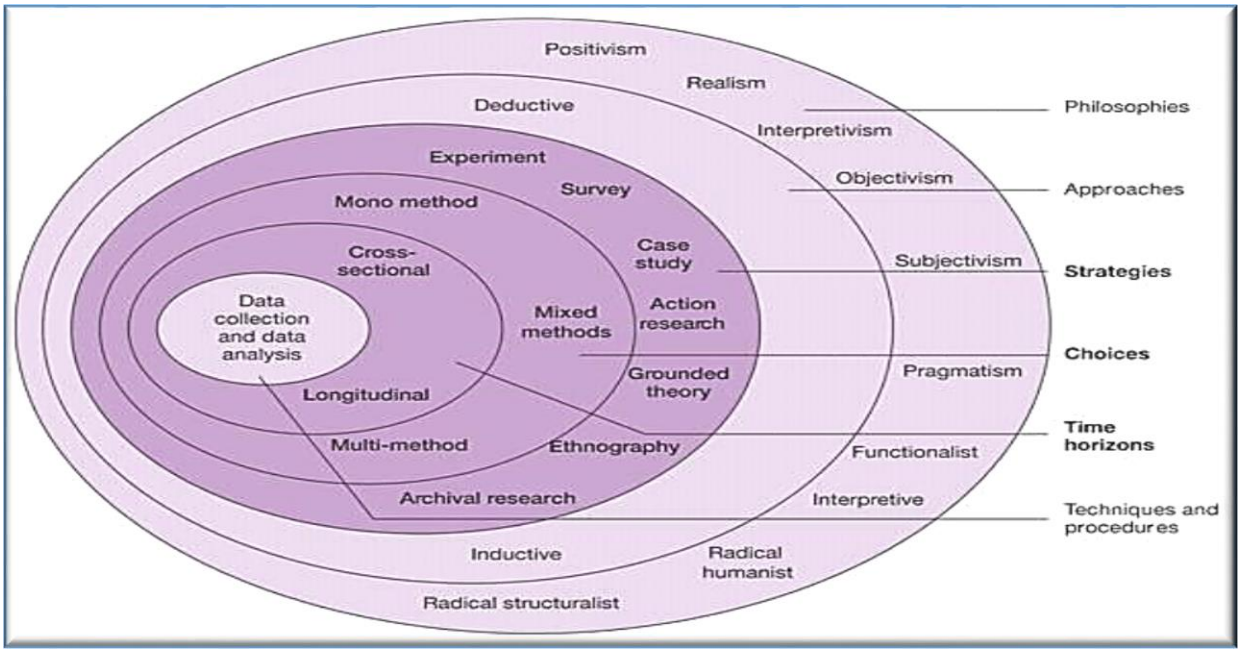

Figure 3.1.The research onion (Saunders et al., 2015)

This is compressed into research philosophy, approach and techniques (nested model). Figures 3.1 and 3.2 depicts that the research onion and nested model contain similar steps. The choice of a research methodology depends on the researcher and research objectives.

Figure 3.2. Nested Model (Kaglioglou et al., 1998)

A comparison between the research onion and the nested model by Keraminiyage (2013) outlined the lapse of research onion as being dependent on the outcome of the previous layer. Keraminiyage (2013) proposed a research methodology framework which addressed this by focusing on research philosophy, approaches, strategies, choices and time horizon which can be identified with techniques. The order of comparing the nested model to the research onion to create a modified model by Keraminiyage (2013) did not consider the comprehensive order of the research onion. The research onion in figure 3.1 has a thorough understanding of the steps which has to be taken by the researcher. In the use of the research onion for social science research, the researcher needs to deliver details of how the framework for the study has to look like. Therefore, the normal process of designing a research methodology framework should consider the fragments of the study from the research philosophy. The nested model and the modification by Keraminiyage (2013) failed to consider the Saunders et al. (2015) provision for a comprehensive guideline towards designing a research methodology framework.

The research onion framework has been used in business and social science research over the years with a great provision for details. The research onion was adopted for this study because of its detailed approach of highlighting the key steps in research. The research onion begins with the research philosophy which defines the steps to be taken by the research based on

ontology, epistemology and axiology. The justification of the choice of the research philosophy for this study will be discussed based on the research objectives.

3.2 Research Philosophy

Research philosophy is the cornerstone of any study. The core strands of research philosophy guide the researcher in making the right decisions about the approach, strategy, data collection techniques and procedures on how to answer the research questions. Williams and Mays (2002) stated that research is based on philosophical principles which define various disciplines. Therefore, research is based on some sets of paradigms which the researcher has to follow. These philosophies are mainly divided into ontology, epistemology and axiology.

3.2.1 Ontology

Ontology relates to the opinion of reality. Ontology attempts to know if knowledge is a product of the mind or it exists, in this instance, it suggests ***realism*** and ***idealism*** (Carr, 2006; Khin and Heng, 2012; Krauss, 2005; Lawson, 2004; Morgan and Smircich, 1980). Reality can be seen different by different researchers, and when approaching a research, the way in which reality is perceived affects how knowledge is derived. Therefore, the school of thought of each researcher has profound effects on the knowledge created in the form of theories. The researcher can be an idealist who believes that his thoughts and experiences affect the events of the research or the people interacting with the environment in the sense of a real world. This, in turn, affects how issues are viewed from a realist perspective. Therefore, the stands of realism and idealism school of thought act as focal poles defining how research will be conducted right from the beginning. Wangombe (2013) posited that realism or idealism might not be the only two stands when it comes to viewing reality, the realm of symbolic disclosure, social construction or contextual field of information can also be of significance. This form of reality largely depends on the objectives of the research. Table 4 below further explains the ontological stands adopted for this research.

3.2.2 Epistemology

Epistemology is the philosophy which relates to how knowledge can be recognised, developed or acknowledged (Mack, 2010; Mkansi and Acheampong, 2012; and Schuh and Barab, 2007). Epistemology considers alternative ways of approaching research (Hill, 1984; Khin and Heng,

2012). Eriksson and Kovalainen (2008) explained that epistemology might be objective or subjective; objective epistemology recognises the outside world which is hypothetical impartial. The subjective epistemology suggests that the outside world is in the realm of clarifications from reflection. The epistemological stand, in this case, is ***positivism*** or ***interpretivism*** (Holden & Lynch, 2004). The positivist analyses data from the quantitative perspective. In this instance, data is gathered using questionnaires, surveys, experiments and so on (Holden and Lynch, 2004). The intrepretivist or social constructionism aims to increase the general understanding of reality. Therefore the experience of the researcher is included as part of the study, includes the opinion of stakeholders in inducing theoretical concepts (Easterby-Smith, Thorpe, & Lowe, 2008**).** The positivist philosophical stand is directly related to the realist stand, while the social constructionist stand is in line with the realist concept. The epistemological positions for this study are further explained in table 4 below.

3.2.3 Axiology

Axiology concerns are related to how value is judged by the researcher. The value can be seen as being necessary for research. The researcher would definitely want to use his experience in the study or it may be included in the study (Saunders et al., 2015). Therefore, the concept of value-free and value-laden research has been argued by social science researchers over the years. In a value-free scenario, the researcher or the respondent has an impartial contribution of feelings and past experiences throughout the study (Hill, 1984). A value-laden research includes studies which add personal emotions, feeling and past experiences of the scientist or respondent. The axiological positions for this research are highlighted and justified in table 4 below.

3.2.4. Justification for the research philosophical stands adopted

Table 3 below described the morale behind the philosophical stands adopted for this study. This is based on the research objectives in the first section. This justification is tailored to the research objectives of this study. The ontological, epistemological and axiological concepts of realism, idealism, positivism, interpretivism, value-free and value-laden have been explained in the earlier subsections. The philosophical concept adopted for each research objective defines what type of research approach and strategy that are adopted for the research.

Table 3.1. The philosophical stands with justification adopted for each objective

		Ontology	Ontology	Epistemology	Epistemology	Axiology	Axiology
S/N	**Research Objectives**	**Realism**	**Idealism**	**Positivism**	**Intrepretivism**	**Value-Free**	**Value-laden**
1	To identify and evaluate the post-contract cost control techniques used in the construction industry.	The expected knowledge does not exist outside the social phenomenon. Therefore, realism will not be used	Knowledge is derived from existing social phenomena. Idealism will be used in this case.	This objective will not be independent of the researcher. Therefore, positivism cannot be used. This objective can easily be resolved using literature review.	This objective involves the stakeholders' opinion. It will involve general understanding of the situation	The experience and opinion of the researcher is not required for the conclusions in this research	It will be value-laden because the evaluation of the post-contract cost control process will not be independent of the researcher's opinion and experience. The research objective identification process also depends on the rich literature review gathered by the researcher

2	To establish and evaluate the techniques used in post-contract cost controlling management in small and medium scale construction companies in Nigeria.	Some of the post-contract cost control techniques can exist outside the social phenomena. Therefore realism will be adopted	The remaining aspect of the objective which involves evaluating the post-contract technique will adopt idealism because some knowledge can exist in the literature.	This objective involve the activities of the researcher in identifying the post-contract cost control techniques in the outside world. Therefore the positivist stand will be partly adopted	The evaluation and some identification process involve stakeholders in the academia. Therefore the interpretive stand is necessary for this objective.	The value-free concept is related to the positivist aspect and realism. Therefore it will be partly value-free	This objective involves the use of the researcher's experience and opinion in evaluating the identified post-contract control techniques. Therefore it will also be partly value-laden.
3	To identify and evaluate the critical post-contract cost controlling activities for incremental cost reduction in small and medium scale construction companies in Nigeria.	In this objective, the nature of reality depends on the social phenomena of the outside world	Realist stand is required because of some of the factors which exist outside literature articles.	The positivism stand of this objective is based on the unit of analysis which will be identified and reduced to simplest terms.	The objective seeks to increase the general understanding of the study. Therefore literature will be required in the identification process. Interviews are also required in this case.	The objective required the independence of the research. positivist stand, therefore it will also be partly value-free	The idealist stands adopted makes this objective value-free.

4	To review and evaluate the critical success factors of adopting kaizen in small and medium scale construction companies in Nigeria.	In evaluating the concept kaizen costing, the perspective of the social event has to be from outside the phenomenon	The idealist stand is required for knowledge within the phenomenon.	The independence of the researcher is required in resolving this objective. Due to these reasons, the positivist position is required for this research.	Interpretivism is required for this objective because the opinion of Quantity Surveyors and contractors are imperative.	The realist, idealist and positivist stand makes value-free essential for this objective	The researcher's choice of idealism and interpretive also necessitates a value biased position for this study
5	To develop and validate a framework based on kaizen, which can be integrated into the post-contract cost control practices in small and medium scale construction companies in Nigeria.	The kaizen costing framework development process will require a lot of knowledge which has to be gathered from outside the social event. Realism is therefore required for this objective.	There is no knowledge required to be gathered within the social event of kaizen costing at this stage. Idealism is not needed.	The positivist stand in this study is not necessary because this objective needs opinions in terms of interviews from the stakeholders.	Intrepretivism is required for this study because the opinion of key stakeholders were required for the validation of the framework	The adopted positions of realism and positivism dictate the axiological stand. A value-laden position is therefore required. .	The objective does not demand the input of the researcher in the framework development process. The value-laden stand cannot be adopted.

Table 7 above justifies each philosophical stand for each objective based on the interpretation of each objective in relation to the philosophical stands.

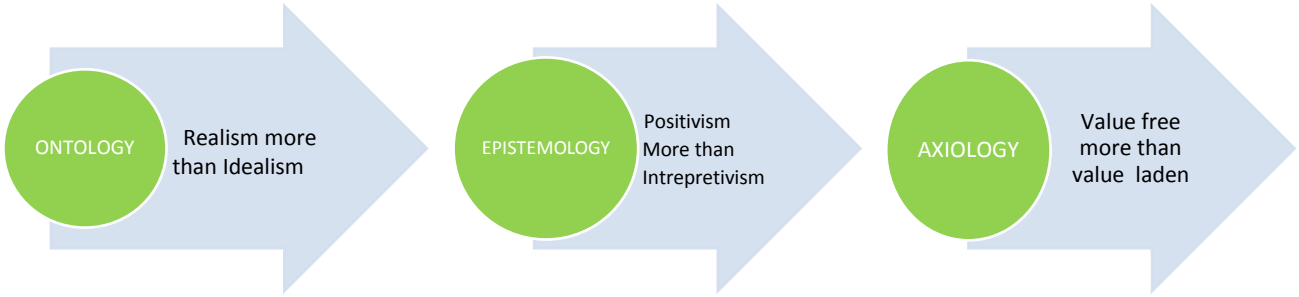

Figure 3.3. Research philosophy choice for this study

The overall choice of research philosophy for the study is summarised in the illustration above. This is based on the research philosophical stands for each of the objectives. In summary, the study is more of realism than idealism; positivisms than interpretivism; value free than value-laden.

Initially, this study seems to be more of intrepretivism because of the limited literature which would be required to resolve the objectives. However, having identified the research philosophical positions for the research objectives, the stands in figure 3.3 justifies the study. This would also affect the research approach other sections of the study such as strategy techniques and methods.

The first step for the research methodology framework has been defined through the philosophical stands in figure 3.3. The direction for the research approach will be based on these philosophical stands. The next research onion layer is the research approach.

3.3 The research approach

The research approach is the second layer of the research onion. Research approach pertains to the activities which will be carried out in order for the investigator to achieve the research aims and objectives (Easterby-Smith et al., 2008). Saunders et al. (2015) opined that research approaches are based on research philosophies. The research approach can be ***deductive*** or ***inductive***. The inductive approach is based on interpretivism while the deductive approach is more of positivism when considered from the epistemological perspective. The deductive approach views a research from a broader perspective to the main specific unit of investigation. Losee (1993) noted that the method of reasoning in deductive approach involves the creation

of concepts or theories which are then tested via observation. Inductive approach is the direct opposite of deductive approach. Inductive approach is more flexible compared to deductive approach because it is subjective and allows the researcher to observe, create a hypothesis which is established as theories (Mertens, 2008). This study will make use of both deductive and inductive approaches; this is combination is known as the abductive (Levin-Rozalis, 2004). The deductive approach will involve literature review and data collection process to identify the critical success factors for the theoretical framework development. Due to inadequate literature about kaizen philosophy and kaizen costing in the construction industry, the inductive approach will be required to build up theories. Thus the ***abductive approach*** is the overall approach for this research. The research approach has been defined for this study as being abductive; this is also linked to the research philosophy in table 3.1. The next layer of the research onion is the research strategy.

3.4 The research strategy

The third layer of the research onion is research strategy. The research strategy pertains to the structural process of collecting and analysing data. Hence, surveys, case study, archival analysis, ethnography, action research, field research, game or role playing are examples of research (Wisker, 2009). These strategies have their strengths and weaknesses; however, the choice of a research strategy depends on the research aim, objectives and questions.
The sensitivity of the research strategies will be by the research objectives have to be analysed. The various research strategies will be discussed in the sections below.

Table 3.2. Comparing the different types of research strategies which can be used for this study

Research strategy	Appropriateness for the study
Surveys	Surveys are used to collect data from a large population. The survey is not only a data collection technique but involves questionnaires and in-depth interviews, content analysis, observation and so on (De Vaus, 2013). This will be suitable for this study because of some objectives which will require gathering a large amount of data which cut across various professions. For this study surveys will be quantitative and qualitative.

Action research	Action research involves experiments which are out of the laboratory or a controlled environment; they are practical forms of research will involve a lot of field work. Action research involves the use of controlled group for data collection (Saunders et al., 2015). This method will not suit any of the research objectives because of the cross-sectional nature of the research and the scope of the study.
Experiment	Experiments will have to be carried out in a controlled environment with a controlled group. This study will not make use of experiments because the researcher's objectives involve are a form of social science research. Experiments are usually used for pure sciences.
Case study	Case study research can be quantitative or qualitative in nature. This form of research seeks to generate answers to questions such as 'what', 'why' and 'how' (Yin, 2009). This research strategy will suitable for some of the research questions and objectives. However, this part will be conducted using survey interviews for simplicity. Case study research can be longitudinal or cross-sectional making using of interviews as research instruments.
Literature review	A literature review as a form of research strategy could be content analysis, word, count, narrative analysis, taxonomy analysis, qualitative comparative analysis and so on (Onwuegbuzie et al., 2012) . Some of the research objectives will be resolved from the content of the literature review in this study.

The different research strategies, which have been highlighted in table 3.2 has analysed the strengths of the research strategies and its appropriateness to answer the research questions and objectives. The main strategies which have been selected are literature review and surveys. The choice of research strategy is also justified based on the nature of the research approach which is abductive and the philosophical stands for the study. The position of the research strategy is related to the philosophical stands from the table 3.1 and figure 3.3. Since the study is abductive and it combines the use of interview and a form quantitative investigation. The survey research strategy will fit into the choice of research philosophy and approach**.**

Further justification for the research strategy for this study is based on the type of strategy adopted by the researchers in the area of kaizen, kaizen costing and continuous improvement implementation. This will be discussed in the next sub-section.

3.4.1 Justification for survey strategy over other strategies

Based on existing research on continuous improvement, kaizen and kaizen costing in sectors such as automobile manufacturing, agriculture, education and construction, case study strategy has been adopted (Barber et al., 2006, Brunet and New, 2003, Crocitto, 2015, Emiliani, 2001, Emiliani, 2005, Fang and Kleiner, 2003, Giaretta, 2005, Heavey et al., 2014, Hwang and Staley, 2005, Jin and Doolen, 2014). The case study approach has been widely used for research in areas to investigate the concept of kaizen where they are existing. For instance, Brunet and New (2003) used a case study to assess the presence of kaizen in a number of selected companies in Japan. Case study for implementation kaizen has not been considered by (Barber et al., 2006, Brunet and New, 2003, Crocitto, 2015, Emiliani, 2001, Emiliani, 2005, Fang and Kleiner, 2003, Giaretta, 2005, Heavey et al., 2014, Hwang and Staley, 2005, Jin and Doolen, 2014). In implementing a new method such as kaizen, interviews and questionnaires are essential to obtain attitudinal perceptions towards change and usefulness. Furthermore, there is an existing kaizen or continuous improvement process in most studies related to kaizen which adopted case study. Most of the studies which adopt case study are exploratory sought after questions such as "what", "why" and "how" (Yin, 2014). Action research was used by Vivan et al. (2015) to create a kaizen model for building construction. Vivan et al. (2015) adopted this approach because of the longitudinal timeline of the study and the scope of research. This research has a shorter timeline based on the scope which is an adaptation of kaizen for process improvement of post-contract cost control.

The larger population in Lagos, Nigeria was targeted for the right amount of perception towards kaizen and kaizen costing. Kaizen ad kaizen costing concept is still new, and it was introduced with the English term "continuous improvement". The question being asked in the research objectives deals with introducing new concepts. Interviews were used to investigate the perception of SMSCC in Lagos, Nigeria towards a new concept such as continuous improvement (kaizen). Although, mutually exclusive questions such as "Yes" and "No" were used in the survey questionnaire, the purpose of the strategy was to gather sufficient data for a robust analysis via triangulation. Further justifications of survey strategy for this study will be discussed in the next sub-section.

3.4.2 Survey research strategy

The survey can be a form of quantitative or qualitative research which involves questionnaire distribution and interviewing respondents (De Vaus, 2013). The main features of the survey are evident in the type of data collected and the approach employed in analysing the data (De Vaus, 2013). Therefore, surveys can be used for quantitative and qualitative data analysis. Since, survey can be qualitative, interviews can also be used as a form of form. Some researchers might view surveys are a method of data collection. Sapsford and Jupp (2006) stated that survey is meticulous and can be quantified. It also gives details about a population. Surveys targets a larger population compared to focus groups and case studies. Survey are not only about quantitative data but interviews collected from the respondents.

In this study, the interview survey was carried out among the same population for the questionnaire survey. The research objectives which used the survey strategy will be discussed in section 3.4.3.The research strategy is based on the findings of the literature review in section two. A literature review has provided an opportunity for the research to evaluate the present articles which will be used for the survey interviews and questionnaire.

3.4.3 Literature review synthesis

A literature review is a very vital step in any research. This is the selection of available documents which can be published or unpublished materials, which are related to the topic. These documents contain data, evidence, facts and research carried out by various authors (Hart, 1998). The purpose of a literature review is to identify the gaps within a particular field of study. For empirical research, this assists in developing research questions and proffering appropriate solutions (Eisenhardt and Graebner, 2007). According to Saunders et al. (2015), the literature review aspect helps the researcher develop ideas from existing knowledge and research. This was used to create a strong aim and objective of the study. The concept of synthesising literature is to create a very robust argument about the justification for the research and identify basic challenges which might also influence the research problems based on other investigations by various academics. Gill and Johnson (2010) argued that the drawback of the literature review is that the research can focus on the descriptive aspect of various articles rather than critique the narratives quality, strength and source of data. This investigation did a critique of the existing cost management system and identified various gaps within the post-contract cost control techniques.

In this study, the post-contract cost control techniques were synthesised using literature review (refer to section 2, table 2.1). The critical success factors required for the implementation of kaizen costing and cost reduction in SMSCC were identified from existing articles (refer to section 2.9, table 2.5) . Literature review synthesis also enables the researcher to design research instruments such as questionnaires and interview questions. The design of the research instruments was based on the type of research objectives. Table 3.3 below highlights the type of research strategy implemented for each objective in this study.

Table 3.3. The research strategy and purpose adopted for each research objectives and questions

S/N	**Research Objectives**	**Purpose**	**Research strategy adopted**
1	To identify and evaluate the general post-contract cost control techniques used in the construction industry.	To have a general comparative basis for analysis the second objective. This will give a general overview of what is happening in other construction industries around the world	Literature review
2.	To identify and evaluate the methods used in post-contract cost control management in small and medium scale construction companies in Lagos, Nigeria.	This will help identify the problems in the post-contract cost control and how kaizen costing can be used to solve the problems.	Literature review, Survey (Quantitative and qualitative)
3	To identify and evaluate the critical post-contract cost controlling activities for incremental cost reduction in small and medium scale construction companies in Nigeria.	The important activities which are required for cost reduction has to be identified in order to build a framework	Literature review, Survey (Quantitative)
4	To identify and evaluate the critical success factors of adopting kaizen costing in construction companies in Lagos, Nigeria.	This will look at the enablers and barriers of kaizen costing in Nigeria. This will further identify the problems in the post-contract cost control system and also help in structuring the framework.	Literature review, Survey (Quantitative)

5	To develop and validate a framework based on kaizen philosophy and kaizen costing which can be integrated into the post-contract cost control practices in small and medium scale construction companies in Nigeria	This framework will be developed for industry validation. Expert interviews from the construction industry professionals particularly Quantity Surveyors will be required. This is also required to reduce cost during construction activities.	Survey (Interview)

Table 3.3 highlighted the selected strategy for each objective; this is a process designed from the beginning using research philosophy. The research methodology made use of the research onion which has the research philosophy, approach and strategy for the first three layers. The next layer of the research onion is the research choice.

3.5 The research choice

According to Saunders et al. (2015) the research choice which is the fourth later in the research onion can be mono-method (has only one method such as quantitative for data collection and analysis), multi-method (combines qualitative and quantitative but used at different stages of the research) and mixed method (qualitative and quantitative used at the same time). This is a sequential mixed method approach having the qualitative interview as a form of validation for the quantitative survey. The sequential mixed method approach for the study has also been used because it was easier for the respondents to fill the questionnaire compared to the interviews by the contractors.

Mixed method research is a combination of qualitative and quantitative research methods. Amaratunga et al. (2002) opined that mixed method allows the weaknesses of each method (qualitative and quantitative) to be complemented by the strengths of the other. Amaratunga et al. (2002) added that mixed method which is also known as the broad approach is imperative for having an introspective overview of research. The single methodology of qualitative or quantitative can have its demerits impacted on the research, however when combined the results of the investigation will be more insightful. Clark and Creswell (2008) and Saunders et

al. (2015) noted that the concepts of quantitative and qualitative methods in the mixed method should be seen as a form of complementary approach. The mixed method approach was more of realism than idealism. The choice of mixed method approach is linked to section 3.4.1 where the survey research strategy has been selected. The survey research strategy is a mixture of interviews (qualitative) and questionnaire (quantitative). Therefore, the mixed method has been defined by the philosophical stands in table 3.1, the abductive approach and the survey strategy.

The fifth layer of the research onion is the time horizon. The time horizon has to be discussed because of the choices made from the research philosophy to the research method.

3.6 Time horizon

According to Saunders et al. (2015), research problems which are address as a snapshot of the phenomenon at a particular time are described as cross-sectional, while a series of events during the research over a period is longitudinal. Surveys and case studies (shorter period), while longitudinal utilised research strategies such as action research, grounded theory, archival research, case studies (longer period) and experiments (Saunders et al. 2015). This study adopted the cross-sectional time horizon because of the choice of time frame for the data collection and research strategy.

The research technique is the sixth layer of the onion. This is the inner and final core of the research onion in figure 3.1. The research onion by Saunders et al. (2015) presented the data collection, analysis, sampling and questionnaire design as a combination of the techniques. The subsequent sub-sections have addressed the research sampling techniques, questionnaire design and data collection for the study. The method of analysing each research objectives are also discussed.

3.7 Research Techniques

Research techniques in this section look at data collection and analysis. The data collection includes interviews, surveys, questionnaire design, pilot study and research sampling. The statistical tests used for the data collected provided an opportunity for the framework design and validation.

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3.7.1 Semi-structured interviews

This study adopted the mixed method approach, and this will involve a qualitative method of data collection. This research utilised qualitative methods for some of the research objectives. In qualitative research in-depth interview is the foundation of a successful investigation (Easterby-Smith et al., 2008). Easterby-Smith et al., (2008) further stated that semi-structured interviews due to its flexibility, allows the respondents to give more detailed answers compared to other methods such as questionnaires.

Semi-structured interviews allow the respondents to give organised answers to certain questions related to the social event. In this case, kaizen or continuous improvement will be focused on. Strauss and Corbin (1998) noted that interview questions could be based on gaps and questions raised during the literature review. Semi-structured questions designed for data collection in this study for objectives three and four and based on are based on literature review. The contractors who are the owners of SMSCC in Lagos Nigeria were interviewed. The interview process provided an opportunity for the contractors to express their opinion towards continuous improvement, change management and organisational policies towards post-contract cost controlling techniques. Appendix C, contains the structure of the interview questions for the study. Having concluded the survey questionnaire design as a five-point Likert scale as stated in appendix D and the semi-structure interview design in appendix C, the analysis of the data will require statistical tests for each of the objectives. The type of tests depends on the nature of the research strategy, data and objective.

3.7.2 Survey questionnaire design

This study makes use of survey questionnaires and semi-structured interview questions designed for a one-on-one contact with the participants. The questionnaire design is usually based on the type or respondents. Therefore, the response format is vital. De Vaus, (2013) noted that the response format of a questionnaire could be designed to be exhaustive, exclusive, non-exclusive, balanced or unbalanced, ranking based, numerical rating scale (this includes Likert scale, vertical rating ladder, Semantic differential or horizontal), binary choice format, multiple choice format, non-committal (multiple attitude statement and numerical response format); respondent initiated; social desirability and acquiescent response sets. De Vaus (2013) further

noted that the questionnaire layout could influence the answering procedure and the participants' time.

This research adopted the five-point Likert scale because some of the research objectives and questions seek to understand the attitudes and opinions of quantity surveyors towards change, traditional methods used in post-contract cost control and kaizen costing in construction (refer to appendix D, section C). The 5 point Likert scale is also used for objective two and five. This is used for rating the various techniques or critical success factors to a level of agreement. One hundred and thirty-five (135) questionnaires were received out of two hundred and fifty (250) questionnaires sent out.

The survey questionnaire has been designed, the interview questions based on the survey strategy and research sampling technique was designed based on the literature review in section 2.

3.7.3 Pilot study for the research

Pilot study pertains to testing the questions with few participants before the questionnaires are sent out to the field. De Vaus (2013), noted that in order to avoid any misunderstanding during the data collection process it is necessary to check the wording, layout and style of writing with few respondents before it is sent out. Pilot study for the questionnaire survey and semi-structured interview questions were carried out with about five respondents. The feedback led to some adjustments in the questionnaire. Some of my colleagues from Nigeria with a background in construction cost management were involved in the pilot study. Irrelevant questions were eliminated from the questionnaire and semi-structured interview questions. This facilitated quicker understanding of response time from the respondents in the field. The pilot study led to the data collection process and analysis.

3.7.4 Research method and analysis

A literature review was used to select the post-contract cost controlling techniques, the crucial activities for incremental cost reduction and also the critical success factors from the literature review. The coding process allows these identified critical success factors and post-contract cost control techniques to be narrowed down to the important one for the analysis.

The interviewees were contacted via LinkedIn and telephone for the interview process. The details of the interview were recorded on an automatic voice recording app on the researcher's smartphone. These audio recordings were transcribed for further qualitative analysis. The coding process for in the interviews has been clarified with the each objective in sections 3.7.7.5.

The NVIVO coding process makes use of nodes which allows themes to be filtered. The coding process in NVIVO is in ascending manner. This process is used for deductive and inductive coding. Coding allows the researcher to make notes which will invariably lead to theory (Richardson and Morse, 2007). Coding was the first approach for the data gathered using questionnaire and interviews. This study adopted the manual qualitative research analysis. The research analysis was based on the survey research strategy.

The survey questionnaire data collection process was carried out by sending the questionnaire through emails. The word document was password protected. The respondents in the various companies were given the password over the telephone, and they were followed up several times. Some of the interviewees who were involved in the interview provided useful contacts for the survey data distribution.

Coding in quantitative analysis allows each variable to be entered for analysis, cross tabulation and testing. The first step of the coding process ensured that each category of the questionnaire was manually inputted into Microsoft Excel before it was imported into SPSS 23. Descriptive statistics and charts were used to present the data. This is because of the questionnaire format which is in the form of binary choice format and Likert scale. SPSS software packages for the quantitative data analysis. The data analysis and style of presentation are discussed for each research objective and questions in the following sub-sections.

3.7.5 The research sample

The main sampling techniques in surveys are non-probabilistic and probabilistic sampling. Non-probabilistic sampling can be typical people, volunteers, purposive sampling, hazard sampling or quota sampling; probabilistic sampling methods are simply random, stratified, systematic, cluster sampling and multistage area sampling (Weisberg, Kronsnick and Bowen, 1996). Walliman (2006) noted that theoretical sampling which is a form of non-probabilistic

sampling targets the population with adequate knowledge and experience. This is a type of purposive sampling. The survey strategy has been selected in section 3.4. Therefore the sampling technique for this study will be based on specific procedure. The sampling procedure for this research under the survey strategy as noted by Creswell and Clark (2007) is summarised in the table below.

Table 3.4. Phases in data collection process for qualitative and quantitative research

Qualitative Data Collection	**Phases in the process of Research**	**Quantitative Data collection**
1. Purposeful sampling 2. Large number of participants	Sampling procedure	1. Random sampling 2. Adequate size to reduce sampling error and provide sufficient power
1. Construction companies 2. Individuals	Permission needed	1. Construction companies. 2. Individuals
1. Open-ended interviews 2. Open-ended 3. Documents 4. Audiovisual materials	Information to be collected	1. Instruments 2. Checklists
1. Interview protocols	Recording the data	1. Instruments with scores that are reliable and valid

In Table 3.4, the data collection procedure is linked to the sampling techniques. Table 3.4 is also related to qualitative and quantitative data collection. The sampling procedure of collecting the data for the studies which have adopted the survey strategy is a purpose for qualitative and random for quantitative. Hence, the choice of sampling technique was related to the type of instruments and interview structure.

3.7.5.1 Purposive sampling

In this study, theoretical or purposive sampling technique for survey interviews provided an advantage for the interviewees to be chosen based on the experience and profession. Eleven (11) contractors from SMSCC in Lagos, Nigeria, were interviewed (please refer to table 3.6

for interviewee information). This was based on accessibility and availability of the interviewee. The respondent population which are mainly quantity surveyors and project managers in Lagos, Nigeria have the right experience and knowledge in the industry for the interviews. The respondents have at least fifteen years of experience in the construction industry and the right qualifications. The drawback of purposive sampling method is that experience and knowledge can be difficult to measure.

3.7.6 Random sampling technique

Random sampling method was adopted for the questionnaire survey. According to Bray and Rees (1995), "*random sampling is defined as one for which each measurement or count in the population has the same chance (probability) of being selected".* The research sample frame in this study is within the Lagos, state ministry of housing. This provides a list of SMSCC in Lagos, Nigeria. However, this list is only an estimated number with the name of the construction companies. The information gathered from the number of SMSCC from Lagos state Ministry of Housing were based on the registration and contact details of the companies. Lagos state, Nigeria was chosen based on the enormous amount of construction activities in the state. In addition to this Lagos generates the one-quarter of Nigeria's GDP due to the economic activities and number of construction companies (Issa et al., 2013 & Dantata , 2008). Eighty-four (84) companies were contacted out of two hundred and fifty (250) which make up 25% of the overall population. There are about one-thousand (1000) SMSCC in Lagos, Nigeria according to the Lagos State Ministry of Housing (Sanni and Durodola, 2012). Sanni and Durodola (2010) also noted that 40% of the population size in its few hundreds is enough as a sample population in research. Erickson and Nosanchuk (2002) observed that sample size depends on the number of subjects the research intends to look at. The author also proposed the formula for sample size as:

$$\frac{\sigma}{\sqrt{N}} = \frac{\sigma}{27.34}; if\ N = 750, SE = \frac{\sigma}{55}$$

The standard error is "SE". Therefore, the square root of the total number is the sample size. However, in order to analyse more details from a large data sample. The sample size will be beyond twenty-seven (27). In this study eighty-four (84) SMSCC were contacted for data collection purposes, this is the company sample size. Two hundred and fifty (250) respondents in these companies were chosen as the broader sample size in order to cover one-third of the population. In addition, the research questions covering post-contract cost control techniques

and critical success factors for the implementation of kaizen costing for post-contract cost control required quantity surveyors and project manager samples within the SMSCC. Overall, two hundred and fifty (250) questionnaires were distributed to the eighty-four (84) companies, but only one hundred and thirty-five (135) were returned. The response rate is 54% and this was achieved by following-up the respondents. The questionnaires which were not filled properly were returned to the respondents for amendments.

The research onion as described the research philosophy, approach, methods, choice of research, time horizon and data collection methods. The research onion provided a guide for the design. The research techniques based the choice of the sampling technique on what is usually used for survey strategy as stated by Creswell and Clark (2007) which is purposive sampling and random sampling techniques.

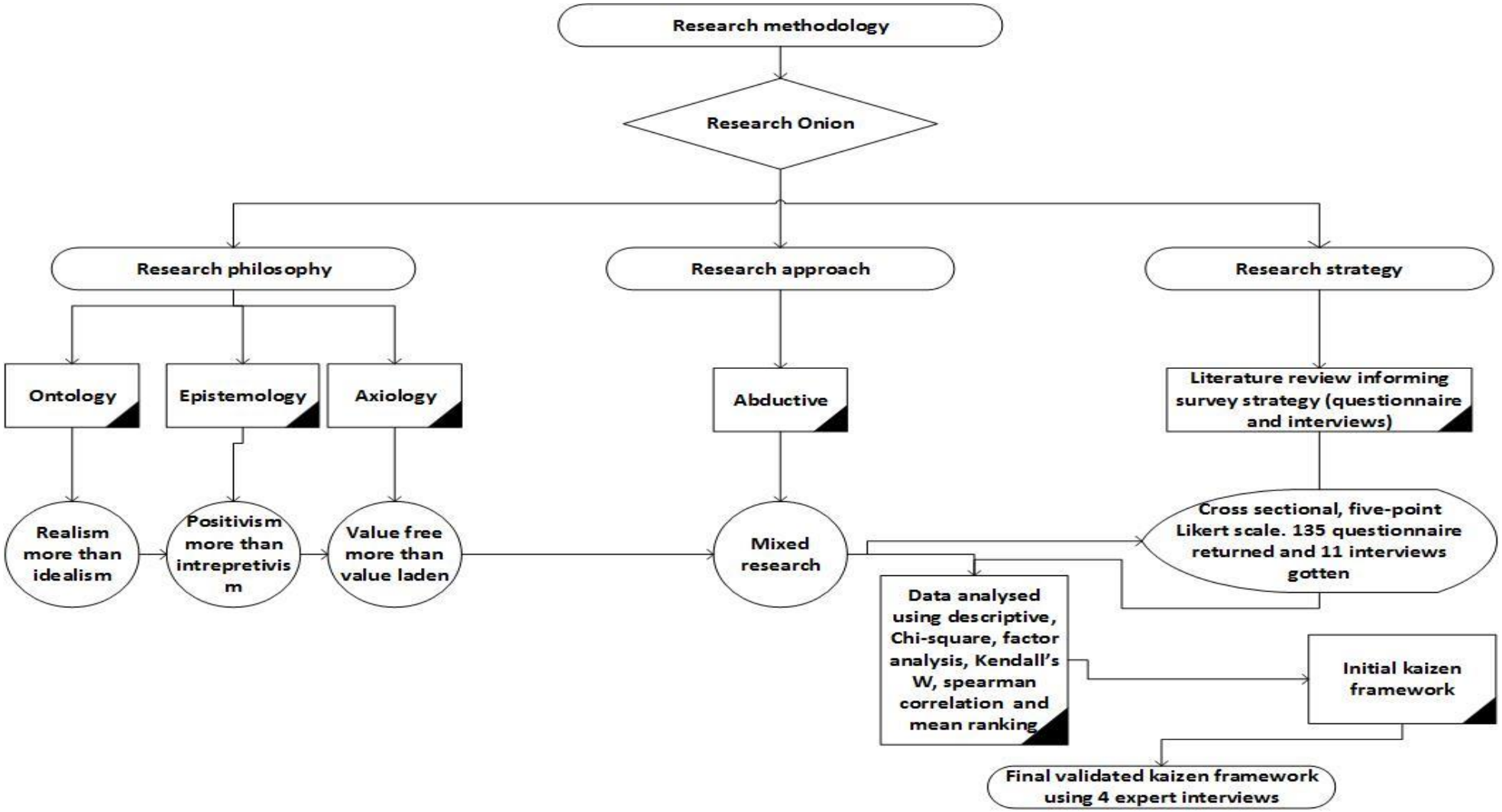


Figure 3.4. Conceptual framework for the research methodology

Figure 3.4 above displays the conceptual research framework for this investigation. This illustrates the steps which were followed in order to achieve some research objective which is to develop a kaizen costing framework for small and medium scale construction companies in Lagos, Nigeria. Data analysis and presentation is a major step in this framework design.

3.7.7 Parametric and non-parametric tests

Data can be categorised into parametric and non-parametric. Parametric data are data derived from assumption laden probabilistic distribution and inferences are made from such distributions, non-parametric data known as assumption free data, and there are fewer assumptions which can be deduced from the data (Field, 2009; Pallant, 2016). The type of tests to conduct for parametric and non-parametric data are different. This is because in any data which is essentially based on ranking involve a non-parametric test. Data which are mutually exclusive with a "YES" or "NO" response are tested non-parametrically because they are nominal variables. In some cases, mutually exclusive data may also be parametric, but for this purpose of this study they are viewed as being non-parametric. The scaled data which have figures to be filled or ticked are tested parametrically. Pallant (2016) provides a list of parametric test and non-parametric test alternatives. This is displayed in the table below.

Table 3.5. Parametric tests and their non-parametric alternatives

Parametric Test	**Non-Parametric Test**
Pearson correlation test	Spearman's correlation test
T-test for independent measure, 2 groups	Mann- Whitney U test
One-Way ANOVA Independent measure,	Kruskal-Wallis test
Paired sample T- test	Wilcoxon test
One way repeated measures ANOVA	Friedman test
None	Chi-square test for goodness of fit
None	Chi-square test for independence
None	Kappa measure of agreement
None	Kendall's coefficient of concordance

The choice of parametric and non-parametric tests displayed above depends on the nature of objectives or research questions. Therefore, this study adopted the required test based on the data collected and the research objectives and questions.

