



**Cape Peninsula
University of Technology**

**FRAMEWORK FOR EFFECTIVE MANAGEMENT OF COST CONSTRAINT ON
BUILDING PROJECT DELIVERY IN SOUTH AFRICA**

By

IMISIOLOUSEYI JULIUS AKINYEDE

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Supervisor: Dr JA Fapohunda

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ABSTRACT

According to findings presented in literature, construction projects are restrained within budgeted cost. Hence, the operational system is challenged within prohibitive cost limits to deliver projects at a stipulated time and at a satisfactory quality. This has prompted the intention of establishing effective management of cost constraint on building project delivery in South Africa. Data for the main study were collected through observations, semi-structured and unstructured qualitative interviews and quantitative close-ended questionnaires administered to construction stakeholders working in the Western Cape and Gauteng provinces, South Africa. Findings are that the following are factors that affect cost during building production process: additional works without contractual procedure, inadequate co-ordination of design phase and construction phase during production by project managers, financial mismanagement, frequent changes in design, cost of materials in the market, fluctuation of price of materials. Additional findings are proper monitoring and controlling at stages during production, procurement of competent contractors and subcontractors, involvement of experienced professionals in production, proper briefing by the client during production process, targeting quality during production, prompt decision taking during production, and the establishment of effective communication systems on site during production, frequent changes in building design by the client during production affect construction cost; frequent changes in building design during production cause rework; changes in building design during construction caused by errors and omissions detected affects quality of project delivered; and specification due to procurement of new materials during construction causes changes in building design, labour productivities, wrong planning for machine usage on site, late delivery of equipment during production and unanticipated increases in prices of building materials. Late delivery of materials also affects production process. Regular meetings on site will promote efficient productivities of human resources, team work on site during production, general progress reports on site during production, projects schedule/timetable for production and work programmes for site activities.

The study concluded by recommending that proper adoption of these findings by the South African construction stakeholders during production processes will enhance delivery of building projects at reduced construction resources, at the standard of quality expected, at the time stipulated, at the budgeted cost specified, and to the satisfaction of the client. Interest will be achieved as illustrated under each objective of the research study. This research recommends further investigation of the effects of building material supply management during production processes in the South African construction industry.

Keywords: Budgeted cost, Building, Cost, Cost constraint, Construction industry, Delivery time, Product, Production process, Stakeholders, Quality project

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DEDICATION

This dissertation is dedicated to God Almighty for his guidance upon my life.

GLOSSARY

The following terms are defined according to the context of the research topic:

Constraint	a factor that confines production processes in the construction industry to limited budget
Budgeted cost	the actual amount of money assigned to a project for completion
Cost	the total cost that includes important materials purchased, construction activities, all professional fees and other related costs
Money	used to purchase construction resources
Budgeting	making a financial arrangement for a construction process and assigning the resources linked with the project (i.e. money, men, machines, and materials) to cost centres
Estimate cost	a process of estimating the actual amount of monetary resources needed to complete all project activities

LIST OF PUBLICATIONS

The followings are list of publications during the master programme

Akinyede, I.J. & Fapohunda, J.A. 2014. *The Impact of Design Changes on Budgeted Cost of Building Projects in South Africa*. In Iaryea, S. and Ibem, E (Eds) Proceedings 8th Construction industry Development Board (cidb) Postgraduate Conference, 10-11 February 2014, University of the Witwatersrand, Johannesburg, South Africa: 537-546.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

The construction industry has recorded the highest percentage as employer of labour, boosting the nation's economic process through improvement and development of other industries and individual economic attainment. However, construction management plans, supervision, techniques of control of equipment, materials and management of knowledge areas during production processes have all been challenged by cost limitation, particularly in delivery of project at budgeted cost specified. Al-Najjar and Enshassi (2008) have found that in recent years, the construction industry and its operational systems are challenged by cost restraint to deliver projects at the stipulated time and at a certified quality. A project is termed as 'successful' if delivered within budgeted cost at a planned time with the quality expected. Thus, it is imperative to have control on cost performance of projects to ensure the construction cost is within the budgeted cost (Ali & Kamarazzuman, 2010). Likewise, mismanagement of cost by stakeholders during the production process leads to delivery of the project at construction costs above the budgeted cost (Arcila & Newton, 2012). Cost is clearly a constraint that hampers project progress, since it results in the loss of huge amounts of profit to the contractor (Kasimu 2012). Azhar *et al.* (2008) identified budgeted cost as a prime factor that has proven to be a significant factor for project success. Other top ten cost factors affecting budgeted cost included the following: (1) fluctuation in price of raw materials, (2) unstable cost of manufactured materials, (3) high cost of machineries, (4) lowest bidding procurement procedures, (5) poor project (site) management, (6) poor cost control, (7) delay between design and procurement phases, (8) incorrect/inappropriate method of cost estimate, (9) additional work, and (10) unsupportive government policies.

The findings of Dibonwa (2009) affirmed that project managers and owners were found to play main contributory roles in activities that impact project cost increase at conception/planning and design stage. In addition, Dibonwa (2009) explained that the project implementation stage apportioned blame to contractors, architects and quantity surveyors for construction cost increments. Quantity surveyors and contractors were discovered to be responsible for budgeted cost increase at the completion/commissioning stage. Likewise, Vidalis and Najafi (2002) discovered that cost and time overrun have been a common glitch challenging most construction projects. Further, Vidalis and Najafi (2002) explained that many factors, such as utility and weather damage delay, can lead to a situation where actual cost and project schedule exceed planned project objectives. Assaf

and Al-hajji (2006) affirmed that achieving project objectives during production processes is significant. Sambasivan and Soon (2007) identified delay as a serious problem to the construction industry as it results in time overrun, budgeted cost increments, disputes, litigations and project desertion. Similarly, Desai and Desale (2013) ascertained that delays are regarded as a significant problem affecting building production processes in delivery of projects at stipulated time, as a result of escalation of price of materials, delays in obtaining permits from authorities and delays in producing detail drawings.

Apolot *et al.* (2011) observed that as the construction industry continues to increase in size, the planning and budgeting problems increase simultaneously, and most construction firms are hindered by delay and increases in budgeted cost. Also, Bell (2011) emphasised that delays can affect construction costs as a result of legal and contractual issues, construction scheduling and claims. However, Rena (2012) observed that project objectives cannot be achieved unless proper management of a construction process is implemented—such as effective planning, budgeting, safety, and quality control of project—and are considered even during the production process.

Memon *et al.* (2010) established that the construction cost at which a project is delivered is one of the most important ways of assessing the success of a project, particularly as cost causes great anxiety to stakeholders who are involved in the construction industry. Further, Memon *et al.* (2010) listed numerous factors affecting construction cost such as cash flow and financial difficulties confronting contractors, contractor's poor site management and supervision, contractor's lack of experience, scarcity of site workers, and inadequate planning and timetabling by contractors. Rahman *et al.* (2013) affirmed that construction cost is a major problem challenging the construction industry globally and thus needs urgent attention to improve the operational techniques in delivery of quality project that meets with client objectives. Memon *et al.* (2013) explained that the identified factors impacting construction costs are poor site management and supervision, incompetent subcontractors, programme delay, improper planning and scheduling, lack of experience of workers and frequent design changes. Memon *et al.* (2011) discovered that cost is significant during the building production process in the delivery of projects that satisfied client interest. Hence, increase in construction cost above budgeted cost was observed as one of the most constantly occurring issues in construction globally. This, must, therefore, be more thoroughly investigated to determine with even more precision the potentially detrimental effects of cost during building production process.

Ganiyu and Zubairu (2010) discovered that a major problem in the Nigerian construction industry concerns those construction projects that are completed at a construction cost

higher than budgeted cost. Likewise, Ali *et al.* (2010) observed that budgeted cost increments are a great problem to the construction industry in Malaysia. Also, Ali *et al.* (2010) further clarified the factors causing budgeted cost increments in Malaysia as inaccurate estimation of original cost and mistake in design. Sae-Hyun and Moon Seo Hyun (2010) argued that for construction to progress smoothly, effective cost estimation is vital, mainly in the conceptual and design stages. Also, in the early stage of construction, a contractor must require precise forecasts from the client which accurately reflects their supply information.

A study conducted by Nega (2008) revealed that the majority of construction projects are challenged by budgeted cost increase as projects delivered at construction cost exceed the initial amount budgeted. The study also identified the escalation of costs of construction from an increase of price of materials, lack of proper planning, modifications in design due to improvements required by client, and excess quantity during construction—all of these as causes in increase of budgeted cost. Also, Rahman *et al.* (2013) observed that the success of any construction project depends significantly on how efficiently and effectively the management runs. Moreover, factors challenging contractors during production process are identified as the fluctuation of price of materials, cash flow and financial problems, and shortage of materials—all as reasons why a project cannot be completed within budgeted cost.

The survey conducted by CIDB 2011 on construction quality in South Africa concluded that client dissatisfaction with the quality of completed projects on around 2% of the projects surveyed in 2009 interpret to dissatisfaction on complete work in the public sector to an amount of around R3.5 billion per year as a result of procurement related barriers. Findings from literature point to the need of the establishment of a framework for effective management of cost constraints on building project delivery. Consequently, one of the key objectives of this study was to establish an operational technique for management of construction costs in order to for a project to remain within the scope of budgeted cost.

1.2 Problem statement

The budgeted cost specified is a limitation challenging construction in delivery of quality project at stipulated time; this, then, underscores the need to establish a framework for effective management of cost constraint on building project delivery in South Africa. Nega (2008), for example, emphasised that completion of a construction project within budgeted cost becomes difficult; cost, then, has been affecting overall project performance. Likewise, Al-Najjar *et al.* (2008) affirmed that the main objective of a construction firm is to upgrade project performance through cost reduction, completion of project within budgeted limit and

at specified time. Also, Parveen and Saha (2012) confirmed that a project operator's main goal is to complete the project within both minimum time as well as minimum cost. Hence, construction cost increase is an enemy of cost restraint. Cost restraint challenges serve as an impediment in the construction industry from the achievement of its objectives. Athanas are to optimise project duration and also to develop the schedule that leads to the minimum total project cost.

A study by Aguma and Festus (2011) in South Africa argued that cost of construction increase is impacted by cost limitation challenges of construction during the building production process, thus leading to late completion of project delivery in South Africa, further degenerated by poor quality performances of building projects. Similarly, Emuze and Smallwood (2011) argued that the South African construction industry is challenged with a range of project performance issues: added cost in the project, poor quality, client dissatisfaction, rework and defects. The study of contractors in South Africa by Smallwood and Emuze (2012) argued that post-project services remaining within budget and time performances are more important to clients. Smallwood and Emuze (2012) point out, however, that contractors in South Africa have not met these requirements. Sidumendi (2009) established that poor capacity, poor quality, low productivity and low profit margins continue to characterise the mainstream of the South African construction industry.

Azhar *et al.* (2008) contended that a completed project may not rightfully be regarded as a successful work unless the cost constraint applied to it is satisfied. Cost limitation has been an epidemic problem to the construction industry in delivery of projects at the budgeted limit within the stipulated time. Unfortunately, previous researchers have not fully addressed the issue of the effect of cost constraint on building project delivery. Therefore, Operational systems of the construction industry have been challenged with cost restraint during production process in delivery of building projects at budgeted cost within specified time.

1.3 Aim of research

The aim of this research is to establish a framework for effective management of cost constraint on building project delivery in South Africa.

1.4 Objectives of research

The objectives of this research are as follows:

1. to identify the factors that affect cost during building production processes;
2. to identify the modality of achieving quality building projects during production processes;

3. to investigate the effect of changes in building design during production process on budgeted cost;
4. to assess the impact of budgeted cost on management of construction resources;
5. to ascertain how cost can be efficiently utilised without negatively affecting delivery time and quality expected during production process; and
6. to establish a framework for management of construction costs in order to remain within the limit of budgeted cost.

1.5 Research questions

The following are the questions this research seeks to address:

1. What are the factors that affect cost during the building production process?
2. What are the modalities of achieving quality building projects during the production process?
3. What are the effects on budgeted cost of changes in building design during the production process?
4. What is the impact of budgeted cost on management of construction resources?
5. How can cost be efficiently utilised without affecting delivery time and quality expected during production processes?
6. How can a framework for management of construction cost be established in order to stay within the limit of budgeted cost?

1.6 Preliminary literature review

1.6.1 Cost of construction impact

The cost of construction is primarily a combination of the cost of money spent on site, the cost of materials, the cost of labour and the cost of management (Azhar, Farooqui & Ahmed 2008). Similarly, Azhar *et al.* (2008) identified factors that caused an increase in cost of construction: fluctuation of prices of materials as world commodity prices increase for basic building materials, the current state of the local economy, the quality of materials, and simple supply and demand processes.

Ameh and Osegbo (2011) defined the closed end of the construction process as a production process that consists of an input combining materials, labour, capital and energy in delivery of project that satisfies client interest.

1.6.2 Construction management impact

Jaggar *et al.* (2002) described project management as the duty of an organisation to ensure that the function of planning, control and feedback are brought about in terms of design, cost, time and quality (project objective equals project management). From a survey conducted, Azhar *et al.* (2008) discovered that a cost efficient site is a product of efficient management; frequent changes in scope are caused by inadequate planning and viability studies. Hence, with a determined attention, scope changes are avoidable and additional work which causes cost overrun can be considerably reduced. Similarly, Al-Najjar and Enshassi (2008) discovered that poor scheduling is a problem on construction cost: failing to have the right material, the right information, the right training and the right worker at the right place at the right time. Al-Najjar *et al.* (2008) further explained that time delay is caused by improper planning as well as construction cost increase. Also, Alwi (2003) argued that a factor that causes cost increase in a project site is lack of proper manner of developing a human resource plan. PMBOK (2008) stated that worker resource plans on site is the process of classifying and documenting project tasks, duties and essential skills.

1.7 Research methodology

An initial exploratory study will be conducted in order to generate more reliable objectives and precise questions for the study of a framework for effective management of cost constraint on building project delivery in South Africa. The study involved an extensive review of existing literature relating to the topic. In this research, both qualitative interviews and quantitative questionnaires will be employed to gain understanding of the insightful views of construction professionals in South Africa toward a framework for effective management of cost constraint on building project delivery. A purposive sampling approach will be the technique employed for the selection of a population for this study. Site visitation will be carried out to actually determine which of the construction companies have experienced and qualified stakeholders among their staff members who can adequately answer the questionnaire survey. Surveys will be conducted among the clients, project managers, contract managers, quantity surveyors, architects, structural engineers and site engineers through distribution of close-ended questionnaires to be collected as data. Questionnaires will be administered to the sample of the population. Findings obtained will be used for the research design of the main study. Participant observations will be among

the techniques adopted to observe the group of samples being researched: views will be shared, observations and experiences will be recorded. Figure 1.1 describes the concept of the study in relationship with existing knowledge, and Figure 1.2 explains the research procedures known as research flow chart.