3.7.7.1 Chi-square test for the background of the respondents

Chi Square test was also used for the background of the respondents. The Chi-square test for independence was used to evaluate the perception of the respondents towards change, the usefulness of post-contract cost control templates, stakeholders and other variables in the first section of the questionnaire. According to Argyrous (2005), "*two cases are statistically independent if the classification of cases in terms of one variable is not related to the classification of those cases in terms of the other variable*". Therefore, the two variables will be evaluated for their significance. The Phi and Cramer's V values were used to evaluate the strength of the relationship between the variables. Cross tabulation of the two variables in terms of the observed count for cost and project managers' perspectives provided two perspectives to for the analysis.

The background of the respondents provided an overview of what the respondent's company entails, how the respondents will respond to change and the perception towards the continuous improvement. Based on the findings of the background of the respondents, each of the research objectives was analysed with the relevant statistical or qualitative mechanisms.

3.7.7.2 Data analysis for the first objective

The first objective which involves identifying post-contract cost control techniques used in the construction industry is based on literature synthesis. This is because there are available documents on various post-contract cost control techniques used in the construction industry. Literature review synthesis was used for this objective. The analysis will be based on the content of the document, aimed at identifying all available techniques used in post-contract cost management during construction. The purpose of this objective is to identify the kinds of techniques used on a global level (please refer to table 2.1).

3.7.7.3 Data analysis for the second objective

The second objective involves identifying and evaluating the post-contract cost control, techniques used in the Nigerian construction industry. This method involves a mixed approach of qualitative and quantitative analysis. The survey strategy utilised semi-structured interviews to identify the various post-contract cost control techniques used in SMSCC in Lagos, Nigeria. The interviewees' background has been expatiated in section 3.7.7.5. The background of the interviewees provided an idea of how they would evaluate the present post-contract cost controlling techniques used in their construction companies. These techniques are documented as part of a survey questionnaire that used the Likert scale to rate their level of effectiveness and importance. The Kendall W test was used to rank these post-contract cost control techniques afterwards. Kendall W test is a non-parametric test.

According to Legendre (2005), "*Kendall's coefficient of concordance (W), is a measure of the agreement among several (p) judges who are assessing a given set of n objects".* This test evaluated the degree of similarity between two sets of ranks for the same set of variables. This rank was compared each variable as a pair in order to rank the most important variable. Mehta and Patel (2012) noted that Kendal W test is a scaled Friedman's test with the formula:

$$W = \frac{Tf}{N(K-1)}$$

The test produces the p values which are the asymptotic p-value. If the p-value is less than 0.05 this is acceptable. Also Kendall's coefficient of concordance W should also be less than 0.05 for acceptable values (Mehta and Patel, 2012). The ranking produced by Kendall's W coefficient of concordance is a form of measure of association (Mehta and Patel, 2012). The author further noted that Kendall's W is a measure of the degree to which the *K* applicants agree with the *N* judge. This measures the level of effectiveness or importance for the various post-contract cost control techniques which are used by small and medium scale construction companies in Lagos, Nigeria.

3.7.7.4 Data analysis for the third objective

The third objective which is to identify and evaluate the most critical post-contract cost controlling activities for continuous cost reduction needed for kaizen costing in small and medium scale construction companies in Lagos, Nigeria, was analysed using Kendall's W test.

The result was presented as a table. Spearman rho correlation test evaluated the relationship between the post-contract cost controlling activities for the development of the framework. This was used to create a link between the critical activities.

3.7.7.5 Data analysis for the fourth objective: Factor analysis and NVIVO

The fourth objective which involved establishing the critical success factors for kaizen implementation collected data using semi-structured interviews in SMSCC in Lagos, Nigeria. The content of the interviews was presented as a paragraph text and in table format. This was carried out using NVIVO to link the relationships between the different eleven (11) interviewees. Crowley et al., (2002) explained that the QSR NVIVO qualitative provides an avenue for coding, building theories and text retrieval. Content analysis is also carried out in NVIVO. The purpose of the qualitative interview in this study is to categorise the themes, find out emerging themes from the respondents, develop relationships and models that reflect the respondents' views. This can be carried out manually or with the aid of software packages such as Hyper RESEARCHTM, QSR N6 and NVIVO 10 are some of the options available for qualitative analysis. Saunders et al. (2015) described NVIVO as an easy tool for qualitative analysis. This tool was used for analysis the responses of the semi-structured interviews in this research. An overview of the content analysis process used in NVIVO for interviews is very similar to manual content analysis.

According to Flick (2009), content analysis can be used to qualitatively analyse any document or material in any form. Content analysis was used in this report to build up theory using contextual analysis of the responses displayed in NVIVO 10. Schmidt (2004) highlighted the steps for conducting content analysis as being:

a) Categorization of the materials which will be carried out by reading through the transcribed interview and identifying individual aspects which are related to the investigation.
b) The various categories are compiled as themes for the research objective or question.
c) The compiled themes are broken down into nodes or smaller codes which contain detailed information related to the research objective or questions.
d) This coded information was linked together to form cases.
e) These cases are interpreted to give meaning to the research.

NVIVO 10 follows the same processes highlighted above. The software package follows the process of importing transcribed sources into a folder, coding the associated sentences into nodes, creating relationships and also models. The use of NVIVO 10 for this research objective is the most suitable because NVIVO 10 allows the researcher to query word frequency and analyse the emerging themes in the interview.

The use of NVIVO 10 makes it easy to analyse the presence and understanding of kaizen within small and medium scale construction organisations in Lagos, Nigeria and also identify the type of post-contract cost control techniques used in these companies.

a) Interviewees' background

The NVIVO process of analysing the critical success factors began with data collection involved eleven (11) highly experienced project managers and quantity surveyors having fifteen (15) to twenty-nine years of experience in the construction industry. The respondents also have qualifications ranging from BSc degree to MSc degree in Quantity Surveying and construction or project management. This is summarised in the table below.

Table 3.6. List of Interviewees for the study

Profession	Code	Job Role	Years of experience	Highest Qualification	Project type
Quantity Surveyor	QS1	Managing Director	15	MSc	Building and civil engineering
Project manager/ Architect	PM1	Managing Director	20	BSc	Building and civil engineering construction
Project manager/ Architect	PM2	General Manager	21	BSc	Building construction
Project manager	PM3	Managing Director	15	MSc	Building and airport construction
Quantity Surveyor	QS2	Principal Partner	17	BSc	Building construction

Project manager	PM4	Contractor/Director	25	BSc	Residential housing
Quantity Surveyor	QS3	Principal partner	23	BSc	Building construction
Quantity Surveyor	QS4	Chairman	29	BSc	Building construction
Project Manager	PM5	General manager	19	MSc	Building and residential housing
Quantity Surveyor	QS5	Assistant Director	17	MSc	Building and civil engineering
Quantity Surveyor	QS6	Director	23	BSc	Building and civil engineering

Based on the theoretical sampling approach adopted for the semi-structure interview, the years of experience for each of the respondents is essential. Theoretical sampling enables the researcher to get the required knowledge from the experts. This does not depend on the random larger population but very few experts with in-depth views about the subject. Fifteen years of experience in the construction industry is the least experienced in the pie chart above, and the combined experience for all the respondents is two hundred and twenty-four (224) years. The respondents in Table 3.6 are top executives and principal partners in construction and quantity surveying companies. Some of Quantities Surveying companies in Nigeria work alongside the contractor. Therefore, the principal partners have been interviewed as part of this study. Quantitative data were gathered from the survey and presented in the form of pie charts. The findings were triangulated with these interview responses. The questions for this interview is based on the need for resolving the second and third objectives; the second objective involves identifying and critically reviewing the post-contract cost control techniques used in the Nigerian construction industry, while the second objective looks at identifying. The interviews reached a saturation point when the respondents kept on providing the same feedback. This is attained with the eleventh interviewee.

The fourth objective which is to identify and evaluate the critical success factors of adopting kaizen costing in construction companies in Lagos, Nigeria will be resolved by first identifying the individual critical success factors in the literature review before it is rated by respondents in a survey questionnaire. The critical success factors were extracted from the literature review in chapter 2. They were classified for data collection purposes. The factors were analysed using factor analysis.

b) Factor analysis

According to Cornish (2007), factor analysis is a data reduction through the multivariate method. Pallant (2016) also supported this by noting that factor analysis is a combination of various factors techniques with steps for reduction of the principal components. The author further advised that principal component analysis and factor analysis are distinct. Both approaches use the correlation pattern to produce a smaller number of linear combinations. Yong and Pearce (2013) stated that the main purpose of factor analysis is to provide a structured pattern, which makes it easier for the researcher to understand the logic behind the relationship. The author also stated that factor analysis could be used for exploratory factor analysis and confirmatory factor analysis. For this study, it was an exploratory factor analysis. The critical success factors for the fourth objective were identified using literature synthesis in chapter 2, and the drivers were listed out and categorised. The categorisation does not provide the critical success factors for the implementation of kaizen costing but only classified the drivers for the respondents to answer the questionnaires. The process of factor analysis starts with the validity of the cases. There are only one hundred and thirty-five cases in this study. According to Pallant (2016), 150 cases is the benchmark. However, smaller samples can be considered if the solutions have high loading marker variables above 0.80. Stevens (1996) and Bartlett (1954) as cited by as cited by Pallant (2016) opined that smaller samples with the good reliability of factor structures and the Kaiser-Mayer-Olkin (KMO) measure of sampling adequacy would have an index of 0.6 for a good analysis. If the KMO is less than 0.6, there will not be a good factor analysis. Therefore, some variables were be reduced. The reduction process starts with the reliability of data with KMO. The principal component factor extractor was used for this study; this considers the best factors which reflect the comparison of the variables (Pallant, 2016). Other types of factor analysis extraction are principal factors, image factoring, maximum likelihood factoring, alpha factoring, unweighted least squares and generalised least squares.

The extraction process is followed by the decision making which can be based on kaizer's criterion, parallel analysis and scree plot (Field, 2009). The scree plot was used for this investigation. The scree plot displays the eigenvalues of the factors. The factors above the elbow were retained. The factor rotation and interpretation was determined after the number of factors has been decided. This presents the pattern of loadings for easier interpretation.

3.7.7.6 Data analysis for the fifth objective

The framework in social science research has been described as a list of guidelines, things to do, frameworks are usually in forms of graphical representation and diagrams (Jahre et al. 2016; Chay et al. 2015; Hagberg et al. 2016; Soni & Kodali 2016). Frameworks are designed to provide useful information to the end-user on how things can be done. Some frameworks can be a combination of models and which can be combined to produce an overall framework. The framework development process for the entire study is the last objective for kaizen costing framework for SMSCC. The process involved three modelling techniques. The three models are required for the three sections of the research objectives. The first section is the post-contract cost control, the second is kaizen activities, and the final is kaizen and kaizen costing implementation. The modelling techniques are business process model and notation; capability maturity model; and IDEF0. These three models were chosen based on their relationship with continuous improvement. In strategically improving the post-contract cost control process in construction, certain models such as capability maturity, process improvements such as IDEF0 and BPMN have been used for process improvement (Johannsen et al., 2014; Keraminiyage, Amaratunga, and Haigh, 2005; & Veis et al., 2009). Other models such IDEF1 and IDEF2 to 10 are used for information modelling. IDEF0, BPMN and CMM present the best options for designing a kaizen framework for SMSCC in Nigeria. The various stages for kaizen costing for post-contract cost control management in SMSCC in Nigeria were amplified using these modelling techniques. The combination of the models provided the framework. These models are explained in the next sub-sections.

a) Business process model and notation

Business process model and notation (BPMN) utilises standard business process diagrams (BPD) to represent the processes involved in business. Business process model and notation (BPMN) was developed by an industry association known as BPMN. Org (Recker, 2010). This

group is only a collection of a Notations without end-user. (Johannsen et al., 2014, Recker, 2010). BPMN is used for improving business processes (Johannsen et al., 2014). The process diagrams are represented as graphical notations similar to the function flowchart procedure. BPMN does not only identifies the processes involved in the business but also the stakeholders. BPMN is a modelling tool. It is available on Microsoft visio. Although, there is a specialised software for BPMN, the core concept of modelling the business process is the same. It provides execution languages and graphics for business administrators. This allows the business process to be viewed from a clearer perspective for improvement and execution purposes.

The construction business is not so different from any other business. Therefore, there has to be a process modelled for the construction business. The purpose of using BPMN in this investigation is to allow design a model for implementing kaizen philosophy in the workplace. The kaizen hypothetical model in the workplace is relevant for possible future implementation by the management of SMSCC, in this instance, the contractors. The BPMN models for kaizen was designed in the SMSCC workplace. In addition, the purpose of BPMN in this investigation is to link other models to it to form a framework. The symbols for BPMN are presented in the illustrations below.

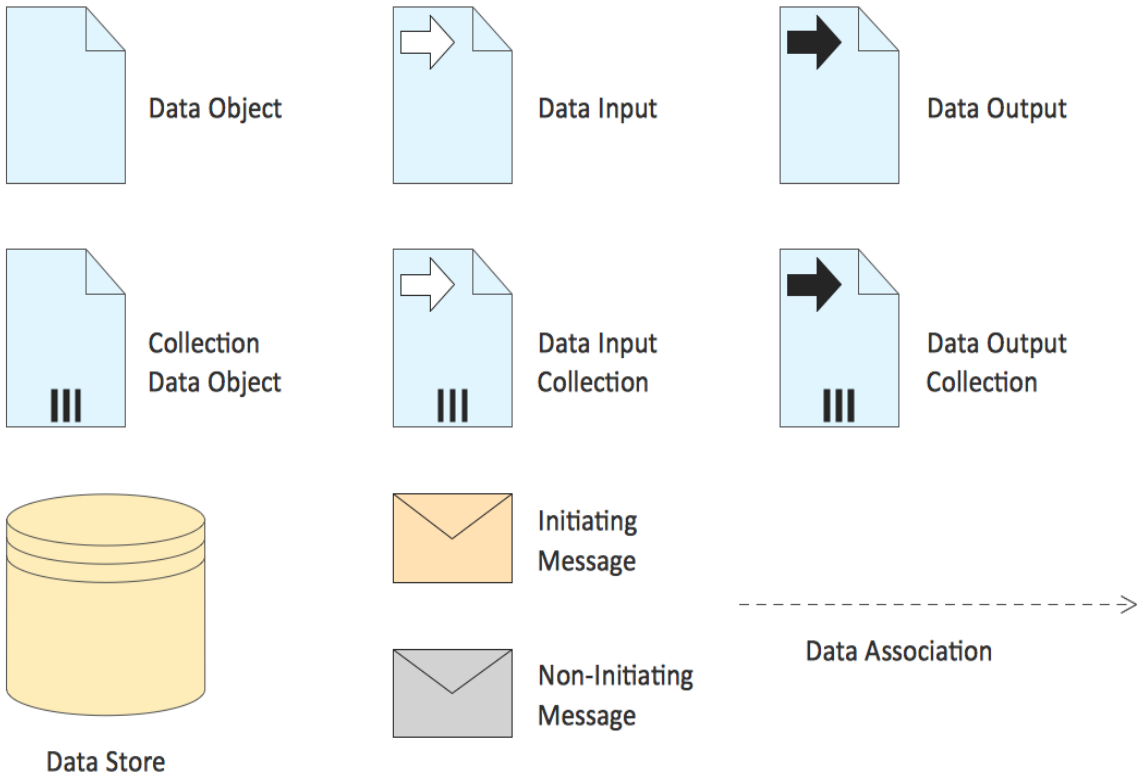


Figure 3.5. BPMN symbols (Conceptdraw, 2016)

The symbols range from the data object, input and output, which is used to denote the information which can be communicated with other stakeholders. The data storage can be a computer system or any form of physical or electronic storage. Message symbol which is an envelope denotes the important information which is passed to other stakeholders in the business. The arrows also indicate the type of association and direction of information flow within the business. BPMN was combined with other forms of modelling techniques such as capability maturity model and IDEF0 for the framework development.

b) Capability maturity model

According to Narasimhan (2001), Capability maturity model (CMM) was developed by the Software Engineering Institute (SEI). Narasimhan (2001) further stated that it is used for process improvement in the software industry. CMM is used for process improvement in the software development industry. Although, the construction industry has attempted to adopt this process improvement technique the challenges of adopting is based on the cost implications (Keraminiyage, Amaratunga, and Haigh, 2005). The Structured process improved of construction enterprises (SPICE) was a research which started at the University of Salford in 1998 to address the Egan, and Latham reports of 1998 and 1994 respectively. The five levels of CMM are:

1) Level 1, initial or chaotic
2) Level 2, planned or tracked
3) Level 3, Good practice sharing
4) Level 4, Quantitatively controlled
5) Level 5, continuously improving.

The existing maturity modes such as business Intelligence and corporate performance management do not have the evolutionary stages as CMM (Aho, 2103). The essence of CMM in this study is for stakeholders involved in construction cost management to understand the various levels of maturity in SMSCC. Each of these levels in reflects the current situation of SMSCC in Nigeria. Furthermore, the model provides a good overview of how SMSCC can improve using kaizen and kaizen costing. This model is very important for the development of the framework.

The level, 1 which is initial or chaotic, is characterised by a lot of management issues and set-backs (Sun et al. 2009; and Weber et al., 1993). At this stage, the focus is about the detail of standardisation in terms of template, organisation, knowledge management, organisational learning, motivation and strategic planning for future projects (Sarshar et al., 2002). Most construction organisations at this level have been characterised to be small and medium in nature. The commonalities in SMSCC are the aforementioned challenges. Furthermore, the initial level is also seem as the immature stage, where the SMSCC roughly predicts project costs with very poor cost planning and post-contract cost management activities (Sarshar et al., 2002; Weber et al., 1993). The final quality of the buildings constructed are of low quality, clients are unsatisfied and the employees are usually demotivated.

The repeatable stage is the second level. This is also known as planned or tracked (Aho 2013; Sun et al., 2009). Within SMSCC, most challenge faced here is digitisation and learning from the unorganised phase. The critical success factors for developing the organisation has to be determined. New policies are formed for reorganising the construction cost management system in place (Weber et al., 1993). At this repeatable phase, the organisation is developed to the point of knowledge management to a considerable extent. This process takes a lot of planning and re-organisation. The organisation needs a stable project management model for effective project delivery. Key performance indicators are also issued out to the employees in order to monitor their performance.

The next level is the defined or good practice sharing. The level 3, has a defined organisation process, which is implemented and monitored (Weber et al., 1993). The organisation has to develop training programmes at this stage (Sun et al., 2009; and Aho, 2013). The training programmes in SMSCC may be part of the incurred cost, but it raises the standard of operations within the organisation. The relevant technology in the field of construction cost management should be introduced at this stage. Additional, co-ordination of activities within the company should involve every employee. Hence, peer review is required to enhance the knowledge level of the employees. Employees are trained to retrain other employees.

The management or quantitate level is the fourth level before the final optimisation stage for continuous improvement (Aho, 2013; Sarshar et al., 2002). This level makes use of quantitatively controlled activities to enhance the delivery of construction projects within

SMSCC. Hence, site office and post-project review meeting are common. Historical cost data from previous construction projects will create an opportunity for organisational learning.

The optimised or continuous improvement level is the fifth level which has the bedrock for continuously improving the organisation (Sun et al., 2009; Weber et al., 1993). The feature of this stage is continuous improvement of all process and change management. Change management is a main characteristic of the optimised level (Aho 2013; Sarshar et al. 2002). The changes are rapid and incremental. The incremental process will necessitate quantitative analysis of the previous projects and the identification of waste production activities at regular intervals. All employees of the organisation has to involve in this change management process. Therefore, there has to be effective communication and relationship management between the employer and the employees.

c) ICAM Definition for Function Modelling zero (IDEF0)

This model involves the evaluation of post-contract cost controlling techniques. It was modelled with kaizen costing using using Icam definition for function modelling (IDEF0), Where the ICAM is an acronym for integrated computer-aided manufacturing (Veis et al., 2009). IDEF0 is similar to Gantt chart, network diagram. However, IDEF0 allows professionals view complex processes from a more simplified perspective (Veis et al., 2009). IDEF0 is mainly used for business process re-engineering, production planning and control, integrated product development, just-in-time and construction process improvement (Mayer et al., 1992, Soung-Hie and Ki-Jin, 2000, Veis et al., 2009). Basically, IDEF0 is used to organise workflows in a more logical and simplified manner to create a model of activities. This model is embedded in a framework which is used generally to improve the business process. The basic components of IDEF0 are the input control, mechanism, function and output (Hirao et al., 2008, Imran et al., 2010). This is illustrated below.

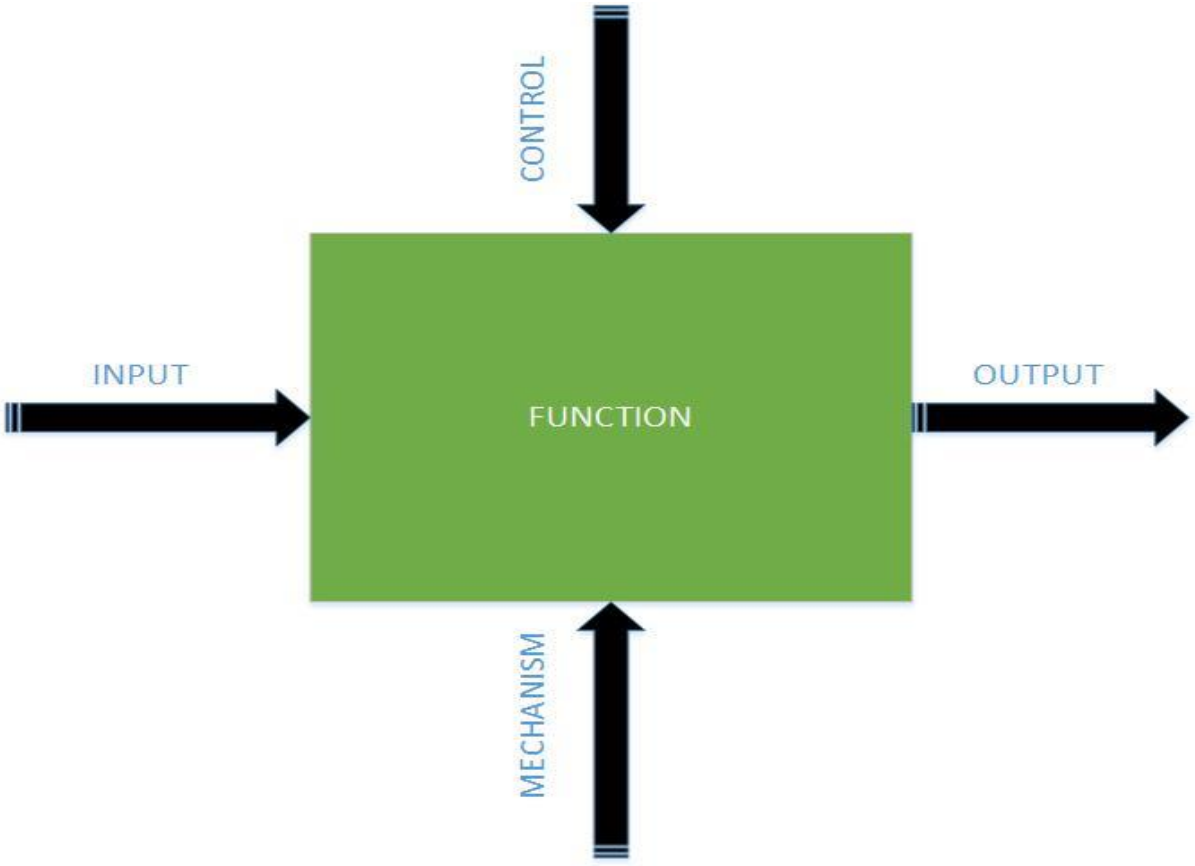


Figure 3.6. The IDEF0 process, derived from Soung-Hie and Ki-Jin (2000)

According to Soung-Hie and Ki-Jin (2000), the IDEF0 illustration above the function is the activity which will be carried out, the inputs are factors which the activities can alter. The control is external constraints which can impede the success of the activities while the mechanism is the tool or means to fulfil the activity. The output is the result of the activity. To represent the framework in this study, the IDEF0 is decomposed into various activity groups. However, this depends on the section of construction activity during the validation phase of this study.

The framework was developed using BPMN, IIDEF0 and CMM. The process of validating the framework was based on the opinions of experts in SMSCC in Lagos, Nigeria.

3.7.7.7 Framework validation

This section is also part of the fifth objective which is framework development for kaizen costing in SMSCC in Nigeria. The framework designed based on the output data analysis as described in section 3.7.7.1 to 3.7.6 was validated using five expert opinions from contractors.

The choice of four expert opinions is based on the purposive sampling technique from section 3.7.1. The experts with the right experience in the right profession fitting the scope of the study in section 1.3 were required to provide their opinion on the framework. The findings of the experts were used to modify the framework for the final framework.

3.7.8 Triangulation of data analysis

Triangulation of data involves combining the analysis of qualitative and quantitative data. When there are two types of data (qualitative and quantitative) available for a particular objective, triangulation is necessary (Ingram, 2002). Triangulation of data strengthens the validity of research (Gibson and Brown, 2009). Yin (2003) noted that the purpose of triangulation is convergence and completeness. This creates a robust argument for a particular objective. For this study, triangulation will be employed for the second and fourth objectives. The fourth objective which involves the critical success factors for implementing kaizen in Nigerian SMSCC, looked at content analysis through NVIVO from eleven (11) respondents and also feedback from one hundred and thirty-five (135) respondents. This provides a diverse perspective for the analysis. The triangulation for this study involves methodological triangulation, source triangulation and discipline triangulation. The triangulation procedure as highlighted by Yin (2003) and Saunders et al. (2015) are explained below.

Table 3.7. Triangulation methods used in the study

Type of triangulation	Description	Approach
Methodological	Data collection	Data from Semi-structured interviews and questionnaire were compared
	Data analysis	Comparing findings from NVIVO content analysis to statistical tests from SPSS 23
Source	Perspective/Origin	Data was obtained from experts in the areas of cost and project management. Contractors with over

		fifteen-year experience in the industry were considered.
Discipline	Discussion	Comparison of existing literature, which has been reviewed, with the results of the content analysis and tests.

This study has used a mixed method approach. Therefore, the methodological triangulation made use of the findings of the interview and the questionnaire. This was used for the research objective relating to evaluating the post-contract cost controlling techniques in Nigeria and also identifying and assessing the presence of kaizen in SMSCC in Nigeria. The interview source was obtained from professionals who have a minimum of fifteen years of experience in the industry. Contractors cost and project managers were identified as the major contributors to the perception of adding a new method and technique for post-contract cost control. The final comparison through literature was carried out in the discussion of framework development and validation section of the chapter. This allowed for triangulation between existing literature and the findings of this study.

From the triangulation of the study which has discussed in section 3.7.8 above to the data analysis and techniques used for data collection. The research methodology has provided the useful design and framework structure. However, the validity and reliability of the study are crucial. The next sub-sections addressed the research validity and reliability.

3.8 Research Validity

Field (2009) noted that "*validity refer to whether an instrument measures what it was designed to measure*". The design of the questionnaire and semi-structure interview questions depends on has to be tailored to the perspective of the sample population and size. The nature of validity as stated by Field (2009) can be criterion validity, which depends on the existing phenomenon, or situation or content validity when the design of the research instruments fulfils the requirement for data collection. In this study, the use of pilot study has helped in assessing the validity of research instruments. Also, the design of the questionnaires includes a brief explanation of kaizen and a participant information sheet detailing the required information to fill the questionnaire. Reliability pertains to the acquisition of the best result under different

conditions (Field, 2009). In addition, Saunders et al. (2015) opined that in other to enhance the validity and reliability of a study mixed method approach is vital. This justifies the choice of mixed method approach for this investigation. Triangulation of data, which involve the mixed method approach, was used for objectives two and three. In order to ensure the validity and reliability of the data collected, planning the research design from the onset is very vital. Four (4) expert interviews were conducted for validating the Kaizen costing framework. This pointed out the errors and omissions. The various types of validity will be explained in detail in relation to this investigation.

3.8.1 Criterion-related validity

According to Drost (2011), criterion-related validity is a form of predictive validity. This is also the degree of the relationship between a test measure and another criterion; this is usually evaluated using correlation. This implies that the outcome of a survey can be compared with other existing records to ensure that it is correct. In this instance, some of the details the cost and project managers provided were corroborated with what the employers provided in the interview sessions. Furthermore, the quantitative data provided by the respondents was an indication of what is existing in the cost management circle in Nigeria. This was corroborated using the existing literature. The comparison, which can occur in the future, is referred to as **predictive validity**. Hence, the researcher has collected the data, but the measure to compare this data is not yet available.

Concurrent validity is a type of criterion-related validity where the criterion in the research instrument exists alongside the responses provided. Therefore, the measures provided for each of the criteria are available to compare with the data. **Convergent and discriminant validity** is another form of construct validity where the validation process is tested across various measures, and the divergent validity allows the researcher to test the data with other distinct measures which are related at the same time.

3.8.2 Content validity

Content validity is a qualitative way of addressing ambiguity in social science research. Content validity ensures that the questions asked in the questionnaires or interviews are related to the basic knowledge level of the respondents. This also depends on the type of research. This study used terms such as kaizen and kaizen costing. For the purpose of data collection, the

researcher used the term "continuous improvement in cost management as the basic terminology. Also, certain concepts relating to continuous improvements were asked in the survey questionnaire and interviews. The concepts are stakeholders' involvement, perception towards change, post-project review, waste reduction policy and use of templates for the easy conduct of post-contract cost control. The basic method of conducting content validity is by asking a number of questions about the questionnaire and the judgement of experts with a high level of experience. This study made use of expert opinions for validation and pilot study for the survey instruments.

3.8.3 Construct validity

Construct validity was obtained via multiple sources of evidence. This began with the literature review of existing books, journals, documents and reports to establish a background to post-contract cost control, kaizen costing in construction and small and medium scale construction industries. Furthermore, interviews with experts and professionals within the SMSCC were embarked to assess their perception towards change and innovation in the area of post-contract cost control. In a bid to construct validity with respect to the peculiar survey strategy encompassing quantitative and qualitative interviews, a similar approach as described above was initiated whereby specific documents and reports peculiar to each case were reviewed, and findings were cross-referenced with interviews.

3.8.4 Face validity

Drost (2011) opined, "*Face validity is the subjective judgement on the operationalisation of a construct*". Face validity has been criticised by many authors as not being good enough for validation because it only depends on the subjective view of the researcher based on personal opinion (Trochim, 2006). This form of validity is under construct validity, but it is rarely used because it is not enough to form of validity for research purposes. Although, subjectivity is required through the research process, it has very little effect on the strength of validation.

3.8.5 Translation validity

Just like face validity, which is based on subjective judgement, translation validity also depends on the subjective opinion of the researcher for operationalisation. Translation validity refers to the extent in which the operationalisation portrays the intent of the construct. The research

instruments have to be designed to reflect the overall theoretical background of the study. Therefore, the judgement is based on personal experience and opinion.

3.8.6 Internal Validity

The research will follow an explanation-building approach whereby certain conditions will yield to other conditions thus establishing a causal relationship (Yin 2013). The explanation building aspect, in this case, starts with the interview analysis with the contractors and survey questions by the employees. Internal validity demonstrates a causal relationship between two variables, thereby distinguishing it from spurious relationships (Saunders 2015). However, internal validity cannot be applied to exploratory studies (Yin 2013). "Testing" being a threat to internal validity as mentioned by (Saunders 2015) was met with a notification of ambiguity to all participants to negate the effect it might have on the process.

3.8.7 External Validity

Generalising a research's findings to other relevant settings or groups shows external validity Saunders 2015). Furthermore, establishing a domain whereby the findings of research can be generalised exhibits external validity (Yin 2013). Hence, it is, therefore, necessary to replicate a study in another context(s) to be able to confirm generalizability. External validity related to the generalising to other conditions, duration and respondents. External validity addresses the findings from another point of view that is not usually within the group of participants or stakeholders.

3.9 Research reliability

Reliability relates to the consistency of a measure. It deals with the extent to which the data obtained are affected by random errors. When random errors build up over time, it affects the validity of the data. Hence, errors are unavoidable in data analysis. Nonetheless, there is a level of reliability, which is acceptable for a good data analysis. There are many ways to determine the reliability of data: this is based on the type of reliability. According to Drost (2011) there is four type of reliability, they are inter-rater reliability; test-retest reliability, parallel-forms reliability and internal consistency reliability.

3.9.1 Inter-rater reliability

Inter-rater or inter-observer reliability is carried out when there is an exploration of opinion, behaviour or perception towards a judgement. Therefore, there is more than one judgement for the same opinion. This implies that different stakeholders provide a various judgement on the rating. The level of agreement of this study can differ. This study used Kendall's coefficient of concordance to establish the level of agreement from the Likert scale for post-contract cost controlling techniques. The first perception was of the level of effectiveness and the second was from the angle of importance. The results showed consistencies in the rating between the two perceptions. This example of inter-rater reliability enables the researcher to address the loopholes in the study.

3.9.2 Test-Retest Reliability

Test-retest reliability involves finding out if the output of the data from the same set of respondents is the same over a period. Hence, the questionnaires are administered to a set of respondents. This is later re-administered at a different time in the future. This allows the researcher to assess the responses from a different point in times. A correlation test can be conducted on the two sets of data to evaluate the reliability.

3.9.3 Parallel-forms reliability

In parallel reliability the same questionnaires or interview questions are administered to the same population at the same time. Therefore, the researcher will design the questions towards a particular set of the construct. The construct in this study is continuous improvement in construction. This construct was investigated through the same set of the population with various questions in the questionnaire. The construct was divided into sub-constructs, which targeted the knowledge level, and understanding contractors, cost and project managers have in the area of continuous improvement. The study did not distribute separate questionnaires to but the questions posed within the questionnaire were a repetition of the intended construction that is continuous improvement.

3.9.4 Internal consistency reliability

This type of reliability makes use of one single measurement instrument administered to the same population to evaluate reliability. Inter-item correlation within the group of constructs

provides enough evidence for a good evaluation of the reliability. Another method of conducting internal reliability is through split-half. Split-half reliability randomly divides the items, which supports the concepts into two. Cronbach alpha is an average of all the possible halves. Pallant (2016) stated that Cronbach alpha is displayed the mean inter-item correlation for the construct. The Cronbach alpha test available on SPSS 23 was used for the reliability of the data for this study. The reliability and validity of the research in sections 3.9 and 3.8 respectively, created a research error checking system for the study. Ethical considerations of the study provide a good to ensuring the study ends in an ethical manner.

3.10 Ethical Considerations

The research ethics for data collection, storage and analysis were followed for this investigation. The names of the interviewees and questionnaire respondents remained anonymous. The names of their companies also followed this rule. The data collected were stored in a password-protected system. It will be disposed of four months after this study has been concluded.

3.11 Summary of the research methodology

The research methodology for this study employed the research onion model. The research philosophy is the bedrock for defining the research strategy and techniques for each objective and questions. The survey research was adopted because of its dual nature (quantitative and qualitative). The literature review was used to establish the basic post-contract techniques used in the construction industry and the critical success factors for the various objectives. These the sample size for each of the qualitative data collection were theoretical and random sampling. The interviews informed the development of the questionnaire. The questionnaire had passed through the pilot study phase before it was distributed and many errors were corrected. The five-point Likert scale format questionnaires were distributed to two hundred and fifty (250) small and medium scale construction companies via email and fifty-four percent of the questionnaires were returned. The semi-structured interview was carried out through a telephone conversation. Eleven interviewees were contacted. The interviewees were mainly contractors who owned SMSCC in Lagos, Nigeria. The method of analysis for each objective has also been discussed. Kendall's coefficient of concordance, factor analysis, Spearman's correlation, Chi-square was adopted as statistical tests for this study. This was carried out via IBM SPSS 23. The framework for this study was designed using BPMN, capability maturity

model and IDEF0 on Microsoft Visio. The finding of the data collection will be validated using four (4) expert interviews. The summary of the research onion for the methodology used for this study is displayed below.

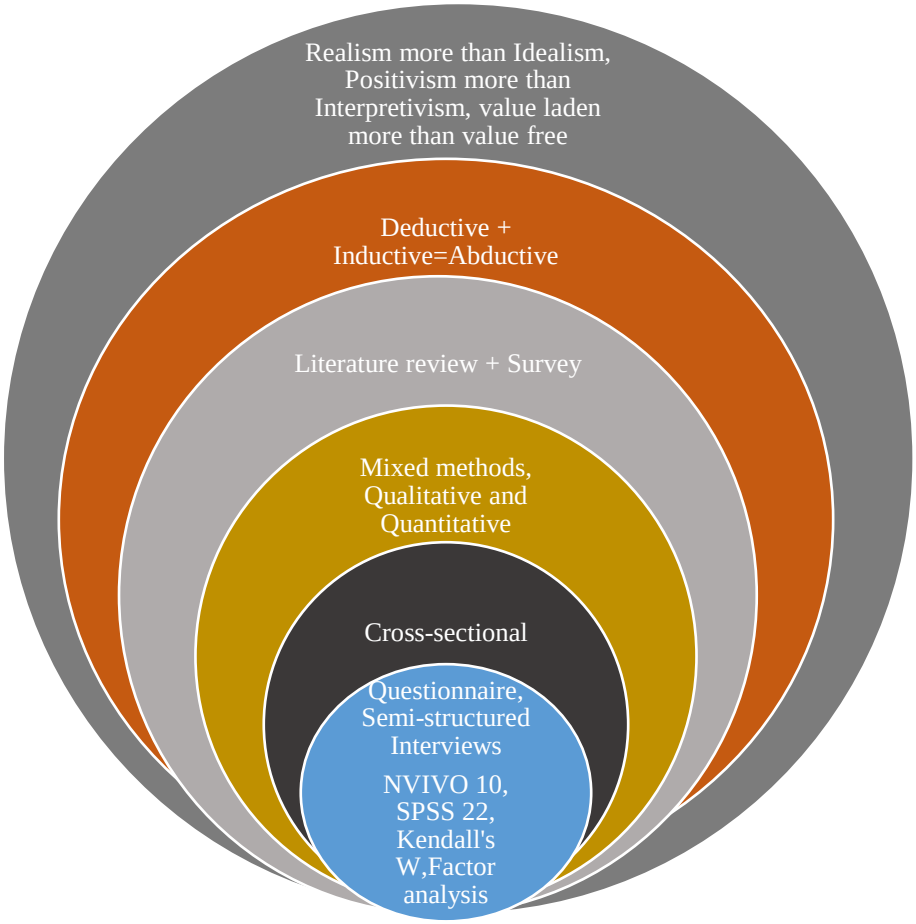


Figure 3.7. Research Onion showing the adopted philosophies, and other layers

The research methodology which has provided the inputs in the research onions in Figure 3.7 created an opportunity for the data obtained to be analysed and presented. The analysis in chapter four and research discussion in chapter five provided the desired inputs for the kaizen framework in chapter six.

Chapter Four

Data Analysis

4.0 Introduction to data analysis

In section one, the research objectives were defined based on the justifications for the study. The justifications for this study were enhanced in the next section through the review of the focal literature. The review of the focal literature identified the research gaps which the objectives have to resolve. The process of data analysis took a step further with the design of the research methodology using the research onion. In section 3.7.7.2 to 3.7.7.6, the process of analysing the data collected as explained in section 3.7.5 and 3.7.5 have produced this data analysis section. Qualitative and quantitative data analysis based on the abductive research approach in section 3.3 were used for this analysis. The research objectives were taken in accordance with section 1.2.1. Therefore, research objective one (identification of post-contract cost controlling techniques) has been resolved in the literature review section 2.2.4, table 2.1. The discussion of the finding of research objective one will be discussed in section five. Hence, this data analysis section began from research objective two. The background of the respondents for this study provided information about the nature of the company, profession, scale of the organisation and the type of post-contract cost controlling method in use. This is discussed in the next section.

4.1 Professional summary of the respondents

The various respondents are Quantity Surveyors (QS) and project managers (PM). The quantity surveyor is mainly quantity surveyors, while the project managers are usually the architect, quantity surveyor or civil engineer working in the role of a project manager. The term quantity surveyor was used because some companies have accountant preparing the cashflow and cost forecast. The number of cost and project managers have been expressed in the form of a pie chart. This chart distinguishes the number of project managers from a quantity surveyor. Fifty-seven percent (57%) of the respondents are quantity surveyor, while forty-three percent (43%) are project managers from a total population of one hundred and thirty-five (135).

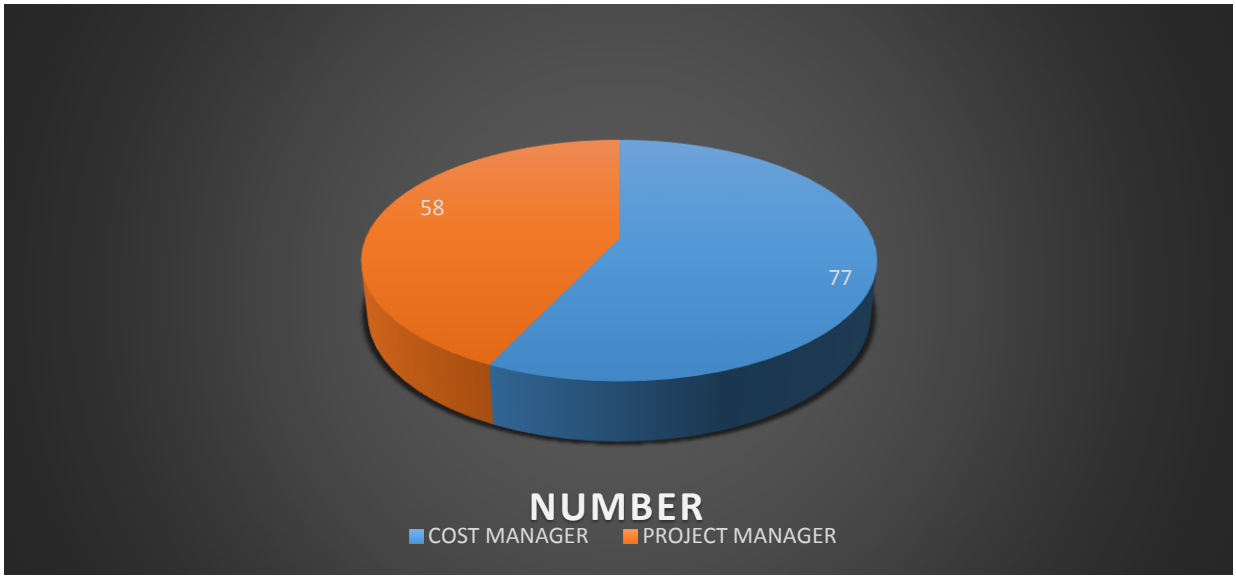


Figure 4.1. Pie chart showing the number of respondents

Seventy-seven (77) quantity surveyor and fifty-eight (58) project managers responded to the questionnaire. Some of these respondents are from the same construction company. However, a total of eighty-four (84) companies responded to the questionnaire.

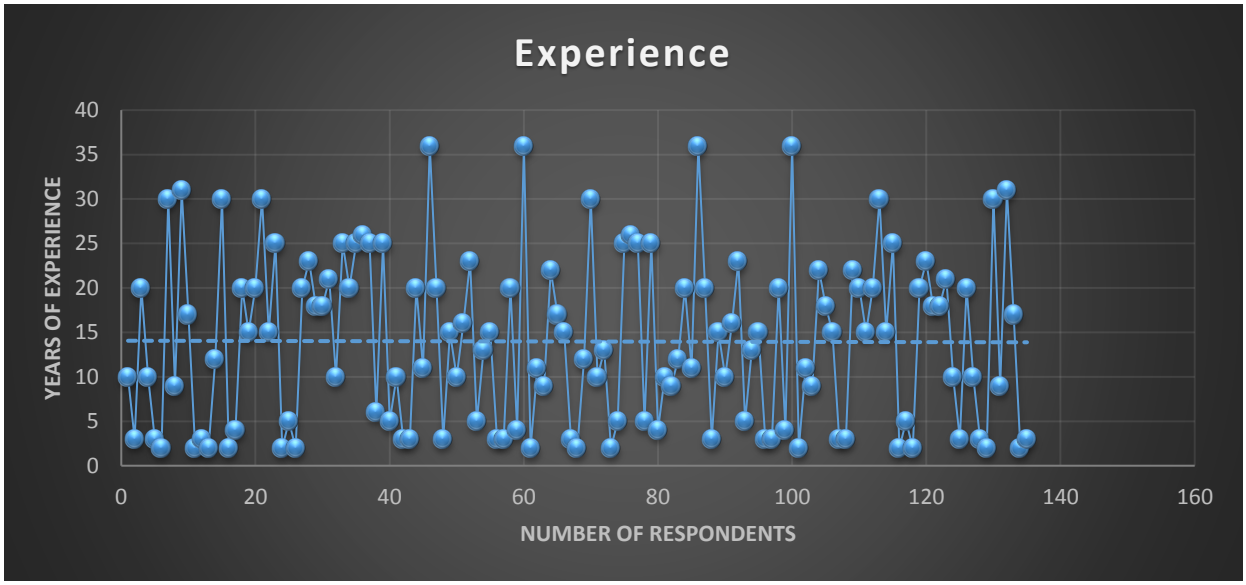


Figure 4.2. Graph showing the linear years of experience of the respondents

The majority of the population have a linear experience which is below fifteen years (15). In this instance two (2) to fifteen (15) years This is good enough for this study which has adopted random sampling for the quantitative data collection.

4.1.1 Scaling of the respondents' organisation

The number of staff is one of the criteria for determining the size of an organisation. Therefore, for the data collection small and medium scale construction companies were selected for this study. From the chart above the number of staff for the majority of the organisations are below fifty (50). This is indicated by the linear number of staff in the chart below.

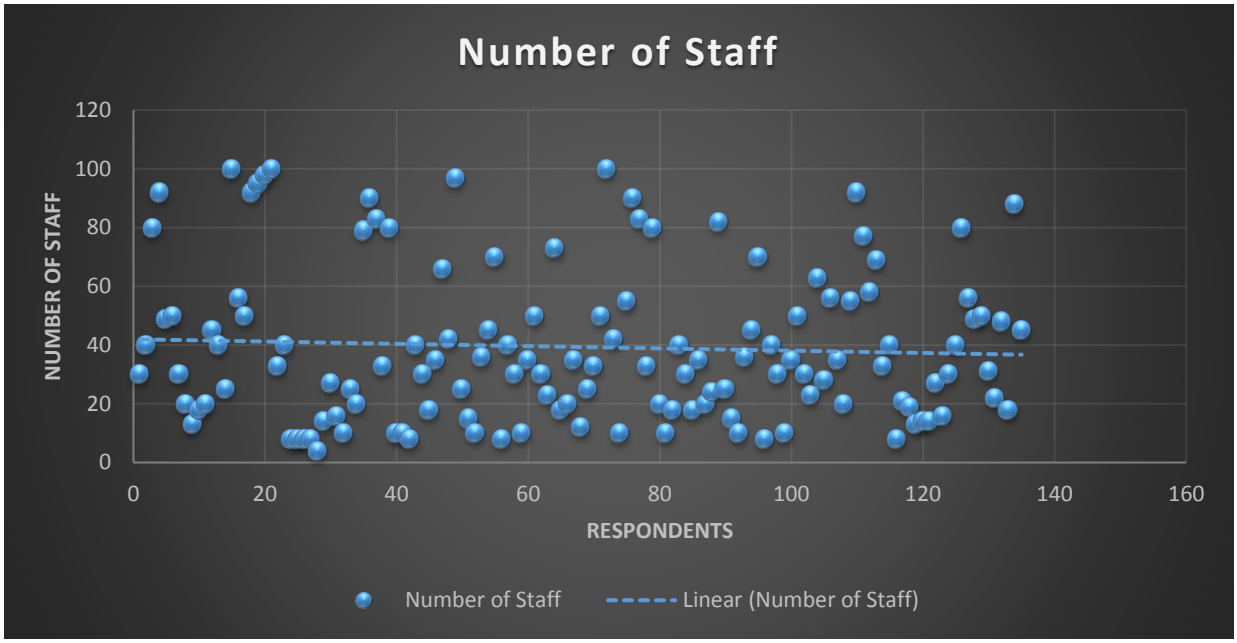


Figure 4.3. Graph showing the type of organisation

The remaining population above this figure represent medium scale companies having up to one hundred employees (100). The shows that the majority of the respondents' organisation are based in small construction companies.

The background of the respondents in terms of company size and number of respondents has been defined in section 4.1 and 4.1.1. The type of post-contract cost controlling method used in these SMSCC in Nigeria will be required for further understanding and an addition to the justification in section 1.1.

4.1.2 Analysis for post-contract cost controlling methods in Nigerian SMSCC

The method used in handling post-contract cost control is important to establish; this is for kaizen implementation purposes and empirical justification of the study. This is an important driver for the development of the kaizen costing framework and a justification for kaizen costing.

From the pie chart below ninety-eight percent (98%) of the respondents, which comprises one hundred and thirty-two (132) respondents noted that traditional costing is the cost control method used and less than two (2) percent, noted that they made use of earned value analysis and activity based costing.

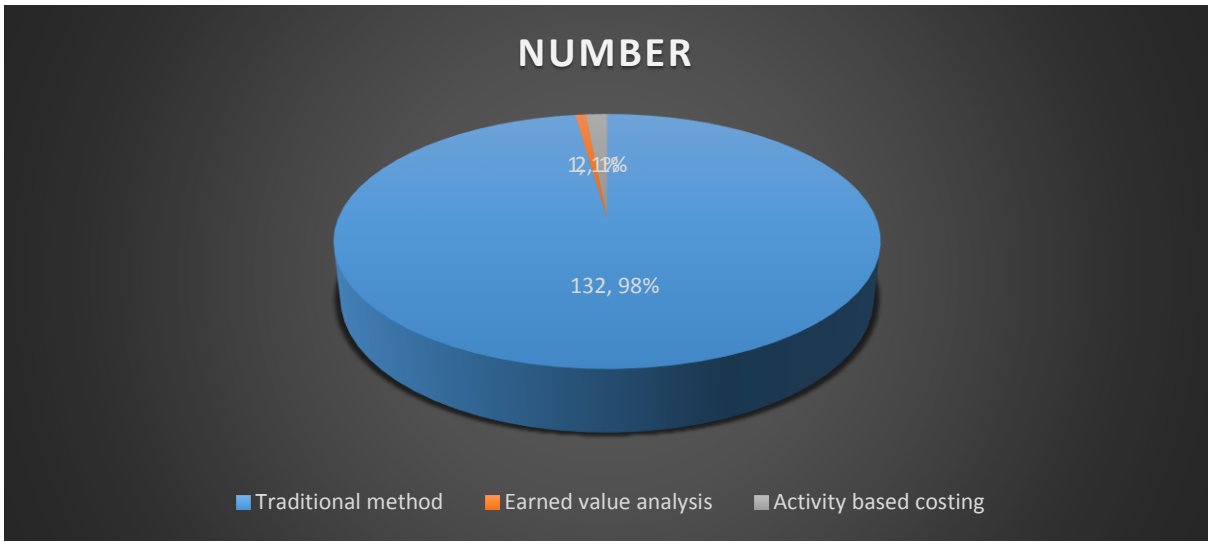


Figure 4.4. Pie chart showing the type of post-contract cost control methods used

Although, other methods such as value analysis, target costing and kaizen costing were presented in the questionnaire, only these three methods were identified as the cost control methods used in the industry. Other methods of managing project cost during construction were also investigated. Two (2) respondents highlighted periodic valuation as a method and one respondent identified variation pricing and negotiation as another method. Considering these new methods identified (periodic valuation and variation pricing), in the expression of terminologies in cost management, they are classified as post-contract cost control techniques.

The reliability of the data provided for the background of the respondents, this is required for effective analysis of the data.

Table 4.1. Reliability test for the background of the study

Cronbach's Alpha	N of Items
.767	14

The Cronbach alpha test for the background of the study and has fourteen variables providing a reliability of 0.77. This shows that there is a very good inter-item consistency and the analysis has a good reliability. These five variables include the type of respondent, number of the company, type of post-contract cost control techniques, templates for post-contract cost control, the involvement of stakeholders for overhead cost reduction, openness to new ideas, and other perception towards change in section 4.3 and 4.4.

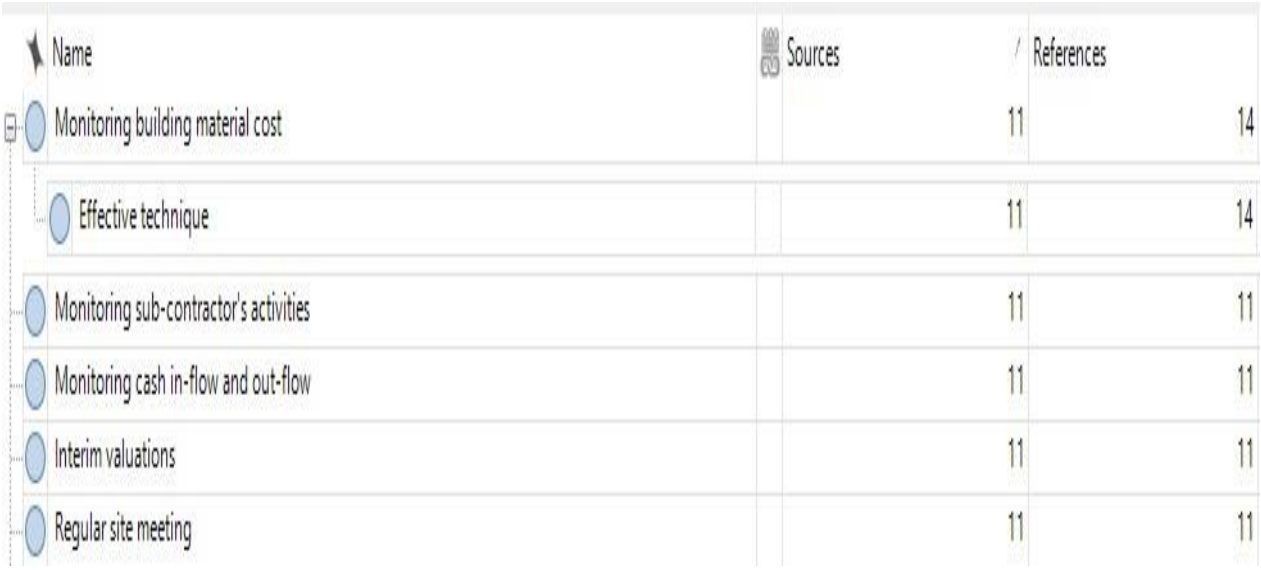
In section 4.1.2, the post-contract cost controlling methods were investigated to provide a background of the methods used in the Nigerian construction industry. The traditional method used is related traditional post-contract cost controlling techniques used in Nigeria. Interviews were conducted to establish the post-contract cost controlling techniques.

4.2 Research objective two: Establishing and evaluating the techniques used in post-contract cost control in SMSCC in Nigeria

In establishing the techniques used for post-contract cost control in Nigerian SMSCC, review of the focal literature provided the findings of table 2.1. In addition to this, the interview process was used identify the post-contract cost controlling techniques which are used by SMSCC in Nigeria. The interviewees highlighted in section 3.7.7.5, provided feedback on the type of techniques used for post-contract cost controlling in Nigeria and their associated problems. The findings of the interview are provided in the next sub-section using NVIVO 10.

4.2.1 Qualitative findings for the post-contract cost controlling techniques used in SMSCC in Nigeria

NVIVO 10 was used to analyse the transcribed audio recording. The major themes associated with the findings are explained using the NVIVO in figure 4.5.



Name	Sources	References
Monitoring building material cost	11	14
Effective technique	11	14
Monitoring sub-contractor's activities	11	11
Monitoring cash in-flow and out-flow	11	11
Interim valuations	11	11
Regular site meeting	11	11

Figure 4.5. NVIVO themes for the interviews on post-contract cost control

Post-contract cost controlling techniques as based on questions in appendix C, section 4, have provided the main themes as below:

1) Monitoring building material cost
2) Monitoring sub-contractor's activities
3) Monitoring cash in-flow and out-flow
4) Interim valuation
5) Regular site meeting

4.2.1.1 Monitoring material cost

The process of monitoring material cost was considered as the most important these and at the same time effective by all the contractors interviewed. Respondents QS3 considered the cost of building materials in Nigeria as a determinant factor for the final construction cost. QS3

noted that "*the cost of Dangote cement has changed over the years, even though the cost of blocks has been steady, the recent changes in cement prices always affect construction cost".*

QS1 further added that "*the cost of cement cannot be monitored effectively, but we have been able to strategically calculate the total amount of cement using a schedule of materials for the program of works. If we decide the amount of cement required for the entire project, they are purchased on time to avoid price fluctuations".* The process of calculating the schedule of materials required for the construction process is very important for cost control during construction. Therefore, if building materials are purchased on time, price fluctuations can be avoided. Timely purchase of building materials has been considered by interviewee PM2 as the most effective way of controlling construction cost of building materials. PM2 stated that *"building materials can be bought and stored for future use on site, most of the times we have used this method, and we have been able to avoid price fluctuations. This is the best way of controlling construction cost".* The attitude contractors have towards the monitoring, and timely purchase of building materials have been very helpful in controlling cost during construction.

4.2.1.2 Monitoring subcontractor's activities

Subcontractors on site play an important role in the construction process. In the Nigerian construction industry, they supply some building materials and also construct some parts of the project. The contractors interviewed in this study seemed not to be comfortable with the activities of the subcontractors. This is usually as a result of unethical practices on the site either by the contractor or subcontractor. In section 2.8, unethical practices in SMSCC in Nigeria is very common. Although, unethical practices with the organisational culture of Nigerian SMSCC is not the scope of this study. They play a very crucial role in the control of cost during construction. Theft, bribery, kick-back have been reported by most small and medium scale contractors in Nigeria. Respondent QS1 opined that "*most subcontractors have inflated the cost of construction and if they are well monitored, the cost control process will be easier for us to handle".* This may not be the case for all contractors in other parts of Nigeria, but the feedback provided by the eleven (11) interviewees indicated that the building contractors have a level of distrust for the subcontractors.

4.2.1.3 Monitoring cash-inflow and out-flow

Monthly financial statements and cashflow calculations were identified as the major process used to control the cost of construction. Respondent PM5 opined that "*the monthly payments by the client and expenses are calculated and documented by the quantity surveyor every month. This process ensures that we have an idea of how much we are expending and additional cost we require for further work on site".* All the interviewees considered cashflow calculation as an important technique for the construction process. This was highlighted in table 2.1 of section 2. According to Ashworth and Perera (2015), cashflow calculations is one of the most important techniques for monitoring cost of construction.

4.2.1.4 Interim valuations

In section 2, table 2.1, measuring work on site for further payments by the client is considered to be one of the best methods of controlling the cost of construction. Interviewee PM2 stated that *"interim valuations have been very effective and it is an important technique used by most contractors in Nigeria".* Interim valuation is a very popular post-contract cost controlling technique. This sub-theme has been the major technique used by quantity surveyor all around the world. All the respondents categorically identified interim valuation as the technique used by quantity surveyors for the overall process of controlling the cost of construction on site. Interim valuation identified as the major process of post-contract cost control by Ashworth and Perera (2015) in section 2.1.

4.2.1.5 Regular site meetings

Regular site meetings by stakeholders involved in the building construction process is an important technique for controlling and enhancing construction cost in Nigeria. Respondent QS2 stated that "*Most construction projects I have been involved in had regular site meetings every month, these site meeting did not involve the client because he was not in town. We were able to identify problems with the construction project and discussed likely solutions. This process also helped with negotiations of rates with the subcontractor and suppliers".* Site meeting conducted at intervals was identified in Table 2.1 as a technique used in post-contract cost control.

Having elucidated the post-contract cost control themes from section 4.2.1.1 to 4.2.1.5, the problems with these techniques were also investigated. The respondents explained the issues with these techniques in the next subsection.

4.2.1.6 Challenges post-contract cost control techniques have during utilisation

Design variations have an impact on post-contract cost controlling techniques on construction sites in Nigeria. Respondents PM3 identified changes during construction and design as a major challenge, PM3 noted that "*…even though we have tried to control the cost of construction on site by improving the checking the cost of materials, cashflow calculations and monthly statements, there will still be changes by the architect or client."* Interviewee QS1 stated that *"… changes during construction are almost unavoidable under construction".* These changes affect the process of construction, and they have a considerable impact on the cost of construction. Furthermore, the communication on the site is also a major challenge identified by the respondents.

Interviewees QS2 explained that *"… in most building projects I have participated in, there have been communication gaps between the architect and me, this caused some delays and additional costs".* Communication was identified in section 2. 8 as a key variable in any organisation for development. Communication gap on construction sites can be bridged with regular site meetings which can occur monthly. The process of communication by the stakeholders on site, including the client, has to improve to reduce unnecessary cost. This cost can be imbedded in the overhead cost and mark ups. Fluctuations in prices of building materials as identified in section 2.2 is a major challenge which can affect the effectiveness of post-contract cost controlling techniques.

Price fluctuations as identified in section 2.2 and 4.2.1.1 limits the effectiveness of monitoring material cost. The cost of cement and other building materials as discussed in section 4.1.1.1 cannot always be mitigated by timely purchase. This is as a result of delays in payment by the client. Financial challenges are experienced by almost small and medium scale contractor in Nigeria.

Financial difficulties are very common in most construction companies owned by small and medium scale contractors. Financing construction projects in Nigeria have been a challenge for small and medium scale contractors. Post-contract cost controlling techniques is dependent on the execution of the construction plan. If there are delays in payment, the contractor has may deem it fit to use the company finance to continue the project. Interviewee PM1 stated that *"... payment delays have made it difficult for us to continue with some project we have and the price fluctuations can affect the cost of building materials we have not bought".* Monitoring cost of building materials and other techniques used in cost control on the site can be affected by the delays in payment which can lead to increased cost of construction. This does not always apply to all building projects, but from the responses of the interviewees, small and medium scale contractors have the challenge of financing construction projects in Nigeria. Implementing kaizen costing within post-contract cost control can be challenging considering the external influence on post-contract cost control. These influences are payment by the client, price fluctuations and internal influences such as communication and project financing.

The findings from 4.2.1.1 to 4.2.1.5 have identified monitoring material cost, contractors' activities, cash in-flows and out-flows, interim valuation and regular site meeting with exceptions of other major techniques used in the Nigerian construction industry. These identified post-contract cost controlling techniques will be further discussed in chapter five. The identified technique from interview and literature were used during further quantitative analysis in the next section.

4.2.2 Quantitative analysis of post-contract cost controlling techniques using Kendall's coefficient of concordance

In section 4.1.2, the post-contract cost controlling methods identified traditional costing method as the main method used in post-contract cost control. Techniques used in post-contract cost control emanated from the traditional costing method in construction. Therefore, the main elements of post-contract cost controlling in Nigerian SMSCC have been identified table 2.1 and section 4.2.1.1 to 4.2.1.5. The established techniques have to be evaluated for effectiveness and importance.

The purpose of testing post-contract cost controlling techniques using Kendall's coefficient of concordance is to evaluate the most effective and important post-contract cost control

techniques and also consider what small and medium scale construction organisations in Lagos are using. The most effective techniques used in post-contract cost control are the techniques, which creates more success when implemented. The techniques that produce the desired results when required is the most effective technique. Therefore, these techniques have more impact on the entire construction project during the execution phase. The most important post-contract cost controlling is one, which cannot be left out during post-contract cost control activities. These techniques are processes which the cost or project manager might have to always adopt during construction in order to ensure that the project stays within budget.

The evaluation made use of the Likert scale 1-5 (Please refer to appendix C, section C). The analysis in this sub-section and section 4.2.3.1 and 4.2.3.2 are associated with objective two, which deals with the evaluation of post-contract cost control techniques used in Nigeria. It is imperative to evaluate the effective and important post-contract cost control techniques because it is used to address the problems facing traditional post-contract cost control in small and medium scale construction companies in Lagos, Nigeria. This is also required to understand implementable strategies for kaizen and kaizen costing in this type of organisations based on the respondents' perception towards these techniques.

This enabled the researcher to identify the major challenges facing the traditional post-contract cost control system. The results of this test assisted juxtaposing the present level of post-contract cost control system used in practice in Nigeria with what is used in other developed countries such as the United Kingdom, Japan and the United States of America. The effectiveness test is to provide a clear view of ingredients for a framework required for the implementation of kaizen costing in small and medium scale construction companies in Nigeria. The reliability of the data for post-contract cost control in Nigeria has to be evaluated before they are tested.

4.2.2.1 Reliability test for the background of post-contract cost controlling techniques used in SMSCC in Nigeria

Cronbach alpha test provided the details of the reliability of data involving post-contract controlling techniques in Nigerian SMSCC analysis in the section 4.2.2.2 and 4.2.2.3. This reliability test is necessary for the researcher to check the extent of internal consistency in this analysis and to ensure there are no discrepancies.

Table 4.2: Case summary for the background of the investigation

Cases	N	%
Valid	135	100.0
Excluded[a]	0	.0
Total	135	100.0

For the reliability section, there are no missing values for the cases. This is because the researcher returned the questionnaires several times to the respondents to fill the missing spaces. Furthermore, the respondents answered most of the questions in the first page compared to other pages.

4.2.2.2 Effectiveness of identified post-contract cost controlling techniques using Kendall's coefficient of concordance

The bar charts in figure 4.5 reflect the effectiveness of the post-contract cost control techniques using Kendal W test. The various post-contract cost control techniques were obtained from literature review and semi-structured interviews.

From the chart below, the techniques, which involve monitoring material cost ranks the highest with a value of 11.33, interim valuations, is perceived to be the second most effective with a value of 10.98. The use of established working budget such as cost information from the bill of quantities, preliminary items of work and material schedule ranks third with a value of 10.62. Taking corrective action and monitoring equipment cost has a value of 10.61 and 10.41 respectively. They both ranked fourth and fifth. The least most effective post-contract cost control technique is cashflows. This has a value of 7.85. Other less effective techniques are variation management, cost forecasting, profit and loss summary and cost ratio, with values 7.86, 8.09, 8.4 and 8.4 respectively.

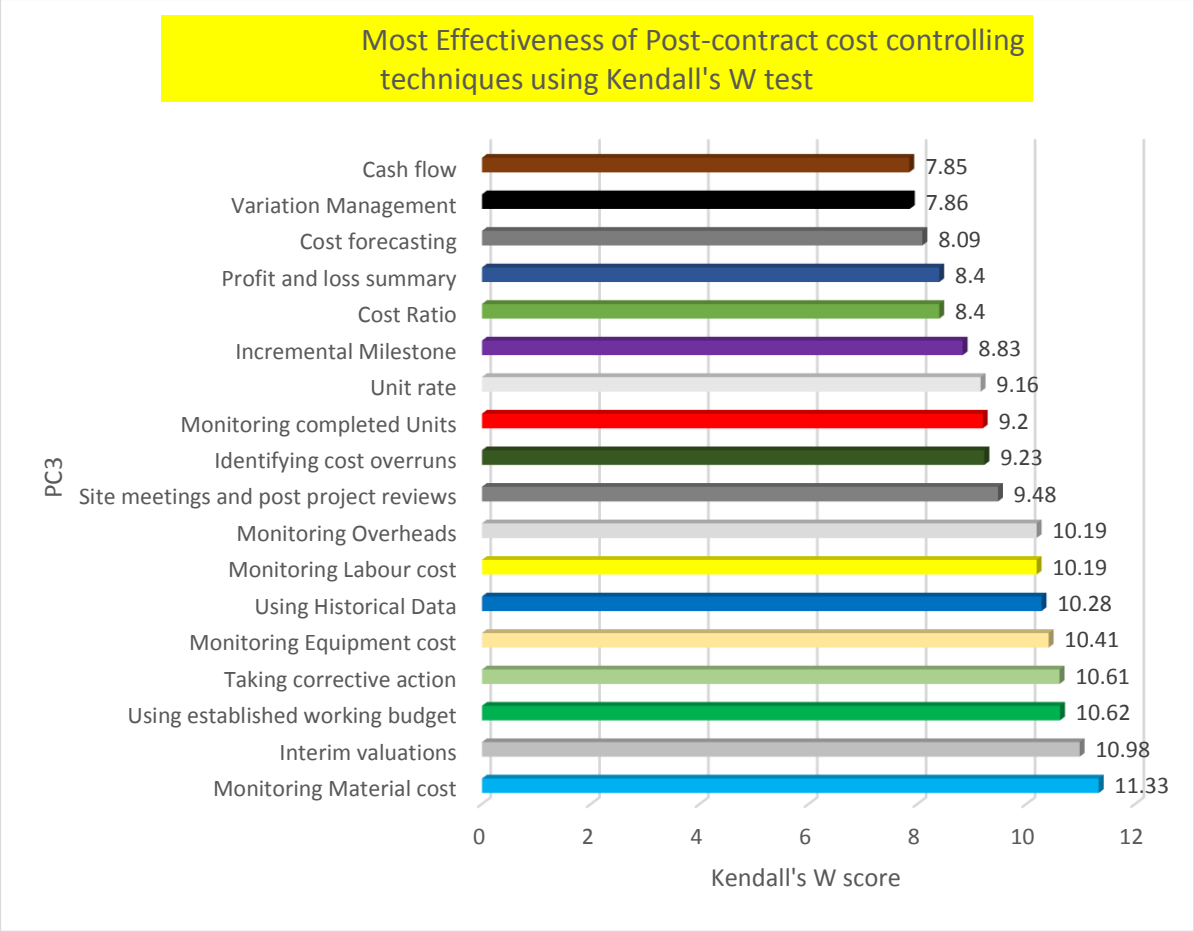


Figure 4.6. Effectiveness of post-contract cost controlling techniques

The degree of agreement of this ranking Kendall's W is given as 0.05. Kendall's W value is always between 0 and 1. 0 indicates that there is no agreement between the respondents, while 1 indicates perfect agreement (Pallant, 2016). This has been discussed in detail in section 3.8.6.

The respondents' position on each of the post-contract cost control techniques is not in complete agreement with each. The respondents have divergent opinions concerning this question. This implies that the respondents have varying views on the subject. Nonetheless, there is a significant association between the post-contract cost control techniques and the respondents.

Table 4.3. Kendall's W test for effectiveness of post-contract cost control techniques

N	135
Kendall's W[a]	.050
Chi-Square	113.973
df	17
Asymp. Sig.	.000

a. Kendall's Coefficient of Concordance

The respondents prioritized these post-contract cost control techniques as listed in the bar chart above in descending order. The asymptotic significance value was also less than 0.05. Therefore, there is a high significant association between the respondents and the techniques. This indicates that there is a very little agreement between the respondents in terms of their responses. There are divergent views on about the effectiveness of the post-contract cost controlling techniques in figure 4.5. The main focus is the ranking on figure 4.5 showing the most effective post-contract cost controlling techniques and high significance. The effectiveness of post-contract cost controlling techniques can differ from the importance (please refer to section 4.2.3 for an explanation of effectiveness and importance). Therefore, there is need to also evaluate the importance of these techniques for comparison.

4.2.2.3 Kendall's coefficient of concordance for the most important post-contract cost controlling techniques

The most important post-contract cost control techniques as explained in section 4.2.2 using Kendall's coefficient of concordance test explained in section 3.7.7.3 would also be used for this analysis. This also ranks the various techniques in descending order. The chart in figure 4.6 also reflects similar scenarios to the effectiveness bar chart where monitoring material cost is considered the most important post-contract cost control technique. Monitoring material cost had a value of 11.44. Monitoring labour cost had a value of 11.26 and is ranked second, while profit and loss summary, using established working budget, site meeting and post project reviews were ranked third, fourth and fifth with values 11.13, 11.03 and 10.43 respectively. The least most important technique is variation management with a Kendall W score of 6.88. The cost ratio is second to the least most important with a Kendall W score of 8.01. Other techniques ranked by the respondents are monitoring overheads, cashflow and using historical data. These techniques have values of 8.31, 8.37, and 8.62 respectively.

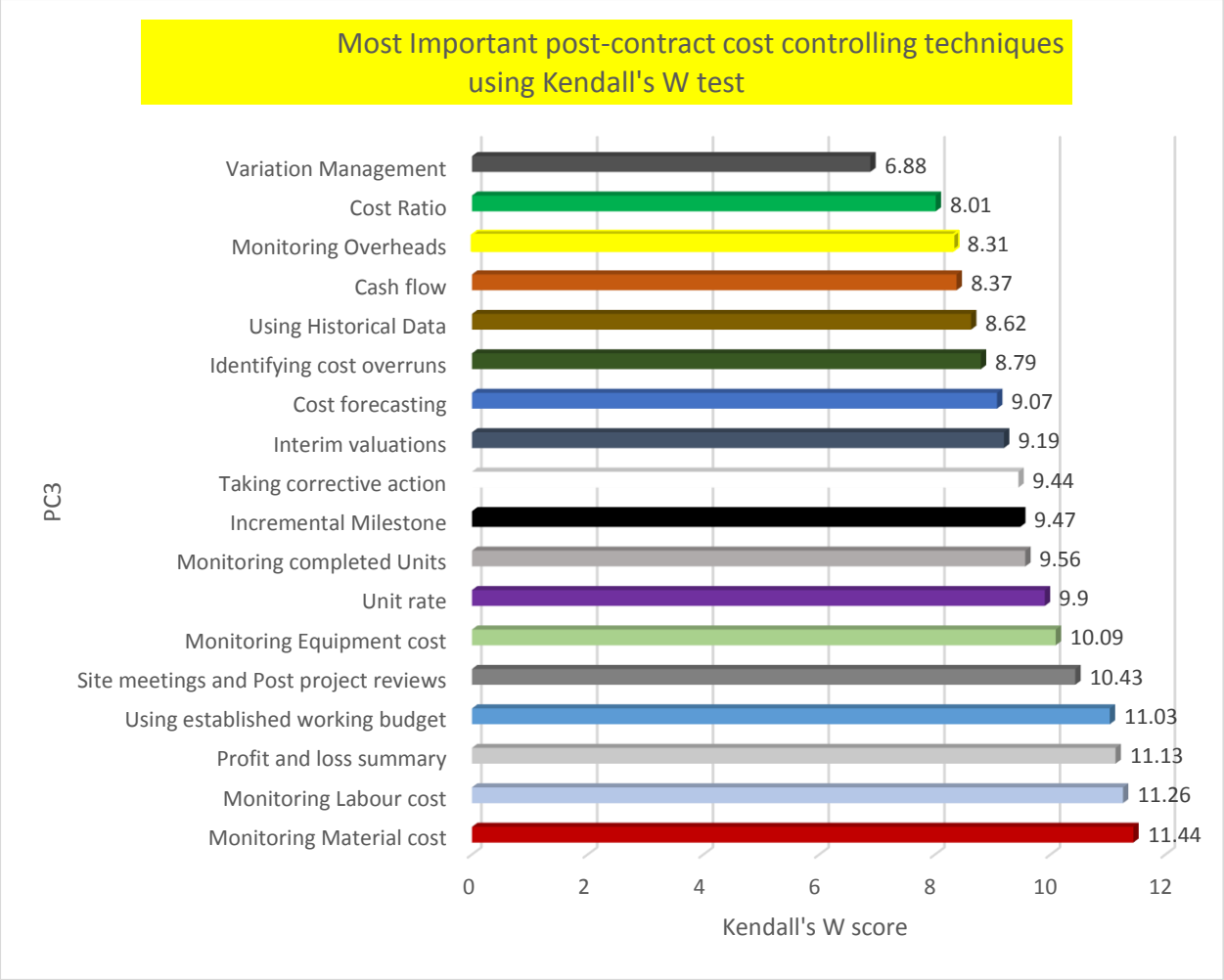


Figure 4.7. Important post-contract cost control techniques presented in bar chart

The Kendall W score of 0.043 shows an insignificant level of agreement for the most important post-contract cost control techniques and the respondent's ranking on the Likert scale.

Table 4.4. Kendall's W test for important post-contract cost control techniques

N	135
Kendall's W[a]	.043
Chi-Square	145.451
df	17
Asymp. Sig.	.000

a. Kendall's Coefficient of Concordance

The asymptotic Significance value is also less than 0.05, thereby reflecting the significance of the respondents and the techniques. The findings of section 4.2.2.2 and 4.2.2.3 for effectiveness and importance of post-contract cost controlling techniques proves that monitoring material cost is the most effective and important technique. These findings also correlate with the interview findings. Cashflow was ranked very low in effectiveness and importance of post-contract cost controlling techniques.

The effective and most important post-contract cost control techniques have been addressed in this section. The next section triangulates the interview findings with Kendall's coefficient of concordance as a summary.

4.2.3 Summary and triangulation of findings for objective two: establishing and evaluating post-contract cost controlling techniques used in SMSCC in Nigeria

Post-contract cost controlling techniques used in Nigeria were identified using available literature in section 2.1 and table 2.1. Due to the limited literature on post-contract cost controlling techniques used in Nigeria, the interview was conducted to understand the post-contract cost controlling techniques used in SMSCC in Nigeria. The findings revealed that monitoring of building material cost, subcontractor's activities, interim valuation, cashflow and regular site meeting are the major techniques used in Nigeria. These findings correlate with the quantitative analysis identifying monitoring of material cost on construction sites as the most effective and important post-contract cost controlling technique. Site meeting and post-project reviews were ranked 9^{th} and 5^{th} on the effectiveness and importance scale respectively. The major discrepancy was a cashflow calculation which was ranked lowest on the level of effectiveness and 15^{th} of importance scale. The reason why this occurred will be discussed in section six based on available literature.

One of the techniques identified by Nigerian contractors in the interview was monitoring the activities of contractors. This seems to be part of the activities on site which can be reduced continually for the purpose of implementing kaizen costing. This is an objective in this study which can be resolve with Kendall's coefficient of concordance.

4.3 Research objective three: Identifying and assessing the most critical activities requiring incremental cost reduction for kaizen costing implementation

The critical activities on construction sites are different from the critical success factors for the implementation of kaizen costing. These activities are the detailed processes which can be reduced continually for the attainment of kaizen costing on construction sites.

This section addresses the key critical post-contract cost control activities which enable the researcher to create a framework for kaizen costing required for small and medium scale construction companies in Lagos, Nigeria. The critical post-contract cost control activities are abbreviated below. These factors were identified from sections 2.5.1 and table 2.4 in the literature review chapter.

Table 4.5. Abbreviations for the activities all the captions should give a proper meaning

Abbreviation	Meaning
MESETUP	Continual cost reduction of overhead cost of activities related to mobilisation and equipment setup will keep the project cost within budget
DRR	Continual reduction of activities related to drawing reviews will eliminate unnecessary cost thereby keeping the project cost within budget
PI	Continual reduction of overhead costs associated with preliminary items of work such as site office, storage, security, electricity, water supply, first aid and so on will eventually help the creation of more profit and improve project delivery
CGPG	Continual reduction of overhead costs related to construction cost planning, general planning, resource planning and project reports will create more profit for the contractor
CVMINI	Ensuring activities related to construction variations are continually minimised will create more profit for the contractor
PEOVER	Continual reduction of plant and equipment depreciation overhead cost throughout the construction phase will keep the project cost within budget
POM	The cost of activities related to purchasing orders and material deliveries can be reduced continually throughout the construction phase to control the project cost for optimum profit.
PSL	Overhead cost related to paying suppliers, subcontractors and labourers can be reduced continually throughout the construction phase to keep the project cost within budget

The section where the factors were extracted from in the literature review covered monitoring material, plant, labour and overheads, elimination of unnecessary activities, planning and stakeholders. The various post-contract cost control activities ranked using the Likert scale were analysed using Kendall's coefficient of concordance test (please refer to appendix C, section D). This test ranks the critical activities displayed the level of agreement among the respondents.