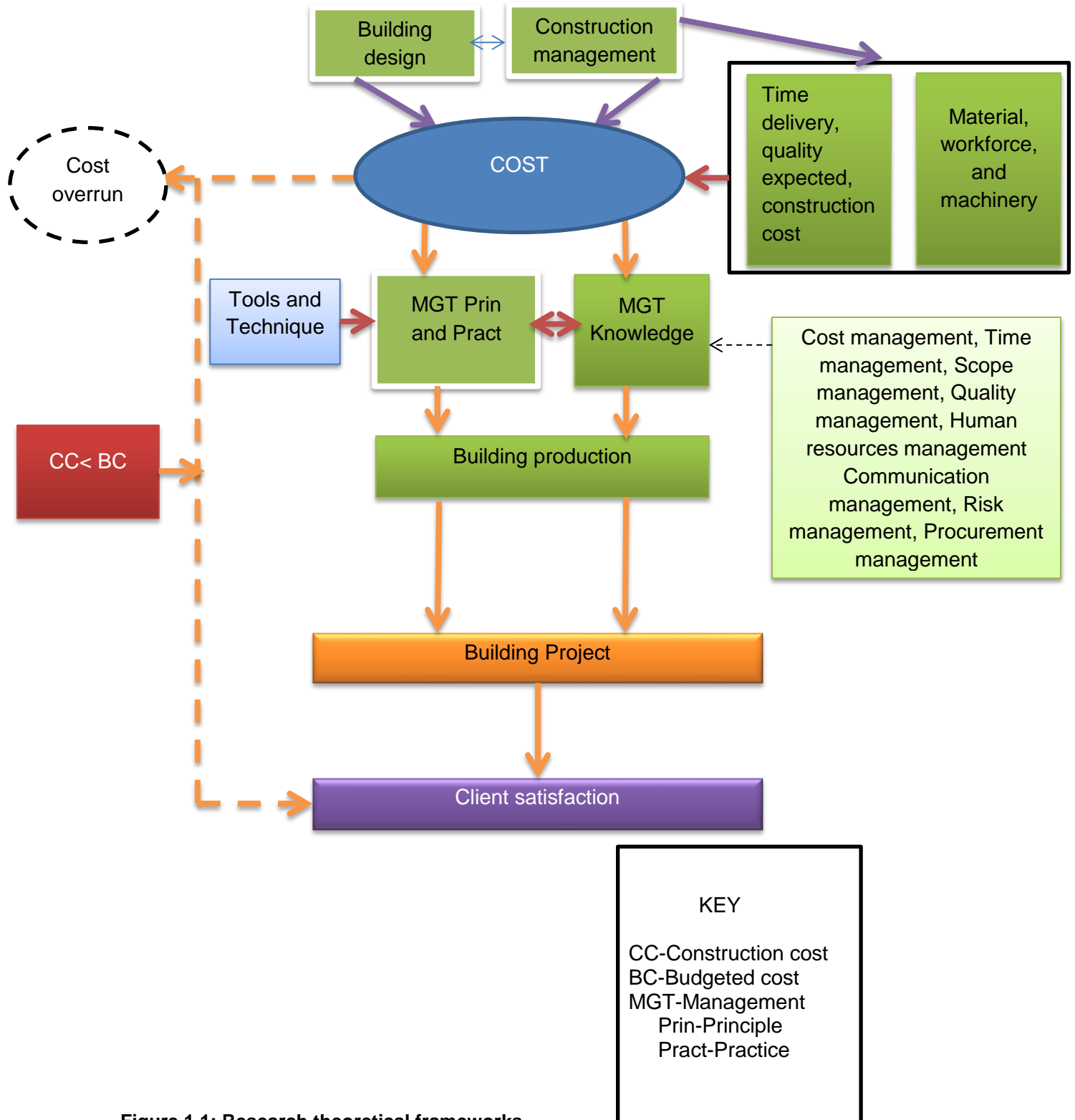


Figure 1.1: Research theoretical frameworks

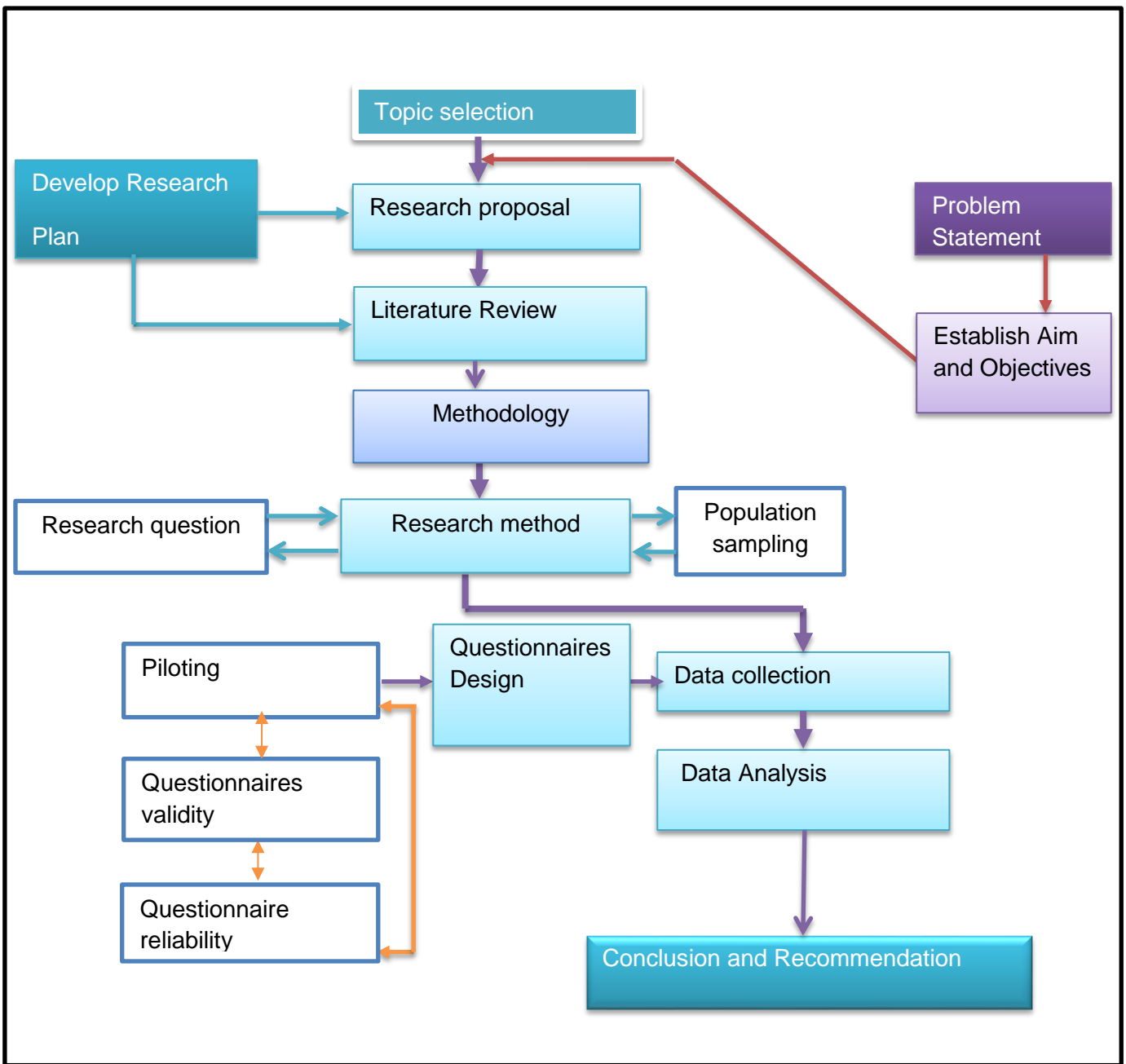


Figure 1.2: Research flow chart

1.8 Scope of research

The research will be limited to data gathered from the construction industry in the Western Cape and Gauteng provinces. The gathered information will be from stakeholders in construction and consultancy firms, project managers, site managers, architects, quantity surveyors, contractors, contract managers and construction clients.

1.9 Key assumptions

It is believed that proposed construction industries and consultant firms identified for the survey will cooperate and allow access to their sites.

1.10 Ethical considerations

In regard to ethical standards, the names of construction firms, stakeholders and team managers participating in the process will not be recorded on research instruments.

No salary or any other form of compensation will be paid to any respondent or participant in the research. Quality assumptions will be made in regard to the following steps:

- capturing of quality data;
- competence and conduct of interviewers;
- completeness and correctness of questionnaires; and
- accuracy of calculations.

1.11 Chapter outline

Chapter One: This is an introductory chapter, incorporating the background information, research aims and objectives, the problem statement, preliminary literature review, methodology, limitations, key concepts and chapter outline.

Chapter Two: Previous studies and investigations of numerous researchers relating to the topic will be reviewed under the literature, focussing particularly on literature relating to the factors that affect cost and on the effect of cost restraint on building production processes.

Chapter Three: This chapter explains the methodology that will be used to conduct the research and to establish the aims and objective. Sample size will be discussed, as well as instruments for data collection and the manner in which the research will be managed.

Chapter Four: This chapter will analyse data collected. Findings obtained will be discussed and presented.

Chapter Five: This chapter explains the conclusion of the research and presents recommendations for further investigation.

1.12 Chapter summary

This chapter illustrates the entire research study. The background of the study provided insightful explanation of the framework for effective management of cost constraint on building project delivery in South Africa. Preliminary literature reviews explain the cost constraint associated with building production processes, the problem statement of the study, the effects of project and delivery project above specified budgeted cost. The goal of the study is to establish a framework for effective management of cost constraint on building project delivery in South Africa. The key objective is to establish operational techniques for management of construction cost in order to stay below the limiting cap of budgeted cost. The ethical considerations for collection of data in this research will comply with assumed standards.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature concerning cost management, cost overrun and production, and the problems associated with delivery of project above budgeted cost and over time specified. This section discusses numerous aspects of construction cost: cost as a constraint, construction team, design team, construction resources, building production process, cost in relation to other construction constraints, cost and management knowledge areas, consideration of management principles and practices, funding of projects, timely delivery, and communication during production processes. The purpose of this research is to ascertain how cost can be efficiently utilised without affecting delivery time and quality expected during production process. The study reviewed literature pertaining to factors affecting cost during production processes and the modality of achieving a quality building project during production process, the effects of changes in building design during the production process on budgeted cost, and the impact of budgeted cost on management of construction resources. Findings will be used to establish an operational technique for management of construction cost in order to remain under the limit of budgeted cost.

2.2 Construction cost as a constraint

Constraints are defined as those factors that confine the production process within the construction industry. The stakeholders in the construction industry should be conscious of the fact that these constraints – time, quality, cost – are inter-related, and that adjustment to any of the factors will affect the others. Hence, failure on the part of the stakeholders to recognise these factors, leads to issues that may cause project failures in the construction industry.

Cost is very important in the construction industry; it is especially significant during the production process. Ashar *et al.* (2008) argued that a project is successful when it is completed at an estimated budgeted cost within time frame. Budget increase, though, could result in unanticipated time schedule delay (Ashar *et al.*, 2008). Memon *et al.* (2010) discovered that cost is a motivating force for success in building production processes as well as being very important throughout the construction management life cycle. Similarly, Ganiyu and Zubairu (2010) discovered that cost has been the major problem confronting the Nigerian construction industry in delivery of projects at budgeted cost that has been specified. In addition, Ganiyu and Zubairu (2010) recommended the development of

analytical cost models that capture the factors affecting cost during building production processes. Al-kharachi and Skitmore (2009) contended that cost issues are significant during production processes in delivery of project at specified time and at quality expected by the client.

Ganiyu and Zubairu (2010) discovered that when a project is 'successful', this implies that the project accomplished its technical performance, maintained the timely delivery and within the budgeted cost. Furthermore, as clarified by Ganiyu Zubairu (2010), most building clients are quite aware of economic constraints which have made it mandatory that any available budget should be spent wisely to achieve best economic advantage. Similarly, Desai and Desale (2013) affirmed that a project is successful when it is completed at budgeted cost within time frame. Desai and Desale (2013) argued that delay is a constant problem in private residential projects in Nashik city. Fugar and Baah (2010) discovered that financial group factors ranked highest in consideration of all the factors that caused delay in a construction project in Ghana. Hence, specified budgeted cost is a limitation to construction which clearly impedes the production process. Many researchers have found that very often cost causes delay in building production processes globally. Likewise, Fugar and Baah (2010) argued further that cost problems render it difficult for contractors to procure materials for building construction processes in Ghana, clarifying that the material group delay factor was ranked the second most important factor that causes construction delay.

Nega (2008) argued that inability of a construction firm to complete project at budgeted cost within time frame at quality expected is a major problem causing anxiety for construction operators. Nega (2008) argued further that a building production process completed does not necessarily mean that the client is satisfied with the project delivered. Client satisfaction depends not just on completion, but on completion *within* the budgeted cost specified and meeting up with the requirements specified. Fatoye (2012) affirmed that the goal of any construction firm is to complete project within a budgeted cost and quality expected, and when the construction cost could not match up with the budgeted cost during production process, disputes and further delays arose.

The client should prepare adequately prior to the inception of construction activities on site, ensuring the availability of cash. The cash must flow throughout the construction process to avoid construction delay. Similarly, Sunday (2010) argued that client and consultant should make certain that all the necessary needs and funding techniques must be readily available during the production process, in fact, before the commencement of any project.

2.3 Construction team

The production process in the construction industry involves various people with their professional skills, knowledge, and experiences: the major requirements for construction team members is to work in unity, share common objectives and deliver quality project within the stipulated time specified (Azmy 2012). Likewise, Fryer (1990) argued that those in the construction industry are increasingly recognising the value of training their skilled employees in team work procedures during the building production processes. Team work training involves educating workers as to how to work together in a team-like manner through persistence and positive mind-sets, a sense of urgency, accessibility and openness to ideas. Urcher and Loosemore (2004) considered the client, project manager, financier, legal consultant, architect, project consultant, main contractor, sub-contractor and quantity surveyor as members of the construction team. The composition of members of the construction team depends largely on the size of the project. Stages of building production processes are used to form construction team members, stages defining the role of team member and their responsibility during production. Fryer (1990) provided useful insight concerning the roles and responsibilities performed by construction team members during building production: identifying the priority of the work to be done, concentrating on getting results, being a team organiser, being a team monitor in project delivery, being a group harmoniser in term of team spirit, and being a problem evaluator. Langford, Hancock *et al* (1995) argued that construction is labour-intensive, acknowledging that the level of labour intensity varies from construction firm to construction firm, project to project, country to country. Construction exists in order to contribute to the satisfaction of human needs and wants.

Construction activities on a project site will be achieved through effective team work, activities which involve several professionals with distinct academic training. The working relationship among construction stakeholders influences good end-project outcome and thus, overall productivity. Effective team work does not occur automatically; it is fraught with many challenges as the sources of the problems tend to be deficiencies in proper organisation, conflicts, lack of proper communication and ineffective participation of individuals (Azmy, 2012). An effective team shares common purposes and goals, shares leadership, ground rules for interactions, meetings, trust and openness. Efficient team work is essential in the construction industry. There are interpersonal issues that team members in the industry need to embrace, such as trust, respect, and leadership. These are the factors that enhance adequate use of budgeted cost during production process (Cohn & Ralston, 2005).

Cohn and Ralston (2005) counselled that construction teams are groups of professional coming from different backgrounds with different reactions and social needs. A team can have an impact, whether negative or positive, in solving differences. Failing to take action to influence good team work may lead to inefficient performance on site. Cohn and Ralston (2005) identified a team as a group of professionals coming together to achieve a common goal and to deliver a quality project. The assessment of work done does not depend on individual contribution, but in actual fact, on how efficiently the group can collaborate together to complete tasks. Team work increases the opportunity of learning a new profession in the construction industry, and therefore enhances productivity. Searching for new tradesmen during production processes will be avoided and delays in production will equally be avoided. The effect of long delays in the construction industry hurt budgeted cost. Fryer (1990) discovered from research findings that there is the possibility of learning new innovation in one's job as a result of working together as a team. This also improves the quality of the standard of living. Fryer (1990) concurred that team work influences an employee's personal and professional growth. Uher and Loosemore (2004) identify construction crews as responsible for management of activities on site. Every member of the group has a well-defined role to play, and any act of irresponsibility by any group member may have a detrimental effect on the construction processes. The responsibility on every member of the group is to oversee effective management of site activities, and budgeted cost is used as guidance for achieving the requirements of the client.

Azmy (2012) explained that it is very important for any construction team to have full knowledge of how a project activity will be organised on site, as construction has been challenged by delivery time and budgeted cost specified. The limitation as a result of fixed time and budgeted cost constituted an impediment toward the progress of construction activities on site. The construction team should fashion a technique at the inception stage to arrest the frequent cost escalation and delays in delivery time; the total freedom of construction process from these obnoxious effects of cost escalation and time overrun will allow a smooth running of construction (Parker 2008).