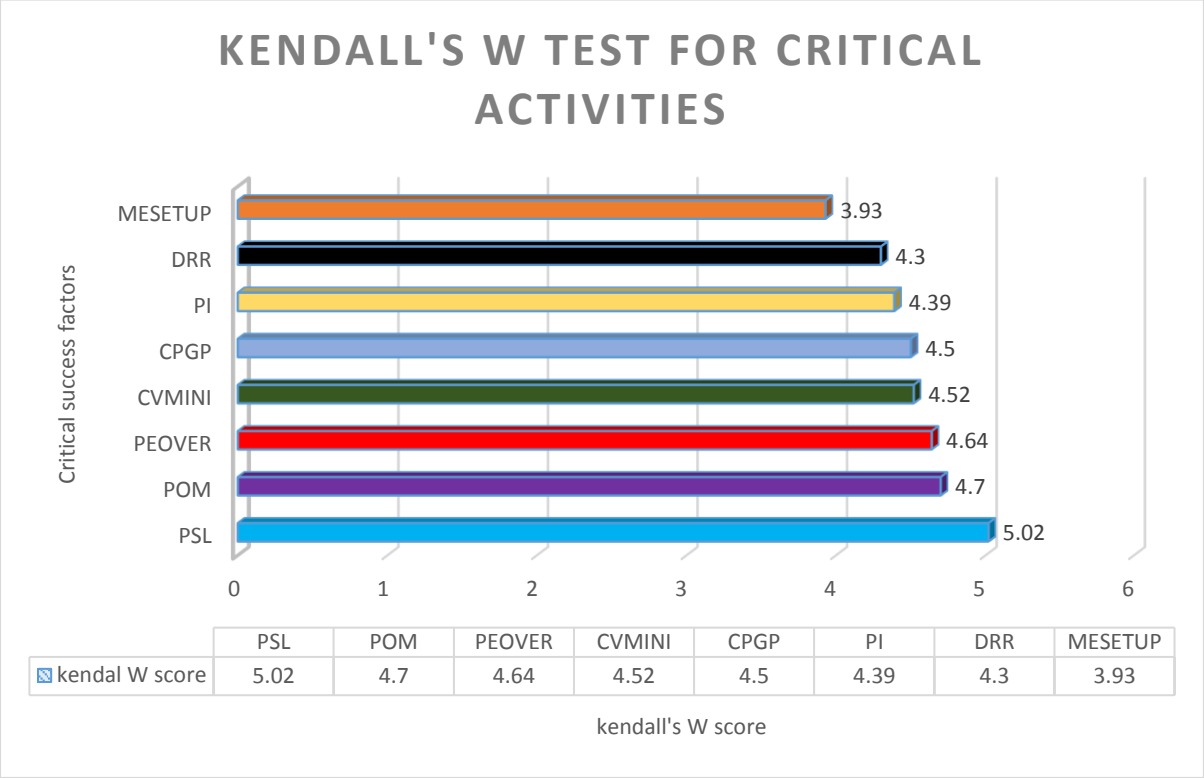


Figure 4.8. Bar chart for the most critical post-contract cost control activities

From the table above, PSL representing "*overhead cost related to paying suppliers, subcontractors and labourers can be reduced continually throughout the construction phase to keep the project cost within budget".* This is ranked highest with a Kendall's W score of 5.02. POM, which is the cost of activities related to purchasing orders and material deliveries, *can be reduced continually throughout the construction phase to control the project cost for optimum profit* has a Kendall's W score of 4.70. The least critical activity is MESETUP that stands for *Continuous cost reduction of overhead cost of activities related to mobilisation and equipment setup will keep the project cost within budget*, with a score of 3.93. The Kendall's W score for each of the critical activities for continual cost reduction (Kaizen costing) highlight

the most important activities which quantity surveyors and project managers have to focus on during post-contract cost controlling process. The activities were prioritised in order for cost and project managers in small and medium scale construction organisations to address the most important activities, which would enable them, to reduce the cost. This is necessary for the framework development in section six because of the line of focus in Kendall's coefficient of concordance for this analysis is given as 0.02.

Table 4.6. Kendall's W test for the most critical activities

N	135
Kendall's W[a]	.020
Chi-Square	19.077
df	7
Asymp. Sig.	.008

This figure is very low and shows that there is almost no agreement between the respondents. The asymptotic significance is 0.008<0.05 hence, the respondents have a significant association with the critical success factors. This is required for the model design in IDEF0 and related how the important activities would link together. Therefore, there will be more focus on the overhead cost for suppliers and subcontractors. Purchase orders and cost of equipment and plants can be reduced continually for the attainment of kaizen costing during construction. This finding is related to the monitoring material cost during from the post-contract cost control techniques.

4.3.1 Correlation between the critical activities required for the incremental cost reduction for kaizen costing implementation

This test was carried out to further validate the findings of section 5.4. The spearman rho's correlation was used to test the strength of the relationship between the factors for the activities, which will be important for continual cost reduction for an effective actualization for kaizen costing.

Table 4.7. Spearman correlation table for the activities

Spearman's rho			1	2	3	4	5	6	7	8
1	PEOVER	Correlation Coefficient	1.000	.195*	-.042	.032	-.091	.021	-.017	.225**
		Sig. (2-tailed)	.	.026	.634	.719	.314	.817	.850	.010
2		N	133	130	129	130	125	124	129	131
	MEsetup	Correlation Coefficient	.195*	1.000	.085	.004	.032	-.062	.001	-.026
3		Sig. (2-tailed)	.026	.	.337	.963	.720	.497	.989	.765
		N	130	132	130	129	125	124	128	130
4	DRreviews	Correlation Coefficient	-.042	.085	1.000	-.007	.117	.028	.117	-.051
5		Sig. (2-tailed)	.634	.337	.	.933	.195	.756	.190	.566
		N	129	130	131	128	124	123	127	129
6	CVMINI	Correlation Coefficient	.032	.004	-.007	1.000	-.040	.216*	.239**	.034
		Sig. (2-tailed)	.719	.963	.933	.	.658	.017	.007	.699
7		N	130	129	128	132	124	123	128	130
8	POM	Correlation Coefficient	-.091	.032	.117	-.040	1.000	.245**	.195*	.000
		Sig. (2-tailed)	.314	.720	.195	.658	.	.007	.029	.997
		N	125	125	124	124	127	121	125	125
	PSL	Correlation Coefficient	.021	-.062	.028	.216*	.245**	1.000	.066	.101
		Sig. (2-tailed)	.817	.497	.756	.017	.007	.	.471	.264
		N	124	124	123	123	121	126	123	124
	CPGP	Correlation Coefficient	-.017	.001	.117	.239**	.195*	.066	1.000	.088
		Sig. (2-tailed)	.850	.989	.190	.007	.029	.471	.	.322
		N	129	128	127	128	125	123	131	129
	PI	Correlation Coefficient	.225**	-.026	-.051	.034	.000	.101	.088	1.000
		Sig. (2-tailed)	.010	.765	.566	.699	.997	.264	.322	.
		N	131	130	129	130	125	124	129	133

The purpose of this test is to create a link between the activities, which are categorised as crucial in Kendall's coefficient of concordance test. The most crucial activity is PSL. The

spearman correlation statistical test in the table below has identified a weak positive correlation between PSL and CVMINI at 0.216.

The correlation with ** indicated significant correlation which is 2 tailed at 0.01 and * indicates correlation which is significant at 0.05. The significance of these set of the variable is 0.017, in this case, $p<0.05$. Furthermore, PSL and POM has a weak correlation of 0.245 and a significance of 0.007; this is less than 0.05. This implies that overhead cost related to paying suppliers, subcontractors and labourers could be reduced continually throughout the construction phase to keep the project cost within budget is slightly related to activities involving construction variations are continually minimised can create more profit for the contractor. In addition, overhead cost related to paying suppliers, subcontractors and labourers could be reduced continually throughout the construction phase to keep the project cost within budget, is also slightly related to Cost of activities related to purchasing orders and material deliveries can be reduced continually throughout the construction phase to control the project cost for optimum profit.

Activities which are related to variation management (CIVIMINI), can be continually reduced along with the incremental reduction of activities related to payment of suppliers and subcontractors (PSL). The relationship between CIVIMINI and PSL have a weak correlation of 0.25 with the high significance of 0.007. Therefore, PSL and POM along with PSL and CVMINI will part of the IDEF0 model in the framework design (please refer to section 2.7.7.6, number c). These are related to monitoring cost of material, variation management and monitoring overheads.

4.3.2 Summary of findings for research objective three: Most critical activities requiring continual reduction

Some activities on construction sites generate an overhead cost. These activities were established using literature review in section 2.5, 2.6 and 2.7. In table 4.5, the activities extracted from the literature review section were summarised and used for data collection on the Likert scale. The findings of the activities requiring incremental reduction inferred that the administrative process involving an overhead cost in payment of subcontractors and suppliers might be reduced using the plan-do-check-act process to allow the attainment of kaizen for profitability, quality, and client satisfaction. This plan-do-check-act process also includes negotiation and monitoring the activities of subcontractors on the construction site (please refer

to section 4.2.1.2). Reduction of overhead for purchase orders and material handling is a very crucial activity in the construction process. Furthermore, a Spearman correlation linking the activities together indicated that variation management on construction sites should be linked to the payment of subcontractors and suppliers.

The findings of the post-contract cost controlling techniques in section 4.2.2 and 4.2.3 were linked to the activities on construction site requiring incremental cost reduction for kaizen costing implementation in chapter six (framework and validation). The critical success factors for the adoption of kaizen in SMSCC in Nigeria were identified using available literature in section 2.9, table 2.5. The analysis of the factors was addressed with factor analysis.

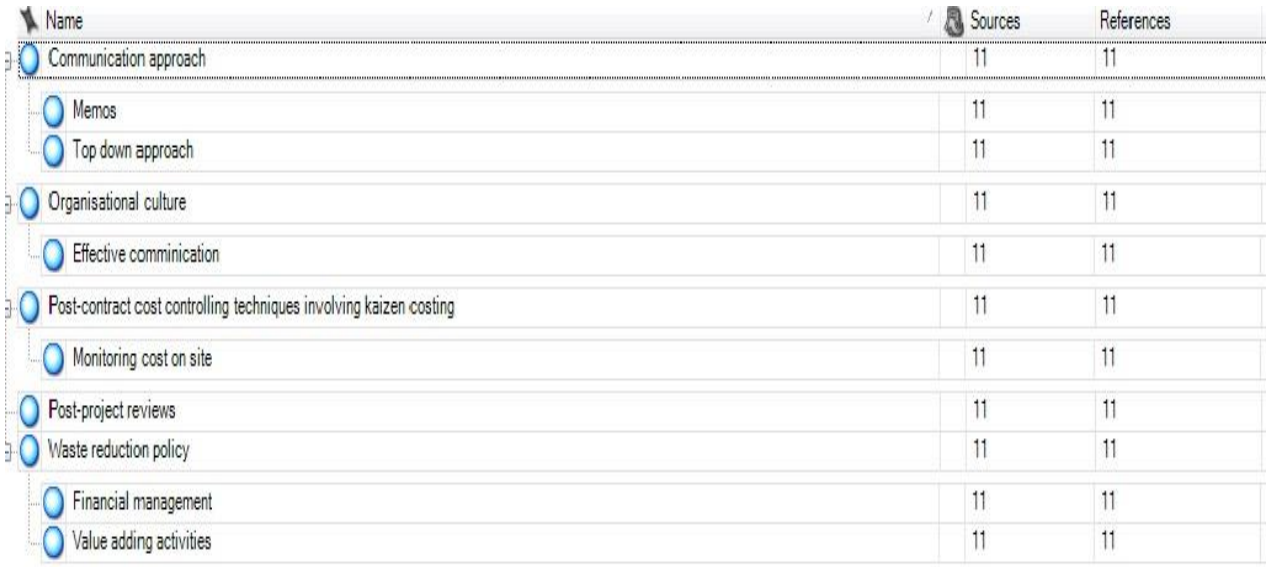
4.4 Research objective four: Analysing the critical success factors for kaizen implementation

The critical activities required for kaizen costing have been investigated in section 4.3. However the critical success factors for these activities are essential. The critical success factors for kaizen implementing is what will make the crucial activities in section 4.3 successful when implemented. Therefore, it is highly imperative to evaluate the critical success factors for the implementation of kaizen and kaizen costing in SMSCC in Nigeria. The critical success factors cover kaizen within the office and kaizen costing on a construction site during post-contract cost control. The process of extracting the data in section 2.9 and table 2.5 was based on the available factors used in developing countries such as China, Brazil and India. However, this has to be supported by the critical success factors which can be particular to Nigeria construction industry.

The survey interview process was used to elucidate the critical success factors for the implementation of kaizen in the Nigerian construction industry. Hence, eleven (11) contractors interviewed in section 4.2.1 provided feedback on the strategy which can be used to implement kaizen in their construction companies. This was after a participant information sheet was provided and further information on what kaizen and kaizen costing entails were provided by the researcher. The manner of approach during the interview was not based on the available literature review findings in section 2.9, but on the opinions of the respondents.

4.4.1 Qualitative findings for critical success factors for kaizen implementation in Nigerian SMSCC

The critical success factors for the implementation of kaizen and kaizen costing in SMSCC in Nigeria were investigated qualitatively. The interview process followed the NVIVO 10 analysis of section 3.7.7.3. The findings of the NVIVO analysis for the critical success factors for kaizen and kaizen costing implementation in Nigeria provided five (5) themes. These themes are summarised in figure 4.9 below.



Name	Sources	References
Communication approach	11	11
Memos	11	11
Top down approach	11	11
Organisational culture	11	11
Effective comminication	11	11
Post-contract cost controlling techniques involving kaizen costing	11	11
Monitoring cost on site	11	11
Post-project reviews	11	11
Waste reduction policy	11	11
Financial management	11	11
Value adding activities	11	11

Figure 4.9. NVIVO themes and sub-themes for the critical success factors for implementing kaizen and kaizen costing in Nigerian SMSCC

a) Organisational culture
b) Communication approach
c) Waste reduction policy
d) Post-contract cost controlling techniques involving kaizen costing
e) Post-project reviews

Theme 1- Organisational culture

The nature of the organisation, in this study small and medium scale, is a major determinant factor in the overall process of implementing kaizen. All eleven respondents categorised their organisational structure to be a simple one. From the quotes of a director QS6 in a small and medium scale construction, a company in Lagos stated that "… *It depends on the communication between the staff and the temporary staff, but our structure is simple."* Most small and medium scale organisations have very small number of staff. They can find it easy to implement new ideas such as kaizen, but they are concerned with the cost of adopting a new process such as kaizen. Respondent QS2 noted that "*I think having a new process within my company can be difficult because of the cost, we need to focus the available capital we have on construction projects and paying the salary of workers".* The fear of change in these companies can impose a barrier or implementation challenge. Therefore, the level of communication is very important within these construction companies in Nigeria. This also has an effect on communication approach. Communication is very important in implementing kaizen. The complexity of a construction organisation has an important effect on the implementation of kaizen (Please refer to section 2.8).

Theme 2- Communication approach

The style of communication can be very useful in identifying the presence of kaizen in small and medium scale construction companies in Nigeria (refer to section 2.8 in the literature review). The communication approach can be top-down or bottom-up or non-specific. Eleven respondents noted that the top-down approach is the major communication approach within their organisations. According to respondent QS4 who is a chairperson of the company: *"…communication within our company is very easy and fluid, but at times it depends on the communication between the staff and the temporary staff, but our structure is simple".*
In this response, the respondent QS4 also indicated that communication between the staff and other staff who are temporary workers within the office and on the site is very essential. Although, the management of the company can be involved in daily communication via memos as indicated by respondent QS1: "…*We send out memos and organise a meeting with the staff. There is no specific pattern of communication..."*

The regular meeting in the office and memos are means of communication (Please refer to section 4.2.1.5). Respondent QS1 indicated that there is no specific approach within his

organisation. In this instance, it cannot be adequate to clearly identify certain problems within the organisation, which can be eliminated. Waste elimination will be very difficult if there is poor communication between workers and the management Four (4) respondents noted that regular memos are sent to the staff on a regular basis. This is based on the number of staff within the organisation. Three interviewees noted that new ideas could easily be communicated freely from the organisation. Kaizen may thrive in this type of organisations based on the acceptance of new innovation and ideas.

Theme 3-Waste reduction policy

In total eight (8) directors interviewed do not have any documented policy on reducing waste in their companies. Not all the eleven (11) respondents gave a direct response to waste reduction within their organisations. Nonetheless, five (5) interviewees noted that time management policy within the company is vital. Time management includes absence, lateness and keeping a working schedule. Only three (3) interviewees have existing waste reduction policy. However, this policy has to do with financial prudence and time management. Respondent PM2 noted that:

> *"…this is no policy on time management, but we have a documented policy on material waste reduction."*

All the three (3) respondents with waste reduction policy review their policies regularly. The concept of waste reduction in an establishment is an element of kaizen. This is related to the employee-employer relationship. In investigating the presence of kaizen within a small and medium scale construction company in Nigeria, identifying waste reduction policies within these organisations gave an inkling of how the management function addresses continuous improvement. Reviewing existing policies on waste reduction gives a clearer understanding of how the system behaves towards cost reduction (please refer to section 2.5.1).

Theme 4- Post-contract cost controlling techniques involving kaizen costing

In investigating the concept of post-contract cost control within a small and medium scale construction in eleven companies in Lagos Nigeria, provided a broad theme which is "***cost monitoring".*** Eight (8) out of the eleven respondents noted that cost monitoring of all forms is the major technique for project cost control. During the interview respondent, PM4 stated that:"

…The major technique we use is the conventional way of monitoring project as the project progresses. We also manage variations." The interviewees saw the monitoring process as a process which can be improved over the course of the project through kaizen. The monitoring activities as stated in section 4.2.1.1 and 4.2.1.2 provided an idea of how kaizen can be implemented with kaizen costing.

Theme 5-Post-Project reviews

The post-project review is a critical success factor for the implementation of kaizen costing. Post-project review is very different from the regular site meetings. It is a general meeting after the entire construction process that is used to evaluate the project performance. The seven (7) respondents highlighted that post-project reviews are conducted after the end of the project, and it has been having a great impact on their performance in subsequent construction projects. Respondent PM3 stated that: *"…Yes, we do organise after project meetings to analyse our performance, and we have been improving on it."*

The transcribed interview of respondent PM3 highlighted that the performance of the company has been improving over the years based on post-project reviews. Other respondents such as QS2 also stated that: *"…Post-project reviews have a positive impact on our projects, and it gives us the opportunity to identify our mistakes and improve our project delivery."*

Post-project reviews are important for continuous improvement within a construction organisation. This aspect creates a channel to implement the tenets of kaizen within a construction establishment (Please refer to section 2.8 and 2.9).

The findings of the interview for critical success factor of kaizen and kaizen costing in the Nigerian construction industry provides an opportunity for triangulation with the quantitative data from table 2.5. The first theme investigated the knowledge level of kaizen, and it indicated that kaizen or continuous improvement is still very new to contractors in Nigeria. Hence, the following themes after the first theme will be triangulated with the finding of the quantitative data.

a) Organisational culture
b) Communication approach
c) Waste reduction policy
d) Post-contract cost controlling techniques involving kaizen costing

e) Post-project reviews

The five these listed above were provided by the contractors in small and medium scale construction organisations. They do not have the full details of the drivers for the factors. Therefore, the quantitative analysis will provide additional information about how kaizen can be successfully implemented in Nigerian SMSCC. The quantitative analysis addressed the background of the companies in terms of openness to change, innovation and ideas before going to the factor analysis.

4.4.2 Quantitative analysis for research objective four involving critical success factors for the implementation of kaizen in Nigerian SMSCC

The critical success factors for implementing kaizen in SMSCC in Nigeria can be implemented by their perception towards change, innovation and new ideas were also investigated. The following sections addressed the perception of the respondents who were quantity surveyors and project managers in SMSCC in Nigeria. The critical success factors for kaizen implementation were extracted from literature review section 2.9, table 2.5.

4.4.2.1 Availability of Post-contract cost control template

The purpose of this question was to evaluate the standardisation of the post-contract cost control process in Nigerian SMSCC. The possibility of integrating kaizen costing with the available template during implementation is also imperative (please refer to section 2.6). Most construction companies have a template for post-contract cost control. This makes it easier for young cost and project managers to handle existing challenges without supervision. Furthermore, the overhead cost reduction can easily be enhanced using special templates for this process. The post-contract cost control template in most construction organisations is a total that enables the cost and project manager to understand the modus operandi of project cost control within the organisation. This also helps the cost and project managers have accurate evaluations during post-project reviews (please refer to section 4.4.1, theme 6).

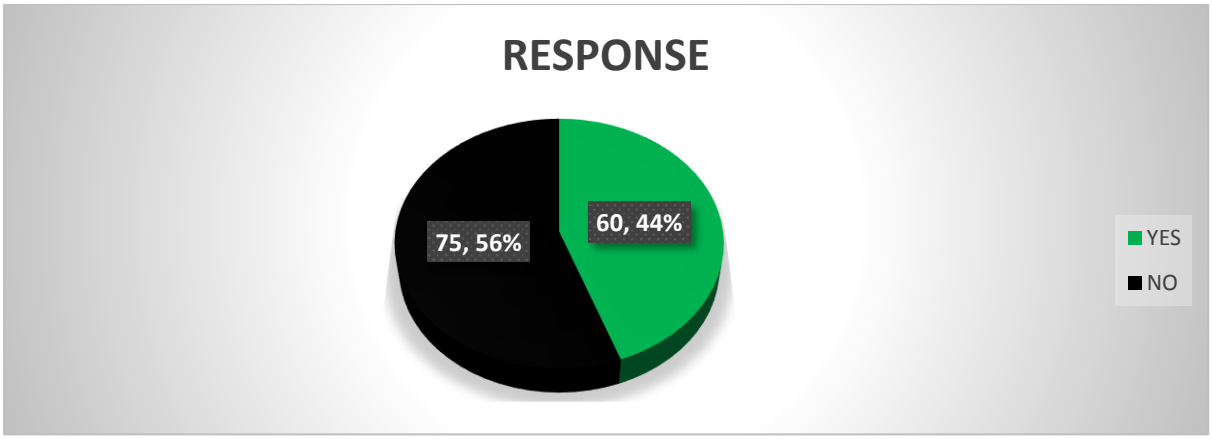


Figure 4.10. Pie chart showing the response to availability of Post-contract cost control template

The number of respondents indicated they made use of a special template for post-contract cost control is sixty (60), this is about forty-four (44) percent of the population, while seventy-five (75) respondents did not use a special template. Therefore, fifty-six (56) percent of the population had no organized framework for conducting post-contract post control during their projects.

Table 4.8. Job and Availability of a template for PC3 cross tabulation

			Availability of a template for PC3		Total
			YES	NO	
Job	Quantity surveyor	Count	33	44	77
	Project Manager	Count	27	31	58
Total		Count	60	75	135

The responses given by cost and project managers to the question based on the use of a post-contract cost control template can differ. Most quantity surveyors indicated that there was no cost reduction template within their organisation. The observed count is forty-four (44), only thirty-three (33) gave a positive response. The Thirty-one project managers responded negatively, while twenty-seven (27) project managers responded positively.

Table 4.9. Chi-Square Tests for the response to availability of Post-contract cost control template

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.183[a]	1	.669		
Continuity Correction[b]	.064	1	.800		
Likelihood Ratio	.183	1	.669		
Fisher's Exact Test				.728	.400
Linear-by-Linear Association	.182	1	.670		
N of Valid Cases	135				

The responses of the cost and project managers to this question probably depend on their job role. However, associating the job roles to the responses can be tested using the Chi-square test. This only proved the significance of the job role to the individual responses. The Chi-square test provided the continuity correction value of 0.064. The Asymptotic significance value, which is to test the association, is given as 0.800. The p-value should be less than 0.05. Therefore, there is no significance between the job roles of the respondent and the availability.

Table 4.10. Symmetric Measures table for the response to availability of Post-contract cost control template

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.037	.669
	Cramer's V	.037	.669
N of Valid Cases		135	

The effect of the job role on the responses was tested using the phi coefficient. The phi coefficient was given to be -0.037, this coefficient is very small, and it reflects the strength of the variables. Therefore, the respondents' job role had no significant effect on the availability of a template for post-contract cost reduction.

The availability of a template for monitoring and controlling cost during construction can make it easier for kaizen costing activities to take place. In a situation where there is no standardised procedure for conduction post-contract cost control, the incremental process of managing cost

during construction cannot be feasible in these companies. However, the level of openness to new ideas can make a change of processes during cost control possible.

4.4.2.2 Openness to new ideas within the organisation

This question is required to access the perception of SMSCC in Nigeria towards new ideas from the perspective of the employees. The employer (contractors) during the interview noted that post-project review is conducted in Theme 5 of section 4.4.1. Therefore, it is required to also verify from the employees. Openness to new ideas and innovation within these organisations was investigated in order to check the perception of the organisation towards change. In this instance, it is not related to implementing a new idea (please refer to section 4.4.1). The employees identify most problems; they feel open or free to communicate with the management. In cases where the employees feel, their ideas cannot be passed on to the management, then continuous improvement cannot exist in such a workplace.

The responses are based on the perceptions of the employees rather than management. This provided more suitable answers compared to the management, because in most cases the organisation may want to defend itself by providing positive responses. Nonetheless, it was gathered that nine (9) organisations out of the one hundred and thirty-five (135) responses were not open to new ideas or innovation from the employees. Sixty-five (65) respondents noted that their company was slightly open to new ideas. This implies that not all ideas are welcome and the respondents find it very difficult to communicate suggestions to the upper management.

Forty- six (46) respondents highlighted that their organisation is open to new ideas whenever it is presented to them. In this instance, they employees (respondents) find it very easy to communicate their suggestions and ideas to the upper management and them management acts on it to improve.

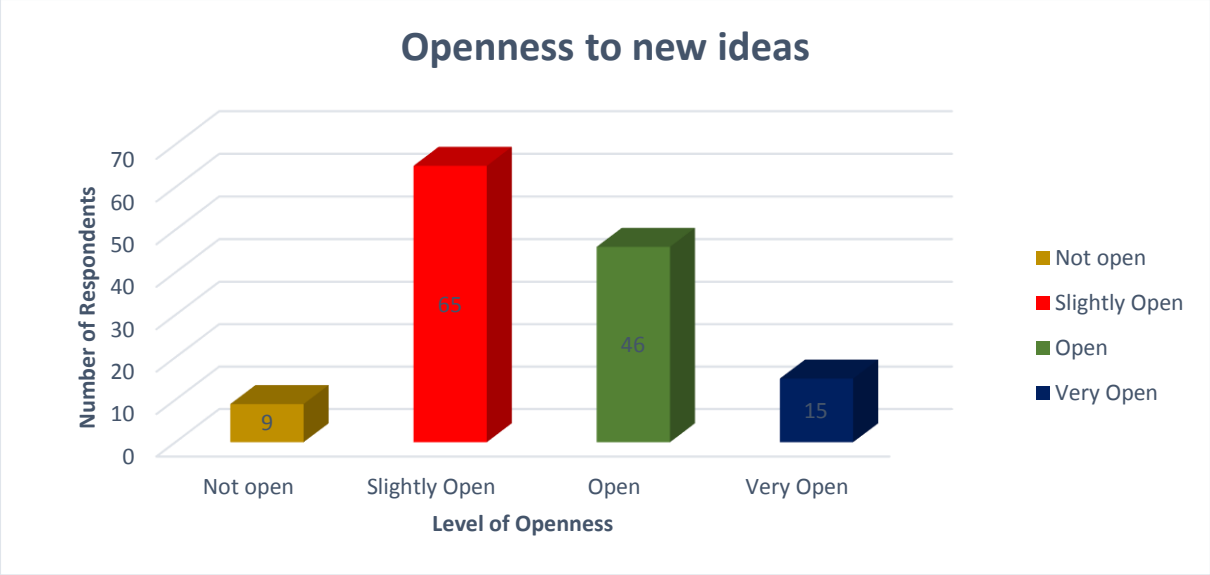


Figure 4.11. Bar chart showing the level of openness to new ideas

Fifteen (15) respondents only answered the "very open" category. This category of respondents indicated that their organisation made very good use of their ideas to improve and innovate quickly. In such an organisation, the management can have a research team. From the findings, very few small and medium scale construction organisations actually respond to new ideas, while the larger population of the respondents believe that their organisation is slightly open to new ideas and innovation.

Table 4.11. Job and Openness to new ideas and innovation cross tabulation

			Openness to new ideas and innovation				Total
			Not Open	Slightly open	Open	Very Open	
Job	Quantity Surveyor	Count	0	38	36	3	77
	Project Manager	Count	9	27	10	12	58
Total		Count	9	65	46	15	135

The position of the respondents (cost and project manager) is observed to be very different for each of the questions. Table 4.11 above reflects each respondent stand on the openness to new ideas and innovation within the organisation. Thirty-eight (38) quantity surveyors in small and medium scale construction companies in Lagos, Nigeria indicated that their organisation were

slightly open to new ideas and innovation. Thirty-six (36) quantity surveyors noted that their company is open to new ideas and innovation while only three (3) quantity surveyors stated that their company was very open to new ideas and innovation. No quantity surveyor stated that his or her organisation is not open to new ideas and innovation.

Table 4.12. Chi-Square Tests for Job and Openness to new ideas and innovation

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	28.855[a]	3	.000
Likelihood Ratio	33.046	3	.000
Linear-by-Linear Association	.710	1	.399
N of Valid Cases	135		

Chi-square for this type of table makes use of Pearson Chi-square value and asymptotic significance. In this computation, the asymptotic significance is 2 sided. The Pearson Chi-square value is 28.855, while the Asymp sig, is 0.00<0.05. The association value is also observed to be 0.71, and the asymptotic sig. is 0.399<0.05. This indicates a significant association between the job roles and the openness to new ideas and innovation in these companies. The respondents' views are not just random; they are targeted at the population of the cost and project managers.

Table 4.13: Symmetric measures for Job and Openness to new ideas and innovation

		Value	Approx. Sig.
Nominal by Nominal	Phi	.462	.000
	Cramer's V	.462	.000
N of Valid Cases		135	

The effect of respondents' views about openness to new ideas and innovation within the organisations is also evaluated using the Cramer V's coefficient. The Cramer's V coefficient in this study is given as 0.462. This is because any table which is larger than 2 by 2 uses the Cramer' V (Pallant, 2016). This value indicates that there is a medium effect almost close to 0.50 Cohen's criteria. Therefore, the job roles have a medium effect on the openness to new ideas and innovation.

From the findings from tables 4.11 to 4.13 indicates that this forty-eight point two percent (48.2%) of the respondents who are employees think that their companies are slightly open to new ideas and innovation. Slightly open in this study implies that the companies do not always accept new ideas and does not change easily. Continuous improvement on the management and post-contract cost control level may not exist. This is different from the interview findings in section 4.4.1 Theme 2, 3 and 6. The employees have provided a detailed account of how things are done within the organisation. Consequently, the study needs to look further into the encouragement of a new form of post-contract cost controlling technique such as kaizen costing.

4.4.2.3 Encouragement of a new form of post-contract cost controlling method

An organisations' ability to encourage new forms of post-contract cost control is an indication of accepting change and this related to the organisation's behaviour towards continuous improvement (kaizen). This is essential for the critical success factors and the post-contract cost controlling techniques. The views of the respondents to this question reflect how well the organisation is willing to adopt a new form of post-contract cost control. Although, the management of an organisation can be unwilling to innovate and make use of the new idea, the employees can be ready to make use of new forms of post-contract cost control methods and techniques (please refer to section 4.4.1, Theme 2). This was investigated, and the results indicate that over seventy (70) percent of the respondents wants a change in the post-contract cost controlling techniques used. This is indicated by the number of responses which is ninety-five (95) out of the total population of one hundred and thirty-five (135). Only forty respondents indicated that they did not want a change (this is about thirty percent of the respondents).

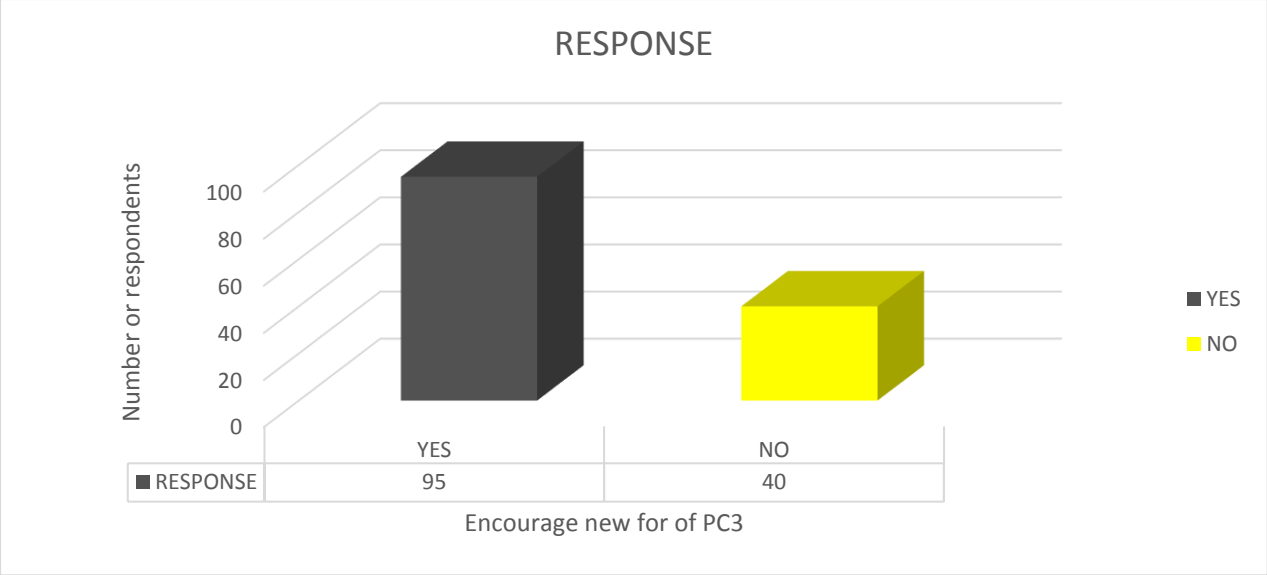


Figure 4.12. Bar chart illustrating the response to encouraging new form of post-contract cost controlling method

Based on the result so far, the use of the new method of post-contract cost control such as target costing, activity based costing and kaizen costing (please refer to sections 2.4.5 to 2.9), is alien to the respondents (Olabisi et al. 2012). However, the majority of the respondents who are cost and project managers wants a change of method and techniques in cost management activities in SMSCC in Lagos, Nigeria. Quantity surveyors' and project managers' views are differentiated in the table below. This reflects the number of cost and project managers who noted that they would encourage new forms of post-contract cost control.

Table 4.14. Cross tabulation for job and encouragement for new form of post-contract cost control

			Encourage new form of PC3		Total
			Yes	No	
Job	Quantity Surveyor	Count	55	22	77
	Project Manager	Count	40	18	58
Total		Count	95	40	135
		Expected Count	95.0	40.0	135.0

Fifty-five (55) quantity surveyors indicated that they would encourage a new form of post-contract cost control, while an observed count of twenty-two (22) noted that they would not encourage a new form of post-contract cost control. Forty (40) project managers noted that would encourage a new form of post-contract cost control. Nevertheless, eighteen (18) project managers stated that they are satisfied with the present post-contract cost control techniques used.

This variable is also important for the researcher to investigate the presence of kaizen philosophy within the organisation. The employees have an open perception towards a new form of post-contract controlling method or technique. They are open to change. Therefore, the problem with adopting new systems, methods and techniques will be with the management of the companies.

Table 4.15. Chi-Square Tests for job and encouragement of new form of post-contract cost controlling method

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.096[a]	1	.756		
Continuity Correction[b]	.014	1	.905		
Likelihood Ratio	.096	1	.757		
Fisher's Exact Test				.849	.451
Linear-by-Linear Association	.096	1	.757		
N of Valid Cases	135				

The Chi-square test was used to assess the association between the job roles of the participants interested in a new form of post-contract cost control. The continuity correction value of 0.014 was recorded and the Asymp. Sig. value of 0.756 was also recorded. Since 0.756>0.05, there is no significant association between job roles of the participants and the encouragement of a new form of post-contract cost control.

Table 4.16. Symmetric measures table for the encouragement of a new form of post-contract cost control

		Value	Approx. Sig.
Nominal by Nominal	Phi	.027	.756
	Cramer's V	.027	.756
N of Valid Cases		135	

The phi coefficient of 0.027 is recorded for the test of the strength of association between the job role of the respondents and the encouragement of a new form of PC3. This value, 0.027 is very small and shows that the job role has no effect on interests in the new form of post-contract cost control. Therefore, the encouragement of a new form of PC3 is very independent of job roles.

This section has presented the findings of the presence of kaizen costing in small and medium scale construction companies in Lagos, Nigeria. The type of methods used for post-contract cost control and availability of templates in section 4.4.2.2. The respondents' perception towards change in terms of post-contract cost controlling method is positive considering the findings of tables 4.14 and 4.15 above.

The respondents' view of change indicates readiness for kaizen and kaizen costing if introduced. Based, on the findings from section 4.4.2.1 to 4.4.2.3, the existing employees in Nigerian SMSCC are willing to adopt a new method of controlling cost on site. However, it seems the employers are not so willing to change to any new method or technique because of the cost which can be involved. The impact in this investigation on the critical success factors will be discussed in section six. Consequently, an evaluation of the critical success factors in the next section aided further discussion of the strategic change in post-contract cost control within the Nigerian construction industry.

4.4.3 Quantitative analysis of the critical success factors for implementing kaizen in SMSCC in Nigeria

Section 4.4.2 addressed the readiness of Nigerian SMSCC for kaizen. The readiness looked at the perception towards change, openness to new ideas and the available structure of post-

contract cost control. This section looks at the identified factors from a literature review in table 2.5, section 2.9. The findings of this section will be combined with section 4.4.1 and 4.4.2. The overall purpose of the analysis from section 4.1 to 4.4.3 is to develop a strategy for realigning the post-contract cost control process in Nigerian SMSCC. This can only happen by understanding the problems with the post-contract cost control process.

Change of post-contract cost controlling method is possible within the Nigerian construction industry. This is based on the findings of section 4.4.1 and 4.4.2. In the interview, some contractors are ready to adopt kaizen, and in the quantitative background findings of the critical success factors, cost and project managers are ready to adopt new methods for post-contract cost control. Hence, the literature review and interview findings provided an opportunity for post-contract cost control to be improved with a modern method such as kaizen.

To check the reliability of data obtained from the respondents, Cronbach alpha was used. The reliability as stated in section 3.9 is very important before data analysis. In all, there are one hundred and twenty (120) valid data for this analysis. This is 88.9% of the total 135 responses. Only 11.1% of the data is missing.

Table 4.17: Reliability statistics for the critical success factors

Cronbach's Alpha	N of Items
.947	48

The Cronbach alpha value is 0.95; this shows a very good internal consistency of the data. According to Pallant (2016), the closer the value of the Cronbach alpha towards 1 the greater the internal consistency. The reliability of the factors from the literature review has been established. Hence the factoring process will reduce and group the factors into the required classes. This starts with the Kaiser-Meyer-Olkin measure of sampling procedure from factor analysis. Factor analysis as explained in section 3.8.9 is required for the empirical reduction and classification of the factors into critical groups.

Factor analysis as discussed in section 3.8.9 will be used to resolve the fourth objective. A number of factors have been identified using the review of focal literature in section 2.9 and table 2.5. Forty-eight factors were identified based on the categories of organisational structure,

contract procurement and documentation, construction process and technical know-how, government and regulatory influence, financial risk management and litigation, communication and teamwork, decision making and finally relationship management. These categories were only used to make it easier for the respondents to fill the questionnaire. The critical success factors were tested using the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy to assess the adequacy of the data for factor analysis. This is based on the principal components. If the KMO is above 0.6, then the data is unreliable for the analysis. The first stage of the KMO test did not provide the required sampling adequacy. This is indicated in appendix table E from table 5.34 to 5.38. Four factors (drivers) were eliminated to give the KMO and Bartlett's test in the table below:

Table 4.18. KMO and Bartlett's test after the second iteration

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.639
Bartlett's Test of Sphericity	Approx. Chi-Square	5008.688
	df	946
	Sig.	.000

Therefore, some factors have to be eliminated. Some unimportant factors with less than 0.4 coefficient in the correlation matrix will be eliminated. An eigenvalue of 1 was used for the principal components. The findings of the scree plot for the forty-eight (48) factors which were later reduced to forty-four (44) factors for KMO adequacy provided four major categories from the elbow of the curve. This is illustrated below.