Alsuliman *et al.* (2012) discovered that thorough contract documentation and good communication and cooperation among construction team members are major elements that can make a management system more effective on site. A good communication procedure established among a construction team on site will enhance construction production activities. The efficient communication on site will allow for a quick decision on burdening issues such as budgeted cost, time overrun and quality expected. Azmy (2012) indicated that the phases of a construction project are enough to form a construction team and define all roles and responsibilities, not necessarily in relation to contractual roles.

A construction project consists of six major phases: project briefing, designing, specifying, tendering, constructing and maintaining. Construction projects have stages, and each phase has its own team members. As soon as the tasks are completed, the team disengages from site and another team will come on board to carry out assignments given in regard to contract documents. Each phase will help the team to monitor budgeted cost, anticipated time, and provide feedback to the project manager. The typical project phase, illustrated in Figure 2.1, demonstrates the construction stage and its professional functions as a guide for forming a construction team. Figure 2.2 explains the analysis of a construction team in each stage according to the normal function performed at a construction site.

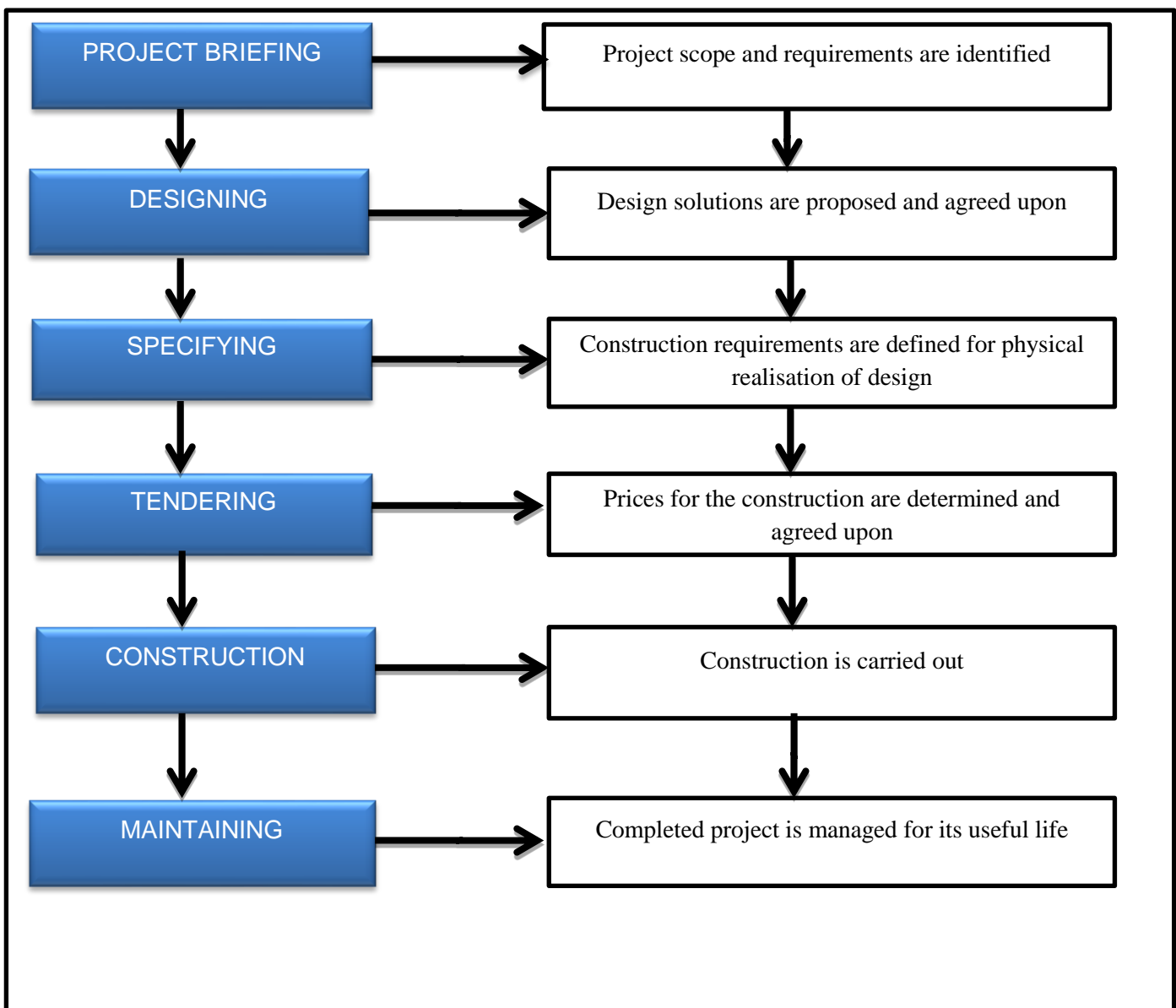


Figure 2.1 Construction process (adopted from Azemy 2012)

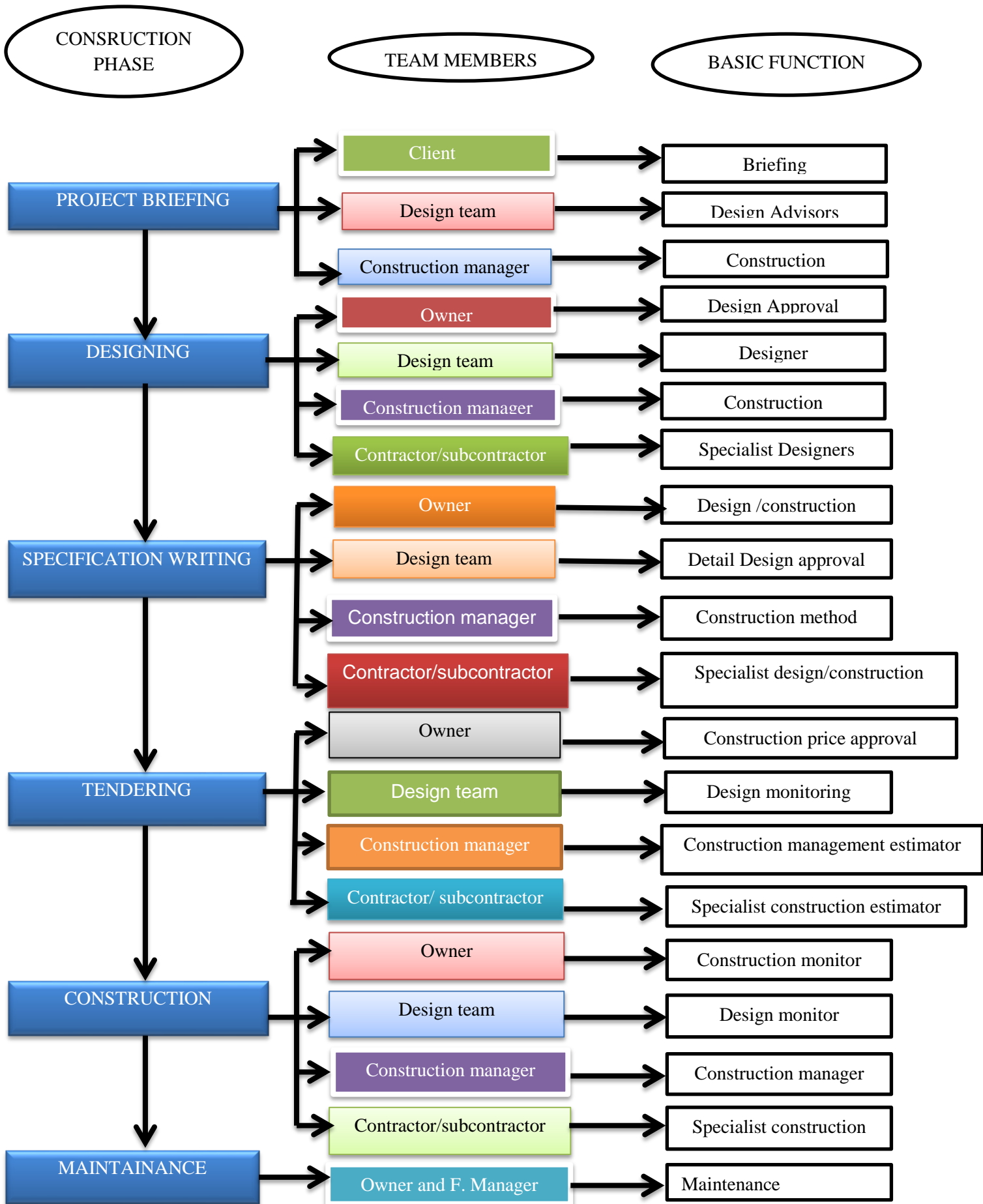


Figure 2.2: Construction team and responsibilities (adopted from Azmy 2012)

Azmy (2012) stated that activities in the construction industry are related to budgeted control and time constraint. It is very important for every member of a construction team to be properly informed as to how to set up a formidable team on site and maintain an effective team during operation on site. The selection of team members usually based on individual capability — efficiency, discipline, skill, expertise, and experience — is considered. The construction team should aspire for success during production processes if working together as a group. Parker (2008) stated that one of the greatest frustrations in the construction industry is the failure of teams to function smoothly.

2.4 Design team members

2.4.1 Introduction

Design teams are groups of professionals coming together to actualise client interest; this group plays a major contributory role during conceptualisation and the planning stage of the construction production process. Design team members may include the client, architect, structural engineer, quantity surveyor, building services engineer, contract manager and contractor. The composition of the design team depends on the size of the project. The design team members may determine the project starting and ending time. They may also contribute a great deal towards the completion date of a project because it depends greatly on the nature of drawings and specifications provided to the contractor (Azmy 2012).

Design documents are comprised of the following: drawings, specifications, and structural detailing. Inadequacies in the drawing, specification and documentation are sources of aggravations to the construction industry. Constant changes to design during the construction phase as a result of inefficiencies on the part of designers have constituted many problems that lead to rework, delay, variation, claim, and cost overrun (Arain & Pheng, 2006). Further findings by Arain and Pheng (2006) contended that variation is a result of constant design changes during construction and may cause substantial changes to project time, cost and quality. Client are being challenged by difficulties in the management of constant variation of orders as a result of poor design; however, this unpleasant situation can be reduced if a good management machinery system can be invoked for the handling of the building design stage.

Al-Dubaisi (2000) studied and reported that design changes are inevitable in any construction project, so the client may be forced by new technology discovered to affect change order into design. Designers may be influenced by the cost limitations of the project

and thus review design to upgrade the standard of design on better optimisation. Likewise, errors or omissions detected during the construction phase may force the designer to affect a change to design. Each of these identified factors is a source of design change. Similarly, Lam *et al* (2007) argued that design should be simplified for construction in order to allow for capability building during production processes. Construction ability was first defined as “the magnitude to which the plan of a building services ease of erection” (Lam et al 2007), signifying that plan outcome has an important effect on easiness of the building production process.

2.4.2 Design team

To Arain and Assaf (2006) argued that the construction industry was fragmented because different teams of professionals managed the design and construction phase. Professionals aim to achieve the same goal; designers, though, have a conceptual mind and contractors have a concrete mind. Achieving this goal has remained an elusive task leading to strong criticism of construction as reported in several reports by Memon (2013) and Lam *et al.* (2007).

Mendelsohn (1997) confirmed that even though 75% of the problems associated with the construction industry stem from the design phase, the contractors are not exonerated from the problems within the construction industry. Also, these glitches were often compounded by in-built design defects. The way to reduce defects from site is to start from the initial emphasis on what the project team can do to eradicate this problematic situation of the design phase in construction industry. Arian and Assaf (2006) contended that the recognition of causes of variation order is paramount at the design stage; designers should design according to the required materials needed on site to avoid non-availability of materials; the correction of errors and omissions needs to be rectified *before* going into production processes.

Alsuliman *et al.* (2012) stated that the construction team should establish a knowledge base of similar past projects, thus giving them the opportunity to plan more effectively prior to starting a project. Lack of proper planning is a common cause of change in design which affects construction processes, as a frequent change to design will attract claim from the contractor and such a claim will affect the construction cost. A change in contract plan, drawings and specifications will alter the contractor’s plan. This signifies the need for the contractor to go back to the drawing board to recalculate the cost of labour, cost of materials and schedule. Al-Dubaisi (2000) agreed that planning is very important in the construction industry. A solid plan at the very start of any project by the design team will enhance the

design process and will facilitate construction activities. Planning ahead of an activity in the construction industry will improve on the efficiency of the working operation of the team members. Al-Dubaisi (2000) further clarified that the harm engendered from ineffective planning of work in the construction industry includes delay, disorder in progress of work and change in orders.

Esohofonie (2008) confirmed that the frequent changes of building design structure lead to difficulties stemming from improper project planning and management of design processes. It is imperative that designers plan ahead of time and thoroughly review the design process to accommodate future changes in design. Al-Dubaisi (2000) stated that a change in design will affect material cost, cost of labour and schedule. Frequent changes in design may also affect construction costs and construction processes, both of which will result in variation and claims. Memon (2013) confirmed that cost is a major driving force throughout the life cycle of a project; regrettably, the construction industry regularly fails to deliver building projects at budgeted cost specified and within time expected. Also, Al-Dubaisi (2000) confirmed that the financing of a construction project depends on client budgeted cost-earmarked; delay in payment to contractor, however, will also impede the progress of construction activities on site. Furthermore, Al-Dubaisi (2002) explained that despite the fact that the construction industry in Saudi Arabia is a small industry, it is under-financed and consequently the materials supplier cannot be paid for months. This results in delay, on occasion forcing the construction industry to halt the entire production process.

2.4.2.1 Client as a member of the design team

The client briefs the architect of the requirements pertaining to the project. Consequently, the architect develops schemes and concepts based on the client brief. Success at the construction phase depends on the relationship between architects, contractors and clients (Olatunji & William, 2009). In addition, Olatunji and William (2009) argued that the client's ideas of design initiation are worsened when the client's practical brief is excessively difficult to be understood by the designer, or even worse, appears to be vague. Effective production processes are linked to project initiative. Likewise, ineffective cost performance and other functional disputes among construction team members are linked to inadequate briefings by clients.

Alsuliman *et al.* (2012) confirmed that the client initiates most changes during the design phase, and it was further clarified by Alsuliman *et al.* (2012) that design errors are regarded as the most important causes of variation orders in large building projects in the Saudi construction industry. Failure of designers to comply with the client's requests will cause

frequent changes during production processes. On the other hand, the involvement of the contractor at the design stage will assist in the quality of design expected by the client; also this involvement will aid the contractor in understanding design and the contract document from inception (Arian & Pheng 2006).

Esohofonie (2008) confirmed that the client is the financier and the project motivator, playing a prominent role in the construction industry in terms of decision making. The client also motivates progress of work on site through regular payment. The role played by client in construction is vital as the client specifies the necessary requirements for a building, financing the project from inception stage to completion stage, and dictating authority through the financial capability to the consultant and the contractor on site.

Rahman *et al.* (2013) confirmed that money is highly needed on site, showing that the role it plays in the construction process is crucial. Without cash, nothing can be accomplished on site. The design and specification of any contract depends solely on monies available. Rahman *et al.* (2013) identified money as a motivating force of construction resources, as the effective performance of resources during production processes depend on cash availability. However, money is subjected to limitations by time, by client requirement, and by effective management of finances on site to produce an efficient output.

Any client, as the owner of a building, should thoroughly carry out a preliminary exploration of the new site; this will help in analysing client requirements before the commencement of design. Similarly, Al-Dubaisi (2000) confirmed that the client should properly carry out a site investigation at the inception stage of design to reduce frequent changes in design details and construction process. Moreover, according to Al-Dubaisi (2000), clients should clearly define the required quality in the design, prior to the commencement of design. Also, design requirement papers on client concept development should be very clearly explained. For quality and effective design requirement detailing, clients should contact professionals for more explanation. It is of paramount importance that the client should implore the services of project managers to itemise desired requirements for design documentation. Arian and Pheng (2006) identified the fact that the construction management team should respond quickly to the variation to enable them to reduce contrary effects on a project. Arian and Pheng (2006) further clarified that variation as a result to design changes may cause substantial elongation to project time, increases in cost and decreases in quality. Clients are being challenged by the difficulty in the management of constant variation orders as a result of poor design. This unpleasant situation can be curbed if an efficient management system can be applied during the planning stage for design, and also during the production process.