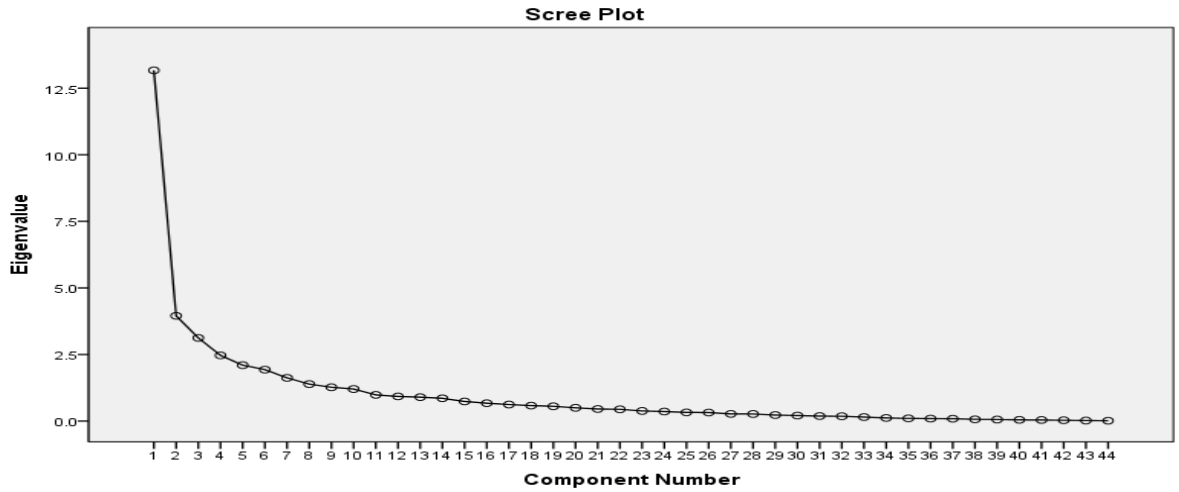


Figure 4.13. Scree plot showing the eigenvalues

Eleven (11) eigenvalues were produced using the communalities. These values are above 1.0, and the scree plot in table 5.40 indicates that the elbow breaks at the fourth point on the graph from the left. The component transformation matrix will be produced using the four identified factor.

Table 4.19. Component transformation matrix

Component	1	2	3	4
1	.612	.523	.443	.393
2	-.145	-.659	.480	.561
3	-.344	.306	-.522	.718
4	-.697	.446	.548	-.126

The component transformation matrix from the principal component extraction also made use of the Varimax with Kaiser Normalisation rotation method. This method extracts the four major components. The four components identified from the scree plot extraction method are correlated with each other for further analysis to prove their correlation. The rotated matrix provides the coefficients of the factors, which are categorised into the four categories. These are presented in the table 4.20 below.

Table 4.20. Rotated matrix table for the factors

Drivers	Component			
	1	2	3	4
Flexible organisation policy	.778			
Existing continuous improvement policy	.681			
Government regulations	.631			
Organisation structure and communication	.614			
Architect/project managers' decision	.598			
Project complexity	.590			
contractor/QS relationship	.585			.503
Employee experience	.572			
Variations and rework during construction	.541			
Excellent remuneration and motivation	.540		.409	

Experienced QS and other staff	.466			
Excellent employee/employer relationship	.459			
Disputes and litigations	.431			
Clarity of exclusions in the contract	.426			
Architect/QS relationship				
Employee empowerment				
Improved teamwork		.752		
Financial status of the company		.730		
Price and design risk		.700		
Excellent working conditions		.667		
Influence of construction professional bodies		.605		
Training of inexperienced employee	.404	.578		
Post-project reviews of cost information		.578		
Contractor decision making		.562		
Standardised production process		.483		
QS site experience	.409	.482	.414	
Regular site meetings		.472		.406
Stability of market conditions				.727
Quality of cost information			.704	
Fraudulent practices and kickbacks			.685	.403
political stability	.427		.684	
Subcontractors' cost			.672	
Payment delays			.643	.446
Price fluctuations			.639	
Suppliers' cost of materials			.571	
Improved contractor-client communication	.473		.538	
Contractor/subcontractor relationship				.727
Contractor/suppliers relationship				.720
QS decisions				.663
Communication among project professionals		.432		.662
Management of overheads on cost				.636
Claims				.618

In-depth knowledge of production process		.509		.564
Construction method		.433		.499

The extraction method was based on the principal Component Analysis. The rotation Method employed Varimax with Kaiser Normalization. The rotation converged in 20 iterations. The four factors extracted with an eigenvalue greater than 1 was used to re-categorize the drivers into four major components as listed in the table above.

The values of the factors which appeared in different components are selected based on the highest value. The overall categorization of the forty-four drivers is named and presented in the table below.

Table 4.21. Categorisation of the drivers into factors

Driver	First CSF **Management function**	Second CSF **Operational efficiency**	Third CSF **Construction Business Management Ethics**	Fourth CSF **Construction cost management**
Driver	Flexible organisational policy	Improved teamwork	Quality of cost information	Stability of market conditions
Driver	Existing continuous improvement policy	Financial status of the company	Fraudulent practices and kickbacks	Contractor/subcontractor relationship
Driver	Government regulations	Price and design risk	political stability	Contractor/suppliers relationship
Driver	Organisational structure and communication	Excellent working conditions	Subcontractors' cost	QS decisions
Driver	Architect/project managers' decision	Influence of construction professional bodies	Payment delays	Communication among project professionals
Driver	Project complexity	Training of inexperienced employee	Price fluctuations	Management of overheads on cost
Driver	contractor/QS relationship	Post-project reviews of cost information	Suppliers' cost of materials	Claims
Driver	Employee experience	Contractor's decision making	Improved contractor-client communication	In-depth knowledge of production process
Driver	Variations and rework during construction	Standardised production process		Construction method
Driver	Excellent remuneration and motivation	QS site experience		Architect/QS relationship
Driver	Excellent employee/employer relationship	Regular site meetings		Accuracy of estimates

Driver	Experienced QS and other staff			
Driver	Disputes and litigations			
Driver	Clarity of exclusions in the contract			

The forty-four drivers have been allocated to the critical success factors based on the pattern matrix. The names given to the categories are based on the similarities between the drivers. The most important drivers in each category are now tested for their level of importance using Kendall's test for concordance. The four factors are management function, operational efficiency, construction business management ethics and construction cost management as discussed in the sub-sections below

4.4.3.1 Assessing the drivers for the management function critical success factor

In assessing the drivers for management function, Kendall's coefficient of concordance was used to address the major significance and mean rank of rank of the drivers. Excellent remuneration and motivation ranked highest with a value of 29.85. This driver also has a very high significance value of 0.002. Excellent employee/ employer relationship ranked second with a value of 27.66.

Table 4.22. Significance and mean values for the first critical success factors.

Management Function	Asymp Sig.	Mean	Rank
Excellent remuneration and motivation	0.002	29.85	1
Excellent employee/employer relationship	0.047	27.66	2
Employee experience	0.139	25.86	3
Project complexity	0.199	25.65	4
Government regulations	0.035	25.42	5
contractor/QS relationship	0.003	25.06	6
Variations and rework during construction	0.000	25.01	7

Experienced QS and other staff	0.628	24.86	8
Architect/project managers' decision	0.019	23.81	9
Organisational structure and communication	0.931	23.36	10
Clarity of exclusions in the contract	0.026	23.04	11
Existing continuous improvement policy	0.004	21.91	12
Disputes and litigations	0.100	19.11	13
Flexible organisational policy	0.047	17.48	14

Excellent remuneration has the highest rank with a mean score of 29.85; excellent employee-employer relationship has a means a score of 27.66 and is ranked second. The third rank on the list of drivers is employee experience at 25.86. The mean ranks are also compared to the asymptotic significance values that should be less than 0.050 for a level of significance. The most significant driver is variation and reworks during construction at 0.000, while excellent remuneration has a significant value of 0.002. The contractor-quantity surveyor relationship is significant at 0.003.

4.4.3.2 Assessing the drivers for operational efficiency critical success factors

The mean ranking identified 26.01 for the mean of excellent working conditions. The asymptotic significance is 0.001. The contractor's decision making was ranked second with a mean value of 24.74 and a high significance of 0.006. The experience of the quantity surveyor resident on the site is 24.69 but this driver is insignificant.

The price and design risk has a mean score of 19.44 and a significant value of 0.013. Post project reviews of cost information were ranked lowest with a mean score of 17.20. The significance of post-project review is high at 0.041. The post-project review is very important for the implementation of kaizen and kaizen costing for construction. This is because the review of the completed project data and cost information provides an avenue for the SMSCC to improve continually. The values of the mean score and significance for operational efficiency on construction sites has been summarised in table 4.23.

Table 4.23. Ranking of the factors for operational efficiency

Operational efficiency	Asymp. Sig.	Mean	Rank
Excellent working conditions	0.001	26.01	1
Contractor's decision making	0.006	24.74	2
QS site experience	0.466	24.69	3
Training of inexperienced employee	0.405	24.60	4
Regular site meetings	0.205	21.86	5
Influence of construction professional bodies	0.119	21.74	6
Improved teamwork	0.567	20.06	7
Financial status of the company	0.115	19.84	8
Price and design risk	0.013	19.44	9
Standardised production process	0.092	18.21	10
Post-project reviews of cost information	0.041	17.20	11

4.4.3.3 Assessing the drivers for construction business management and ethics critical success factor

The main three drivers for construction business management and ethics are improved contractor-client communication; quality of cost information and subcontractors' cost. The mean values for each of these are 26.29, 25.71, and 22.71 respectively. The main significant drivers for this factor are suppliers' cost of materials; political stability and quality of cost information with values 0.000, 0.002 and 0.029 respectively.

Table 4.24. Ranking of factors for construction business management and ethic

Construction Business Management and Ethics	Asymp Sig.	Mean	Rank
Improved contractor-client communication	0.091	26.29	1
Quality of cost information	0.029	25.71	2
Subcontractors' cost	0.641	22.16	3
political stability	0.002	21.79	4
Payment delays	0.505	20.70	5
Suppliers' cost of materials	0.000	20.45	6
Fraudulent practices and kickbacks	0.367	19.81	7
Price fluctuations	0.115	18.74	8

Fraudulent practices and kickbacks is a major issue with most construction businesses in Nigeria. This factor was ranked 7th with a mean of 19.81 and a significance value of 0.367. The issues of kickbacks relate with a collection of bribes and award of subcontracts, which with some amount of money returned back to the awardee. The respondents can perceive this process to be a normal situation. However, this factor is very important for the adoption of kaizen costing on SMSCC in Nigeria.

4.4.3.4 Assessing the drivers for construction cost management

Construction cost management is a very important factor the implementation of kaizen costing in the post-contract cost control process. This factor was titled construction cost management because of the planning activities evident in the drivers. The activities with the most important mean scores are claims, updating cost information during construction, the stability of market conditions. These drivers have mean scores of 24.62, 24.05 and 23.85 respectively.

The most significant drivers are the quantity surveyors' decision on the site (0.019); stability of market conditions (0.006) and updating cost information during construction (0.009).

Table 4.25. Ranking for construction cost management

Construction cost management	Asymp Sig.	Mean	Rank
Claims	0.043	24.62	1
Updating cost information during construction	0.009	24.05	2
Stability of market conditions	0.006	23.85	3
Accuracy of estimates	0.527	23.77	4
In-depth knowledge of production process	0.277	23.18	5
Architect/QS relationship	0.077	22.42	6
QS decisions	0.019	21.32	7
Construction method	0.67	21.26	8
Communication among project professionals	0.89	20.13	9
Contractor/suppliers relationship	0.719	19.87	10
Management of overheads	0.800	18.24	11

These drivers have the most significant values for construction cost information critical success factor. Most contractors view claims as an avenue to make more profit in the Nigerian construction industry. This process usually starts from the measurement of construction work, estimation, and stability of market conditions. The management of overheads was ranked 11th with the lowest mean score of 18.28. Overhead management by the contractor is one of the most important monitoring techniques in post-contract cost control. This is also very vital for incremental cost management. The respondents who are employees of SMSCC in Lagos, Nigeria have not identified this factor as an important one for the implementation of kaizen and kaizen costing.

4.5 Summary of data analysis

The background of the respondents' organisation, which have been assessed as being small and medium scale in nature, were evaluated for performance. The background also indicates that 98% of the post-contract cost controlling methods used in Nigerian SMSCC is the traditional method. The remaining 2% use activity based costing and earned value analysis. The first research objectives have been resolved in section 2.1 and in table 2.1. The focus of the analysis was on the second, third and fourth research objectives.

The second objective that covers the assessment of post-contract cost controlling techniques in Nigerian SMSCC. This objective viewed post-contract cost controlling techniques from the perspective of effectiveness and importance with the interview opinions of the contractors. The type of post-contract cost controlling technique used in the Nigerian construction industry was extracted from literature, and the interviewees identified, monitoring of building material cost, contractors' activities, regular site meetings, interim valuation and cashflow calculations the techniques used in post-contract cost control in Nigeria. The assessment of the post-contract cost controlling techniques made use of Kendall's coefficient of concordance to assess the effectiveness and importance of post-contract cost controlling techniques in the Nigerian construction industry. This is because the researcher intends to create a two-point view of validating the consistency of the assessment. Monitoring of the cost of building materials was identified as the most effective and most important factor. Monitoring labour cost is also viewed as very important, but second to the Mariela cost. Interim valuations have proved to be very effective also. Quantity surveyor always uses interim valuations. Variation management, cashflow calculation and monitoring of overheads are also very important for the post-contract cost control process according to studies. However, these aforementioned techniques were ranked very low on the effective and importance scales. Cashflow was ranked as the lowest for the effectiveness chart, while variation management was ranked lowest for the importance chart. Nonetheless, these techniques will be included in the IDEF0 model design as part of the framework.

The third research objective in this study investigated critical activities for post-contract cost control process. These activities were ranked using Kendall's coefficient of concordance and the relationship between the activities was identified using spearman correlation. The ranking revealed that the overhead cost relating to the payment of subcontractors and suppliers could be reduced incrementally to create more profit for the contractor. This activity was ranked highest, activities relating to the reduction of purchase orders was ranked second while the cost incurred from hiring plants and equipment was ranked third. The spearman correlation also provided the feedback for the relationship between these activities. The overhead cost reduction for payment of supplier and subcontractors and purchase order for building materials reduction are related. Reducing overhead cost and ensuring that variations are adequately minimised over the course of the execution phase are linked together. These activities will be part of the IDEF0 model for the framework.

The fourth research objective covered the qualitative and quantitative investigations of the critical success factors for implementing kaizen in SMSCC in Nigeria. The background of the respondents and their inclination towards continuous improvement and change was also examined. The background was examined to create an overall view of how cost and project managers working in the companies where the interview took place perceive change. It was deduced that cost and project managers are very open to new forms of post-contract cost controlling methods such as kaizen. Therefore, if kaizen can be implemented if the respondents agree to explore kaizen with traditional post-contract cost control procedure. The openness to new ideas within the populations' companies is slightly open at a percentage of forty-eight point two percent (48.2%). These figures indicate that kaizen is in SMSCC is still very new to cost and project managers. Nonetheless, the respondents are open to the use of a new form of post-contract cost control mechanism. This is evident in the seventy percent (70) of the respondents who agreed to this suggestion. The interview findings extracted six major themes which are related to what was extracted from literature in section 2.9. The findings noted that organisational culture, communication approach, waste reduction policy, post-contract cost controlling techniques with kaizen costing and post-project reviews are critical for the successful implementation of kaizen. The factor analysis was used to categorise the factors into four categories. These are management function, operational efficiency, construction business management and ethics and construction cost management.

The next section will address the findings from each research objective based on the research strategies of literature review (for the first objective), survey interviews and survey questionnaires. The discussion section explained the summary of the findings in the chapter and supported it with relevant literature.

Chapter Five

Discussion of Findings

5.0 Introduction to discussion of findings

This section discusses the findings of the research objectives in chapter one and the findings in section four. The findings have made use of the statistical and qualitative methods used in section 3.7.7.1 to 3.7.7.5. The summary of the findings from section four is discussed in this section for the purpose of designing the kaizen framework in section six. They are further elucidated in the conclusion chapter.

5.1 Research objective two: Post-contract cost control in the Nigerian construction industry

The evaluation of these post-contract cost controlling techniques was carried out using the test for the level of agreement and ranking. This was done using Kendall's coefficient of concordance. The perspectives of the evaluation were based on effectiveness and importance. The process of developing a new approach for the SMSCC in Nigeria started with the review of the focal literature. The literature review findings of post-contract cost control techniques started with the evaluation of focal literature relating to the cost management systems and method in Nigeria. The detailed analysis of the literature findings of the type of post-contract cost controlling techniques used around the world was evaluated in section 4.2.2.2 and 4.2.2.3. This listed out eighteen different type of post-contract cost controlling techniques used in the construction industry. The detailed explanation and description of these techniques were discussed in table 2.1. The elucidated list of post-contract cost controlling techniques from the literature was also used for the Nigerian construction industry. The findings of the literature review indicated that most quantity surveyors around the world and academics find it difficult to differentiate between post-contract cost controlling techniques and construction methods and systems.

During the interview in SMSCC, the type of post-contract cost controlling techniques used in the industry was mainly identified monitoring of building materials cost, subcontractor's activities, interim valuation, regular site meetings and cashflow calculations. This was

explained in section 4.1.2.1 to 4.1.2.3. The findings from the contractors were used as part of the survey question in appendix D.

The further quantitative analysis was carried out on the type of post-contract cost controlling techniques in Nigeria with the aid of Kendall's coefficient of concordance test to rank the post-contract cost controlling techniques and also evaluate the level of agreement between the respondents; this was analysed in section 4.2.2.2 and 4.2.2.3. The evaluation aspect of the objective was carried out using Kendall's coefficient of concordance. The Kendall's W test ranked the various post-contract cost control techniques and also evaluated the most effective techniques and most important techniques. The most effective and most important techniques were identified as monitoring material cost. Cashflow was ranked lowest as the least effective technique. Variation management is at the bottom of the most important technique. Using working budget during the construction process was ranked second as an effective technique. The bill of quantities according to Rad (2002) and Oyedele (2015) have a lot of inaccuracies with the use of measurement CAD software. Once there is a problem with the design, there will be inaccurate estimates.

In section 2.1 of the literature review, Ashworth and Perera (2015) highlighted the first step of post-contract cost control as being monitoring and interim valuations, cashflow, monthly statements and issuing final certificates as the major steps for post-contract cost control. The techniques were no highlighted. Monitoring cost involves performance metrics (Oyedele, 2015), cost controlling activities depends on the processes on the site are within budget. Some of these processes include a site visit, meetings, monthly cashflow calculation and payment of contractors. Some authors argue that you cannot control cost but only monitor what is going on during construction and take corrective actions. The debate between cost monitoring and control activities can only be because of the semantics. For this investigation cost control is the art of reducing unnecessary expenses during construction, while budget monitoring is the process of ensuring the project is within the established working budget, hence bill of quantities.

The findings of the literature review for post-contract cost controlling techniques correlate with the interview findings to an extent. The interview findings only provide five post-contract cost controlling techniques in section 4.2.1. The only difference between the findings of literature review and the quantitative analysis of sections 4.2.2.2 and 4.2.2.3 indicate a problem with

cashflow. The cashflow calculation is an integral part of the post-contract cost control Ashworth and Perera (2015). However, cashflow in the quantitative analysis of 4.2.2.2 and 4.2.2.3 indicated that it has low effectiveness and importance. Nonetheless, due to the importance of cashflow in the post-contract cost control process, it will be part of the kaizen framework in this study.

Kaizen costing pertains to reducing expense during construction and maintaining quality for optimum profit and client satisfaction (MÍkva et al. 2016; Knechtges & Decker 2014; Radharamanan et al. 1996). Therefore, the controlling activities on the site based on the techniques should include the principles plan-do-check-act. The plan-do-check-act as explained in section 2.6 will require one of the professional stakeholders to be activity involved in the plan-do-check-act process. The framework for post-contract cost control will definitely involve monitoring activities as interim valuations as a major process for incrementally reducing the expenses on site. The IDEF0 model will be used for this process. The involvement of stakeholders and collaboration during the kaizen costing process is also very necessary. The involvement of stakeholders for cost reduction during construction is very important, for the post-contract cost control (MÍkva et al., 2016; Knechtges & Decker, 2014; Radharamanan et al., 1996; Recht & Wilderom 1998; Higuchi et al., 2015; Tsao et al., 2015; Ortiz, 2010; and Maarof & Mahmud, 2016). Collaboration in the workplace and with the client is a pre-requisite for the implementation of continuous improvement in every respect. This challenge is the organisational learning process within the organisation (please refer to section 4.2.1.6). Cost data should be stored for future use and the outcomes of the final project cost. The Nigerian SMSCC needs to adopt organisation learning through reviewing past project and involve good housekeeping during cost monitoring on site through the plan-do-check-act process. Organisational learning is a culture built over time within the organisation that intent to improve their entire operations. In this instance, organisational learning is important for post-contract cost controlling techniques through post-project reviews.

The analysis of post-contract cost controlling techniques reveals that the kaizen framework will depend on monitoring of building material on the construction site, interim valuations and using established working budget, variation management monitoring overhead and cashflow analysis. The aforementioned post-contract cost controlling techniques will be part of the IDEF0 model for improvement.

This section has amplified the evaluation of post-contracted cost control from section 4.2.2.2 and 4.2.2.3 into organisational learning and the need to improve post-contract cost control process. This improvement can be carried using kaizen costing (please refer to section 2.4.5). Hence, the need to understand how kaizen costing can work with the traditional post-contract cost control process used in the Nigerian industry as identified in section 4.1 is imperative.

5.2 Research objective three: Crucial activities which kaizen costing require on construction sites in Nigeria

This research objective pertains to identifying and critically assess the most critical post-contract cost control activities required for continuous cost reduction needed for kaizen costing in SMSCC in Nigeria.

The critical post-contract cost control activities for continuous cost reduction required for the implementation of kaizen costing were identified from the literature review. The analysis shows that *overhead cost related to paying suppliers, subcontractors and labourers could be reduced continually throughout the construction phase to keep the project cost within budget* was ranked highest with a score of 5.02. This implies that stakeholder's involvement is vital to the implementation of kaizen costing. In most instances, suppliers and subcontractors have a great impact on the final cost of construction in Nigeria. If these costs are not checked, cost overruns and project abandonment can occur due to limited project finance. *Continual cost reduction of overhead cost of activities related to mobilisation and equipment setup will keep the project cost within budget* was ranked lowest with the least score of 3.93. Mobilisation and equipment setup for construction work on the site was discovered to be the least important cost for the respondents in small and medium scale construction companies. This can be because these companies had simple projects, which did not require larger equipment and plants. Also, the cost of mobilisation and equipment hiring is fixed and cannot be reduced continually over time.

Olawale and Sun (2013) opined that the nominated subcontractors' and suppliers' have a major role to play which can influence the final cost of construction projects. The continual reduction of overheads costs resulting from the activity of suppliers, subcontractors and labourers will definitely create more profit and value for the contractor and project. In most cases, it is very difficult to monitor the activities of the suppliers because of certain forces in the Nigerian

construction industry. This type of influential factor includes conspiracy with a project team member to inflate the prices of the construction materials, kickback and other vices on the construction site. Inflation, foreign exchange rate and market forces also affect the supplier's and subcontractors' cost.

Incremental reduction of activities related to purchasing orders and material deliveries was identified as the second critical activity. The kaizen team can focus on this aspect to ensure that the wastage arising transportation of material to site and purchase orders are kept within an allowable cost limit. The cost limits allowed can have a profit and overhead of twenty-five percent plus (25 %+). In some construction companies, it is a management function. However, focusing on actions relating to purchase orders and material deliveries will definitely assist the contractor in getting more value for money and client satisfaction.

Continual reduction of plant and equipment depreciation overhead cost throughout the construction phase will keep the project cost within budget was ranked third on the scale. The plants and equipment hiring cost, depreciation and maintenance cost are highly important. This aspect is very difficult to maintain and incrementally reduce cost. This aspect is very critical to the success of the project. The final account for the project depends on these factors. Therefore, the quantity surveyor needs to address precise steps, which pertain to plant and equipment hiring.

Furthermore, spearman rho's correlation test was conducted to link the most important activities, continual reduction of overhead cost relating to payment of supplier and subcontractor with other activities. The findings revealed that overhead cost relating labourers, suppliers and subcontractors cost can be related to construction variation changes is very essential. Subcontractors and suppliers payments can lead to variations when there are several changes during the course of the project. Moreover, claims are paid to contractors when there are variations in construction. Minimising claims will reduce the effect of a dispute between contractors and clients (Brand and Davenport, 2012; Champion, 2011; Druker and White; 1997). Moreover, most contractors have viewed construction projects as opportunities to claim for funds arising from variation. Therefore, contractors expect more variation during the course of the project timeline. The relationship between administrative overheads relating to payment overheads is related to claims.

Claims in Nigerian construction industry was studied by Olanrewaju and Anavhe (2014), the author concluded that claims are always existing in most construction projects and to avoid enormous claims stakeholders, participatory approach should be adopted. Olanrewaju and Anavhe (2014) also added that most claims are behavioural issues rather than technical matters. Since behavioural issues are important in claims management for overhead cost and other unnecessary charges for the client; the contractor needs to have a positive attitude towards variation management and claims. More attention has to be given to claims reduction and variation management in the IDEF0 model for the framework. The post-contract cost control process for a hypothetical project identified in figure 2.3 from chapter 2 becomes more complicated and incur additional cost as a result of claims. Apart from claims, there are correlations between the critical activities for kaizen costing implementation which can indicate additional challenges for resolution.

The second type of correlation identified was between the payment of labourer, suppliers or subcontractors and overhead cost relating to purchase order, the cost of construction materials. These correlation results were related to supplier and subcontractors. When materials are supplied to the construction site, the supplier and subcontractors are paid. If the overhead cost relating to this process if reduced continually. There will be an overall effect on the performance of the project in terms of delivery time, profit, quality and relationship with other stakeholders.

The findings of the literature review in section 2.5.1 provided details of important activities on construction sites which can lead to cost overrun as a result of the overhead costs involved in these activities. The findings of section 4.3 and 4.3.1 correlated with the findings of most authors in the construction cost management field such as Potts (2008), Oyedele (2015), Rad (2002), Ashworth and Perera (2015) and Samphaongoen (2010) have all identified the key principle of reducing cost during construction. The expenses are related to the construction activities, building materials, purchase orders, administrative charges, overheads and all other miscellaneous expenses. Overhead cost related to payment of suppliers and subcontractors, purchase orders and equipment cost are related to post-contract cost controlling techniques such as monitoring of building material, labour and equipment. The aforementioned activities will be linked to the identified major techniques in 5.1 in the IDEF0 model for framework development.

Having addressed the post-contract cost controlling techniques in section 5.1 and the critical activities which can be enhanced with kaizen costing during post-contract cost control in section 5.2, the critical success factors for the adopting of kaizen in SMSCC will aid the preparation of the framework with the available findings discussed above.

5.3 Research objective four: Critical success factors for the implementation of kaizen in Nigerian SMSCC

This research objective was addressed through a combination of semi-structured interviews and survey questionnaires. Although, it can be difficult to identify precisely the critical success factors for kaizen in Nigeria construction industry, the interview process was combined with the findings of section 2.9 and table 2.5. One hundred and thirty-five (135) respondents answered the survey questionnaires. The questions asked was based on openness to new ideas and innovations. The findings revealed that forty-eight percent (48%) of the respondents believe that their organisation was slightly open to new ideas and innovation, while thirty-four percent (34%) of the respondents. Eleven percent (11%) responded that their organisation was very open and just seven percent (7%) of the respondents think their organisation was not open. The cost and project managers' opinion of communicating with the upper management whenever they had ideas was investigated based on their company's perception towards change. The overall findings revealed that smallest and medium scale construction companies are not very open to new ideas and innovation. The respondents' view of change was further assessed through the question in section 4.4.2.3 which has to do with the encouragement of a new form of post-contract cost control. Ninety-five (95) respondents stated that they would encourage a new form of post-contract cost control, while forty (40) respondents indicated "NO". This implies that over seventy percent (70%) of the respondents would encourage a new form of post-contract cost control.

The post-project review is a critical success factor for kaizen implementation. This theme was discovered during the interview process to be present in seven (7) small and medium scale businesses (section 4.4.1, theme 6). Post project reviews have been having a positive impact on these businesses (Teale, 1995; Singhvi, 1986). This is relevant for Nigerian SMSCC to improve their competitiveness and grow. This concept always yields result in project management (Earnest, 2015; Walker, 2009; Kransdorff, 1996; Andersen et al,. 2011) and will invariably improve post-contract cost control. Organisational learning is essential for the

capturing tacit and explicit knowledge within organisations (Teale, 1995; Andersen et al., 2011). Post-project reviews follows the process has to ensure that a facilitator is in charge of the process; stakeholders are involved (in some case the community); gather facts and opinions; the process has to be non-judgemental with all fairness; ensure the findings are implemented, and measures have to be put in place for monitoring and feedback (Singhvi 1986; Walker, 2009). This process is very similar to kaizen's plan-do-check-act process.

In a situation where the director of construction companies has been familiar with post-project reviews, introducing a continuous improvement to them will be at ease compared to the remaining four (4) companies that stated that they do not use post project reviews. The availability of a framework for cost reduction such as cost control template lacks in fifty-six percent (56%) of the construction companies. However, forty-four percent (44) of the companies had a template. The importance of innovation in SMSCC can have a relevance if the because the employees are ready to encourage the implementation of a new form of post-contract cost control.

Generally, this investigation discovered that a larger proportion of these companies operate without an adequate framework to reduce waste within the office, communicate properly with the employees, create adequate channels for innovation and new ideas and implement new cost management policies. Stakeholders were not engaged during key activities and there is no cost reduction and maintenance policy. Nonetheless, these SMSCC are willing to adopt new methods and techniques to drive their business forward competitively (please refer to section 4.4.2.1 to 4.4.2.3). Organisational learning through post-project reviews meetings is very important for developing SMSCC. The entire process of identifying kaizen philosophy in SMSCC is to investigate the platform for introducing kaizen and kaizen costing. The next step will involve the activities which will require kaizen costing activities.

Factor analysis explained in section 3.7.7.5 was used to reduce the factors and create the critical success factors. The investigative process for identifying the important forty-eight factors for the implementation of kaizen in Nigerian SMSCC. The drivers have been listed in table 2.1, section 2.9. The drivers were categorised into groups for easier responses from the population.

Factor analysis was conducted to eliminate the non-important drivers. The findings of the factors analysis categorised the findings into four different groups. The four groups are management function, operational efficiency, construction business management and ethics and construction cost management. These major factors will be discussed in the next sections.

5.3.1 Management function

The management of construction activities starts with the decision made by the contracting management, in this case, the contractor or group of contractors. The contractor will make certain decisions based on the type of contract, duration and conditions of contracts. Yngve (1995) noted that an organisation could not exist alone, it has to interact with other systems, other organisations. Certain drivers within and outside influence construction companies. Some of these are flexible organisational policy; existing continuous improvement policy; government regulations; organisational structure and communication; architect/project managers' decision; project complexity; contractor/QS relationship; employee experience; variations and rework during construction; excellent remuneration and motivation; excellent employee/employer relationship; experienced QS and other staff; disputes and litigations and clarity of exclusions in the contract.

Excellent remuneration and motivation, employee/employer relationship and employee experience are all related to what is happening within the organisation. The interaction of the organisation with the external environment has to do with government regulations such as taxes, regulations on SMSCC in Nigeria, financial incentives for SMSCC in Nigeria. The major drivers for a successful business are the human resources, motivation and relationship management within the organisation. These factors are very crucial for the implementation of kaizen within the organisation. The organisational strategy for kaizen implementation has to do with making problems visible, setting high targets and staying in touch with reality (Emiliani, 2005, Singh and Singh, 2015, Smadi, 2009a, Suárez-Barraza et al., 2011). The owners of the company cannot be able to do this alone; they need the input of employees for better identification of problems in the company. Therefore, adequate communication is required for kaizen in the office place. Imai (1997) stated that kaizen in the workplace is known as gemba kaizen, this is important for good housekeeping and management for continuous improvement. Continuous improvement in the place of work can only exist when there is a form of motivation. The motivation of workers to keep track of what is wrong or requires

improvement is crucial. Implementing kaizen in this instance gemba kaizen depends on the experience of the employees. It also depends on the relationship between the employer and the employee.

The management function as discussed in the literature review section 2.5 and 2.8 elucidated the importance of the management function in managing the overall construction process from the office. The findings of the factor analysis in section 4.4.3 corroborate with the findings of the literature review. Management function will be a major part of the BPMN model for the kaizen framework.

5.3.2 Operational efficiency

The modus operandi of most construction companies in the small and medium scale range depends on some drivers. These drivers are excellent working conditions; decisions made by the contractor; the experience of the Quantity Surveyor on site; training of inexperienced employees and other staff; regular site meetings; influence of construction professional bodies; improved teamwork; financial status of the company; price and design risk; standardized production process; and post project reviews of cost information. These drivers were also assessed in terms of their relevance to the implementation of kaizen during construction.
In order to classify the type of driver as being important, the mean ranking and test for significance were utilised. A mean rank of 26.01 was obtained for excellent working conditions with a significance of 0.001<0.050. The excellent working condition on the construction site has to do with security, and health and safety. Similarly, Crema et al. (2015) provided ways of improving the safety with lean and safety methods. Shang and Pheng (2013) also suggested the standardisation of the construction process for easier implementation of kaizen in the construction industry. The process of standardisation in construction does not have to do with the closed working environment like a factory but a well-structured method statement, a work breakdown structure and information management system. Building information modelling is becoming increasingly important for construction purposes now. BIM cannot be relevant in SMSCC in Nigeria because of the high cost.

Contractor's decision-making skills is also an important driver for operational efficiency. The decision made on construction sites by the contractor can be a positive or negative influence on the outcome of the construction project. This was ranked second with a mean score of 24.74

and significance value, which is 0.006, this is less than 0.050. The contractor makes very vital decisions during variation management, claims and the cashflow. Although, the Quantity Surveyor also makes these decisions, the final approval comes from the contractors.

The Quantity Surveyor on site also influences the decisions the contractor make; this is based on some level of experience. A mean ranking score of 24.6 with a non-significance value of 0.466 was obtained from the test. The site quantity surveyor's experience may not be of relevance to the operational efficiency of the site because the architect makes most of the decisions along with the contractor. The next significant driver is price and design risk with a p-value of 0.013, and it was ranked 9th out of 11 with a mean score of 19.44. The price and design risk is very significant to this study because the effect of fluctuations and variation are always influential. This affects the activities, which are related to incremental cost reduction. Design risks can lead to variations, which makes contractors claim for more work on the site.

The literature review findings of activities from 2.5.1 and 2.9 are related to the operations on site. The major operations for kaizen depend on the process carried out for post-contract cost control. Operational efficiency is also related to kaizen within the office. Therefore, the findings of the literature review agree with the factor analysis findings for critical success factors for kaizen implementation in Nigerian SMSCC. Operational efficiency will be part of the BPMN model for the kaizen framework.

5.3.3 Construction business management and ethics

This aspect of construction business has to do with communication, information management, relationship management with the client and ethical business policies during construction. This factor is related to the construction process phase. The drivers for this factor are improved contractor-client communication; subcontractors cost; political stability; payment delays; supplier's cost of materials; fraudulent practices and kickbacks and price fluctuations.

The practices involved in the contractor's client relationship has to do with how the clients who can be, government, quasi-government private clients and organisation or companies make arrangement for procurement with contractors to deliver a project. In Nigeria, certain classes of contractors are forbidden to take part in the submission of tender. SMSCC in Nigeria has many issues with tendering for federal government projects due to the unethical practices

(Ayanda and Laraba, 2011, Bala et al., 2009b, Chukwudi and Tobechukwu, 2014). This fact was corroborated with the result of the mean ranking and significance. Improving contract-client relationship has a mean score of 26.29, but the significance speaks otherwise for this driver. The significance value is 0.091. This value indicates that improving contractor-client relationship may not be very important even though the mean score is high. This can be assessed further if this driver is compared to other types of drivers.

The quality of cost information for the post-contract cost control process starts from the cost-planning phase and the working budget. This value has a mean score of 25.71 and a significance value of 0.029. This driver seems to be more important based significance factor, which is less than 0.050. Cost estimates are always very inaccurate (Andersen et al., 2016, Lim et al., 2016, Park and Papadopoulou, 2012). Oyedele (2015) has also discussed the problems with cost estimates in Nigeria. The factors Oyedele (2015) identified are very crucial and mostly unavoidable. Therefore, the quality of cost information seems more important compared to improving the contractor-client relationship.

The subcontractor's cost is also very vital for managing administrative overheads. This type of costs incurred during the payment of subcontractors are very important, and it can be inflated. The mean score for subcontractors' cost is 22.16, with a significance value of 0.641. The next driver is political stability; this driver is more significant than subcontractors' cost. Political stability has a way of influencing construction business in Nigeria. Oyedele (2015) noted that political stability and security in the northern part of Nigeria would make construction business difficult. In the Sothern parts of Nigeria, thugs are bribed in order to avoid unnecessary violence. These types of conditions affect the implementation of kaizen.

The literature review findings of section 2.8 about the organisational culture discussed the business ethics in Nigeria as a major challenge in the construction industry. The findings of this sub-section validate section 2.8. Construction business management and ethics are essential for the BPMN model and likewise the kaizen framework

For kaizen to be implemented, the construction business and environment have to be standardised. Kaizen can be used to maintain the quality of cost information and delivery time (Brunet and New, 2003a, Colenso, 2000, Doolen et al., 2008). The challenges of business ethics

with kaizen has not really been considered fully, but unethical practices on construction sites have a way of influencing the delivery of the project and overall cost.

5.3.4 Construction cost management

The construction cost management aspect of most SMSCC in Nigeria needs to be reviewed for adequacy. The drivers for the factors highlighted were Claims; Updating cost information during construction; Stability of market conditions; the accuracy of estimates; in-depth knowledge of production process; architect-quantity Surveyor's relationship; quantity surveyors' decision; construction method; communication among project professionals; contractor/suppliers relationship; and management of overheads on cost.

Claims have the highest mean score of 24.62 and a significance of 0.043. The effect of claims on construction cost management has been addressed in section 6.5.1. Excessive claims have a way of leading disputes in construction (Lord and Gray, 2011, Olanrewaju and Anavhe, 2014, Sinden et al., 2012), it is an important factor for implementing kaizen costing. The challenge of construction cost management. The process of updating cost information during construction in the cashflow is very vital for cost monitoring and control. The cost information can arise from materials purchase, overheads relating to site office, maintenance of site utilities and payment of subcontractor, supplier and labourers. The findings for this drivers revealed a mean score of 24.05, the value of the significance is less than 0.050 at 0.009. The process of updating cost information is a corrective process, and it is carried out during variation management.

The stability of market conditions can determine the outcome of final construction cost. This was investigated by (Adegoke, 2016, Odediran et al., 2015, Olatunji, 2008), the stability of market conditions affects the prices of building materials, particularly cement. Prices fluctuations, foreign exchange rate, bank lending rates and the state of the economy all influences construction cost. Olatunji (2008) noted that the tender sums of most construction projects in Nigeria are higher during unstable market conditions. The mean score for unstable market conditions is 23.85, while the significant value is 0.006. This proves that this driver is very significant for the factor.

Kaizen costing cannot implementation will encounter many challenges during unstable market conditions. There has to be a model kaizen costing hypothetic scenario when the market is very volatile, and there are fluctuations and variations.