Likewise, Al-Dubaisi (2000) stated that clients should check design in a well-regulated process after completion.

2.4.2.2 Architect as a member of the design team

The architect is responsible for designing and maintaining the structure of the building and safeguarding drawings and specifications to meet the client's desired requirements. The architect undoubtedly has a close relationship with the client and maintains constant communication during the construction process. The source of information for design requirements is from the client to the architect; if the architect failed to receive proper briefing from the client before going to the drawing board, there may be disappointment on the part of the architect to design in compliance with client requirements. Esohofonie (2008) confirmed that inadequate facts from a client will compel designers to develop design based on their own ideas and beliefs, yet this may not be in the interest of the client; consequently, this will likely lead to challenging situations between the design and construction interaction during production process.

Arain and Pheng (2005) discovered that timely start and completion of a project depend on construction documents: drawings and specifications should be well-detailed and precise. The late arrival of construction documents to the site may cause delay. Most of the construction companies rush to the site based on verbal instruction from the client. Then if the contractor embarks on production activity without detailed working drawings and specifications, this likely results in revolving changes to design during the production process. Arain and Pheng (2005) confirmed from their findings that the use of vague, unclear design details may cause problems of misrepresentation of design by construction team members, inadvertently leading to rework and delay in the project accomplishment. Design should be made simple by designers: improper shape, difficult geometric outlines and complex installation details are problems challenging most construction companies as a result of ineffective design details. Likewise, Lam *et al.* (2007) indicated that effective design details must be balanced with the built-in requirements of clients and creativity quality aspiration of the designer, whilst looking to achieve simplicity should not reduce the artistic quality expected. Lam *et al.* (2007) discovered that "modesty is a form of beauty" can be a school of thought for designers: building design should be somewhat simple to avoid unnecessary errors and omissions. Also, Arain and Pheng (2005) confirmed the argument that design errors usually have detrimental effects on construction projects as it all depends on the period, stage and time of occurrences.

Arain and Pheng (2005) clarified that a designer engaging in unusual design may cause problems. Unusual design being experienced for the first time means that construction team members need an adequate briefing from client. Likewise, Lam *et al.* (2007) confirmed that design details should be made easy. Designers should be more accurate in design detailing if discovering conflicts between design and construction; these should be resolved *before* the commencement of the construction process.

Esohofonie (2008) argued that cost is of paramount importance in the construction industry; thus it is the first issue the consultant must attend to in order to ensure the project is within the client's established budget limit. Designers should design according to the interest of the client and within the budgeted cost. Ambiguous design will cause delay and affect construction cost. Consequently, it is very important to examine design properly to avoid frequent occurrences of design changes; proper examination must be conducted on design before contracting the project to the contractor. Al-Dubaisi confirmed that a design change clause must be added to contract documentation and should be well spelled out to the client, the designer, the consultant and the contractors as to how to effect changes in design during the production process. Arain and Pheng (2005) supported the argument that variation could be controlled, if constant changes to design can be reduced. Construction team members should determine a way to eradicate these difficulties encountered at the design phase. Similarly, Lam *et al.* (2007) supported the argument that the size components of building – such as columns, beams, doors, and construction details – should be designed according to standard in order to save time.

2.4.2.3 Contractor as a member of the design team

The involvement of the contractor at the design stage is necessary because of the technical advice the contractor will convey into design and specification, allowing the contractor to transfer his professional knowledge, skilful ideas and originality into the process (Arain & Pheng, 2006). Involvement of the contractor at the design phase may reduce frequent changes in building design during the construction process. Arain and Pheng (2006) further confirmed that the incorporation of project codes and skill at the design stage help to facilitate construction processes and project performance. The vested responsibility on the contractor is the management of construction resources; effective management of resource on site by the contractor will enhance productivities. Likewise, Esohofonie (2008) confirmed that the contractor is responsible for the production processes; the contractor is saddled with the responsibility of effective management of construction resources, and for efficient building project delivery at budgeted cost, within the time frame. Lam *et al.* (2007) deduced from research findings that contractors should be allowed to be involved in design process as this will enhance design process. Lam *et al.* (2007) made a further clarification that the

contractor cannot improve on design details that are comprised of errors and omissions conceived from the start. Similarly, Esohofonie (2013) discovered that a building design without error will accelerate productivity and reduce cost of construction.

Arain and Pheng (2006) confirmed that many contractors are challenged by inadequate skill or by new technological innovations. If a contractor is not well-versed in new technology, it will be very difficult for the contractor to oversee an effective production process. In the situation of a contractor not being acquainted with new innovations, the contractor will be forced to adopt his own fashion of design entirely as a result of this lack of skilful knowledge to carry out the construction. Al-Dubaisi (2000) discovered that inefficient planning of work in the construction industry frequently leads to delays and disorderliness in progress of work and change order.

2.5 Building production process

Building production processes incorporate the supervision and management of plan, budgeted cost, equipment, materials and labour involved in the production of buildings. This also entails compliance with government rules and regulations, construction rules, codes and contractual stipulations. The production process in the construction industry should be designed to run efficiently, keeping both time and cost minimal, and allowing returns on the investment to be realised as early as possible. Hence, the construction production process may involve the use of techniques like planning, organising, tendering, contracting, inspecting, controlling and formulating of progress charts to assess efficient running on project site. Lavender (1996) defined 'production' as a conversion process which receives input of resources such as labour, material, machinery, and capital and transforms them into a product.

The client is the originator of ideas and the formulator of concepts. Thus, techniques and tools to be employed during the production process in a construction project wholly depend on the information supplied by the client. So the requirements of the client represent substantial information to be used during the production process in the construction industry. Nina (2003) affirmed that client requirements represent the main sources of information for a construction project and thus are of essential importance to the successful development and operation of a project. Further explained by Nina (2003) is that the process in which the client's needs are analysed, clarified and conveyed is called the 'briefing process'. Martins and Formoto (1998) argued in support of the point that it is quite difficult for construction firms to plan, control, develop or choose a construction technique which would sweet the firm modest, as a result of inadequate briefing from the client.

Koskela (1992) described the production process as a method of cycling production flow that has transformation and non-transformation activities, as well as activities that add value to the final building product. Koskela (1992) further explained that management techniques must be used in conjunction with other construction methods that evaluate other aspects related to the technique, such as building performance issues. Similarly, Lavender (1996) argued that the production process adds value; it all depends on the techniques and tools employed by the managers in the construction industry. Thus, it can be agreed that the production process is the source of economic growth because it has the ability to enhance the resources used. Lavender (1996) further clarified the issue that the production process in the construction industry is not dependent on resources available because labour is variable in terms of personality and behaviour. Hence, workers on site are all different in terms of skill, education, training, motivation and attitude toward management of individuals and groups, and also in their behaviour and attitude in different situations.

To Bertelson (2002), the activity in the construction industry is the process that involves production, planning and managing the work flow within the construction processes. Lavender (1996) discovered that the production process in the construction industry is uneasy over adding value to create wealth which society needs. The major factors in the construction industry that influence production are technological and social factors. Egan, in the Rethinking Construction Report (2002), supported the argument that production processes can be referred to as the production of building, structure and infrastructures upon which most economic activities of a nation depend. Effective construction, therefore, has ramifications on the long-term economic growth of any nation; also individual effectiveness has a bearing on the economic growth of a nation. This signifies the need to considered six factors during the production process in the construction industry for enhancement of production reduction in capital cost: moderate construction time, clearer expectations, preventing defects, increasing productivities, increasing income and profit, and proper monitoring of health and safety compliance. Lavender (1996) defines 'production' as a conversion process which receives input of construction resources and capital, and transforms them into delivery of project.

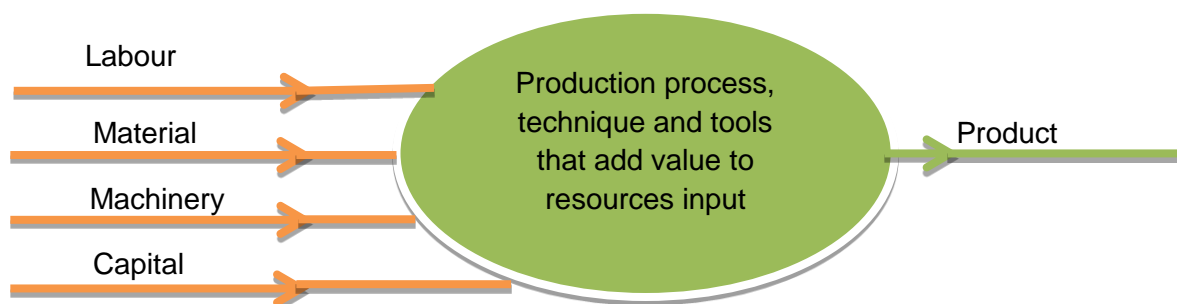


Figure 2.3: Building production process

2.6 Costs in relation to other construction constraints

Constraint is defined as a limitation. Hence, cost, time, and quality are regarded as the limitations that are the most critically challenging in the production process in the construction industry. Therefore, a project manager should regard cost, time, and quality as constraint factors during production process. Similarly, the project manager must fully distinguish the fact that time, cost and quality are constraint factors against any modification to cost, time, and scope, affecting each other. It is an influential step on the part of the project manager to convey the triple constraint information to project stakeholders, thereby ensuring that everyone involved in production process is quite aware of the significance of the triple constraint and potential consequences of adjustment to time and cost. Similarly, Sambasivan and Soon (2007) affirmed that time and cost overruns are clearly inter-related, causing disputes, litigation and even complete abandonment of projects.

Delivery time is referred to the actual time required to produce a deliverable: this is the end result of the production process. Hence, the amount of time required to produce the deliverable will be directly related to the number of requirements that are part of the end result (scope) along with amount of resources allocated to the project (cost). According to Roger (2012), in every construction project, completion within time frame and at budgeted cost specified is one of the most significant factors of which everyone involved must be cognizant. Thus, late delivery of project causes an anxiety for the construction team.

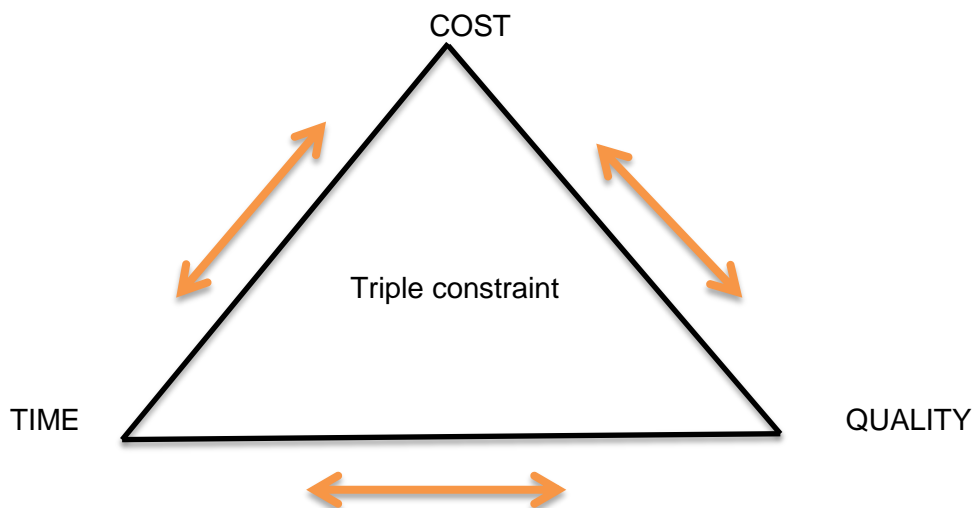


Figure 2.4: Triple constraint concepts (time, cost, and quality relationship)

'Cost' is the estimation of the amount of money that will be required to complete the project. Cost encompasses various things: construction resources, management cost, and risk estimate. All aspects of the project that have a monetary component are included as part of the overall cost structure. It is significant to remember that any adjustment to time stipulated for a project to be delivered then affects budgeted cost. Therefore, the contractor needs to plan effectively for the usage of resources within the time stipulated to avoid cost overrun. Oxley and Poskitt (1986) confirmed the argument that completion of a project faster than scheduled always requires intricate budgetary and cost control.

Scope is the area to be covered by a building project. This must be determined in order to achieve delivery of the building project. The scope is usually identified from inception of the contract to give the project the best chance of success. Scope can potentially change during the project life-cycle, a concept known as 'scope creep'. But of course, a change in scope requirements will affect both the budgeted cost as well as the anticipated quality of a building project. Quality and scope requirements are interrelated and also affect time and cost significantly. Likewise, Zhang and Russell (2005) supported the argument that the accomplishment of the design and construction of a high-quality facility that meets owner and end users requirements is one of the triangle of project objectives, the others of course being time and cost.

Arditi and Gunayin (1997) define quality as "conformance to requirement" representing a technical view of quality and a procedure to assess performance of a building project. Similarly, Arditi and Gunayin (1997) identified quality as "fitness for purpose". Hence, this emphasised that end-user requirements were an attainment of quality involving human judgement in addition to technical measurements. Arditi *et al.* (1998) pointed out the high cost of rework resulting from poor quality work done. Also, according to Arditi *et al.* (1998), quality deviations in the construction industry are very costly. There seems to be an enormous potential for saving money and time if quality deviations are curtailed.

Zhang *et al.* (2005) argued that contractors have difficulty capturing, representing and managing the vast array of quality requirements associated with a project. Also, described further by Zhang *et al.* (2005), some of the requirements are set out in the design drawings and specifications, while others are left to be defined by the contractors handling the project. Thus, many problems exist in the interface between the designer and contractor, affecting the constructability of design components and resultant quality, time and cost. Similarly, Benjorran and Sae-Tae (2011) supported the argument that construction projects contain many uncertainties. Moreover, according to Benjorran and Sae-Tae (2011), construction projects required a number of resources and large amounts of investment. Also, time and

cost are the management goals. For contractors to achieve maximum goal, therefore, they should plan adequately to complete the project in early time with a minimum cost and at quality expected.

2.7 Cost and construction resources

Those involved in construction projects will be acutely aware that money is significantly important in project execution; a completed project within estimated cost is the basic criteria to be used to assess the success of the project (Rahman, Memon & Karim, 2012). A construction project, to be termed successful, depends on how properly the management of the construction resources effectively utilised these resources to achieve the objectives of the project. Similarly, Azhar *et al.* (2008) discovered that construction resource factors have serious effects on construction cost causing projects to be delivered way above the budgeted cost. It is a common case during production that important resource management, if not considered during planning phase of construction project, will negatively affect budgeted cost. Dardiyev *et al.* (2012) argued that it is very important to outline the resource management system during the inception of construction project, allowing for proper budgeting. Ameh and Osegbo (2011) discovered that management of work force, materials and machinery in a construction project is a difficult task when cost is limited. To further clarify, Ameh and Osegbo (2011) counselled that it is very important that workforce, materials and machinery must be readily available at the site during the construction process for effective management of a production process. Likewise, Al-Najjar and Enshassi (2008) explained that border closure and shortage of materials in the market and increase in the price of materials have an effect on construction projects in the Gaza strip which have resulted in time and construction cost increment.

Proper co-ordination and co-operation amongst the construction team and site workers will boost effective productivity during construction, and regular interaction by construction team and constant reports on the progress of work during production process will increase output. When the output of the workforce improves on site, construction cost is affected. Similarly, Alwi (2003) counselled that the construction operator should inaugurate cooperation and regular meetings amongst the construction team from a different level, on trust and working together with harmony and unity. Alwi (2003) further argued that strong friendships should be encouraged between manufacturer and supplier, allowing a good delivery procedure and excessive inventory, and then delay will be moderated. When both manufacturer and suppliers are involved in construction planning from the inception, efficient material management will be in place.

2.7.1 Material resources management

Material resources are vital in the construction industry, the importance representing a substantial proportion of total budgeted cost of a project (Rahman, Memon & Karim, 2012). The increase in the price of building materials will without a doubt increase the cost of a project; clearly, when the price of building materials increases in the market, this will have corresponding effect on budgeted cost, destabilising the schedule time, and delaying the programme of the event the production processes on site. Similarly, Desai and Desale (2013), studying factors affecting a delay in a residential construction project for Nashik city, determined that contractors and owners should have well-developed planning for material in advance to avoid the detrimental effects of an increase in materials prices in the market. They should also have a structured standard system of material procurement management.

Inadequate and irregular supply of materials, late delivery, as well as delivery of incorrect material on site, all affect construction processes. Furthermore, these issues affect the use of other resources, like work force and machinery. Also, these have effect on productivity, time and cost. Raman *et al.* (2012) argued that efficient material management is necessary in the construction industry such as identifying, acquiring, storing, distributing and disposing of materials. Rahman *et al.* (2012) further argued that at the design stage, the designer needs consider the type of materials and the amount to be used to avoid wastage of materials on site. It is also important for a designer to design according to availability of materials in the market to avoid scarcity. Availability of material within the reach of any construction company improves construction productivity, as delays in building production will be avoided, and the time wastage by the work force will be drastically reduced. When efficient material management is in place, material wastage is avoided, and incremental increases in construction cost is likewise avoided. Similarly, Alwi (2003), studying factors influencing construction productivity in Indonesia, recommended that construction operators should consider the use of local materials and natural resources as much as possible, as this will eliminate the need to wait for materials to be imported from other countries.

2.7.2 Workforce resources management

The workforce play a vital role in the construction industry; this is called 'human resources' because human beings are involved. Undeniably, human resources are significant resources that play an important role in construction processes (Rahman *et al.*, 2012). Efficient human resource management in the construction industry reduces resources wastage. This will keep the budgeted cost constrained to a minimum. Idleness will be discouraged when there is efficient management of human resources on site. Likewise, Rahman *et al.* (2012) affirmed that effective human resource management will reduce labour cost and increase the

profit of the construction company. Al-kharachi *et al.* (2009) explained that the quality of human resources available in Saudi Arabia causes low productivity and poor quality of building projects and resultantly, loss of profit to the construction industry. Rahman *et al.* (2012) argued further that effective human resource management in the construction industry will enhance productivity. Thus, overhead expenses will be minimal. Alwi (2003) advised that the construction operational process should be opened to every worker on site, as this will enable the supervisor and foreman to have sense of belonging. Regular meetings must be organised to update on the operation activities on site; this will enhance the production process and delivery of project at budgeted cost specified.

2.7.3 Machinery resources management

The use of machine resources in the construction industry is very important but the selection wholly depends on the nature of the project. For example, a small project will require hand tools, while a large project needs the use of big equipment or machines. During the estimation phase in a construction project, the size of the project needs to be considered in selecting the type of equipment to be used. The cost must be built into the bill of quantity to avoid cost increase during construction processes. A functional machine must be on site to avoid wastage of resources and money. In the construction industry, equipment can either be rented or owned; it all depends on the size of the company. According to Rahman *et al.* (2012), the selection of machine to be used on site must be an integral part of the total plan. The management and the usage of the machine must be well-planned to avoid redundancy and construction increase. Frank, Adwoa and Baah (2010) showed that with the need of machines in the Ghana construction industry, equipment is hired by the contractors. Rarely do contractors own sophisticated equipment. Thus, inadequate planning for the use of machines further effects construction cost.

2.8 Cost and management knowledge areas

Construction management is the application of knowledge, skills, tools and techniques to manage building production processes, and to meet or exceed stakeholder's needs and expectations from a building project. A building production process incorporates the supervision and management of plan, budgeted cost, equipment, materials and labour involved in the production processes (Ahuja *et al.*, 1994). Production in the construction industry involves many series of processes. Project can either be executed in order or in recurring processes. The production processes can be executed through different knowledge areas, each having its own significant effect on project delivery. Knowledge areas encompass several stages of the production process while integration management focuses on entire processes that must be done for delivery of quality project (Fryer, 1990). Sear,

Sear *et al.* (2008) explained that integration management involves the collection of project plan, execution of the project plan, and monitoring and verification of project performance. Integration management performs processes that close out the project. The construction stakeholders have an important role to play using integration management in the delivery of quality a project. This is an important area of management that helps control the entire project (Ahuja *et al.* 1994).

2.8.1 Project management knowledge areas

Knowledge areas are the nine key competencies that project managers must develop to achieve an efficient building production process: 1) scope management; 2) time management; 3) cost management; 4) quality management; 5) human resources management; 6) communication management; 7) risk management; 8) procurement management; and 9) integration management.

2.8.2 Scope management

Scope management involves defining and managing all the work required to successfully complete a building production. Likewise, PMBOK (2008) confirmed that scope encompasses the processes of developing a detailed description of the building and its products, meeting building objectives and documenting stakeholders' needs. PMBOK (2008) further explained that scope management involves management of the requirements of a project, processes of changes to the scope during production through planned technique, routine processes, and co-ordinated methods.

2.8.3 Time management

Time management is concerned with estimating schedule, managing time stipulated to complete the work, developing an acceptable production process schedule and ensuring timely completion of the building production process. It further involves actions to be performed to produce the building and its product deliverables. Similarly, PMBOK (2008) confirmed the discussion that time management is a function of scheduling activity duration and resources, developing schedules by describing activity sequences, durations, resources requirements and schedule constraints to generate the building production schedule.

2.8.4 Cost management

Cost management consists of preparing and managing the budget for the building production. PMBOK (2008) argued in support of the statement that cost management performs the function of approximating the monetary resources involved to complete building production activities. Cost management also determines budget for work packages and

individual activities, and establishes the cost baseline approved by the client. According to PMBOK (2008), cost management involves the processes of controlling cost, managing changes to cost baseline established by the stakeholders and updating building production budget timeously.

2.8.5 Quality management

Quality management involves assurances that the building product will satisfy the stated or implied requirements for which it was undertaken. Griffith (1990) argued in support of the conversation that management of quality in design and construction processes is being directed to ensure quality. Also, quality management directed procurement systems which place a greater emphasis upon providing performance, quality and better value for money. Griffith (1990) further argued that 'quality' describes the client requirements for a quality project. Thus, architect design according to the client aims to provide an acceptable standard of construction, to a respectable cost, and to be produced in a realistic production time. Ahuja *et al.* (1994) contributed a positive argument that quality management of building production involves successfully bringing together a complex mixture of ingredients consisting of teamwork, culture, personal skills, corporate mission, goals, strategies leadership, organisational structure and adequate building production management tools. According to Ahuja *et al.* (1994), quality management involves forthright planning to finalise the requirements needed for the work and define execution principles such as how to disseminate information, and a systematic methodology for the construction team to adopt in order to meet building production goals and client objectives.

2.8.6 Human resources management

Human resources management includes making effective use of the workforce involved with the building production. Similarly, Lavender (1996) argued that human resources management involves the methods that organise, manage and lead the construction team. Also, the construction team is charged with the responsibility for completing the building production processes, and assigning duties to work force. Lavender (1996) argued further that human resources management is charged with the duties of identifying and documenting building production roles, the responsibility of encouraging the construction team to discharge duties efficiently, requiring construction team members to establish a staffing management plan, and reporting relationships between workforces on site. Human resources management monitor and control functions involving the collection of information on matters such as company budget or planned building production cost, time and quality target. They further improve performance by implementing changes in technology to enhance building production performance.

2.8.7 Communication management

Communication management includes making collection, circulating and storing building production information. Frayer (1990) confirmed that communication management is quite significant during the production processes, as it is necessary that stakeholders should identify and document relevant information regarding their interest, involvement and effect on building production processes. Also, communication is necessary to get things done: construction manager always use communication to stir up action. Along with circulating information among the workforce to increase productivity, others communicate with the construction manager to get some action from the manager. Also, communication management allows grievances to be voiced and resolved amicably during site meeting. If every on-site workforce is at peace, there would be greater efficiencies and productivities. And even more positively, attitude change can be achieved through group discussion.

2.8.8 Risk management

Risk management includes the system of classifying, analysing and responding to the risk related to the building production. Also, risk management is a process that deals with characterised properties, their nature and origin, the likelihood of them occurring, and potential consequences (Kwakye, 1997). Similarly, PMBOK (2008) confirmed that risk management involves the process of conducting risk management planning, identification analysis, response planning, and monitoring and control during building production processes. The goals of risk management are to increase the effect of positive events and decrease the effect of negative events in the building production processes. Likewise, risk is a future occurrence. Risk is an unexpected event or condition that, if it occurs, has an impact on building production objectives, objectives which should include scope, schedule, cost and quality.

2.8.9 Procurement management

Procurement management includes buying or procuring goods and services that are needed for a building production from outside the construction company. Simply put, procurement management is involved with the means of generating revenue, so that the overall organisational goal of profitability can be achieved. The construction company will begin by deciding what to produce, before deciding how to market its products (Lavenger, 1990). Procurement management involves the processes necessary to buy or acquire products, services or results needed from outside the building production team. Procurement management can be either the buyer or seller of the product, services or results of a building production processes. Also, procurement management involves the contract management and changes any control needed to develop, manage, contract or buy orders issued by

accredited building construction team members. Likewise, it involves planning procurement through recognising promising sellers and giving details of the approach, selecting a seller, awarding a contract and establishing a procedure of managing procurement interactions and monitoring contract performance and allowing changes and corrections as needed (PMBOK 2008).

2.8.10 Building production management integration

Building production management integration is a central function that affects and is affected by all of the other knowledge areas. Essentially, this is the centre where the knowledge areas are brought together for building production processes. Tools and techniques are the management instruments that assist the project managers and construction team in carrying out the management functions of the integration management.

2.9 Production phases and building production processes live cycle

A building production life cycle is referred to as building production phases. Building production phases vary by the type of buildings or industries that are involved, but some generally accepted phases include the following four: 1) concept, 2) development, 3) implementation, and 4) close-out/completion. The first two phases emphasise planning and are often referred to as building product achievability. To the contrary, the latter two phases emphasise deliverables and are often referred to as building product achievement (Lavender, 1996).

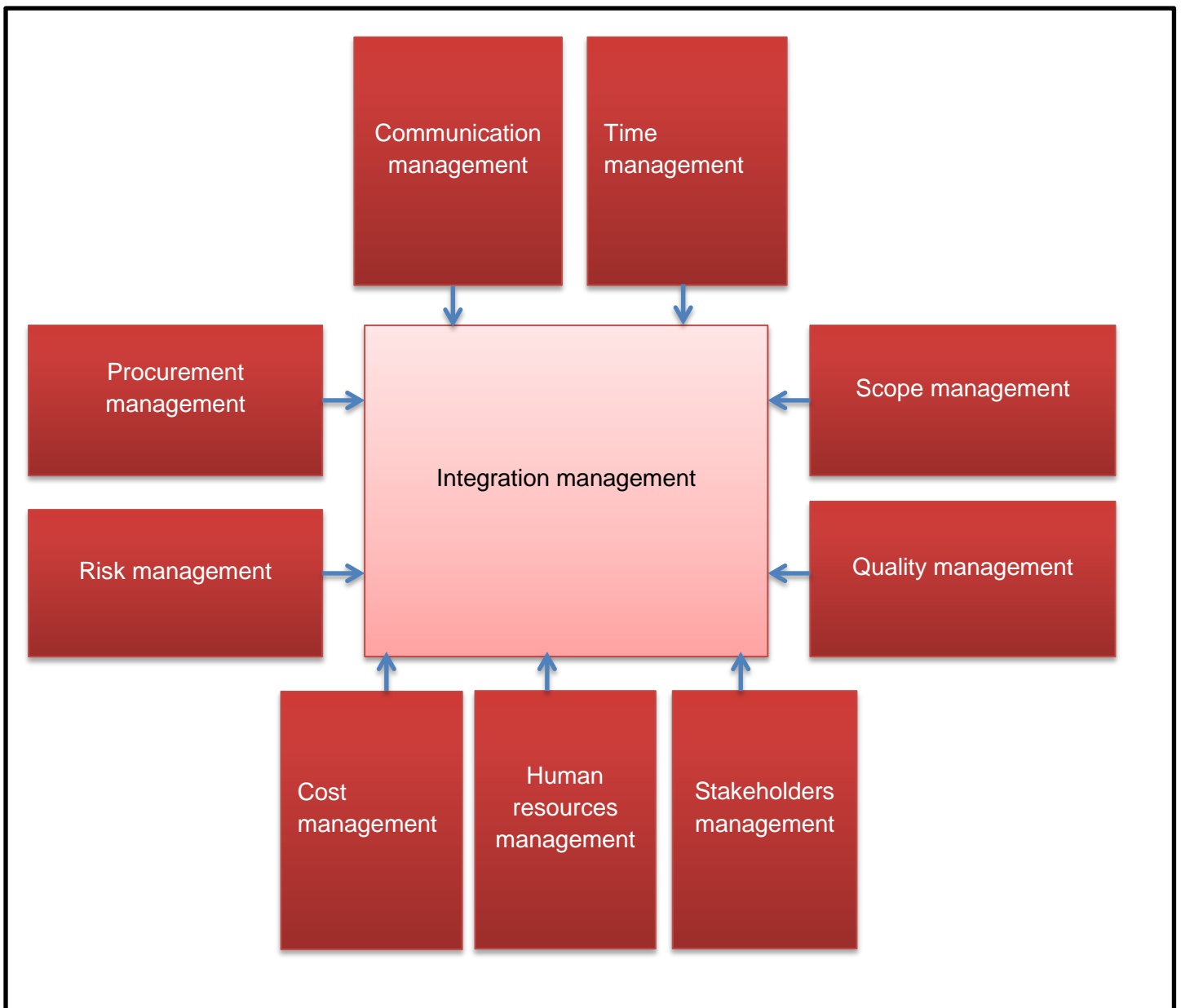


Figure 2.5: Project management knowledge area

2.9.1 Building production process stages

Concept stage: This is to improve the later stages of the building production processes. This stage is to briefly describe what necessitates the project, and to define the objectives and its requirements. A lump cost estimate is derived. Also, a rough overview of the work involved is developed and production processes are broken down into work structure format (Fryer, 1990). Work Breakdown Structure (WBS) during production process is a result a focussing on documents that define the total scope of the building. The Work Breakdown Structure documents break the work tasks out to no more than three levels at concept level (PMBOK, 2008).

Development stage: This is the stage focused on development of a more detailed building plan. Likewise, a more accurate cost estimate is developed and more comprehensive Work Breakdown Structure is developed (Ahuja *et al.*,1996).

Implementation stage: This is the stage where the construction team delivers the required building and its product. An accurate cost of construction is developed and the greater part of the building production time and money will be spent during this phase.

Close-out stage/completion stage: The building production process is completed and all construction activities are endorsed. The completed building as a product will be handed over to the owner followed by a formal acceptance by the client. At this phase, experience gained is documented and generated for reference in similar future building production processes. This documentation is very important should the building production process be a failure or not arrive at the close-out phase. Reference can then be made to previous projects. In addition, the time, scope and cost must be satisfied (Ahuja *et al.*,1996).