The construction management process is the last factor identified in addition to the management function, operational efficiency and construction business management and ethics. The aforementioned factors will be used to develop the BPMN process for kaizen framework for Nigerian SMSCC.

5.4 Summary of discussion

The findings above for post-contract cost control are linked to the present condition of traditional post-contract cost control in Nigeria. The aim of this study is to incorporate kaizen and kaizen costing with the existing techniques for post-contract cost control. The techniques with the most value to cost and project managers in Nigerian SMSCC are monitoring the cost of building materials and labour; interim valuations and the working budget. There can be existing challenges with the cashflow technique, thereby exposing the shortfalls in the use of cashflows in Nigerian SMSCC.

Change management leading to capability maturity is associated with the investigation related to innovation, encouragement of new forms of post-contract cost control are important for the framework. The triangulation process provided an opportunity for the framework to pass through validation. The validation process will provide more implementation evidence. The implementation of kaizen and kaizen costing depends on activities and critical success factors. Monitoring of activities related to overhead cost reduction for paying supplier and subcontractors as an incremental process. Furthermore, activities relating to purchasing orders and variation management are all linked with continual reduction of overhead cost for paying suppliers and subcontractors. These activities are loopholes where cost leakages occur. Management function, construction cost management, operational efficiencies and construction business management and ethics are the four critical success factor for implementation.

The strategic realignment of the post-contract cost control process in Nigerian construction industry using kaizen starts with understanding the post-contract cost controlling process involving certain techniques. The effectiveness and importance of these techniques exposed the problem with the post-contract cost control process. Investigations into kaizen and post-contract cost control linked crucial activities such as payment of subcontractors and supplier;

purchase orders; and hiring equipment all have overheads which can be reduced with PDCA. Overall, the critical success factors for kaizen costing implementation can reposition the post-contract cost control process as a result of cost overrun, and other problems identified in section 1.1. The repositioning of the post-contract cost control process in Nigerian SMSCC requires continuous improvement models leading to an overall framework. These models depend on the findings of this study in section four and the discussions provided in this section.

The framework development process will make use of these findings to create multiple models for kaizen and kaizen costing. There is no current strategy for post-contract cost control in SMSCC and other companies in Nigeria. This strategy will include models and guidelines for post-contract cost control. Most of the construction companies and private quantity surveying consultancies in Nigeria have a very good process for estimating the quantities using quantity surveying software and spreadsheet. Nonetheless, the inaccuracies of cost estimating are carried over to the post-contract stage. The framework development phase is the final objective of this study.

Chapter Six

Framework and validation

6.0 Introduction to framework development and validation

The framework development for kaizen and kaizen costing for SMSCC including the validation of the framework is the final objective of this study. The framework development for the study was done by using BPMN, IDEF0 and capability maturity model. These models have been explained in section 3.7.7.6, a, b, c. At the moment, there is no available framework for Nigerian SMSCC. Kaizen frameworks have bene designed by Vivan et al (2015) and Granja et al. (2005). None of these frameworks designed by Vivan et al. (2015 and Granja et. al, (2005) are related to SMSCC. In designing the kaizen framework for Nigerian SMSCC, the first step is to assess how the activities which the office environment can be improved. BPMN is the best model for the improvement process. For the BPMN symbols, please refer to figures 6.1 and 6.2. The models were explained in each sub-section of this chapter. The two stages of construction planning and execution will be considered in sections 6.1 and 6.2. Continuous improvement cannot start on a construction site without having a culture of continuous improvement within the office. Hence, the improvement process will start from the construction office.

6.1 Stage one: Improving construction activities within the office

The framework for this study will be created using BPMN to improve the construction business from the office. BPMN process made use of the findings from sections 5.3. Section 5.3 discussed 5.3 explored the critical success factors for the implementation of kaizen costing. Two BPMN models will be required to expound the gemba kaizen processes.

In figure 6.1 below, the functions boxes are management, supervisor or line manager and staff. This is based on a hypothetical scenario. *The scenario is based in SMSCC in Nigeria which would like to implement kaizen within the hierarchy before implementing within the construction site. The challenges are communication, re-organising the process of managing information and getting employees to identify problems for further improvement. The problems are currently unknown. Therefore, supervisors within the office need to work along with the*

employees to identify any process which can lead to the contribution of non-value adding activities.

The kaizen in the office (gemba kaizen) starts with identifying the problems that need improvement within the office. The management or any other employee can identify this problem. The identified problem should be stored in a file or computer system for record purposes, and delegated for resolution. This delegation can be sent as a memo or email within the office. A kaizen supervisor can tackle the problem by looking at the non-value added activities within the office. The decision-making process here will be to schedule activities for immediate review or have a brainstorming session with the employees in the next function. At this stage, more problems can be identified in the office for resolution. The problems can be some activities that take more time and has led to financial losses. Therefore, time management, resource allocation, financial management and other wasteful processes have to experience effective management. The management will be involved in this brainstorming meeting with the supervisors and other employees. The findings of the session have to be implemented and monitored for further actions. The implementation and monitoring aspect is carried out the supervisors and the employees. The process can end here or continue with more data stored for future use. This process of identifying process in the office and having immediate resolution with implementation should happen regularly for effective

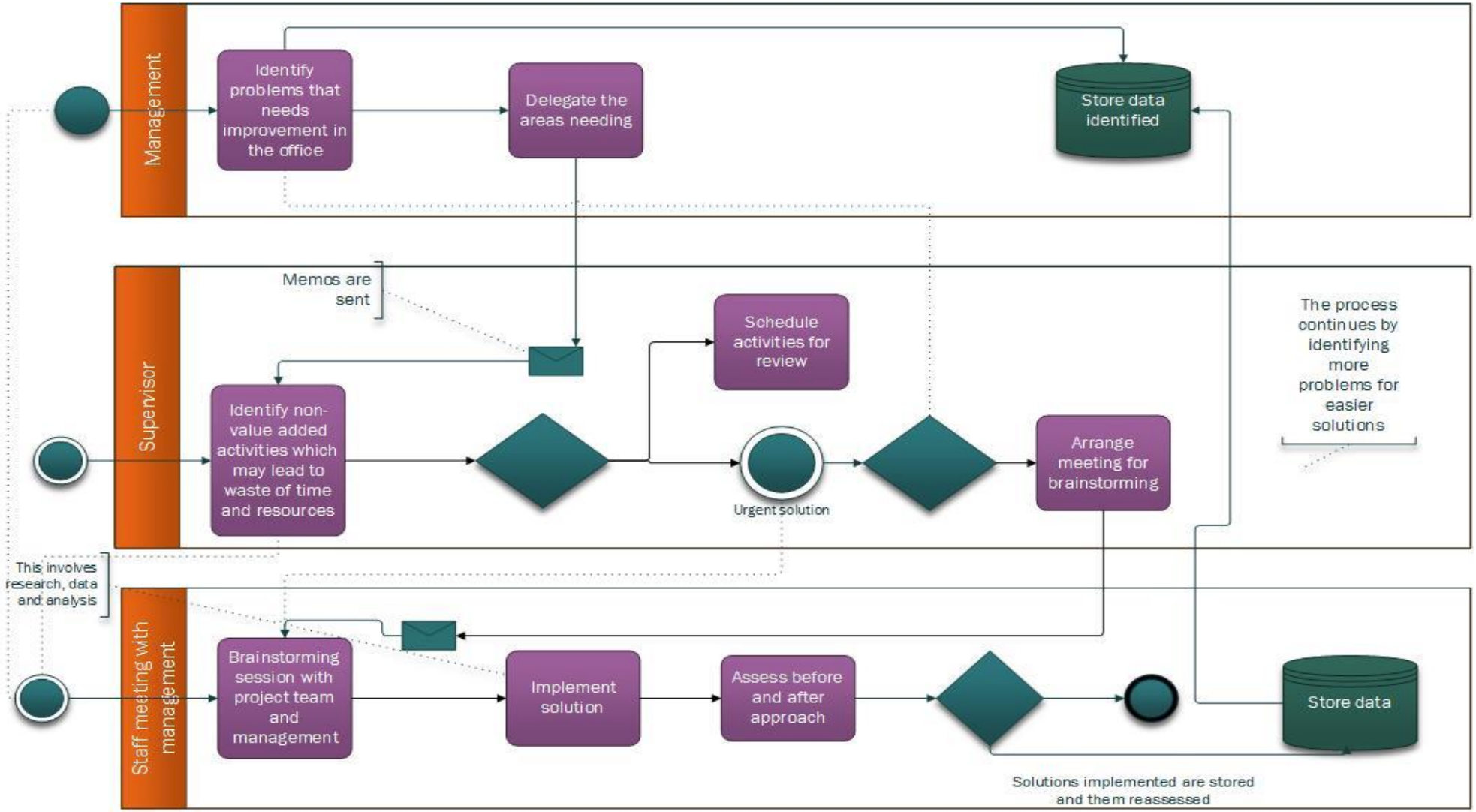


Figure 6.1. BPMN for kaizen process for a hypothetical SMSCC

Kaizen within the office. This process is a plan-do-check-act strategy for office activities. The findings of the study can be developed further with the BPMN model for the CSF. This will be the next stage of kaizen in SMSCC offices.

The final solution for the scenario will involve the BPMN model in figure 6.2. In figure 6.2, the knowledge about kaizen is required. This is based on the findings from section 6.3. Regular training is required for all the employees of the company. This process will lead to a kaizen team formation. Although, every employee has to practice kaizen, the main task of the kaizen team will be to implement and monitor kaizen process outputs. This is also related to the basic kaizen process in figure 6.1. The kaizen process within the office will still follow the plan-do-check-act principle. The implementation of the proposed, evaluation of the impact of the solutions and the monitoring of the solutions in the affected areas of the office requires a continuous process. This continuous process also includes identifying more problems in the affected areas. This creates a learning environment for the management and the staff automatically. Knowledge management in SMSCC starts with this process.

The implementation process in figure 6.2 has to do with the management function. The management function has two major drivers, which are excellent remuneration for motivating the employees and excellent employee-employer relationship. The management of the company needs to have an open communication channel with the organisational structure of the company. This will strengthen the process of improving the SMSCC over time. The next CSF that has to be part of the process is operational efficiency. This is driven by the working conditions for the employees and the decision making the process by the contractor. The decision-making process should involve the stakeholders. The stakeholders are the client, the design team, the cost management team and construction team. The community should be involved at a higher level. Construction business and ethics pertain to activities involving relationship management with the client and stakeholders. In Nigeria, there is a number of fraudulent factors in the cost production process. Most bill of quantities and riddled with the possibility of additional profit. This is connected to the business ethics of construction costing ad cost management.

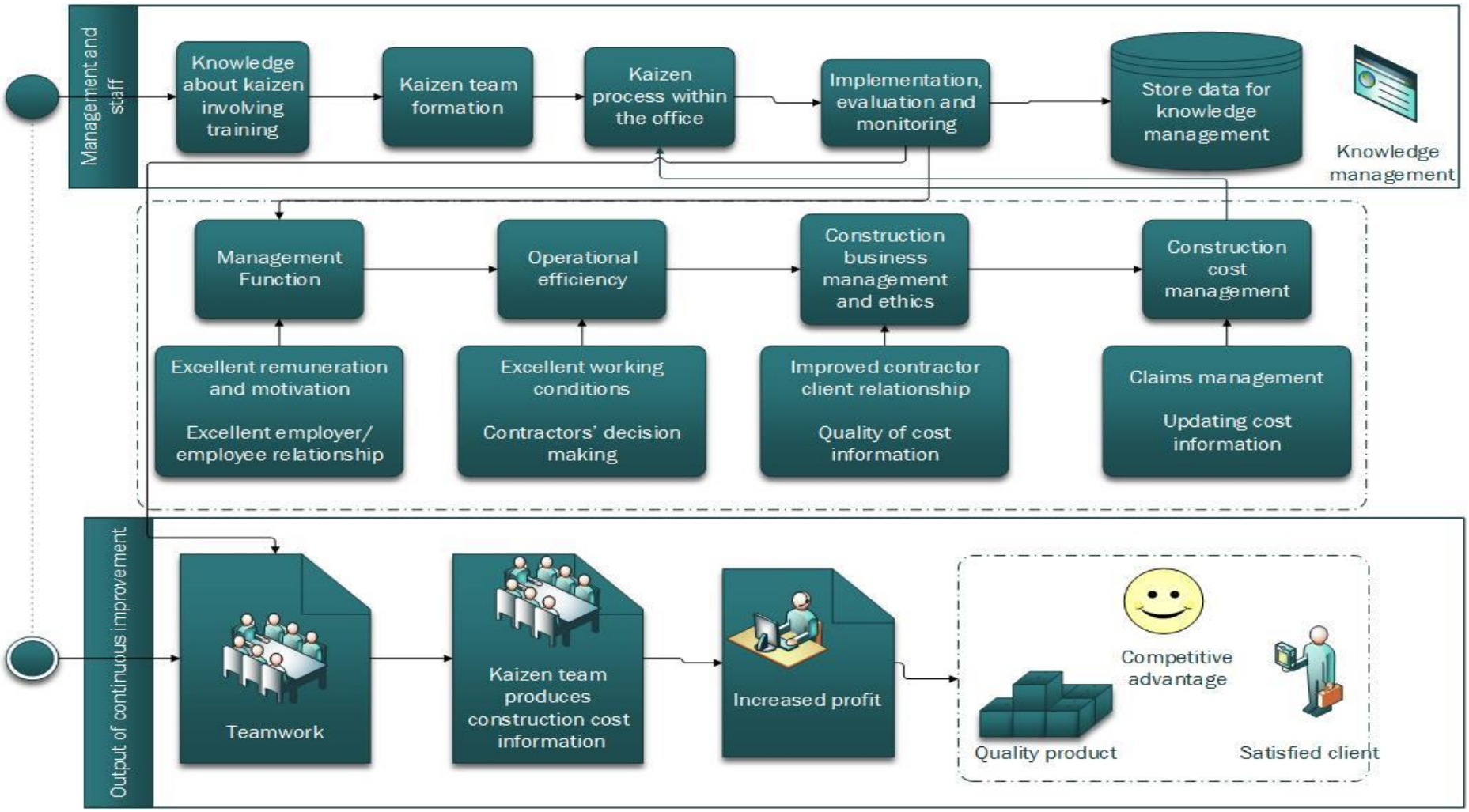


Figure 6.2. Knowledge about kaizen and CSF for continuous improvement

Construction cost management uses the quality of cost information provided by the bill of quantities. The working budget is used during the post-contract cost control stage. Most contracts experience variations in the design there leading to claims. Some claims can lead the dispute and cost overruns. This is interrelated to the business management and ethics. The purchase orders and payment of supplier and subcontractors for building materials, plants and equipment. Cost information has to be updated regularly for the monthly financial statement. This will provide an opportunity for adequate cashflow calculations and monitoring of overheads.

Cost management starts from the inception, which is the briefing phase. However, the cost-planning phase starts feasibility studies where problems can be identified for improvement. The cost limits for the projects are identified. In a situation where it is a costing-to-design project, the quantity surveyor will still need a cost limit for the project. The cost limits will lead the quantity surveyor or the cost planning team to identify the possible financial challenges which can occur during the project. The scheme and detailed design stages will include cost-checking activities with the plan-do-check-act process. These cost checking activities are basically, taking-off and preparing rates for the bill of quantities. The plan-do-check-act process can be incorporated into this aspect. However, it can seem difficult and tasking for the quantity surveyor. It can delay the delivery of tender documents. Cost analysis can also involve plan-do-check-act, but this process will be more effective during the cost control phase with kaizen costing.

The kaizen costing process during the construction phase can be reduced with plan-do-check-act during the planning phase. Nonetheless, cost estimates will always have errors. Implementing kaizen during cost planning just as stated in figure 2.2 is very possible. However, the time it takes to conduct the plan-do-check-act process can cause a lot of delays and cost implications.

6.2 Stage two: Improving post-contract cost control activities and techniques

The IDEF0 is a modelling technique for process improvement. *Figure 6.4 is based on a hypothetical four bedroom building construction projects which have challenges of managing the cover overruns related to building materials and construction equipment. The quantity surveyor has been trying to identify the various loopholes where additional costs are being incurred in via cashflow calculations. Furthermore, their variations in the design have been identified. These challenges can lead to cost overruns, claims and disputes if they are not properly management.*

The solution to this type of hypothetical scenario is to create a flow chart which can be IDEF0 to identify the overall construction process which can be improved. Kaizen costing can be used to mitigate these challenges. The model is usually designed to reflect the improvement in the strategic activities or processes. In this study, the improved process has been developed for the framework. This is displayed in figure 6.3. After the award of contract and mobilisation fee has been paid to the contractors, the construction process commences. This process makes use of the working budget. The overall, desire of the contractor is to make a profit and provide the best quality product on time to a satisfied client; this was illustrated in figure 6.2.

The IDEF0 process in figure 6.3 starts with cost monitoring and control activities using a well set out standard for construction. The model in figure 6.3 is based on a building project. Interim valuations are conducted at intervals based on the Gantt charts or programme of works. The units completed based on the tender sums are sent to the client quantity surveyor for interim payments. This process has to consider the overhead expenses which will be monitored. Some of the overhead expenses will be for water, access road, electricity, sanitation, office overheads such as stationery, tables, chairs and other things associated with the preliminary items of work. The elimination of unnecessary activities and waste in the preliminary item of works are very important. Plan-do-check-act Process is implemented at this stage. An employee can be appointed as a supervisor to focus on this process for timely corrections. Taking corrective action is very important to the implementation of kaizen costing during post-contract cost control.

The stage payments will be entered into the cashflow for calculations. This is connected to the monitoring activities for plants, labour and materials. The contractor quantity surveyor has to reduce and maintain the subcontractors' quotations negotiation skill is required in this case. This negotiation is important for labour rates and plant hire. The plan-do-check-act process also comes into the negotiation skills to identify the best activities for reducing the cost of labour, material and plant. Reducing cost of labour cannot be ideal in developing countries, but kaizen costing can ensure that the labour cost is maintained and the right workers are paid for the right activities.

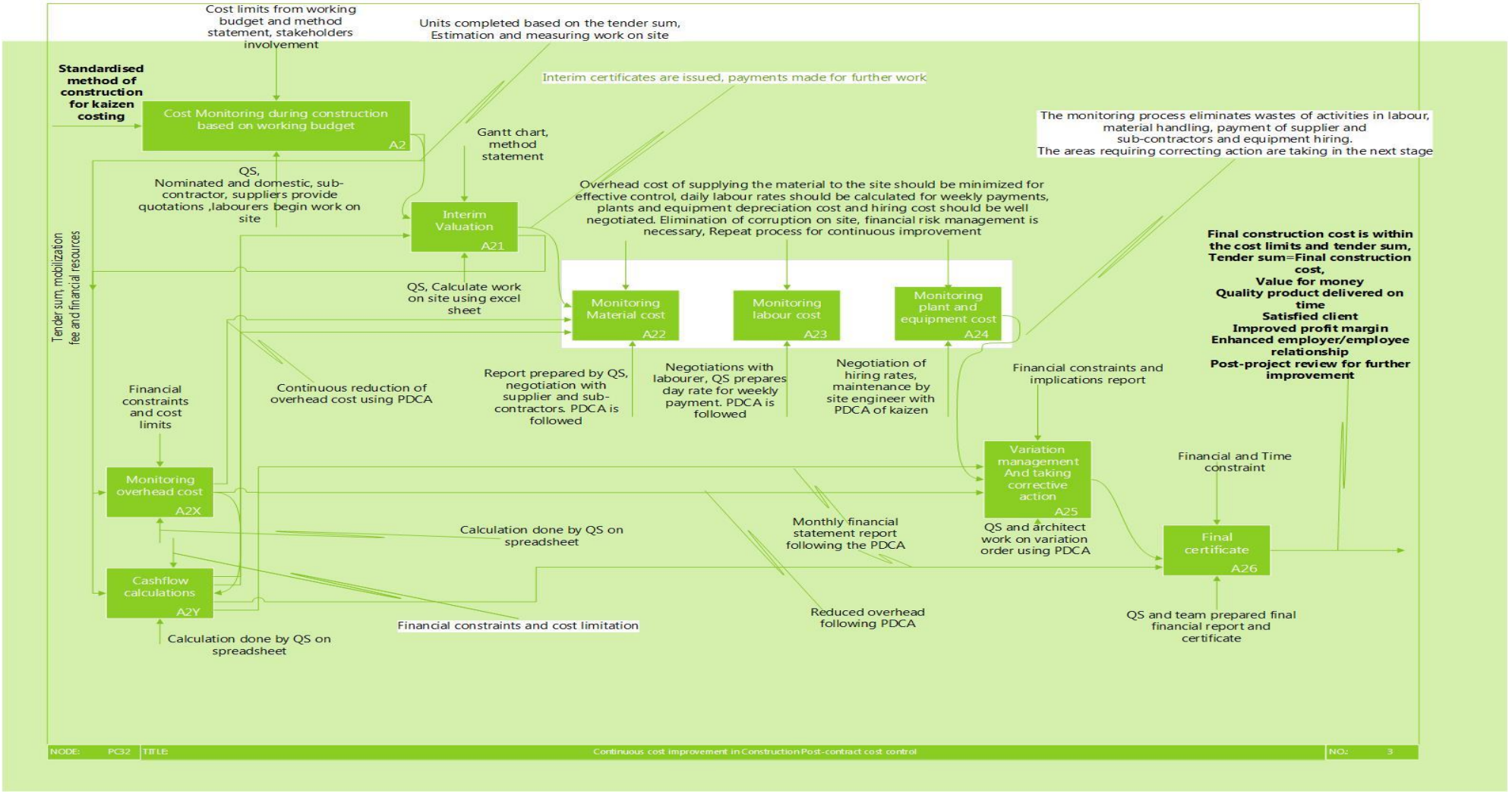


Figure 6.3. IDEF0 process for post-contract cost control of a hypothetical building construction

The monitoring of plant, equipment and labour is very crucial for kaizen costing implementation. Overhead cost relating to material, labour and plants can be reduced continually for the attainment of suitable final construction cost. This process is repeated during each stage of interim valuation and cashflow.

Variation management is another aspect where the contractor quantity surveyor can lay claim to changes in the design. Variation management and financial constraints on the path of the client can lead to dispute, cost overruns and project delays. In Nigeria, variation and have caused a number of projects to be abandoned. Therefore, the quantity surveyor and project manager need to work together quickly to resolve variations. The plan-do-check-act process can be adopted for the elimination of unnecessary activities, products, and waste when conducting variation management.

The quantity surveyor will then prepare the final financial certificate, which is a statement of the overall construction cost. In many projects, the budget of the project is not always equal to the final tender sum. There can be slight overrun in the budget. Nonetheless, most projects involving kaizen costing during the production phase has always experienced increased profit, project completion on time, quality delivery, satisfied client and improved competitive advantage for the positive record and project performance.

6.3 Framework for kaizen and kaizen costing with implementation using capability maturity model for small and medium scale construction companies

CMM as explained in section 3.7.7.6, number b, has five major levels; this was combined with the models to produce the overall framework for this study. The framework combined figures 6.1, 6.2 and 6.4 to form the framework. The framework in figure 6.3 has the CMM model in five levels. These levels are meant for implementation over a time period. Kaizen within the workplace as given placed on the left of the diagram to provide enough information about the importance of having kaizen first as an organisational culture within SMSCC. On the right, the IDEF0 model is also included. BPMN, IDEF0 and CMM are all used for process improvement purposes. The combination of the aforementioned model potentially provides a strong framework.

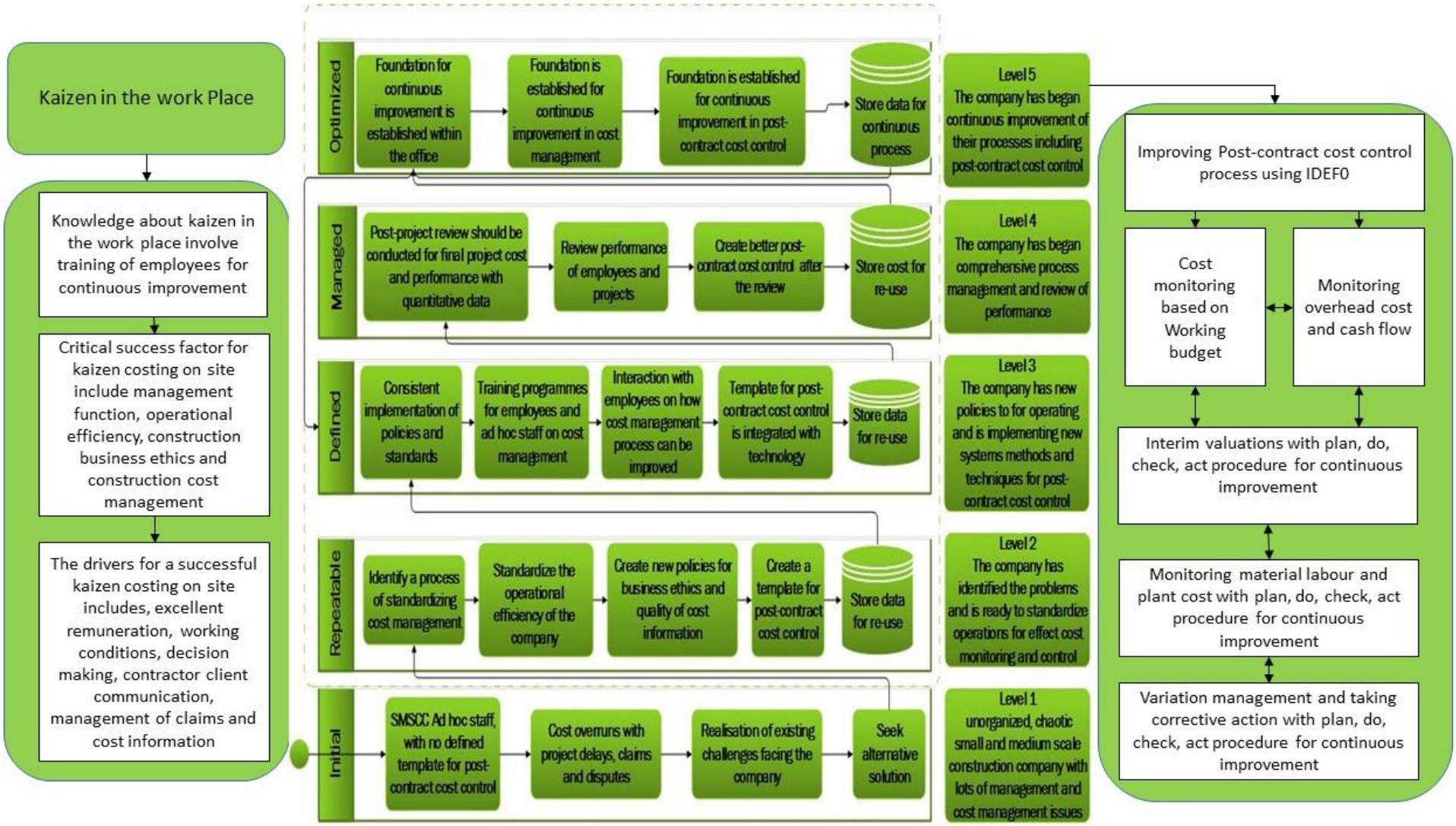


Figure 6.4. Framework for kaizen and kaizen costing in SMSCC

The five levels of CMM is the initially unorganised for SMSCC. This stage is where there is a lot of cost overruns and project delays. The employees find it hard to communicate with the management and share ideas. This stage is where the financial challenges cripple the desire to motivate the employees, and there is low motivation. The SMSCC can also be experiencing low or no profit at this level. The desire to seek alternative solutions can lead the management of SMSCC to look for an alternative to the construction process and profit and growth. Standards are set at the second level; new policies are put in place. These policies will pertain to business ethics and quality of cost information. A post-contract cost control template is created at this stage of the company. The company has matured to a level where the cost information is stored for future use.

The third level is the stage where the SMSCC are implementing policies for the construction cost management. The policies which are well defined are consistent with industry standards and regulations. The post-contract cost control template is integrated with the use of technology. The technology can be measurement software such as cost X, CATO, VECTOR and CAD measure. These will reduce the measurement inaccuracies to a minimum. The post-contract cost control template can make use of PRIMAVERA, spreadsheets or any other project management software to monitor the actual work done on site and juxtapose it with the working budget.

The fourth level is "*managed level".* This is where post-project reviews are conducted regularly to evaluate the project performance and implement the findings for future projects. Performance review KPIs are development for future projects and members of staff. Performance review of the planning and construction team will involve working along with new technologies, knowledge of improving the existing structure of construction cost management.

The final level is the *"optimised level".* This level has created the foundation for formal continuous improvement within the office and on site. Data is stored and reused for the defined level which involves creating new policies for post-contract cost control. The level five can then implement the IDEF0 model on the fifth stage of the framework and ensure continuous improvement is construction cost management is evaluated regularly. This framework can take

over five years to implement if the practicality is based on the levels. The implementation will start from level two.

The models and framework were given to experts who are contractors in Lagos, Nigeria for validation purposes. Their findings were meant to provide further enhancement.

6.4 Framework validation

The purpose of the validation using expert opinions was to address the cost implication; practicality; stakeholder involvement for kaizen and kaizen costing implementation; a timeline of implementation; and potential benefits. Five experienced contractors were contracted for a structured interview session over the phone, but only four could be available for the interview sessions the questions asked for the interview session has been included in appendix D. The findings of the interview session after transcription were summarised in table 6.1 below.

In table 6.1, the important questions are targeting the experts' opinion towards implementation of the framework. In terms of the years of experience, the interviewees have twenty-two 922) to thirty-one years' experience in the construction industry. All the respondents are quantity surveyors except one who is an architect. The cost of implementing the framework was viewed from payment for extra hours, software, computers and stationeries. One of the experts also viewed the framework from the time perspective. The time it will take to brainstorm and proffer solutions is also very important. Nonetheless, the experts feel this framework can carry out in the construction companies if they have the right training.

The practicality aspect of the framework was met with a positive review. However, the reviewers explained that the information in the framework should be reduced. One expert opined that the framework is complex and it should be made simpler. The framework can work if it has the supports of the stakeholders and the staff.

The major stakeholders who would make this framework work are the Nigerian institute of quantity surveyor (NIQS), government ministry for housing and works and the employees within the company.

Table 6.1. Summary of the interview transcripts for the important variables for implementation

Field of expertise	Quantity Surveying	Quantity Surveying	Project manager	Quantity Surveying
Years of Experience	28 years	31 years	22 Years	29 years
Cost implications	The framework seems complex, and it can involve a lot of cost for kaizen. There can be additional payment for the employees who will be involved in the kaizen team.	The value of the framework is difficult to evaluate at the moment. If a small construction company tests the framework, the cost of implementing it can be known.	The cost implication cannot be so much if I address this with my staff. I can form a kaizen team to try it out, but the company can spend more on the recurring tasks	The framework will be expensive because of the cost of stationaries and the time it will take to process the continuous improvement steps. The brainstorming meeting can involve additional time and cost. We can also have to implement more computers for the kaizen process. We will need to include additional cost for new software
Practicality	I think there is too much information in the frameworks making it difficult to understand their purpose or goal. It is also unclear how the frameworks are addressing Nigerian SMEs. The framework should be further simplified.	The information in the levels section can be reduced. It is a good approach for improving small construction companies in Nigeria. It can be implemented. However, I believe part of the stored data should be lessons learned about post-contract control of	There is a complex side to this framework, and we will train to implement the different levels. The left and right section of the framework can be implemented quickly. Except if there will be different levels of implementation over the years.	I have been trying to think about the practicality of this framework and the models for my company; the problem will be with the staff who would be trained, the cost of training and the different stages involved in this framework. I understand the stages are supposed to provide a guide for the company to advance their

		every implemented project.		course in terms of competitiveness and delivery of good buildings but it will be difficult for us because of the training aspect.
Stakeholder involvement	Government and the Nigerian institute of quantity surveyors need to be involved in this type of framework	The Nigerian institute of quantity surveying has to be involved in this framework and other relevant bodies. I think quantity surveyors will want to be parts of this new method of conducting post-contract cost control	Quantity surveyors, project managers, federal ministry or works and housing should also be part of this new innovation	The stakeholders in the construction industry and regulatory bodies should be part of the framework implementation. I think we need to start using new systems developed countries are using to develop their construction industry
Timeline of implementation	It can take up to 10 years for this to be implemented	Judging from the framework, it can only take 5 to 6 years	This can take a long time, probably less than 10 years for it to be implemented in any construction company	The framework has listed a lot of things which can take up to the next 5 to 6 years for it to be fully implemented but I think it depends on the type of construction company

The timeline of implementing this framework according to of the experts is between five (5) to ten (10) years. Therefore, if the major stakeholders such as NIQS and construction companies in Nigeria decide to implement this approach, it would take almost a decade. Nonetheless, the capability maturity model in the framework can definitely work if all the steps at taken into consideration. The cost implication of the framework can be high, but the overall effect in terms of competitiveness will definitely provide a better approach to improving the competitiveness of SMSCC in Nigeria.

The enhancement of this framework will require the involvement of the stakeholders who would participate in the implementation process. The models would not be changed because they have a very positive review for implementation. The BPMN models were reviewed, and the experts noted that they could easily implement the BPMN models. This is the left part of the framework. The IDEF0 model with the process improvement involved a lot of plan-do-check-act processes that can involve the quantity surveyor, project manager or kaizen team to monitor the overall process. The experts also commented about the clarity of the drawing. This will be improved in the final design.

The process of improving and maintaining the overhead cost and other related costs during construction have been explained in sections 2.6 and 5.2. The continuous improvement of cost involve identifying the main gaps where waste has been filled. This process can be achieved with a template for kaizen costing and identifying the areas where the process will be improved. Therefore, the entire construction team would have to be involved in the incremental cost reduction process.

The framework has been modified to address the expert opinions observations. The modified framework in figure 6.5 also have guidelines for the implementation process. The abbreviations used in the drawing will be explained in the guidelines in table 6.2 below.

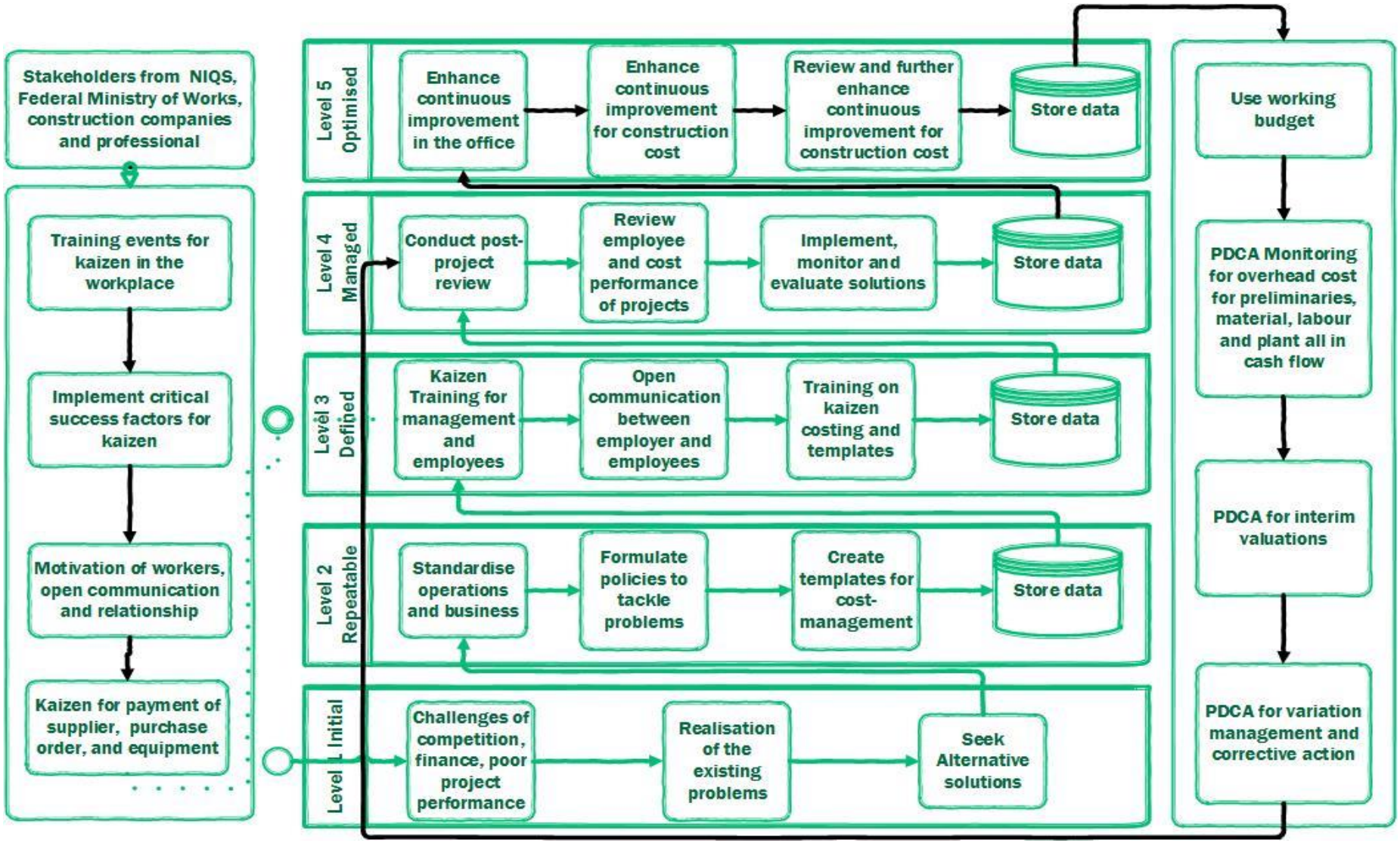


Figure 6.5 Final framework for kaizen and kaizen costing using CMM for SMSCC

The final framework above has been developed based on the shortcoming of the initial framework. The clarity of the framework was the main priority. The IDEF0 aspect in figure 6.4 was removed because it seemed to have confused the experts. The stakeholders were also included in the framework. These stakeholders would lead the use of this framework.

Table 6.2. Guidelines for the kaizen and kaizen costing framework for SMSCC

Levels	Name	Action points	Timeline
1	Initial	At this stage, the small and medium scale construction company is experiencing several managerial, financial and project delivery challenges. The logical thing to do is to seek alternative ways of doing business	6 Months
2	Repeatable	The challenges are identified, and measure is put in place to address the challenges. This measure will lead to the formulation of policies which will require the creation of standard and templates for the construction company. Data management should begin at this level.	6-12 months
3	Defined	This stage is where kaizen critical success factors are implemented after training activities. The benefit if kaizen training within the organisation will definitely outweigh the cost over time. The critical success factors are improving the management of the company through motivation of workers in terms of salary and working conditions. This is followed by the enhanced of the operations by reducing waste in every respect. Monitor the business ethics; this should also be improved with cost information for ethical reasons, such as overpricing and fraud. Lastly, the construction cost management should be enhanced with the removal of avoidable claims and management of project cost on site. Data management should improve here.	24 months
4	Managed	The standardised policies on waste will lead to improved performance metrics for employees and projects. Post-project reviews should be conducted and implemented at this level. The management of the data gathered within four years plus should create and organisational learning environment.	6-12 months
5	Optimised	This is where kaizen costing activities on the construction site are implemented with the plan-do-check-act process (plan-do-check-act process). This would be thought in the kaizen costing training. The kaizen costing process should be embedded in the traditional post-contract cost control process.	12 months and above

The framework and guidelines for kaizen and kaizen costing in SMSCC have been provided in figure 6.4 and table 6.2. The total suggested a timeline for the framework implementation is five (5) to six (6) years.

6.5 Summary of framework development

Post-contract cost control starts with the attitude of construction professional towards cost management. The attitude of the construction professionals in the contractors' company will depend on a number of factors, such as remuneration, working conditions, business ethics, financial risk, decision-making techniques, operations of the company and the quality of cost information provided for cost management.

Post-contract cost control cannot be enhanced within a year it takes to take, and therefore, a strategic process of changing the existing system of doing business needs to be employed. The post-contract cost control strategy has been redesigned to fit into the existing traditional construction costing system in Nigeria. A new technique for managing construction cost such as kaizen costing will change the paradigms of managing construction cost.