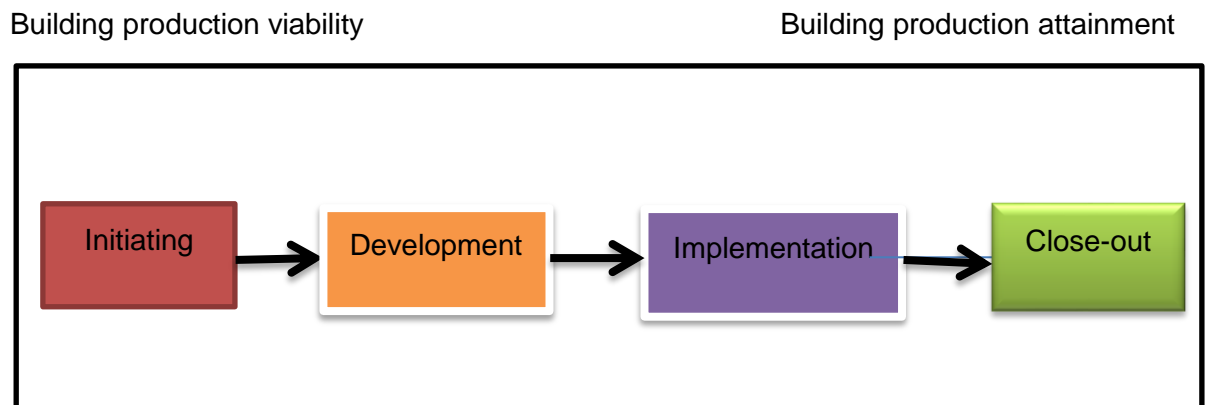


Figure 2.6: Production phases

2.10 Consideration of management principle and practice

Maximum management is important during building production processes; success is achievable through adequate resources made available to the project managers. Likewise, timely approval is necessary for exceptional needs for building production processes (Fryer, 1990). Project management can be seen as a number of connected processes. A process is a series of activities directed toward a particular result. Five project management processes are grouped as follows: 1) initiating processes, 2) planning processes, 3) executing processes, 4) monitoring and controlling processes, and 5) closing processes. It is important

to understand what is involved in each management process group and how they relate to the nine knowledge areas (Calvert, Bailey & Coles, 1995).

2.10.1 Initiating processes

Initiating processes are used to start every phase of the building production processes. Also, as connected with the close-out phase, it is at this initiating phase that the idea is formed. It is used to define the requirements needed for building production processes by the client, architect and the project manager. Lavender (1996) supported the argument that to complete a building production process, the initiating processes are vital to ensure that all requirements are met. Client satisfaction and acceptance of the building and its products are usually considered at this stage. The experiences acquired at this stage are documented and all construction resources are reassigned. Similar to the close-out phase of building production processes, a team must initiate activities to ensure that all the work will be completed, and that the client will accept the building and its products. Likewise, the construction team will document experience acquired from the production and the construction resources will be reassigned to another construction site or the company main office (Walker 2007).

The deliverable time of the building is determined at the initiating process. To that end, budgeted cost involved will be estimated and the project manager and construction team will work toward this budgeted cost to ensure that the building and its product are delivered within this budget. However, the construction resources involved at this stage are usually very low. Likewise, PMBOK (2008) confirmed that is a process performed to define a new building production process or a new phase of an existing building. Similarly, Lavender (1996) argued positively that objectives of construction processes must be firmly established before there is any input of resources to initiate the cycle of building production processes.

2.10.2 Planning processes

This is a devise used to maintain a workable outline to achieve the requirement needed for the building during production processes. A building production plan is generated to define each knowledge area as it relates to the building during the production process at that point in time. These processes are also used to account for changing conditions in construction and in an organisation. Building production processes are frequently revised during each phase of the construction life cycle (Calvert *et al.* 2002).

As this is a development stage, construction resources needed for the production processes are determined at this stage. Likewise, cost, time, scope and quality are modified to enhance

efficient production processes. Also, risk procurement is well-established at the planning stage in relationship to the budgeted cost available. At this development stage, all the nine management knowledge areas are planned in accordance with the budgeted cost for the production processes. Walker (2007) confirmed that planning, co-ordination and control of a project from conception to completion on behalf of a client requires the identification of the client's objectives, such as utility, function, quality, time and cost. Walker (2007) further suggested that the quality of tools and techniques employed by the contractor and the representative of the client are determined by the knowledge acquired by the project team from previous projects. Sears *et al.* (2008) confirmed that planning is the process of devising of a workable outline of operations that, when put into action, will accomplish the successful establishment of an objective. Likewise, PMBOK (2008) argued in support of the discussion that the planning process group involves establishing the scope for the building production processes, redefining the objectives for success, and defining the course of actions and procedures required to attain the objectives that the building production processes was undertaking to deliver to the client. Also, Fryer (1990) suggested that planning is a set of objectives, trying to anticipate what will happen during a building production process and devising ways and means of achieving the targets.

2.10.3 Executing processes

These processes are employed to make certain that the nine knowledge areas are in line with building production processes, and to produce the deliverable output of the stage that the construction is currently in, or the deliverable of the whole production process within the budgeted cost. This executing process includes providing leadership, developing the project team, guaranteeing product quality, authenticating building scope and managing building production processes. Similarly, executing processes are charged with the responsibility of disseminating information across all ranges of the work force involved in production and procuring resources and delivering the building and its products (Calvert *et al.* 2002). Likewise, Pmbok (2008) supported the argument that management of building production involved managing the project team to achieve the project objectives. Also, Walker (2007) argued that a project manager should instantly solve building production management problems. Further, according to Walker (2007), construction management processes involve construction team members on site, irrespective of the titles of the people in the process. PMBOK (2008) confirmed that the executing process group are responsible for completing the work defined in the building production process management plan to satisfy the building specifications.

2.10.4 Controlling and monitoring processes

Calvert *et al.* (1995) confirmed that controlling processes are charged with the responsibility of guaranteeing that the objectives are met. Likewise, building production processes must be frequently monitored and the progress measured against the construction plan to ensure corrective activities are implemented where necessary. Controlling processes comprise performance and status reviews during production processes. Controlling processes are also used to monitor and identify changes and to manage in agreement with the construction plan. Similarly, PMBOK (2008) confirmed that monitoring and controlling process groups are processes necessary to track, review and regulate the progress and performance of the building production processes. Also, Walker (2007) argued in support of the discussion that there is a relationship between integration, monitoring and controlling and achieving efficient building production processes. Walker (2007) agreed that management of the building production process is subjected to external factors, all elements outside the processes. If changes occur on the effects, the monitoring and controlling processes demand a response. Fryer (1990) argued that controlling is a task employed to compare performance with plan. The plan is the yardstick without which the construction team could not control anything. If the project manager does not control performance, the plan is of no value. From this point, it is very clear that planning and controlling are dependent on each other.

2.10.5 Closing-out processes

Closing-out processes are used to validate the acceptance of the building project and bring it to a logical and conclusive end. The close-out is initiated by the initiating group to bring the production to an end at each phase or at the end of the entire building production process. Also, closing out involves documenting construction files, keeping a record of experience gained and receiving official acceptance of the building and its products delivered. Likewise, PMBOK (2008) supported the argument that closing processes are processes performed to finalise all activities involved across all ranges of the process to formally end the building production processes.

2.11 Timely delivery of building product

Inability to complete the building production process within specified time and budgeted cost by contractors has been a major problem challenging the construction industry in delivery of products (Apolot *et al.* 2011). Timely delivery of building products is essential. Project work schedules must be adjusted to accommodate adverse job circumstances; these regulations are necessary so that contract time requirements can be met (Sears *et al.* 2008). Also, Fallahnejad (2013) found that time overrun caused by mismanagement leads to late delivery of building product during production processes. Similarly, Ramanathan *et al.* (2012)

confirmed an increase in the number of building production processes experiencing extensive delays leading to exceeding the initial time and budgeted cost. Ramanathan *et al.* (2012) explained that slipping over in planned schedule has been a common problem during building production process.

2.11.1 Funding of building production processes

Funding of building production is the process of paying the construction resource costs and settling the contractor's fees. Ahuja *et al.* (1994) confirmed that many building production processes have suffered delay and abandonment as a result of poor funding by the client.

2.12 Communication during building production

Communication is the ability to convey messages clearly, vividly and strongly among construction stakeholders by either sketches, drawings, writing or spoken word. It is the tool for leadership and supervision in the construction industry. Communication is the means employed by the construction operators to make reasons known and to stimulate action during the production process (Calvert *et al.*, 2002). Similarly, communication is a tool to achieve objectives in the construction industry. Lack of co-ordination, separation of design and construction phases, lack of trust and arguments between stakeholders are all caused by ineffective communication (Emmitt & Gorse, 2003). Likewise, Moore (2002) confirmed that projects depend on communication. While it is a fact that communication itself cannot complete a building production process (it obviously requires construction resources to operate successfully), effective communication can be achieved by investigating a problem before taking a significant decision. The adoption of a correct procedure is a necessity for optimum outcome during a building production process (Calvert *et al.*, 2002).

Emmitt *et al.* (2003) argued that communication is better handled when co-ordination of both design and construction is carried out either by architect or contractor, than it is when the function has separate co-ordinators. If design and construction do have separate managers, then it is best to ensure early exchange of messages on site activity plans. This step is fundamental towards effective planning for building production processes between designers and contractors. Similarly, communication and control in the construction industry is a process that involves service managers to communicate policy formulated at the office, through the contract manager, to the supervisor, on the implementation of the policies on the construction site (Harris *et al.* 2013). Findings by Emmitt and Gorse (2003) revealed that failures in communication cause conflict, confusion, and doubt among construction stakeholders. Further explained by Emmitt and Gorse (2003), division of duty among the stakeholders has knock-on effects on a supply chain and are seen as wasteful steps. The

situation is complicated further by the fact that each stakeholder brings partialities in decisions being taken, and this also has an effect on communication.

2.13 Summary

This chapter reviewed literature relating to cost constraint, delay in project delivery, management principles and practices, management knowledge areas, cost and construction resources and production processes. Literature revealed that the construction industry often delivers projects at construction costs greater than budgeted cost specified. The construction industry is confined within budgeted cost. Thus, the operational system is challenged with cost limitation to deliver project at the stipulated time and at a certified quality. The construction industry can be described as an active firm which is constantly challenged with uncertainties as a result of mismanagement of costs by the stakeholders. Costs affect the construction production process and delivery time significantly, justifying the investigation of efficient utilisation of cost without affecting delivery time during production process. A project is deemed successful if delivered within budgeted cost at planned time with quality expected. Thus, it is imperative to have control over cost performance of a project to ensure the construction cost remains within the budgeted cost. Literature affirmed that construction stakeholders were found to play a main contributory role in activities that result in project cost increase at conception/planning stage, implementation, and completion/commissioning stage. Hence, this study intends to identify the factors that affect cost during the production process.

Findings from literature indicate that the construction industry mostly completed projects *above* budgeted limit. Thus, factors that affect cost during production were identified as ineffective contract management, additional work, cost of materials in the market, currency exchange rate, economic instability, frequent design changes, government policies, high interest rates charged by banks, incorrect planning, and the lack of coordination between the design and construction phases. Thus, establishment of an operational technique for management of construction costs is necessary for avoidance of these negative construction predicaments. Avoidance of these identified factors will lead to effective construction production processes, reduction of resource waste, more involved cost estimation and more timely delivery

CHAPTER THREE

3.0 METHODOLOGY AND METHODS

3.1 Introductions

This chapter explains the methodology that was used to drive this research study toward a framework for effective management of cost constraint on building project delivery. Research methodology is a systematic way of resolving an identified problem, the process by which researchers go about their work of describing, explaining and predicting phenomena (Rajasekar *et al.* 2013) The objective of research is to discover new facts, and verify and test important facts (Rajasekar *et al.* 2013). Clarke (2005) stated that research methodology defines what constitutes a research activity, its application to a model, concepts, what methods to apply, how to measure progress and how to communicate about an area of research activities. Likewise, Silverman (2000) explained that methodology will indicate a way to develop some theoretical insight into a problem, show how to develop a method, compare and contrast the use of several different methods, and explain why certain methods have been chosen or which data to select from the research. Methodology will indicate how to collect data, analyse some body of data, and indicate a method of reporting the findings. Sarantakos (1988) described methodology as a way of identifying a research model to be employed, basic knowledge related to the subject, research methods in question and a framework to be used.

The starting point of a research study is the selection of a research topic, a problem which a researcher is interested in, and then to find out the causes and solutions to the problem identified (Rajasekar *et al.* 2013). The problem investigated in this study is effective management of cost constraint on building project delivery in South Africa. It is expected that the identification of the factors that affect cost during the building production process will be used to establish an operational technique for management of construction cost in order to stay within the limit of budgeted cost.

3.2 Research methodology approaches and research methods

3.2.1 Research methodology approaches

This is the process of carrying out preliminary work concerning framing questionnaires, collection of data and understanding respondents and categories. It entails carrying out a literature review. Methodology refers to the practices and techniques in research used to gather information. It is a study of methods through which knowledge is gained and used to spell out exactly what must be done in a research study (Silverman, 2000). Literature

relating to a framework for effective management of cost constraint on building project delivery was reviewed, questionnaires were framed from the reviewed literature for the collection of data, and the research approaches employed were identified as both quantitative and qualitative methods.

3.2.2 Research methods

Research methods are the various procedures and techniques employed in a study. They are essentially planned and scientific in nature, including theoretical procedures, observation studies, numerical and statistical approaches. The methods are for collecting samples, generating data and finding a solution to the problem identified (Rajasekar *et al.* 2013). Information collected through observation was used to frame some of the questionnaires; interviews were conducted and statistical approaches employed. The quantitative approach method was used through closed-ended questionnaires to collect information on the factors that affect cost during production process, modalities of achieving quality building during production process, effects of changes in building design during production process on budgeted cost, impact of budgeted cost on management of construction resources, efficient utilisation of cost without negatively affecting delivery time and quality expected during production process, and establishment of operational techniques for management of construction costs in order to remain within the limit of budgeted cost.

The qualitative approach method was employed through the use of open-ended questionnaires to collect information from groups of experienced stakeholders working in the construction industry of South Africa, through semi-structured questionnaires for the interviews conducted concerning modality of achieving a quality building project during production processes, effects of changes in building design during production process on budgeted cost, impact of budgeted cost on management of construction resources, and efficient utilisation of cost without negatively affecting delivery time and quality expected during production process. Observations were conducted on drawings to collect data concerning the causes of constant changes to drawings and the consequent effects on budgeted cost.

3.2.3 Qualitative approach method

Qualitative methods are generally associated with the evolution of social dimensions. Qualitative methods provide results that are usually rich and detailed, offering ideas and concepts to inform about research. Qualitative methods allow feelings of perception by allowing the understanding of the respondents' feelings and thoughts (MacDonald &

Headlam, 1986). Likewise, Rajasekar *et al.* (2013) described qualitative research as a qualitative phenomenon involving quality and applied reasoning, as it is non-numerical and descriptive. The goal of the research is to get the meaning, sensation and definition of the situation. It is exploratory: building drawings, bills of quantities and site programmes of works are the sources of information applied for the qualitative research employed for this study on a framework for effective management of cost constraint on building project delivery. An exploratory study was conducted to gain more information into the effective management of cost constraint on building project delivery through fieldwork and field study. Semi-structured and unstructured interviews were the techniques used to gathered information and data for this study. Qualitative research uses naturalistic methods such as fieldwork, field studies and general methods that are familiar to the people living in these settings (Sarantakos, 1988).

3.2.4 Quantitative approach methods

Quantitative methods are concerned with quantifying things, asking questions and analysing data statistically. The target is to count things in an attempt to explain what is observed. Quantitative methods offer aggregate results by measuring the incidence of various views and opinions in a chosen sample and generalising results from a sample of the population chosen (Silverman, 2000). Likewise, Sarantakos (1988) confirmed that quantitative methods allow data collection, employing many, diverse, simple and straightforward methods. The methods employed are surveys, documentary methods, observation, and experiments. It utilises samples that reflect the attributes of a targeted population, and so the findings it produces relate to the whole population and conclusions drawn through the study are relevant to the whole population. It allows for a claim of representativeness and generalisation: the higher the representativeness, the higher the generalizability of findings and therefore the higher the quality of the study. Quantitative methods attempt to quantify and classify the effective management of cost constraint on building project delivery, considering timely delivery and quality expected. This method was applied through closed-ended questionnaires to collect data from stakeholders in the construction industry.

3.3.1 Secondary data

The information gathered from existing literature is referred to as secondary data. After identifying a problem, the researcher has to do a literature survey related to the problem. A literature survey can be referred to as a collection of research journals, books and other papers related to the identified problem. The review of existing literature will reveal whether or not the defined problem has already been solved. A literature survey can be carried out through published journals and reviews of articles related to the problem (Rajasekar *et al.*,

2013). This study adopted two literature studies: preliminary and comprehensive literature reviews.

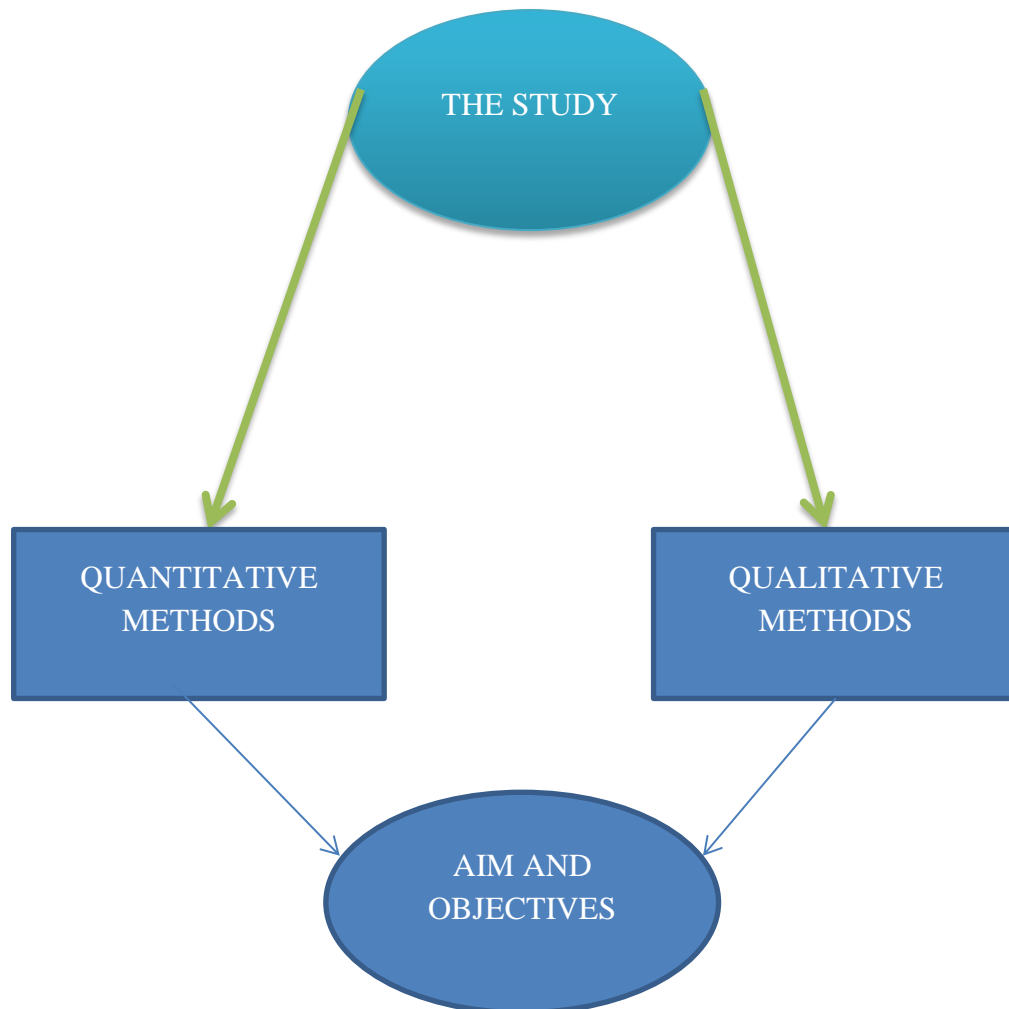


Figure 3.1: Research approach of the study

3.3 Data collection

3.3.2 Preliminary literature review

A preliminary literature review allows insight into the identified problem, allowing the problem to be properly framed; it also gives information on how the proposed research will be formulated. The preliminary literature review allows the problem statement to be framed, and likewise, the background to the research. A preliminary literature review helped in formulating robust objectives toward achieving an effective management of cost constraint on building project delivery. A broad literature review was carried out to develop very important literature topics outlined in the proposal: construction cost as a constraint, design

team, construction team, building production processes, cost in relation to other construction constraints (time and quality), cost and construction resources (workforce management, machinery management, material management), cost and management knowledge areas, consideration of management principles and practices (initiating, planning, co-ordinating, executing, monitoring, closing), timely delivery, funding of project and communication in the construction industry. The techniques used to investigate the problem included a review of journals which publish research articles, text books, unpublished theses and dissertations, and internet web sites. In supporting of these techniques, Rajasekar *et al.* (2013) stated that no research shall be complete unless we make use of the existing knowledge. Review of the literature in any research study is a preliminary step before attempting to plan the study. The availability of this survey information at the Cape Peninsula University of Technology library helped to obtain the necessary information required for the development of the study.

3.3.3 Comprehensive literature review

A comprehensive literature review is an integral part of this study; it is one of the main parts of the body of the research. A comprehensive review of existing literature will ensure that the researcher gets proper understanding of the problem identified. Grbich (2007) supported of the statement that information can be obtained from a review of previous literature. Also, investigable predictions can be derived from the literature. A broad literature review enables the researcher to acquire proper theoretical and practical knowledge to investigate the problem. Also, a literature review will reveal whether or not the problem under investigation relates to previous research studies. A wide all-inclusive literature study will provide an in-depth understanding of whether or not the proposed problem has already been solved by another researcher. Comprehensive reviews of existing literature will enable the researcher to understand what information was compiled, mainly from journals, conferences proceedings, text books, theses and dissertations, and findings by government agents.

3.3.4 Primary data

Surveys are popular methods of collecting primary data. The broad area of survey research embraces measurement procedures that involve asking questions to respondents. They are flexible tools which can produce both qualitative and quantitative information depending on how they are structured and analysed (MacDonald & Headlam, 1986).

3.3.5 Investigative study

Investigative study was employed for the research design: a questionnaire framed from the preliminary literature review was administered to the selected group among the targeted

population in the South African construction industry to determine whether or not the framework for effective management of cost constraint on building project delivery in South Africa has a research status. The selected samples among the population included architects, structural engineers, quantity surveyors, project managers, contractors, contract managers and clients. Likewise, MacDonald and Headlam (1986) confirmed that exploratory studies are relevant to most types of research projects. The exploratory study is conducted within the group that has a strategic role to play in this research. The selected group responded to the questionnaire, unclear questions were underlined by the respondents and returned back, and these underlined questions were amended. The amended questionnaires were subsequently administered to another selected group to confirm the appropriateness of the questions, and the questionnaires were then answered correctly by the respondents with very few amendments.

3.3.6 Population

The population for the research survey needs to be considered for research design (MacDonald & Headlam 1986). Population for a survey design for effective management of cost constraint on building project delivery in South Africa was considered for easy counting, ability to read and ability to complete written surveys or questionnaires.

3.3.7 Population sampling

Sampling is necessary in wider populations that will be engaged in the survey. Sampling is the process of identifying whom you will aim to contact from that large population (MacDonald & Headlam, 1986). As sample procedures need to be accurate and valid, the sample required for a study has to be chosen according to common standards and procedures in order to produce representative results that are suitable to be generalised (Sarantakos, 1988). The targeted sample among the population used for this study is the sample that will be able to answer the questionnaires adequately. The targeted sample among the population in the construction industry of South Africa for effective management of cost constraint on building project delivery are clients, structural engineers, quantity surveyors, project managers, contractors, contract managers, architects, and site engineers.

3.3.8 Probability sampling techniques

Probability sampling is a technique employed for sampling the targeted population instead of using a snowball or convenience approach. The use of this simple random sampling of this targeted population is the approach to mirror the total population. Probability sampling could be considered as a potentially useful technique for providing a representative sample, in particular when access to a large diverse group is available, though statistical generalisation

is not a possible outcome (Grbich 2007). Likewise, Teddlie and Tashakkori (2009) supported the argument that a probability sampling technique involves randomly selecting specific units or cases so that the probability of inclusion for every member of the population is 'determinable'. Considering the operations and outcome of probability sampling, the application may not be suitable for this study; therefore non-probability sampling is the most convenient approach to this study. This technique allows the selection of participants who it is believed will be capable of answering the required questions adequately. The adoption of purposive sampling and snowball approaches were employed in this study.

3.3.9 Non-probability sampling techniques

Non-probability sampling techniques involve the selection of a portion of the limited population to be studied. Also, non-probability sampling was used for the study to identify an incident, a few selected cases relating to people, places and objects, or in attempt to answer the 'how' and 'what' questions (Battaglia, 2011). A non-probability sampling approach method will be employed for this study on a framework for effective management of cost constraint on building project delivery in South Africa.

3.3.10 Purposive sampling approach

Purposive sampling allows a researcher to choose a case because it illustrates some feature or process in which there is interest. However, this does not guarantee any sample selected for a study. Instead, purposive sampling requires that we think critically about the parameters of the population we are interested in and choose our sample case carefully on this basis (Silverman, 2000). The adoption of this technique helps to select construction companies in the Western Cape and Gauteng provinces, South Africa, because of high concentrations of construction industries within these two provinces. Also, the two provinces recorded the highest number of stakeholders working in the construction industry. The commercial centre of South Africa and the head office of the construction industry are situated in these two provinces to which questionnaires were sent, as it was believed that the respondents targeted in the industry would answer the questions adequately. On this basis, it was believed that the questions answered by the respondents could therefore be used to generalise what is happening in the construction industry within the scope of the research. Site visitations were carried out to actually determine which of the construction companies have experienced and qualified stakeholders amongst their staff members who could answer the questionnaire.

3.4 Snowball sampling approach/chain sampling approach

Snowball sampling is a purposive sampling technique approach that includes using informants or partakers to identify additional cases which may be incorporated in a study (Teddlie & Tashakkori, 2009; Kemper *et al.*, 2003; Patton, 2002). This technique helps identify authentic respondents in THE construction industry who also invite similar participants that were included in the sample to answer the questionnaires, identify factors that affect cost during building production process, and identify the modality of achieving quality building project during production processes. The technique was applied for the investigation of a framework for effective management of cost constraint on building project delivery in South Africa.

3.4.1 Gathering of information and data

Gathering of information and data is an essential procedure in research study, a technique used by researchers to gather data including face-to-face interviews, focus groups, participant observation and questionnaire surveys. Silverman (2000) confirmed that researchers can consider four different types of techniques to gather data: 1) interviews, 2) field notes, 3) texts, and 4) transcripts. This research studied effective management of cost constraint on building project delivery and employed face-to-face interviews, participant observation and a questionnaire survey technique to gather data.

3.4.2 Interviews

Interview is a technique that involves a researcher asking a participant questions about a particular phenomenon; it is face-to-face interaction between two or more people. Interviews can be grouped into three main types: semi-structured, unstructured and structured interviews (Willis 2007).

3.4.3 Structured interviews

Structured interviews involve the use of questionnaires that ask participants to select an answer to questions from a list of options. The questions are usually read out by a researcher in a simple tone of voice to avoid influencing the reasoned response of the participant (Willis 2007). This study does not employ the use of structured interviews that asked participants to select options from questionnaires.

3.4.4 Semi-structured interviews

In semi-structured interviews, the interviewer will have a list of topics and particular areas to be covered and some questions may be developed, but the researcher may omit or make additions to some of these questions or areas depending on the situation on the ground and

the flow of the conversation between researcher and participants (Willis 2007). This study used semi-structured interviews to gather data to achieve the aims and objectives of this research. Interviews were conducted in a selected construction industry among construction stakeholders who have experience in a related study on “why projects are delivered at construction cost greater than budgeted cost and time specified”. Similarly, MacDonald and Headlam (1986) confirmed that semi-structured interviews are commonly used techniques that allow a framework to address key topics rather than specific questions, as during the interview the researcher is allowed some flexibility.

3.4.5 Unstructured interviews

This type of interview is an informal discussion; the interviewer will likely go into in-depth discussion with the participant. However, in this type of unstructured interview, it is likely that the researcher would have a selected range of topics to cover in the interview (Willis 2007). Unstructured interviews were used extensively to gather information and data for the framework for effective management of cost constraint on building project delivery; the interviews were conducted among selected construction stakeholders to know why the construction industry delivered projects above budgeted cost and time specified. Likewise, MacDonald and Headlam (1986) confirmed that the method of interview is unplanned questions; issues were addressed by the researcher as they emerged.

3.4.6 Participant observation survey

Source of case study data include participant and non-participant observations. Participant observation occurs when a researcher adopts a system to observe in some way the group being researched and to share views on what has been observed and experienced being recorded and analysed. This technique can be used for getting below the surface of any phenomenon being studied. It works with other research techniques to collect primary data (Willis 2007). This study employed the use of this technique to get in-depth during the exploratory study on the effect of inadequate design on budgeted cost and why construction cost is always higher than budgeted cost after the completion of the project. Two types of participant observation were employed to carry out a case study on effective management of cost constraint on building project delivery in South Africa: ‘observer as participant’ and ‘participant as observer’.

3.4.7 Observer as participant survey

‘Observer as participant’ is one of the techniques employed for this study by the researcher to gather information and data. The group being studied by the researcher is known as the motive of the researcher within the group. The role of the researcher is to observe the actual

participants, although the researcher partially participates in the activities within the group. Observation participation of a researcher in the life of a group involves collective discussion and analysis of personal documents produced within the group (MacDonald & Headlam, 1986). This study employed 'observer as participant' technique to study a group of construction teams carrying out setting-out on new sites to actually know whether or not the errors and omissions discovered during construction were a result of inadequate design.

3.4.8 Participant as observer survey

'Participant as observer' is another practise used to collect information and data by a researcher. The reason for the researcher's involvement in a group is known to all others in the group. This technique allows the researcher to fully engage in all the activities in the group. In this type of technique, the researcher has formal experience to observe and talk to other participants about their experiences with certain issues and activities within the group (MacDonald & Headlam, 1986). Likewise, Blaxter *et al.* (2001) confirmed that observation is a technique of collecting data; observation can be written and recorded in order to be analysed. 'Participant as observer' is referred to as a method whereby the researcher is involved in a group for the purpose of interviews and collecting data from the group. This method was used to investigate modalities of achieving quality building projects during production process. Interviews were conducted within the group, information was collected through observation, and questions were derived to collect data.

3.4.9 Questionnaire survey method

A questionnaire survey method can produce both quantitative and qualitative information and data depending on the structure of the questionnaires. Questionnaire surveys can be used to gathered variety of different types of information and data, generally to gather from a wide range in a sample group in a study for quantitative data (MacDonald & Headlam, 1986). Similarly, Teddlie and Tashakkori (2009) described questionnaire techniques as a very efficient data collection strategy, as they can be closed-ended, open-ended or both, all depending on the structure of the questionnaire. Closed-ended quantitative questionnaires are used more commonly in research studies than are open-ended qualitative questionnaires because cases with closed-ended responses are more efficient to collect and analyse with SPSS software. MacDonald and Headlam (1986) stated that questions to be asked should be related to survey design; questions should not be too complex to be answered by respondents. Another pertinent fact is that the questionnaires should be arranged in sequence order and controlled: too lengthy questionnaires must not be asked, moderate responses and Likert-scale responses should be used, and questionnaires should be used in such a way to avoid introducing a bias. It should be done with objectivity. This

study used a questionnaire survey method that involves both quantitative and qualitative methods to gather information and data concerning effective management of cost constraint on building project delivery in South Africa. Questionnaires were used because they gathered data from a wide range of a sample group in a targeted population in the construction industry for quantitative analysis. Likert scales from 1-5 and 1-4 were used; the Likert scale 1-4 comes into use because the neutral answer is not allowed in this study. The study wanted respondents to contribute meaningfully to the study in order to achieve the aim and objectives of the study. Qualitative questionnaires were used to gather data and information from very few sample groups within the targeted population. It is an unstructured questionnaire for a qualitative method, not using Likert scales.