Kaizen costing is a subset of kaizen and kaizen is of lean construction. Hence, for kaizen costing to be attained, the kaizen philosophy has to be inculcated in the daily lives of SMSCC employees and management. This was associated with the BPMN models of 6.1 and 6.2. The next stage will lead to the overall creation of the IDEF0 model in 6.4. The final framework in figure 6.5 was developed after the corrections from the four experts in Nigerian SMSCC. Cost data management after construction is also required after the post-project review process for continuous improvement. Guidelines for the use of the framework also suggested timelines of implementation. The cost of implementing this framework is unknown, and it will take further studies to include the cost of implementation. This can be a cost-effectiveness evaluation of figure 6.5.

Chapter Seven

Research conclusion, contributions and recommendations

7.0 Introduction to conclusion, contributions and recommendations of the study

In this concluding section, each objective that has been resolved using literature review, survey interviews and questionnaires have been summarised with adequate recommendations. Section two provided a theoretical background for the study leading to the extraction of variables for the interview questions and survey questionnaire design in the succeeding chapter. The methodology section looked at the philosophical undertones for every research objective in table 4.1 and designed the research methodology based on the research onion (please refer to figure 3.7). The fourth chapter addressed the analysis of the research objectives based on the research methodology in chapter three. The fifth and sixth chapter focused on the discussion of research findings and framework development and validation. This is section will look at:

a) The conclusion and recommendations for each objective
b) Contributions to knowledge and practice
c) The limitations of this investigation
d) Recommendations for further studies

An overview of the research objectives synthesis process is explained in the next sub-section for further understanding of the research background.

7.1 Synthesising the research objectives

In developing the research objective, the background of the study identified the problems relating to poor competitiveness, cost overruns, poor project financial and litigations in Nigerian SMSCC from section 1.1. This was expanded in sections 2.4.1 to 2.4.5. These sections addressed the various post-contract cost control options from activity based costing to value engineering, earned value analysis, life cycle costing and kaizen costing. The benefits of kaizen are costing and the merits and demerits compared to other methods were highlighted in table 2.2 and 2.3. This provided an avenue to synthesise the research objectives that will cover the aspects of post-contract control techniques and performance of the techniques; kaizen

philosophy in the Nigerian construction industry, critical success factors and the activities, which will assist the process of kaizen costing. The framework development and validation are the last objectives.

7.2 Objective 1: The critical review of the post-contract cost controlling techniques used in the construction industry

The first objective addressed the post-contract cost control techniques used around the world. The delineation of systems, methods and techniques in cost management resolved the first objective. This is explained in table 2.1. The literature review section 2.1 further explained the process of conducting post-contract cost control in the construction industry. The findings of section 2.1 in the literature review have identified eighteen (18) different techniques for the post-contract cost control process. The different techniques are: monitoring activities such as labour, material, equipment and overhead costs; interim valuation; variation management; site meeting and post-project reviews; unit rate, incremental milestone; taking corrective action, profit and loss account; using working budget; cost forecasting; identifying cost overruns; cashflow; using historical cost data and cost ratios.

The identification of post-contract cost controlling techniques was based on existing literature. Reviewing the articles also provided an opportunity for further explanation about the use of semantics in cost management. The semantics are construction cost management systems, methods and techniques (please refer to sections 2.2 and 2.3 for further explanation). This is because many authors have used the words interchangeably without carefully understanding the implications of these words on the construction cost management niche.

There is a significant usage of the same post-contract cost controlling techniques across various construction industries. The construction industries in developing and developed countries may have different terminologies for the aforementioned post-contract cost controlling techniques, notwithstanding, these are the main post-contract cost controlling techniques used in the construction industry.

7.3: Research objective 2: The review and critically evaluate the techniques used in post-contract cost controlling management in small and medium scale construction companies in Nigeria

The findings from objective one lead to a further literature review of post-contract cost control techniques used in the Nigerian construction industry. Survey interview findings also noted regular site meetings, monitoring activities, building materials, interim valuations and cashflow calculation (section 4.2.1.1 to 4.2.1.5) on construction sites are the major approach for construction cost monitoring. This lead to further discussion about the difference between cost monitoring and cost control during construction. These two concepts were discussed in section 5.1. This section looked at the effectiveness and importance of the post-contract cost controlling techniques in Nigerian SMSCC.

The findings showed that the monitoring cost of material is the most effective and important technique on site. Monitoring cost of materials has to do with inflation, transportation of material to site, purchase order and quotation from supplier and subcontractors. The entire concept of monitoring is very important to the contractor because there is where the profit lies. Monitoring of labour rates on the site is also very essential. The prices of materials and labour can vary from state to state in Nigeria. However, this study was based in Lagos, Nigeria where the price is a bit stable. The choice of Lagos over other states in Nigeria is due to accessibility to data, the numerous construction activities and the fact that Lagos is the commercial nerve centre of Nigeria (Please refer to sections 3.7.6).

The cost of building materials for building construction can fluctuate during the duration of the project. Building material supply is also connected to a number of critical success factors in the discussion from section 5.2. These factors are construction business and ethics. Many fraudulent practices go on during construction activities in Nigeria; this includes bribery, the kickback of fund and inflation of prices, which will affect the quality of cost information. Corruption in the Nigerian construction industry is a major factor that can hinder the effectiveness of any approach to cost management.

Another effective technique is using a working budget. The working budget is the bill of quantities, and it is always riddled with errors from the planning phase. These errors are carried

over to the execution stage. The inaccuracies of working budgets and estimates were discussed in section 2.1 and 2.2. This section looked at the need to focus on post-contract cost control over the planning phase. The justifications in this section aligned with the findings of section 5.3. Nonetheless, working budget is very effective if the unit rates from the budget and quantities are meticulously monitored during the planning stage. The management of variation and cashflow calculation were added to the framework but rated very low in the analysis. A number of a factor might be responsible for this, but it requires further investigation. The changes in post-contract cost control have to evolve over time. This can be carried out using kaizen. Hence, kaizen which is a form of continuous improvement can be existing in SMSCC in Nigeria. Therefore, the third objective investigated the presence of kaizen in SMSCC.

The main conclusion of this research objective is predicated on the first research objective and the findings of the interview. Monitoring of building material cost has been seen to be a major challenge in any construction project. Therefore, the argument is between what monitoring and control is during construction cost management. Construction cost or related activities cannot be controlled but can be monitored and measured against the working budget. In addition to this, negative circumstances cannot be controlled but can be mitigated and corrected.

7.4 Research objective 3: To identify and evaluate the critical post-contract cost controlling activities for incremental cost reduction in small and medium scale construction companies in Nigeria

Identifying the critical activities which will be part of the framework for incremental cost reduction was carried out with the aid of literature review and questionnaire. The workings of kaizen costing (2.6) and the challenges of kaizen costing implementation (2.8) provided literature basis for the development of activities that can be incrementally reduced during construction activities. These activities formed the foundation for the Likert scale questionnaire which was analysed in section 4.3. Kendall's coefficient of concordance and Spearman correlation were used to test the data obtained from one-hundred and thirty-five respondents.

The result indicated that incremental reduction of overhead cost relating to the payment of supplier and subcontractors would lead to continuous improvement of cost. This is related to the conclusion 5.3 for monitoring the cost of building materials. Incremental reduction of overhead cost for administrative charges, transportation of building materials another

associated cost for the payment purposes is very important. Furthermore, the kaizen team should focus on unethical practices because this is where cost leakages can occur.

Other activities are the purchase orders and equipment hire during the construction. The continual reduction of the cost of purchase orders and equipment hire will definitely provide an avenue for contractors to get the best quality material at a good price. The concept of negotiation buy on the path of the contractor, or project manager should not be ignored. This was stated in section 6.4 where this objective was discussed.

In conclusion, the activities leading to the development of a kaizen and kaizen costing framework for SMSCC has to involve these crucial activities. In addition to this, the critical success factors need to incline with the activities that also lead to the post-contract cost control techniques. The crucial activities required for incremental cost reduction is different from the critical success factors. The crucial activities have been highlighted in section 2.5.1 as being activities on construction sites which are capable of generating waste. The critical success factors pertain to implementation enablers and barriers which are mandatory for implementing kaizen (please refer to section 2.9). Hence, the two research objectives differentiated the concept of continuous improvement within the office and the production scene.

7.5 Research objective four: Reviewing and evaluating the critical success factors of adopting kaizen in small and medium scale construction companies in Nigeria

This research objective was resolved using literature review, interviews and questionnaires. The findings of the literature review were identified in table 2.5 from section 2.9. The themes for the interview conducted provided the themes elucidated in section 4.4.1.The major themes organisational culture, communication approach, waste reduction policy, post-contract cost control with kaizen costing and post-project review. This process used the interview and questionnaire format to establish the findings from the perspective of the contractor (employer) and cost and project managers (employees) for the qualitative findings in sections 4.4.2.1 to 4.4.2.3. The initial qualitative findings revealed that cost and project managers are open to new forms of post-contract cost control and are their organisations are open to change.

The presence of kaizen in SMSCC in Nigeria is new, and there is a need for adequate training about the concept of continuous improvement in these SMSCC before it can be implemented. The implementation can take several years. These SMSCC have waste reduction policies (please refer to section 4.4.1), but they are not implemented or reviewed. The post-project review is vital for kaizen in the workplace. In section 4.4.1, theme 7, seven (7) interviewees out of eleven (11) noted that they conduct post-project review meetings. This a major ground for implementing kaizen and kaizen costing. Nonetheless, it is not enough to indicate that kaizen is existing in SMSCC. In conclusion, kaizen exists on a minimal level in Nigerian SMSCC. The findings of the interview were triangulated with the quantitative findings in section 5.3.

This quantitative process began with the review of focal articles about kaizen in section 2.9 and 2.5. This section looked at the various categories of the strategies which could aid the implementation of kaizen in China, India and Brazil which is a developing country. The categories were relationship management, organisational structure, construction process standardisation, government and regulatory bodies, contract documentation and procurement, financial risk management and litigation, communication and teamwork, and decision making.

The factor analysis test was used to reduce the forty-eight factors extracted from the literature review. These factors were listed in table 4.5, were used as the questions for this research objective. The discussion of findings in section 5.2 identified management function, operational efficiency, construction business and ethics, and construction cost management as the critical success factors for kaizen implementing in Nigerian SMSCC.

The eight categories of factors which were extracted in the literature review section only have the organisational structure, financial risk management and litigation, and decision making as the only categories which related to the factors. Furthermore, the driver or factor in these critical success factors has related the motivation from the management function category; working conditions and decision making from the operational efficiency category; quality of cost information for the business and ethics category; and claims and updating cost information for the construction cost management category.

The usefulness of these findings is required in the framework as direction for the contractor or kaizen team to implement and overcome if they are barriers. Kaizen requires guidelines for overcoming certain challenges in the workplace. Therefore, these critical success factors need to be put into practice if kaizen is active. The development of the framework is essential for this study.

The inclusion of management function; operational efficiency; construction business management and ethics; and construction cost management in the framework indicates that the construction process for Nigerian SMSCC depends on the culture within the management of employees, policies and relationships with external stakeholders in construction projects. The effects of decisions from the management of Nigerian SMSCC have on construction cost management has been a major factor lowers their competitive advantage. The development of a kaizen framework including the critical success factors for kaizen implementation is the major ingredient for a useful framework within the Nigerian context.

7.6 Objective 5: Developing and validating the framework based on kaizen philosophy and kaizen costing, which can be integrated into the post-contract cost control practices in small and medium scale construction companies in Nigeria

The final objective which aligns with the aim of this study (to create a modern approach for conducting post-contract cost control in Nigerian small and medium scale construction firms based on kaizen) made use of all the findings from the first objective to the last. BPMN, CMM and IDEF0 models were used to develop the framework (sections 3.7.7.6, numbers a, b and c respectively). BPMN was used to design two model for kaizen in the office. The models in figure 6.1 and 6.2 based their structures on the findings of objective two in discussion section 5.3. These were explained based on the illustration in figure 2.2 for construction cost management. This led to the development of the model in figure 6.3 using IDEF0. The IDEF0 model made use of the discussion section 5.1 where the post-contract cost control process in Nigerian SMSCC identified monitoring activities, interim valuation and the working budget as the most significant techniques. This model included the plan-do-check-act process for kaizen costing explained in section 2.6.

The nature of the framework was based on CMM (figure 6.4). This was used to explain the five level of implementation and kaizen in the office combined with kaizen costing on site. The

framework was validated using four experts who are quantity surveyors and project managers with over twenty years' experience in the construction industry. The interview process created a set of review listed in table 6.1 for enhancing the framework. The reviews were based on cost implications, the measure of practicality, the timeline for implementation and the stakeholders who would be parts of the process. The guidelines in table 6.2 from section 6.4 provided details on how the user of the framework can take the CMM levels by levels and what they need to do. The end user can also have to involve the Nigerian Institute of Quantity Surveyors (NIQS), the Federal ministry of works and housing, and construction professionals in construction companies.

In general, the framework has fulfilled the research objectives and aims of creating a new approach towards post-contract cost control based on kaizen and kaizen costing. Kaizen is a new paradigm in construction cost management and every country requires a unique framework for making use of it. The focus has been on post-contract cost controlling techniques, which cannot exist without the planning phase and critical success factors for implementing the kaizen costing which has been added to framework.

7.7 Contributions to theory

The sections will discuss the impact the study has made to the body of knowledge. This will cover the financial performance of Nigerian SMSCC, cost management, post-contract cost control techniques and kaizen philosophy in the construction industry.

7.7.1 Delineating cost management systems methods and techniques

In sections 2.1 to 2.3, the knowledge about cost management systems' methods and techniques have been expanded based on the categories of cost management terminologies. Most authors have missed used the terminologies. In some cases, earned value analysis is a system, but in reality, it is a method for cost management. The definitions of systems, method and techniques using the dictionary provided an opportunity to create a guideline based on references from authors. This was used to support their definitions in table 2.1. The knowledge created in the literature review section of the study will form a basis for better understanding of cost management.

7.7.2 Important post-contract cost control techniques in the Nigerian construction industry

The knowledge from the study of post-contract cost control is very relevant to the Nigerian construction industry. However, the findings indicate the importance of cost monitoring of building materials for fluctuations, inflation and variations. Although, this is a well-known fact in practice, there has been no relevant knowledge about this in articles. The prices of building materials change rapidly in Nigeria. An example of this is cement. No studies have focused on the monitoring aspect of building materials. In addition, the study has opened an avenue for more research on the effectiveness of cashflow and variation management in developing countries. Cashflow and variation management are one of the most important techniques for managing project cost. However, in this investigation, it was rated to be ineffective and unimportant. Nonetheless, it was added to the IDEF0 model and framework because of the level of importance it has on projects. In general, monitoring of overhead, labour and plant on construction sites have also created an opportunity for more research into the effectiveness and importance in various construction industries around the world.

7.7.3 Critical success factor for implementing kaizen and kaizen costing in the Nigerian construction industry

Obtaining relevant knowledge about the critical success factors for implementing kaizen and kaizen costing also opens the door to critically evaluate the performance of traditional cost control system. The management function, operational efficiency, construction business and ethics, and construction cost management in Nigerian SMSCC provided knowledge for practical implementation of kaizen within a developing country such as Nigeria. There has been no knowledge about the critical success factors of implementing kaizen and kaizen costing in the construction industry. This has created a background for implementing kaizen and kaizen costing. The framework in figures 6.2, 6.6 and the guidelines in table 6.2 clearly indicates the importance of the knowledge obtained. Further studies can be carried out on this for the UK and any other country.

7.7.4 Capability maturity model in the framework for kaizen and kaizen costing in the construction industry

The CMM in the framework in figure 6.5 provided the levels of implementations. There has been no detailed knowledge about the implementation of kaizen and kaizen costing on a CMM framework. This study has created a new paradigm in construction cost management research. Studies about the cost of implementing kaizen and kaizen costing on a CMM scale can restructure the entire process of developing small construction enterprises anywhere in the world. The overarching effect of this framework is the levels of implementation which have never been carried out in any study.

7.8 Contribution to practice

This section highlights the contributions the models and frameworks will add to the construction industry in terms of practicality.

7.8.1 Combing kaizen and kaizen costing with traditional costing

The intention of this study was to create a kaizen and kaizen costing framework implementable in the cost management practice of the Nigerian construction industry. Target costing is usually used during the pre-tender stage to create cost targets, and it is a design to cost technique (Pennanen et al., 2011, Rattray et al., 2007). In situations where the Quantity Surveyor has to cost a design, target costing would not be appropriate. Therefore kaizen costing is an option. This study intends to introduce kaizen costing into the Nigerian construction industry through small and medium scale construction companies in Lagos. The kaizen costing framework to be developed in this investigation is expected to be a strategic realignment tool for changing the conventional post-contract cost control technique to bring about more effectiveness in the Nigerian construction industry. This investigation will bridge the gap between kaizen costing in the manufacturing industry and the construction industry.

The combination of kaizen within the office and kaizen costing on site in a framework can redefine the existing structure of construction companies in Nigeria. This will create room for further improvement of the small and medium enterprises milieu in Nigeria. Hence, the models in 6.1, 6.2 and 6.4 are new paradigms for the construction industry, quantity surveying and project management practices.

7.8.2 Kaizen in the Nigerian construction industry

The detailed finding on kaizen from the literature review in section 2.4.5 to 2.6 indicated that kaizen is still new in the construction industry. The knowledge about kaizen in Nigeria is very limited even though the continuous improvement was the terms used. The construction industry needs to tap into the potentials of kaizen for managerial and construction use. The potential of kaizen for SMSCC in Nigeria was viewed with an open perception. Changing the existing culture of cost management is a task which will take a long time. However, the process starts with the major stakeholders which involve the government and construction professionals in Nigerian SMSCC. Kaizen for corporate governance in construction provides an opportunity to advance the operations of SMSCC. The models in figure 6.1 and 6.2 have been designed to fit into the daily operations of a construction company.

7.8.3 Kaizen costing in post-contract cost control for the construction industry

The post-contract cost management process will improve if the framework in figure 6.5 is implemented over time. The experts who reviewed the framework noted that it might improve their organisation if implemented. The concerns about the cost of implementation can be a concern to the stakeholders at first, but it will definitely provide an opportunity for SMSCC to improve over the timeline of implementation. Furthermore, the plan-do-check-act process in cost controlling provides an opportunity to resolve construction cost issues quickly. The resolution will be on the spot, or it can pass through the kaizen team. The post-contract cost control process using plan-do-check-act will not lead to spending more time for construction purposes but create room for speedy resolution of faults on construction sites.

7.9 Further research recommendations

Recommendation for further research will look at the implementation for kaizen and kaizen costing in the Nigerian construction industry and the critical success factors for implementing kaizen in the UK construction industry.

7.9.1 The cost implementation of kaizen and kaizen costing in the Nigerian construction industry

The Nigerian construction industry can make use of the framework in figure 7.6, but this depends on the stakeholders' decisions to accept it and the cost of implementation. Further research about the cost of implementation can take the form of cost-benefit analysis of the effectiveness of implementing kaizen in the Nigerian construction industry. This research can also consider the economic implications and possible time implications of kaizen in the construction industry. The vagaries of the Nigerian economy needs to be included in this form of study.

7.9.2 Critical success factors for implementing kaizen in the UK construction industry

The UK construction industry has not implemented kaizen. This depends on the organisational culture of the UK construction industry, the capability of the construction countries to adopt continuous improvement and government regulations. This type of study can take into consideration reason kaizen failed in other sectors in the UK and what can be done to improve the system over time. Further studies into the potential benefits of kaizen in the UK and the level of acceptability in the construction industry should be part of this study. The UK construction industry uses the RIBA plan of work to plan for the cost-planning phase. The study can take the case study approach towards the practical application of kaizen in the cost-planning phase.

7.10 Limitations of this study

This findings of this study have produced the kaizen framework which is tailored to SMSCC in the Nigerian construction industry. The generalisation of the findings can be made for the whole of Nigeria based on the economic strength of SMSCC in Lagos state. Furthermore, building information modelling, forms of contract and procurement have been excluded this research. Although, several attempts have been made to include kaizen in the planning phases of construction projects, this research is solely based on the post-contract cost control phase with some references to the planning phase which includes training and implementation of kaizen critical success factors in Nigerian SMSCC.

7.11 Summary of contribution to knowledge and practice

The study has provided detailed, measures to counter the bane of cost overruns and difficulties in managing SMSCC. Although, most SMSCC in Nigeria have the problem of finance, the managerial aspect of the companies can be improved for profitability. The delivery of building to the client will be of a high standard if the models and framework in the study are applied. The practicality of this framework started from the understanding of cost management as being a system, method and technique. This has created an opportunity to focus on the details more than semantics. The post-contract cost control process has different techniques that are viewed to be more effective and important than the other. Monitoring of material, labour, plant and overhead with interim valuations proved to be the centre point of the study. The models and frameworks were based on the techniques and the critical success factors. An incremental reduction of activities that can help reduce the cost of construction along with the strategy in place will realign the current system of post-contract cost control, cost management, competitiveness and performance of SMSCC in Nigeria.

In conclusion, this study has developed a kaizen framework for SMSCC in Nigerian which can strategically reposition the construction companies by applying the plan-do-check-act process within the office and on a construction site. The plan-do-check-act is a continuous improvement technique which can realign the post-contract cost control process, mitigate the effects of cost overrun and also enhance the competitiveness of Nigerian SMSCC.

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APPENDIX

Appendix A

Academic Audit and Governance Committee

College of Science and Technology Research Ethics Panel (CST)

To **Temitope Seun Omotayo (and Dr Udaya Kulatunga)**

cc: **Professor Hisham Elkadi, Head of School of SOBE**

From **Nathalie Audren Howarth, College Research Support Officer**

Date **20/02/2015**

Subject: **Approval of your Project by CST**

Project Title: **A proposed strategic realignment of the post-contract cost control process in the Nigerian construction industry using kaizen costing**

REP Reference: **CST 15/05**

Following your responses to the Panel's queries, based on the information you provided, I can confirm that they have no objections on ethical grounds to your project.

If there are any changes to the project and/or its methodology, please inform the Panel as soon as possible.

Regards,

Nathalie Audren Howarth

College Research Support Office

Appendix B

University of Salford MANCHESTER

Participants Information sheet

Study Title:

A proposed strategic realignment of the post-contract cost control process in the Nigerian construction industry using kaizen

Invitation

I would like to invite you to this study, before you decide, please take time to read the following information to understand why this research is being carried out and its importance.

The level of cost overrun in the construction industry in Nigeria and the rapid development of capital projects in the country require new forms of cost management, most especially in the post-contract cost control aspect. There have been many project abandonment and construction delays in the industry. This research intends to create a framework for managing overhead cost and improving contractors' profit, this is because most small and medium scale construction companies in Nigeria find it difficult to survive as a result of cost overuns (Frimpong et al., 2003, Mansfield et al., 1994, Dikko, 2002). This study will create a post-contract cost management framework which can reduce the cost of a project during construction and ensure the contract does not go bankrupt during a project. This problem can be solved with kaizen. Kaizen is Japanese word for cpontinuous improvement. For the purpose of thisdata collection it we will use the term continuous improvement.

What is the purpose of this study?

The research aims to enhance the current post-contract cost control process in Nigerian indigenous construction and Quantity Surveying firms in Lagos state. A framework will be developed at the end of this study to assist Quantity Surveyors and contractors in making improved cost management decisions which can reduce the cost of labour, materials and plants on site, thereby having a final account within the initial budget and greater profit for the contractor. This study will improve the management of indigenous small scale organisation in Nigeria. Employee-employer relationship will be improved using this framework. The finding of the research will be shared ion conferences and workshops in the Nigerian construction industry and the details will also be published in journals.

Why have I been invited?

This study required to gather information from Quantity Surveyors and contractors in the industry. This is because the cost management of construction process needs the intellectual inputs of a cost a manager, also contractors or a contractor's representative will give details on how they manager post-contract cost. Therefore you input as a Quantity Surveyor or contractor is highly imperative in this research. You inputs will give insightful knowledge into how construction cost is being managed in Nigeria.

Do I have to participate?

Your participation in this research is totally voluntary. We will describe the study and go through the information sheet which we will give you. We will then ask you to sign consent for if you agree to take part in this study. You are free to withdraw at any time from this study.

What will happen to me if I take part?

The data collection process should not be more than 30 minutes. Your information will be totally confidential.

Temitope Omotayo
PhD Student
School of the Built Environment
University of Salford, Manchester
M5 4WT
Email address: T.omotayo@edu.salford.ac.uk
Supervisor's email address: U.Kulatunga@salford.ac.uk

Appendix C

University of Salford MANCHESTER

Semi-structured Interview Questions

Assessing the understanding of kaizen (continuous improvement) philosophy in indigenous construction firms in Lagos Nigeria.

Section 1: Interviewee data

Name of organisation:

Highest educational qualification:

Current job title:

Section 2: Organisational culture

1. Please state the mission statement or organisation core values of your company?
2. What is the number of staff in your organisation?
3. How many construction projects have your company been involved in?
4. Would you consider the structure of your organisation to be simple or complex (Please describe)?
5. Would you consider your organisation to have a top-down or bottom-up communication model?
6. How often do you have staff meeting in your company?

Section 3: Organisation's policy on waste reduction.

1. Does your organisation have a policy for activity waste reduction, time management, material and financial waste reduction?
2. If there is a policy on waste reduction how often is the policy reviewed?
3. Is there a regular review of previous projects handled by your company?
4. Is there a significant impact of post-project reviews on on-going projects and company behaviour towards future projects?
5. Have you heard of Kaizen or continuous improvement (Please state the actual word which you are familiar with)?
6. Please state you know about kaizen or continuous improvement in organisations
7. Do you think continuous improvement can improve post-contract cost control process within your organisation?

Section 4: Post-contract cost controlling techniques.

1. Please can you indicate the most important post-contract cost controlling techniques used during construction?
2. Are these techniques effective?
3. Do you think the post-contract cost controlling techniques you mentioned can be improved with kaizen costing?
4. Please give suggestions on how post-contract cost controlling techniques can be improved with kaizen costing.

Appendix D

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Research Instruments

The development of a Kaizen costing framework for the Nigerian construction industry.

Kaizen costing is a Japanese word for continuous cost improvement during the production stage. Kaizen costing is the philosophy which involves the reduction of material, labour, suppliers' and plant cost during the production stage to increase profit. Therefore, overheads are reduced during each work activity on site and the suppliers are involved in the cost reduction process. Kaizen costing aims to attain good quality with good price through cost reduction; this is achieved through the help of the employees and the management. In kaizen costing, teamwork is required to continuously generate new ideas on how to reduce cost and create more profit for the company.

Questions

Section A

Organisation and professional background

1. Name of organisation…….
2. Company specialisation……
3. Total number of organisations' staff……..
4. Current job title……..
5. Years of experience……....

Section B

Post- contract cost control in construction. Please tick.

1. Which of these methods do you use for cost control during construction?

a) Traditional method ☐ b) Target costing ☐ c) Activity Based ☐ Costing

d) Life cycle costing ☐ e) Value analysis/engineering ☐ f) Earned value Analysis ☐ g) Kaizen costing ☐

2. Please state any other method used for post-contract cost control in your organisation……
……

3. Is there a special template for managing post-contract cost in your organisation?
YES ☐ NO ☐
If Yes, please describe……
…….

4. How open is the management to innovation and ideas?
Not open ☐ slightly open ☐ Open ☐ Very Open ☐

5. Would you encourage a new form of cost reduction during construction in your organisation?
YES ☐ NO ☐

SECTION C

1. Please tick the following post-contract cost control techniques according to the level of effectiveness and importance to a construction project which you have been involved in. The scale is from 1 to 5 for each of the sides. The effectiveness pertains to the impact the technique has on your projects, while the importance is the level of usage.

2.

Effectiveness	**Importance**
1= Not Relevant	***1= Not Important***
2= Not Effective	***2= Moderately Important***
3= Moderately Effective	***3= Important***
4= Effective	***4= Highly Important***
5= Highly Effective	***5= Extremely Important***

1	2	3	4	5	Post-contract cost control Techniques	1	2	3	4	5
					Cashflow					
					Using historical data					
					Site meetings and Post project reviews					
					Taking corrective action					
					Monitoring labour cost					
					Monitoring material cost					
					Monitoring equipment cost					
					Monitoring overheads					
					Variation management					
					Cost ratio					
					Incremental milestone					
					Monitoring completed units					
					Identifying cost overruns					
					Unit rate					
					Cost forecasting					
					Profit and loss summary					
					Interim Valuation					
					Using established budget and target					

Please state below other post-contract cost control techniques which your organisation has used during a project which is extremely important and has been highly effective.

SECTION D

This section involves agreeing with the terms in the table as a reasonable measure of reducing construction cost continually during the entire phase of a construction project. Please tick the most appropriate range on this scale from 1 to 5

1= Strongly disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly agree

Statements	1	2	3	4	5
Continual reduction of plant and equipment depreciation overhead cost throughout the construction phase will keep the project cost within budget					
Continual cost reduction of overhead cost of activities related to mobilisation and equipment setup will keep the project cost within budget					
Continual reduction of activities related to drawing reviews will eliminate unnecessary cost thereby keeping the project cost within budget					
Ensuring activities related to construction variations are continually minimised will create more profit for the contractor					
Cost of activities related to purchase orders and material deliveries can be reduced continually throughout the construction phase to control the project cost for optimum profit					
Overhead cost related to paying suppliers, subcontractors and labourers can be reduced continually throughout the construction phase to keep the project cost within budget					
Continual reduction of overhead costs related to construction cost planning, general planning, resource planning and project reports will create more profit for the contractor					

Continual reduction of overhead costs associated with preliminary items of work such as site office, storage, security, electricity, water supply, first aid and so on will eventually help the creation of more profit and improve project delivery					

Please state below other construction activities which can be reduced to improve construction cost:

SECTION E

Please tick to indicate the degree of importance of the **critical success factors (CSF)** required for the possible implementation of kaizen costing in indigenous construction companies in Nigeria.

Kaizen costing

1= Not Important

2= Important
3= Moderately Important
4= Highly Important
5= Extremely Important

Critical success factors	1	2	3	4	5
Organisational structure					
Flexible organisation policy					
Existing continuous improvement policy					
Organisation structure and communication					
Employee empowerment					
Experienced Quantity surveyors other staff					
Excellent remuneration and motivation					

Excellent working conditions					
Excellent employer/ employee relationship					
Training of inexperienced employee					
Availability of software packages					
Financial status of the construction firm					
Contract documentation and procurement					
Procurement method adopted					
Clarity of exclusions in the contract					
Accuracy of estimates					
Construction process and technical know-how					
Construction method adopted					
In-depth knowledge of production process					
Standardised production process					
Project complexity					
Employee experience					
Quantity Surveyor site experience					
Updating cost information during construction					
Variations and rework during construction					
Government and regulatory influence					
Stability of market conditions					
Political stability					
Government regulations					
Influence of construction professional bodies					
Financial risk management and litigation					
Price and design risk					
Quality of cost information					
Price fluctuations					

Payment delays					
Claims					
Fraudulent practices and kickbacks					
Disputes and litigations					
Suppliers' cost of materials					
Subcontractors' cost					
Communication and teamwork					
Regular site meetings					
Management of overheads on site					
Communication among project professionals					
Post-project reviews of cost information					
Improved teamwork					
Improved contractor-client communication					
Decision making					
Contractor decision-making technique					
Architect/project managers' decision					
Quantity Surveyor's decisions					
Relationship management					
Contractor/suppliers relationship					
Contractor/subcontractor relationship					
Contractor/Quantity Surveyor relationship					
Architect/Quantity Surveyor relationship					

Appendix E

Validation Questions with feedback

1. Please state your field of expertise? ……Quantity Surveying……..

2. How many years of experience do you have in the Nigerian construction industry? .....Five years.....

3. Do you think the framework in Figure 1 can suitable in small and medium scale construction firms in Nigeria for post-contract cost control?
   Comments …… I think it will be difficult for SME to implement the framework in Fig 1 due to limited human, financial and operational resources. Most SMEs in Nigeria and elsewhere operate informal form of management which is devoid of structure, rules and organisation. At best, a SME will have one owner-manager with less than 10 staffers. Their profits are expended on employee welfare and stationaries. Additionally, the framework does not identify the personnel in SME who will be responsible for the action points in levels 1-5. This further makes it difficult for the framework to be implemented. I think there should be clear specification of roles.

4. Do you think the framework in the figure is complete for improving post-contract cost control in Nigeria?
   Comments I think it is important to mention or identify the focus of the post-contract cost control, be it building projects, civil engineering projects, services, overheads etc. Thus the question 4 here is generic and difficult to answer. (I think this also applies to question 3 above). Except if you mean post-contract cost control practices in SME, I think there will be differences in post-contract cost control of different types of contracts or projects. My opinion is that there can be no framework that will be adequate enough for improving post-contract cost control in Nigeria or elsewhere. However, from cost control process using IDEF0 to variation management can help in controlling cost of construction projects in Nigeria
   ……
   ……
   ……

5. Do you think the model in figure 2 is a suitable model is complete and suitable for the framework?

Comments ……The framework in Figure 2 is clearer and implementable. However it will serve the users well to know who has responsibilities within the framework. I think it is complete. However I believe part of the stored data should be lessons learned about post-contract control of every implemented project. This should feed-forwarded to the framework (to the starting point – identification part).
……
……
…….

6. Do you think the model in figure 3 is a suitable model is complete and suitable for the framework?
   Comments ……I think Figure 3 is unclear and irrelevant to activities within SME construction companies in Nigeria.
   ……
   ……
   …….

7. Do you think the model in figure 4 is a suitable model is complete and suitable for the framework?
   Comments ……I think the Fig 4 can be implemented. However it does not make sense that business ethics leads to improved cost management. I think it is better to mention that management function leads to operational efficiency which also leads to increased quality of cost information and finally to cost management……
   ……
   …….

8. Do you think the model in figure 4 has the right information for post-contract cost control?
   Comments ……I think there is need to include information that relates the model directly with post-contract cost control in construction. For instance "quality product" is not a term used in construction
   ……
   ……
   …….

9. Do you think the framework in figure 1 can be implemented in your organisation to improve productivity and performance of projects in terms of cost overrun
   Comments ……Except for the IDEF0, I think the information on the right-hand side of Fig 1 can be implemented in my organisation. The use of ICT in the Nigerian construction industry is still very low. Most SME do not even have websites, lest programming. You may need to rethink a simpler modelling language which can be used in Nigeria.
   ……
   ……
   …….

10. Please provide your overall comment about the framework and the possible years of implementation in figure 1.

    Comments ……I think there is too much information in the frameworks making it difficult to understand their purpose or goal. It is also unclear how the frameworks are addressing Nigerian SMEs. The framework should be further simplified. I think there should not be more than one framework after a PhD research. It will take over ten years for this type of framework to be implemented

Appendix F

Data tables for chapter four

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.478
Bartlett's Test of Sphericity	Approx. Chi-Square	5380.078
	df	1128
	Sig.	.000

Table 5.34 KMO and Bartlett's Test

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
	Flexible organization policy	1.000	.571	.488	.167	.386	.403	.342	.248	.423	.218	.108	.041	.133	.267	.093	.293	.138	.411	.441	.344	.260	.372	.187	.206	.436	.296	.118	.180	-.030	.007	.116	-.090	.377	.310	.036
	Existing continous improvement policy	.571	1.000	.600	.199	.190	.338	.365	.278	.284	.258	.234	-.002	.313	.361	.237	.445	.280	.411	.412	.339	.323	.329	.239	.132	.410	.317	-.028	.168	-.144	.083	.110	-.020	.377	.275	.068
	Organization structure and communication	.488	.600	1.000	.368	.178	.344	.317	.296	.286	.176	.129	.210	.317	.243	.374	.469	.353	.406	.497	.413	.273	.462	.260	.256	.388	.236	.139	.209	.141	.229	.500	.139	.322	.419	.194

	Employee empowerment	.167	.199	.368	1.000	.259	.423	.283	.425	.082	.065	.297	.391	.433	.287	.190	.182	-.011	.272	.366	.308	.159	.429	.095	.359	.030	-.047	.096	.265	.145	.151	.339	.325	.193	.131	.054
	Experienced QS and other staff	.386	.190	.178	.259	1.000	.568	.458	.343	.499	.117	.326	.260	.391	.376	.164	.214	.154	.481	.439	.574	.175	.425	.166	.423	.276	.320	.182	.426	.222	.281	.112	.234	.163	.372	.007
	Excellent renumeration and motivation	.403	.338	.344	.423	.568	1.000	.478	.501	.333	.235	.395	.358	.508	.398	.278	.166	.305	.405	.478	.564	.089	.526	.228	.517	.366	.350	.098	.515	.299	.196	.401	.259	.312	.429	.347
	Excellent working conditions	.342	.365	.317	.283	.458	.478	1.000	.434	.492	.351	.625	.216	.289	.419	.411	.458	.293	.373	.276	.514	.314	.453	.363	.358	.325	.489	.346	.345	.173	.232	.098	.035	.187	.296	.103
	Excellent employee/employer relationship	.248	.278	.296	.425	.343	.501	.434	1.000	.407	.394	.377	.386	.446	.292	.412	.421	.375	.487	.385	.484	.361	.481	.415	.491	.362	.116	.318	.418	.125	.137	.256	.225	.153	.285	.113
	Training of inexperienced employee	.423	.284	.286	.082	.499	.333	.492	.407	1.000	.514	.390	.237	.146	.214	.190	.355	.249	.403	.368	.443	.350	.421	.404	.263	.486	.432	.418	.270	.101	.179	-.098	.017	.204	.289	.160
	Availability of software packages	.218	.258	.176	.065	.117	.235	.351	.394	.514	1.000	.376	.164	.149	.227	.197	.178	.321	.237	.134	.240	.363	.238	.375	.104	.214	.297	.413	.072	-.027	-.002	-.175	-.156	.096	.128	.087
	Financial status of the firm	.108	.234	.129	.297	.326	.395	.625	.377	.390	.376	1.000	.363	.291	.324	.287	.370	.359	.215	.353	.434	.419	.423	.236	.186	.185	.415	.410	.317	.132	.234	-.003	-.068	.026	.007	.028
	Procurement method	.041	-.002	.210	.391	.260	.358	.216	.386	.237	.164	.363	1.000	.354	.330	.307	.108	.158	.155	.464	.223	.191	.317	.279	.289	.173	.067	.189	.339	.282	.213	.234	.402	.035	.151	.289

	Clarity of exclusions in the contract	.133	.313	.317	.433	.391	.508	.289	.446	.146	.149	.291	.354	1.000	.430	.265	.165	.194	.356	.397	.401	.161	.452	.338	.561	.347	.139	.054	.375	.239	.149	.330	.303	.189	.344	.056
	Accuracy of estimates	.267	.361	.243	.287	.376	.398	.419	.292	.214	.227	.324	.330	.430	1.000	.251	.297	.287	.511	.395	.428	.326	.398	.105	.210	.145	.427	.207	.291	.018	.091	.096	.195	.138	.218	.006
	Construction method	.093	.237	.374	.190	.164	.278	.411	.412	.190	.197	.287	.307	.265	.251	1.000	.539	.405	.341	.248	.383	.363	.346	.366	.111	.086	.172	.240	.132	.186	.199	.382	.160	.311	.195	.211
	In-depth knowledge of production process	.293	.445	.469	.182	.214	.166	.458	.421	.355	.178	.370	.108	.165	.297	.539	1.000	.258	.469	.358	.368	.401	.336	.226	.054	.196	.286	.197	.222	.002	.259	.342	.102	.330	.140	-.076
	Standardized production process	.138	.280	.353	-.011	.154	.305	.293	.375	.249	.321	.359	.158	.194	.287	.405	.258	1.000	.382	.410	.406	.368	.329	.388	.258	.307	.451	.395	.339	.029	.194	.090	-.059	-.065	.367	.276
	Project complexity	.411	.411	.406	.272	.481	.405	.373	.487	.403	.237	.215	.155	.356	.511	.341	.469	.382	1.000	.449	.484	.422	.493	.276	.327	.329	.342	.244	.286	.044	.125	.195	.135	.210	.333	.032
	Employee experience	.441	.412	.497	.366	.439	.478	.276	.385	.368	.134	.353	.464	.397	.395	.248	.358	.410	.449	1.000	.600	.366	.421	.366	.435	.420	.161	.119	.615	.110	.344	.242	.329	.193	.355	.230
	QS site expereince	.344	.339	.413	.308	.574	.564	.514	.484	.443	.240	.434	.223	.401	.428	.383	.368	.406	.484	.600	1.000	.552	.526	.387	.481	.289	.456	.385	.586	.264	.406	.270	.321	.228	.571	.278
	Updating cost information during construction	.260	.323	.273	.159	.175	.089	.314	.361	.350	.363	.419	.191	.161	.326	.363	.401	.368	.422	.366	.552	1.000	.481	.560	.019	.133	.342	.642	.205	.058	.117	-.046	.014	.237	.104	-.029

	Variations and rework during construction	.372	.329	.462	.429	.425	.526	.453	.481	.421	.238	.423	.317	.452	.398	.346	.336	.329	.493	.421	.526	.481	1.000	.381	.458	.496	.431	.478	.441	.301	.174	.330	.157	.410	.384	.258
	Stability of market conditions	.187	.239	.260	.095	.166	.228	.363	.415	.404	.375	.236	.279	.338	.105	.366	.226	.388	.276	.366	.387	.560	.381	1.000	.373	.302	.253	.478	.374	.127	.172	.068	.169	.210	.281	.270
	political stability	.206	.132	.256	.359	.423	.517	.358	.491	.263	.104	.186	.289	.561	.210	.111	.054	.258	.327	.435	.481	.019	.458	.373	1.000	.550	.214	.160	.626	.400	.368	.312	.397	.128	.623	.405
	Government regulations	.436	.410	.388	.030	.276	.366	.325	.362	.486	.214	.185	.173	.347	.145	.086	.196	.307	.329	.420	.289	.133	.496	.302	.550	1.000	.431	.101	.478	.075	.160	.175	.039	.384	.511	.387
	Influence of construction professional bodies	.296	.317	.236	-.047	.320	.350	.489	.116	.432	.297	.415	.067	.139	.427	.172	.286	.451	.342	.161	.456	.342	.431	.253	.214	.431	1.000	.503	.329	.035	.172	-.027	-.053	.184	.406	.295
	Price and design risk	.118	-.028	.139	.096	.182	.098	.346	.318	.418	.413	.410	.189	.054	.207	.240	.197	.395	.244	.119	.385	.642	.478	.478	.160	.101	.503	1.000	.208	.189	.113	-.097	-.071	-.017	.144	.009
	Quality of cost information	.180	.168	.209	.265	.426	.515	.345	.418	.270	.072	.317	.339	.375	.291	.132	.222	.339	.286	.615	.586	.205	.441	.374	.626	.478	.329	.208	1.000	.306	.587	.439	.498	.227	.557	.449
	Price fluctuations	-.030	-.144	.141	.145	.222	.299	.173	.125	.101	-.027	.132	.282	.239	.018	.186	.002	.029	.044	.110	.264	.058	.301	.127	.400	.075	.035	.189	.306	1.000	.576	.415	.388	.013	.262	.407
	Payment delays	.007	.083	.229	.151	.281	.196	.232	.137	.179	-.002	.234	.213	.149	.091	.199	.259	.194	.125	.344	.406	.117	.174	.172	.368	.160	.172	.113	.587	.576	1.000	.442	.687	.187	.386	.506
	Claims	.116	.110	.500	.339	.112	.401	.098	.256	-.098	-.175	-.003	.234	.330	.096	.382	.342	.090	.195	.242	.270	-.046	.330	.068	.312	.175	-.027	-.097	.439	.415	.442	1.000	.495	.398	.436	.347

	Fraudulent practices and kickbacks	-.090	-.020	.139	.325	.234	.259	.035	.225	.017	-.156	-.068	.402	.303	.195	.160	.102	-.059	.135	.329	.321	.014	.157	.169	.397	.039	-.053	-.071	.498	.388	.687	.495	1.000	.246	.308	.433
	Disputes and litigations	.377	.377	.322	.193	.163	.312	.187	.153	.204	.096	.026	.035	.189	.138	.311	.330	-.065	.210	.193	.228	.237	.410	.210	.128	.384	.184	-.017	.227	.013	.187	.398	.246	1.000	.290	.306
	Suppliers' cost of materials	.310	.275	.419	.131	.372	.429	.296	.285	.289	.128	.007	.151	.344	.218	.195	.140	.367	.333	.355	.571	.104	.384	.281	.623	.511	.406	.144	.557	.262	.386	.436	.308	.290	1.0000	.542
	Sub-contractors' cost	.036	.068	.194	.054	.007	.347	.103	.113	.160	.087	.028	.289	.056	.006	.211	-.076	.276	.032	.230	.278	-.029	.258	.270	.405	.387	.295	.009	.449	.407	.506	.347	.433	.306	.542	1.000
	Regular site meetings	.336	.465	.481	.120	.271	.482	.427	.385	.398	.265	.336	.267	.284	.338	.371	.578	.240	.361	.337	.441	.253	.437	.207	.239	.403	.444	.248	.410	.155	.324	.388	.290	.355	.340	.184
	Management of overheads on cost	-.057	.252	.303	.287	.117	.171	.220	.144	-.005	.018	.307	.240	.300	.341	.323	.488	.001	.154	.145	.202	.203	.249	.123	.083	.036	.228	.093	.191	.190	.367	.414	.411	.267	.045	.118
	Communication among project professionals	.036	.239	.224	.224	.134	.209	.352	.284	.050	-.007	.346	.084	.110	.230	.277	.502	.157	.166	.070	.241	.085	.102	.003	.143	-.066	.157	.164	.223	.231	.347	.395	.156	.039	.140	-.083

	Post-project reviews of cost informations	.091	.132	.126	.123	.241	.385	.456	.391	.337	.279	.367	.251	.221	.176	.532	.390	.390	.162	.142	.352	.142	.311	.332	.304	.207	.281	.293	.229	.157	.118	.153	-.050	.073	.260	.252
	Improved teamwork	.201	.285	.273	.062	.218	.200	.540	.242	.501	.270	.628	.170	.027	.153	.368	.499	.348	.164	.262	.415	.304	.177	.146	-.055	.177	.382	.297	.132	-.031	.160	.030	-.167	.079	.123	.017
	Improved contractor-client communication	.288	.372	.357	.450	.509	.554	.398	.517	.332	.200	.431	.504	.552	.429	.225	.219	.305	.316	.627	.603	.277	.577	.324	.667	.466	.322	.252	.609	.326	.355	.309	.353	.202	.502	.327
	Contractor decision making	.289	.365	.367	.188	.231	.308	.386	.367	.352	.255	.342	.187	.231	.326	.263	.355	.296	.502	.397	.591	.459	.279	.416	.356	.232	.396	.441	.352	.035	.201	.119	.147	.219	.318	.100
	Architect/project managers' decision	.499	.376	.425	.253	.569	.515	.425	.430	.436	.136	.315	.240	.325	.416	.199	.292	.422	.541	.517	.541	.262	.597	.232	.506	.430	.359	.312	.434	.171	.171	.233	.128	.114	.392	.087
	QS decsions	.207	.238	.226	.159	.209	.267	.146	.091	-.051	-.185	-.040	.022	.163	.271	.180	.182	.035	.218	.230	.305	.070	-.006	.002	.157	-.010	-.049	-.163	.222	.504	.405	.490	.359	.091	.194	.151
	Contractor/suppliers relationship	.189	.332	.370	.152	.064	.287	.102	.357	.016	.038	.105	.329	.154	.118	.502	.420	.237	.220	.400	.241	.230	.230	.207	.062	.084	-.091	-.091	.284	.421	.370	.492	.368	.212	.058	.275

	Contractor/sub-contractor relationship	.274	.400	.517	.183	.267	.379	.291	.382	.072	.004	.132	.257	.276	.270	.390	.496	.264	.365	.407	.377	.187	.288	.268	.333	.173	.096	.005	.444	.488	.514	.578	.412	.152	.335	.247
	contractor/QS relationship	.383	.436	.435	.209	.357	.411	.243	.454	.119	-.003	.079	.184	.343	.259	.301	.275	.174	.338	.356	.389	.217	.322	.210	.340	.283	-.050	-.029	.229	.401	.184	.446	.131	.124	.320	.063
	Architect/QS relationship	.230	.157	.184	.060	.267	.402	.263	.227	.167	.169	.085	.133	.193	.158	.203	.012	.151	.167	.113	.264	.070	.310	.293	.300	.232	.288	.060	.205	.345	.105	.147	.028	.134	.237	.346
Sig. (1-tailed)	Flexible organization policy		.000	.000	.034	.000	.000	.000	.003	.000	.008	.119	.328	.074	.002	.155	.001	.067	.000	.000	.000	.002	.000	.021	.012	.000	.001	.100	.025	.371	.470	.104	.164	.000	.000	.348
	Existing continous improvement policy	.000		.000	.015	.019	.000	.000	.001	.001	.002	.005	.493	.000	.000	.005	.000	.001	.000	.000	.000	.000	.000	.004	.075	.000	.000	.381	.033	.058	.185	.117	.412	.000	.001	.232
	Organization structure and communication	.000	.000		.000	.026	.000	.000	.001	.001	.027	.079	.011	.000	.004	.000	.000	.000	.000	.000	.000	.001	.000	.002	.002	.000	.005	.065	.011	.063	.006	.000	.064	.000	.000	.017
	Employee empowerment	.034	.015	.000		.002	.000	.001	.000	.186	.240	.001	.000	.000	.001	.019	.023	.454	.001	.000	.000	.041	.000	.151	.000	.374	.307	.149	.002	.057	.050	.000	.000	.017	.076	.279

	Experienced QS and other staff	.000	.019	.026	.002		.000	.000	.000	.000	.101	.000	.002	.000	.000	.037	.010	.047	.000	.000	.000	.028	.000	.035	.000	.001	.000	.023	.000	.007	.001	.111	.005	.038	.000	.470
	Excellent renumeration and motivation	.000	.000	.000	.000	.000		.000	.000	.000	.005	.000	.000	.000	.000	.001	.035	.000	.000	.000	.000	.166	.000	.006	.000	.000	.000	.144	.000	.000	.016	.000	.002	.000	.000	.000
	Excellent working conditions	.000	.000	.000	.001	.000	.000		.000	.000	.000	.000	.009	.001	.000	.000	.000	.001	.000	.001	.000	.000	.000	.000	.000	.000	.000	.000	.000	.029	.005	.144	.352	.020	.001	.131
	Excellent employee/employer relationship	.003	.001	.001	.000	.000	.000	.000		.000	.000	.000	.000	.000	.001	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.103	.000	.000	.087	.067	.002	.007	.048	.001	.110
	Training of inexperienced employee	.000	.001	.001	.186	.000	.000	.000	.000		.000	.000	.005	.056	.009	.019	.000	.003	.000	.000	.000	.000	.000	.000	.002	.000	.000	.000	.001	.136	.025	.144	.426	.013	.001	.041
	Availability of software packages	.008	.002	.027	.240	.101	.005	.000	.000	.000		.000	.036	.052	.006	.016	.026	.000	.005	.072	.004	.000	.004	.000	.130	.009	.001	.000	.219	.384	.493	.028	.044	.150	.081	.171
	Financial status of the firm	.119	.005	.079	.001	.000	.000	.000	.000	.000	.000		.000	.001	.000	.001	.000	.000	.009	.000	.000	.000	.000	.005	.021	.022	.000	.000	.000	.075	.005	.486	.231	.389	.469	.380
	Procurement method	.328	.493	.011	.000	.002	.000	.009	.000	.005	.036	.000		.000	.000	.000	.121	.042	.045	.000	.007	.018	.000	.001	.001	.029	.232	.020	.000	.001	.010	.005	.000	.352	.050	.001

	Clarity of exclusions in the contract	.074	.000	.000	.000	.000	.000	.001	.000	.056	.052	.001	.000		.000	.002	.036	.017	.000	.000	.000	.039	.000	.000	.000	.000	.065	.278	.000	.004	.053	.000	.000	.019	.000	.273
	Accuracy of estimates	.002	.000	.004	.001	.000	.000	.000	.001	.009	.006	.000	.000	.000		.003	.001	.001	.000	.000	.000	.000	.000	.126	.011	.057	.000	.012	.001	.423	.160	.149	.017	.067	.008	.472
	Construction method	.155	.005	.000	.019	.037	.001	.000	.000	.019	.016	.001	.000	.002	.003		.000	.000	.000	.003	.000	.000	.000	.000	.113	.175	.030	.004	.076	.021	.015	.000	.041	.000	.016	.010
	In-depth knowledge of production process	.001	.000	.000	.023	.010	.035	.000	.000	.000	.026	.000	.121	.036	.001	.000		.002	.000	.000	.000	.000	.000	.006	.278	.016	.001	.015	.007	.490	.002	.000	.134	.000	.064	.205
	Standardized production process	.067	.001	.000	.454	.047	.000	.001	.000	.003	.000	.000	.042	.017	.001	.000	.002		.000	.000	.000	.000	.000	.000	.002	.000	.000	.000	.000	.377	.017	.164	.260	.240	.000	.001
	Project complexity	.000	.000	.000	.001	.000	.000	.000	.000	.000	.005	.009	.045	.000	.000	.000	.000	.000		.000	.000	.000	.000	.001	.000	.000	.000	.004	.001	.315	.087	.016	.070	.011	.000	.364
	Employee experience	.000	.000	.000	.000	.000	.000	.001	.000	.000	.072	.000	.000	.000	.000	.003	.000	.000	.000		.000	.000	.000	.000	.000	.000	.040	.098	.000	.115	.000	.004	.000	.018	.000	.006
	QS site expereince	.000	.000	.000	.000	.000	.000	.000	.000	.000	.004	.000	.007	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.001	.000	.000	.000	.002	.000	.001	.000	.006	.000	.001
	Updating cost information during construction	.002	.000	.001	.041	.028	.166	.000	.000	.000	.000	.000	.018	.039	.000	.000	.000	.000	.000	.000	.000		.000	.000	.420	.074	.000	.000	.012	.263	.102	.308	.441	.005	.129	.375

	Variations and rework during construction	.000	.000	.000	.000	.000	.000	.000	.000	.000	.004	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.028	.000	.044	.000	.000	.002
	Stability of market conditions	.021	.004	.002	.151	.035	.006	.000	.000	.000	.000	.005	.001	.000	.126	.000	.006	.000	.001	.000	.000	.000	.000		.000	.000	.003	.000	.000	.084	.030	.230	.032	.011	.001	.001
	political stability	.012	.075	.002	.000	.000	.000	.000	.000	.002	.130	.021	.001	.000	.011	.113	.278	.002	.000	.000	.000	.420	.000	.000		.000	.009	.041	.000	.000	.000	.000	.000	.081	.000	.000
	Government regulations	.000	.000	.000	.374	.001	.000	.000	.000	.000	.009	.022	.029	.000	.057	.175	.016	.000	.000	.000	.001	.074	.000	.000	.000		.000	.136	.000	.209	.040	.028	.337	.000	.000	.000
	Influence of construction professional bodies	.001	.000	.005	.307	.000	.000	.000	.103	.000	.001	.000	.232	.065	.000	.030	.001	.000	.000	.040	.000	.000	.000	.003	.009	.000		.000	.000	.354	.030	.384	.283	.022	.000	.001
	Price and design risk	.100	.381	.065	.149	.023	.144	.000	.000	.000	.000	.000	.020	.278	.012	.004	.015	.000	.004	.098	.000	.000	.000	.000	.041	.136	.000		.011	.020	.109	.147	.220	.428	.058	.461
	Quality of cost information	.025	.033	.011	.002	.000	.000	.000	.000	.001	.219	.000	.000	.000	.001	.076	.007	.000	.001	.000	.000	.012	.000	.000	.000	.000	.000	.011		.000	.000	.000	.000	.006	.000	.000
	Price fluctuations	.371	.058	.063	.057	.007	.000	.029	.087	.136	.384	.075	.001	.004	.423	.021	.490	.377	.315	.115	.002	.263	.000	.084	.000	.209	.354	.020	.000		.000	.000	.000	.445	.002	.000
	Payment delays	.470	.185	.006	.050	.001	.016	.005	.067	.025	.493	.005	.010	.053	.160	.015	.002	.017	.087	.000	.000	.102	.028	.030	.000	.040	.030	.109	.000	.000		.000	.000	.021	.000	.000
	Claims	.104	.117	.000	.000	.111	.000	.144	.002	.144	.028	.486	.005	.000	.149	.000	.000	.164	.016	.004	.001	.308	.000	.230	.000	.028	.384	.147	.000	.000	.000		.000	.000	.000	.000

	Fraudulent practices and kickbacks	.164	.412	.064	.000	.005	.002	.352	.007	.426	.044	.231	.000	.000	.017	.041	.134	.260	.070	.000	.000	.441	.044	.032	.000	.337	.283	.220	.000	.000	.000	.000		.003	.000	.000	.000
	Disputes and litigations	.000	.000	.000	.017	.038	.000	.020	.048	.013	.150	.389	.352	.019	.067	.000	.000	.240	.011	.018	.006	.005	.000	.011	.081	.000	.022	.428	.006	.445	.021	.000	.003		.001	.000	.000
	Suppliers' cost of materials	.000	.001	.000	.076	.000	.000	.001	.001	.001	.081	.469	.050	.000	.008	.016	.064	.000	.000	.000	.000	.129	.000	.001	.000	.000	.000	.058	.000	.002	.000	.000	.000	.001		.000	.000
	Sub-contractors' cost	.348	.232	.017	.279	.470	.000	.131	.110	.041	.171	.380	.001	.273	.472	.010	.205	.001	.364	.006	.001	.375	.002	.001	.000	.000	.001	.461	.000	.000	.000	.000	.000	.000	.000	.000	
	Regular site meetings	.000	.000	.000	.096	.001	.000	.000	.000	.000	.002	.000	.002	.001	.000	.000	.000	.004	.000	.000	.000	.003	.000	.012	.004	.000	.000	.003	.000	.046	.000	.000	.001	.000	.000	.000	.022
	Management of overheads on cost	.267	.003	.000	.001	.102	.031	.008	.058	.480	.422	.000	.004	.000	.000	.000	.000	.494	.046	.057	.013	.013	.003	.090	.183	.348	.006	.155	.018	.019	.000	.000	.000	.002	.315	.100	
	Communication among project professionals	.347	.004	.007	.007	.072	.011	.000	.001	.292	.470	.000	.181	.116	.006	.001	.000	.044	.035	.224	.004	.177	.134	.486	.059	.237	.043	.037	.007	.006	.000	.000	.045	.336	.063	.184	

	Post-project reviews of cost informations	.162	.075	.085	.090	.004	.000	.000	.000	.000	.001	.000	.003	.008	.027	.000	.000	.000	.039	.061	.000	.061	.000	.000	.000	.012	.001	.001	.006	.043	.099	.048	.294	.214	.002	.003
	Improved teamwork	.014	.001	.001	.250	.008	.014	.000	.004	.000	.001	.000	.032	.385	.048	.000	.000	.000	.037	.002	.000	.000	.027	.056	.275	.026	.000	.000	.075	.368	.040	.371	.034	.197	.091	.428
	Improved contractor-client communication	.001	.000	.000	.000	.000	.000	.000	.000	.000	.014	.000	.000	.000	.000	.007	.008	.000	.000	.000	.000	.001	.000	.000	.000	.000	.000	.003	.000	.000	.000	.000	.000	.013	.000	.000
	Contractor decision making	.001	.000	.000	.020	.006	.000	.000	.000	.000	.002	.000	.021	.006	.000	.002	.000	.001	.000	.000	.000	.000	.001	.000	.000	.005	.000	.000	.000	.350	.014	.097	.055	.008	.000	.138
	Architect/project managers' decision	.000	.000	.000	.003	.000	.000	.000	.000	.000	.070	.000	.004	.000	.000	.015	.001	.000	.000	.000	.000	.002	.000	.005	.000	.000	.000	.000	.000	.031	.031	.005	.082	.108	.000	.172
	QS decsions	.012	.004	.007	.042	.011	.002	.056	.162	.290	.021	.333	.406	.038	.001	.024	.024	.354	.008	.006	.000	.224	.474	.493	.044	.458	.299	.037	.007	.000	.000	.000	.000	.161	.017	.050
	Contractor/suppliers relationship	.019	.000	.000	.048	.243	.001	.133	.000	.432	.340	.127	.000	.047	.099	.000	.000	.005	.008	.000	.004	.006	.006	.012	.251	.182	.161	.161	.001	.000	.000	.000	.000	.010	.265	.001
	Contractor/sub-contractor relationship	.001	.000	.000	.023	.002	.000	.001	.000	.218	.481	.076	.002	.001	.001	.000	.000	.002	.000	.000	.000	.020	.001	.002	.000	.029	.148	.476	.000	.000	.000	.000	.000	.049	.000	.003

	contractor/QS relationship	.000	.000	.000	.011	.000	.000	.004	.000	.098	.487	.195	.022	.000	.002	.000	.001	.029	.000	.000	.000	.009	.000	.011	.000	.001	.294	.378	.006	.000	.022	.000	.077	.088	.000	.247
	Architect/QS relationship	.006	.044	.022	.258	.002	.000	.002	.006	.034	.033	.178	.074	.017	.042	.013	.448	.049	.034	.110	.002	.225	.000	.001	.000	.005	.001	.256	.012	.000	.127	.055	.382	.073	.005	.000

Correlation matrix continues

	Regular site meetings	Management of overheads on cost	Communication among project professionals	Post-project reviews of cost informations	Improved teamwork	Improved contractor-client communication	Contractor decision making	Architect/project manager's' decision	QS decsions	Contractor/suppliers relationship	Contractor/sub-contractor relationship	contractor/QS relationship	Architect/QS relationship
Flexible organization policy	.336	-.057	.036	.091	.201	.288	.289	.499	.207	.189	.274	.383	.230
Existing continous improvement policy	.465	.252	.239	.132	.285	.372	.365	.376	.238	.332	.400	.436	.157
Organization structure and communication	.481	.303	.224	.126	.273	.357	.367	.425	.226	.370	.517	.435	.184
Employee empowerment	.120	.287	.224	.123	.062	.450	.188	.253	.159	.152	.183	.209	.060
Experienced QS and other staff	.271	.117	.134	.241	.218	.509	.231	.569	.209	.064	.267	.357	.267
Excellent renumeration and motivation	.482	.171	.209	.385	.200	.554	.308	.515	.267	.287	.379	.411	.402

Excellent working conditions	.427	.220	.352	.456	.540	.398	.386	.425	.146	.102	.291	.243	.263
Excellent employee/employer relationship	.385	.144	.284	.391	.242	.517	.367	.430	.091	.357	.382	.454	.227
Training of inexperienced employee	.398	-.005	.050	.337	.501	.332	.352	.436	-.051	.016	.072	.119	.167
Availability of software packages	.265	.018	-.007	.279	.270	.200	.255	.136	-.185	.038	.004	-.003	.169
Financial status of the firm	.336	.307	.346	.367	.628	.431	.342	.315	-.040	.105	.132	.079	.085
Procurement method	.267	.240	.084	.251	.170	.504	.187	.240	.022	.329	.257	.184	.133
Clarity of exclusions in the contract	.284	.300	.110	.221	.027	.552	.231	.325	.163	.154	.276	.343	.193
Accuracy of estimates	.338	.341	.230	.176	.153	.429	.326	.416	.271	.118	.270	.259	.158
Construction method	.371	.323	.277	.532	.368	.225	.263	.199	.180	.502	.390	.301	.203
In-depth knowledge of production process	.578	.488	.502	.390	.499	.219	.355	.292	.182	.420	.496	.275	.012
Standardized production process	.240	.001	.157	.390	.348	.305	.296	.422	.035	.237	.264	.174	.151
Project complexity	.361	.154	.166	.162	.164	.316	.502	.541	.218	.220	.365	.338	.167
Employee experience	.337	.145	.070	.142	.262	.627	.397	.517	.230	.400	.407	.356	.113
QS site expereince	.441	.202	.241	.352	.415	.603	.591	.541	.305	.241	.377	.389	.264
Updating cost information during construction	.253	.203	.085	.142	.304	.277	.459	.262	.070	.230	.187	.217	.070
Variations and rework during construction	.437	.249	.102	.311	.177	.577	.279	.597	-.006	.230	.288	.322	.310

Stability of market conditions	.207	.123	.003	.332	.146	.324	.416	.232	.002	.207	.268	.210	.293
political stability	.239	.083	.143	.304	-.055	.667	.356	.506	.157	.062	.333	.340	.300
Government regulations	.403	.036	-.066	.207	.177	.466	.232	.430	-.010	.084	.173	.283	.232
Influence of construction professional bodies	.444	.228	.157	.281	.382	.322	.396	.359	-.049	-.091	.096	-.050	.288
Price and design risk	.248	.093	.164	.293	.297	.252	.441	.312	-.163	-.091	.005	-.029	.060
Quality of cost information	.410	.191	.223	.229	.132	.609	.352	.434	.222	.284	.444	.229	.205
Price fluctuations	.155	.190	.231	.157	-.031	.326	.035	.171	.504	.421	.488	.401	.345
Payment delays	.324	.367	.347	.118	.160	.355	.201	.171	.405	.370	.514	.184	.105
Claims	.388	.414	.395	.153	.030	.309	.119	.233	.490	.492	.578	.446	.147
Fraudulent practices and kickbacks	.290	.411	.156	-.050	-.167	.353	.147	.128	.359	.368	.412	.131	.028
Disputes and litigations	.355	.267	.039	.073	.079	.202	.219	.114	.091	.212	.152	.124	.134
Suppliers' cost of materials	.340	.045	.140	.260	.123	.502	.318	.392	.194	.058	.335	.320	.237
Sub-contractors' cost	.184	.118	-.083	.252	.017	.327	.100	.087	.151	.275	.247	.063	.346
Regular site meetings	1.000	.559	.488	.324	.334	.328	.467	.422	.150	.310	.476	.202	.033
Management of overheads on cost	.559	1.000	.515	.188	.200	.234	.304	.204	.284	.375	.403	.152	-.039
Communication among project professionals	.488	.515	1.000	.330	.468	.152	.364	.261	.401	.241	.463	.280	.007
Post-project reviews of cost informations	.324	.188	.330	1.000	.504	.304	.200	.278	-.001	.205	.201	.238	.299
Improved teamwork	.334	.200	.468	.504	1.000	.192	.391	.293	-.003	.116	.026	.046	.033

	Improved contractor-client communication	.328	.234	.152	.304	.192	1.000	.304	.537	.203	.221	.368	.470	.239
	Contractor decision making	.467	.304	.364	.200	.391	.304	1.000	.528	.143	.140	.287	.162	.020
	Architect/project managers' decision	.422	.204	.261	.278	.293	.537	.528	1.000	.282	.275	.355	.427	.143
	QS decsions	.150	.284	.401	-.001	-.003	.203	.143	.282	1.000	.555	.593	.648	.270
	Contractor/suppliers relationship	.310	.375	.241	.205	.116	.221	.140	.275	.555	1.000	.707	.540	.316
	Contractor/sub-contractor relationship	.476	.403	.463	.201	.026	.368	.287	.355	.593	.707	1.000	.658	.298
	contractor/QS relationship	.202	.152	.280	.238	.046	.470	.162	.427	.648	.540	.658	1.000	.433
	Architect/QS relationship	.033	-.039	.007	.299	.033	.239	.020	.143	.270	.316	.298	.433	1.000
	Flexible organization policy	.000	.267	.347	.162	.014	.001	.001	.000	.012	.019	.001	.000	.006
	Existing continous improvement policy	.000	.003	.004	.075	.001	.000	.000	.000	.004	.000	.000	.000	.044
	Organization structure and communication	.000	.000	.007	.085	.001	.000	.000	.000	.007	.000	.000	.000	.022
Sig. (1-tailed)	Employee empowerment	.096	.001	.007	.090	.250	.000	.020	.003	.042	.048	.023	.011	.258
	Experienced QS and other staff	.001	.102	.072	.004	.008	.000	.006	.000	.011	.243	.002	.000	.002
	Excellent renumeration and motivation	.000	.031	.011	.000	.014	.000	.000	.000	.002	.001	.000	.000	.000
	Excellent working conditions	.000	.008	.000	.000	.000	.000	.000	.000	.056	.133	.001	.004	.002

Excellent employee/employer relationship	.000	.058	.001	.000	.004	.000	.000	.000	.162	.000	.000	.000	.006
Training of inexperienced employee	.000	.480	.292	.000	.000	.000	.000	.000	.290	.432	.218	.098	.034
Availability of software packages	.002	.422	.470	.001	.001	.014	.002	.070	.021	.340	.481	.487	.033
Financial status of the firm	.000	.000	.000	.000	.000	.000	.000	.000	.333	.127	.076	.195	.178
Procurement method	.002	.004	.181	.003	.032	.000	.021	.004	.406	.000	.002	.022	.074
Clarity of exclusions in the contract	.001	.000	.116	.008	.385	.000	.006	.000	.038	.047	.001	.000	.017
Accuracy of estimates	.000	.000	.006	.027	.048	.000	.000	.000	.001	.099	.001	.002	.042
Construction method	.000	.000	.001	.000	.000	.007	.002	.015	.024	.000	.000	.000	.013
In-depth knowledge of production process	.000	.000	.000	.000	.000	.008	.000	.001	.024	.000	.000	.001	.448
Standardized production process	.004	.494	.044	.000	.000	.000	.001	.000	.354	.005	.002	.029	.049
Project complexity	.000	.046	.035	.039	.037	.000	.000	.000	.008	.008	.000	.000	.034
Employee experience	.000	.057	.224	.061	.002	.000	.000	.000	.006	.000	.000	.000	.110
QS site expereince	.000	.013	.004	.000	.000	.000	.000	.000	.000	.004	.000	.000	.002
Updating cost information during construction	.003	.013	.177	.061	.000	.001	.000	.002	.224	.006	.020	.009	.225
Variations and rework during construction	.000	.003	.134	.000	.027	.000	.001	.000	.474	.006	.001	.000	.000

Stability of market conditions	.012	.090	.486	.000	.056	.000	.000	.005	.493	.012	.002	.011	.001
political stability	.004	.183	.059	.000	.275	.000	.000	.000	.044	.251	.000	.000	.000
Government regulations	.000	.348	.237	.012	.026	.000	.005	.000	.458	.182	.029	.001	.005
Influence of construction professional bodies	.000	.006	.043	.001	.000	.000	.000	.000	.299	.161	.148	.294	.001
Price and design risk	.003	.155	.037	.001	.000	.003	.000	.000	.037	.161	.476	.378	.256
Quality of cost information	.000	.018	.007	.006	.075	.000	.000	.000	.007	.001	.000	.006	.012
Price fluctuations	.046	.019	.006	.043	.368	.000	.350	.031	.000	.000	.000	.000	.000
Payment delays	.000	.000	.000	.099	.040	.000	.014	.031	.000	.000	.000	.022	.127
Claims	.000	.000	.000	.048	.371	.000	.097	.005	.000	.000	.000	.000	.055
Fraudulent practices and kickbacks	.001	.000	.045	.294	.034	.000	.055	.082	.000	.000	.000	.077	.382
Disputes and litigations	.000	.002	.336	.214	.197	.013	.008	.108	.161	.010	.049	.088	.073
Suppliers' cost of materials	.000	.315	.063	.002	.091	.000	.000	.000	.017	.265	.000	.000	.005
Sub-contractors' cost	.022	.100	.184	.003	.428	.000	.138	.172	.050	.001	.003	.247	.000
Regular site meetings		.000	.000	.000	.000	.000	.000	.000	.051	.000	.000	.014	.361
Management of overheads on cost	.000		.000	.020	.014	.005	.000	.013	.001	.000	.000	.049	.337
Communication among project professionals	.000	.000		.000	.000	.048	.000	.002	.000	.004	.000	.001	.470
Post-project reviews of cost informations	.000	.020	.000		.000	.000	.014	.001	.497	.012	.014	.004	.000
Improved teamwork	.000	.014	.000	.000		.018	.000	.001	.487	.104	.390	.310	.360

Improved contractor-client communication	.000	.005	.048	.000	.018		.000	.000	.013	.008	.000	.000	.004
Contractor decision making	.000	.000	.000	.014	.000	.000		.000	.059	.064	.001	.038	.414
Architect/project managers' decision	.000	.013	.002	.001	.001	.000	.000		.001	.001	.000	.000	.059
QS decsions	.051	.001	.000	.497	.487	.013	.059	.001		.000	.000	.000	.001
Contractor/suppliers relationship	.000	.000	.004	.012	.104	.008	.064	.001	.000		.000	.000	.000
Contractor/sub-contractor relationship	.000	.000	.000	.014	.390	.000	.001	.000	.000	.000		.000	.000
contractor/QS relationship	.014	.049	.001	.004	.310	.000	.038	.000	.000	.000	.000		.000
Architect/QS relationship	.361	.337	.470	.000	.360	.004	.414	.059	.001	.000	.000	.000	

Table 5.35: correlation matrix

	Initial
Flexible organization policy	1.000
Existing continous improvement policy	1.000
Organization structure and communication	1.000
Employee empowerment	1.000
Experienced QS and other staff	1.000
Excellent renumeration and motivation	1.000
Excellent working conditions	1.000
Excellent employee/employer relationship	1.000
Training of inexperienced employee	1.000
Availability of software packages	1.000
Financial status of the firm	1.000
Procurement method	1.000

Clarity of exclusions in the contract	1.000
Accuracy of estimates	1.000
Construction method	1.000
In-depth knowledge of production process	1.000
Standardized production process	1.000
Project complexity	1.000
Employee experience	1.000
QS site expereince	1.000
Updating cost information during construction	1.000
Variations and rework during construction	1.000
Stability of market conditions	1.000
political stability	1.000
Government regulations	1.000

Influence of construction professional bodies	1.000
Price and design risk	1.000
Quality of cost information	1.000
Price fluctuations	1.000
Payment delays	1.000
Claims	1.000
Fraudulent practices and kickbacks	1.000
Disputes and litigations	1.000
Suppliers' cost of materials	1.000
Sub-contractors' cost	1.000
Regular site meetings	1.000
Management of overheads on cost	1.000
Communication among project professionals	1.000
Post-project reviews of cost informations	1.000

Improved teamwork	1.000
Improved contractor-client communication	1.000
Contractor decision making	1.000
Architect/project managers' decision	1.000
QS decsions	1.000
Contractor/suppliers relationship	1.000
Contractor/sub-contractor relationship	1.000
contractor/QS relationship	1.000
Architect/QS relationship	1.000

Table 5.36: Communalities

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	14.376	29.949	29.949
2	4.516	9.409	39.358
3	3.178	6.621	45.980
4	2.566	5.345	51.325
5	2.133	4.443	55.768
6	1.969	4.103	59.871
7	1.805	3.760	63.631
8	1.645	3.428	67.059
9	1.320	2.751	69.810
10	1.255	2.615	72.425
11	1.145	2.386	74.811
12	.994	2.071	76.881
13	.988	2.059	78.940
14	.922	1.922	80.862
15	.828	1.724	82.586

16	.737	1.535	84.122
17	.699	1.457	85.578
18	.604	1.258	86.836
19	.575	1.198	88.034
20	.563	1.173	89.207
21	.500	1.041	90.248
22	.477	.993	91.241
23	.427	.890	92.131
24	.382	.796	92.927
25	.356	.741	93.668
26	.343	.715	94.383
27	.312	.650	95.033
28	.285	.595	95.628
29	.255	.532	96.160
30	.232	.483	96.643
31	.216	.450	97.092
32	.199	.415	97.507
33	.189	.395	97.902

34	.160	.334	98.236
35	.142	.295	98.531
36	.107	.224	98.755
37	.099	.206	98.961
38	.081	.168	99.129
39	.076	.159	99.288
40	.072	.150	99.438
41	.059	.122	99.560
42	.050	.104	99.664
43	.047	.098	99.762
44	.033	.068	99.830
45	.029	.061	99.891
46	.022	.046	99.937
47	.017	.035	99.972
48	.014	.028	100.000

Table 5.37: Total Variance Explained

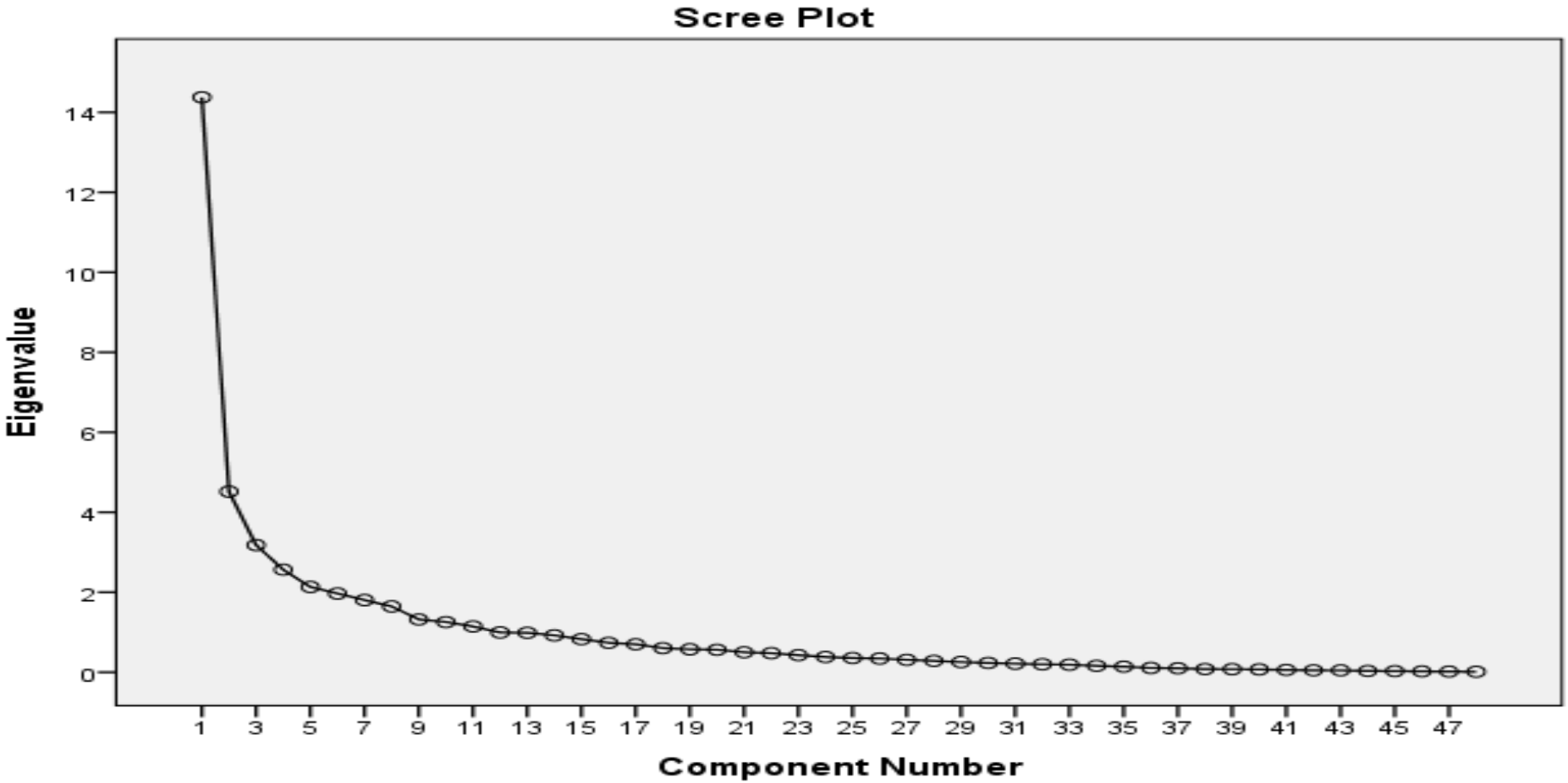

Table 5.38: Scree plot