3.4.10 Questionnaire design

Questionnaires are designed for collection of data and easy access to the respondents of a larger population without much stress of gathering group discussion. Grbich (2007) stated that questionnaire design that omits levels of uncertainty would be easy to undertake and produce less complex findings. The exploratory study conducted, objectives and literature review outlined for this research formed the basis for the structure and formulation of questionnaires for effective management of cost constraint on building project delivery in South Africa. Table 3.1 shows the questionnaire design for the research. Section A of the questionnaire requested information about respondents' details. Section B obtained information about the project types, cost and time specified, cost of construction and delivery time. Section C obtained information from the stakeholders on how the administrative management of their company is being carried out. Section D collected information concerning factors that affect cost during building production process using a Likert scale of 1-Strongly disagree to 4-Strongly agree. Section E gathered information concerning the modality of achieving quality in building projects during production processes using a Likert scale of 1-Strongly disagree to 4-Strongly agree. Section F indicated the effect of changes in building design during production processed on budgeted cost using a Likert scale of 1-Strongly disagree to 4-Strongly agree. Section G classified the impact of budgeted cost on management of construction resources, with the following groupings: G1-indicate the level at which you accept the effect of human resources management on budgeted cost using a Likert scale 1-Perfectly unacceptable to 5-Perfectly acceptable. G2-indicate the level at which you agree that management of machinery has an effect on budgeted cost using Likert scale 1-Strongly disagree to 4-Strongly agree. G3-indicate the level at which you agree about the effect of building materials on budgeted cost during production process using a Likert scale 1-Strongly disagree to 4-Strongly agree. Section H identified efficient utilisation

of cost without affecting delivery time and quality expected during building production process using Likert scale 1-Ineffective to 5-Perfectly effective.

The research objectives will be achieved through the use of design questionnaires (Table 3.2). Figure 3.2 illustrates the sequence of achieving research objectives. The targeted respondents to be used in the survey are stakeholders in the construction industry. The questionnaire was administered to the targeted respondents, both open-ended and closed-ended questions being the techniques used to collect data for this study.

3.5 Closed-ended questionnaires

A closed-ended question is a question administered to the respondents by a researcher; it has alternative responses to the topic in question with a sliding scale. It can also pose a list of options include rating, ranking or with other quantitative forms. The respondents are asked to fix responses and the respondent is expected to choose from the list of options with which the respondent most agrees (Sarantakos, 1988). Closed-ended questions were formulated from the objectives of the study framework for effective management of cost constraint on building project delivery in South Africa. These were used to ask the respondents to fix responses and tick from lists of options the option with which the respondent most strongly agreed. Likert scales are used to rate the questionnaire from a sliding scale 1-5 and 1-4, and through this process quantitative data were collected for statistical analysis.

Table 3.1: Questionnaire design

Section No	Section Title	Objectives to be addressed
A	Respondent details	To determine the particulars of respondents involved in the study
B	Project distinguishing	Type of project and information concerning the project
C	Administrative management rules and practices	Information on management steps of each respondent's firm
D	To identify the factors that affect cost during production process	Objective 1
E	To identify the modality of achieving quality building projects during production process	Objective 2
F	To investigate the effect of changes in building design during production process on budgeted cost	Objective 3
G	To assess the impact of budgeted cost on management of construction resources	Objective 4
H	To ascertain how cost can be efficiently utilised without affecting delivery time and quality expected during production process	Objective 5
I	To establish an operational technique for management of construction cost in order to be within the limit of budgeted cost	Objective 6

Table 3.2: Method of achieving objectives

Objectives	Purpose of Objectives	Achieving Objectives
To identify the factors that affect cost during building production process	Delivery of project at budgeted cost and time specified	The objective can be achieved through review of related literature, observation and questionnaires
To identify the modality of achieving quality building project during building production process	Delivery of quality building project that satisfies client and end users interest	This can be achieved through review of literature, interview, observation and questionnaire
To investigate the effect of changes in building design during production process on budgeted cost	To achieve adequate design for production process at construction cost equal to budgeted cost	This can be achieved through review of literature, interviews, observation on building design drawings and questionnaires
To assess the impact of budgeted cost on management of construction resources	To tutor construction stakeholders on how to make best use of construction resources for productivities within the budgeted cost	Review of literature, interview, observation and questionnaire can be used to achieve this objective
To ascertain how cost can be efficiently utilised without affecting delivery time and quality expected during production process	To achieve delivery of project at time and quality specify without affecting budgeted cost	The objective can be achieved by reviewing related literature, interviewing the respondents who have knowledge concerning the questions; questionnaires will be administered to the relevant respondent, observation of relevant documents and work done.
To establish operational techniques for management of construction cost in order to be within the limit of budgeted cost	To achieve the use of techniques that can be used to deliver project at construction cost that equal to budgeted cost or construction cost to be less than budgeted cost	The objective can be achieved through the results obtained from the findings and review of relevant literatures

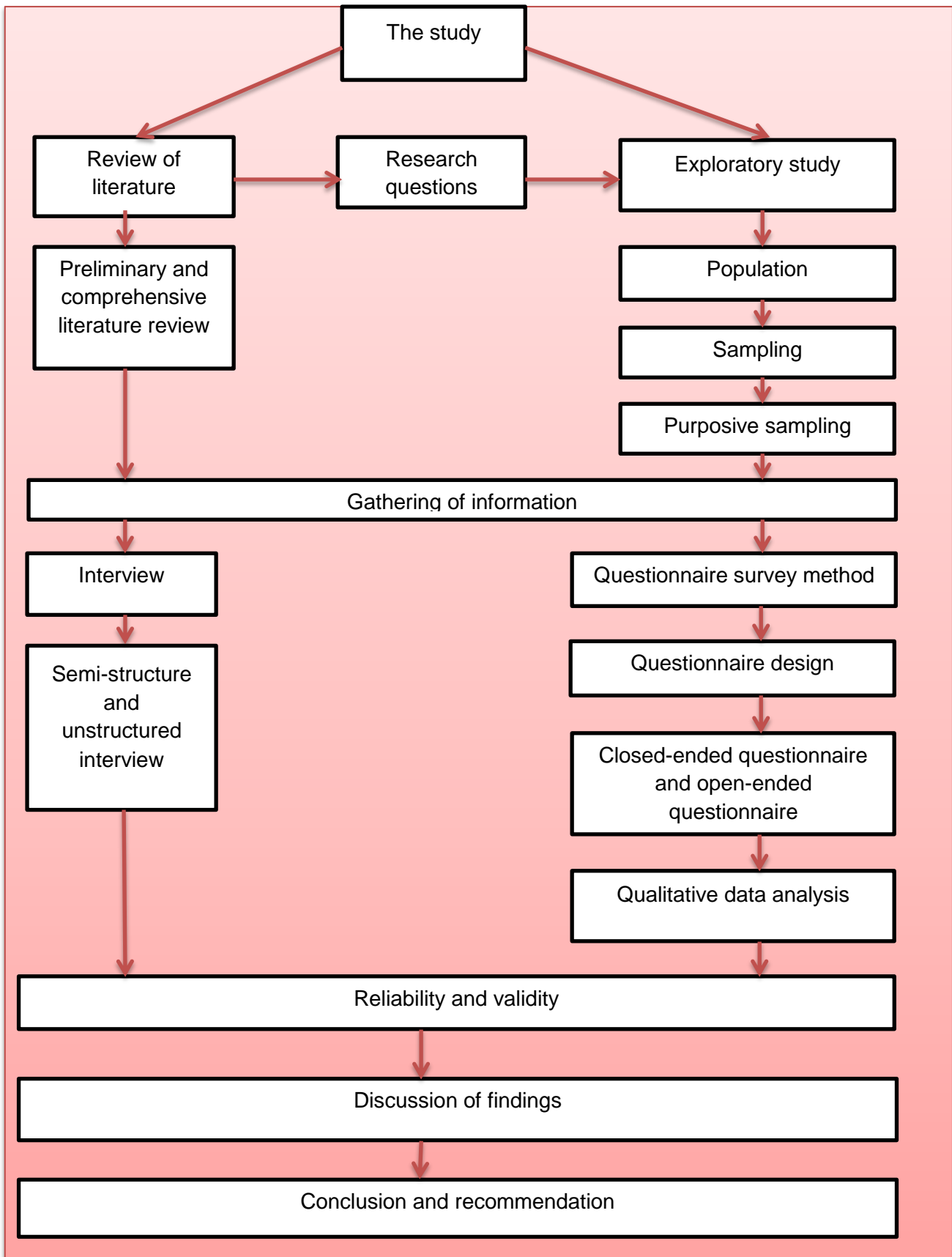


Figure 3.2: Sequence of achieving research objectives

3.5.1 Open-ended questionnaire

An open-ended questionnaire asks opinion seeking questions. The respondents are free to formulate their answers the way they consider the most appropriate in their own manner of seeing things and in their own language of understanding. A question posed intends to obtain respondents' views about a topic; the answers are left with the respondent to his own perspective and viewing of the issue (Sarantakos, 1988). Open-ended questionnaires are used to collect data for the study of a framework for effective management of cost constraint on building project delivery in South Africa. The respondents were asked to respond to selected topics related to the objectives of this study in their own perspective and with their own view of the issue. Effective responses were collected from the respondents as data.

3.5.2 Data analysis

Data analysis is a process whereby all the data and information collected are compiled to make sense out of the information gathered and to identify the meaning and conclusions derived from the data. The data collected from the sample group of the population through questionnaires by the researcher are raw data. This raw data are converted into meaningful statements called analysis and interpretation of data (Sarantakos, 1998). The information and data collected for the study of a framework for effective management of cost constraint on building project delivery in South Africa will be analysed by SPSS version 22 and the results will be interpreted accordingly.

3.5.3 Qualitative data analysis

Qualitative analysis is a procedure central to the development of new ideas and theories by relating evidence to abstract concepts and to theory generation. Data collection, analysis and evaluation are one and the same process. During data analysis, the researcher searches for patterns of data, and when such patterns are identified, data are interpreted (Sarantakos, 1988). Similarly, Willis (2007) described qualitative analysis as a process that involves data analysis and interpretation, a procedure that involves philosophy of science and the methods of communicating the findings.

3.5.4 Quantitative data analysis

Quantitative data analysis is analysis that involves numbers using different types of statistical techniques. Descriptive and inferential techniques are used in quantitative data analysis (Teddlie & Tashakkori, 2009). Sarantakos (1988) described quantitative analysis as a process of summarising and relating data, precisely the process of data analysis including data preparation, counting, grouping, relating, predicting and statistical testing.

3.5.5 Descriptive statistical methods

Descriptive statistical methods are techniques employed for summarising data collected through quantitative methods and easily interpreted by tables, graphs or single representations of a group of scores. It measures of centre tendency mode, mean and median, the goal being to make the data understandable and then communicate the findings. The quantitative questionnaire will be captured using statistical package for social science (SPSS); the summary and conclusion will then be drawn (Teddlie & Tashakkori, 2009). The study of framework for effective management of cost constraint on building project delivery in South Africa will be analysed by descriptive statistical methods. The results will be interpreted by tables, mode, mean and median.

3.5.6 Inferential statistical methods

Inferential statistical methods are defined as part of statistical procedures that draw conclusions from samples obtained in a group to larger population. Inferential statistical methods involve the testing of differences between group means and relationships between variables (Teddlie & Tashakkori, 2009). This method cannot be applied in this study because hypotheses are not used for the study and testing between two variables is not required. Hypothesis allows the uses of t-test, analysis of variance (ANOVA) and analysis of covariance (ANCOVA).

3.5.7 Testing the questions, validity and reliability of the research instrument

3.5.8 Measurement of validity

Measurement validity is a process used by the researcher to determine whether the data represents the concepts they were assumed to capture. Validity is the level to which the data accurately measures what they were intended to measure. It is simply defined as authenticity of data collected to produce a desired result (Teddlie & Tashakkori, 2009). The true indicator and credibility of respondents used in this study of framework for effective management of cost constraint on building project delivery are experienced construction stakeholders for data collection through quantitative methods. Willis (2007) confirmed that validity is believability that data captured represent the concept of the study.

3.5.9 Measurement of reliability

Measurement of reliability is a process that determines whether the data collected consistently and accurately represent the concept under examination. Reliability of measurement is a procedure that accurately and consistently yields reliable results if given repeated trials. Reliability all depends on which data collection method used by the researcher, if replicated by others, will yield consistent findings (Teddlie & Tashakkori, 2009).

Similarly, Willis (2007) described measurement of reliability as stability of results. If the study is repeated several times, the same result must be obtained when tested through the use of Cronbach's alpha co-efficient. Cronbach's alpha co-efficient ranges in value from 0 to 1, the test can be performed on Likert-scaled type questions. In this study on framework for effective management of cost constraint on building project delivery in South Africa, the reliability tests were performed on the Likert scale questions by using Cronbach's alpha co-efficient.

3.6 Types of research methodology

These following types of research methodology itemised are not applicable to this study, yet it is significant that they be included for clarification.

3.6.1 Historical research

Walliman (2006) counselled that historical research is a process that involves exploring the meanings and relationships of event using historic artefacts, records and writings. It investigates past events to reveal reasons for why and how things occurred. The document to be investigated must be carefully scrutinised to be certain that it is genuine. The method of collecting data for historical research is specifically based on observation or experimentation. Likewise, Munslow (2006) expressed it this way: historical research is the study of the past and present, with an eye to the future.

3.6.2 Comparative research

Walliman (2006) advocated that comparative research aimed at comparing people's experiences of different communities between times in the past or in parallel situations in the present. It is a research study that uses references from the past and compares these with the present.

3.6.3 Descriptive research

American Dietetic Association (2008) defined descriptive research as methods to obtain information used in devising hypotheses and proposing associations. Descriptive research provides background information concerning an event in question. It examines the situation in order to establish what the norm is. Observation is one of the methods used to collecting data under descriptive research; information gathering can be achieved through interviews, questionnaires, and visual recording instruments (Walliman, 2006).

3.6.4 Correlation research

Miles and Shevlin (2005) described correlation as a measure of the extent to which two variables are linearly related. Walliman (2006) explained that correlation research measures

the relationship between two problems; the advantage of correlation research is that it allows measurement of numbers of variables studied. It gives an estimation of the probable accuracy of the prediction made. The limitation in correlation research, however, is that while the association of variable can be established, the cause and effect relationship is not revealed.

3.6.5 Experimental research

Experimental research differs from its approach when compared with other research: it has firm control over the objects of study. The researcher controls every condition that is relevant in determining the events investigated; effects are then observed when the conditions are intentionally manipulated. The laboratory experiment represents one of the purest forms of this research type. The significant characteristics of the experimental approach are the effects and causes (Walliman, 2006).

3.6.6 Evaluation research

Evaluation research is a descriptive type of research targeted at dealing with different social issues, intending to get the facts from the study of political, social, cultural, and contextual elements involved (Walliman 2006). Paulsen and Dailep (2002) described evaluation research as a process of monitoring programme implementation. Paulsen and Dailep (2002) mentioned that the significant importance of evaluation research is that it helps identify problems with programme implementation before the programme ends.

3.6.7 Action research

Persons and Brown (2002) defined action research as a form of research by teachers as a way of solving emerging problems and improving professional practices in their own classrooms. Action research involves observation and data collection which can then be used by researchers in decision making and development of more effective classroom strategies. Action research is carried out in the real world rather than through manipulation of conditions as in experimental research; although it has a similarity to experimental research, content monitoring and evaluation are carried out in action research and the conclusions from the findings are applied immediately. Action research relies on observation and behaviour to collect data, and it is targeted on a particular problem and situation (Walliman, 2006).

3.6.8 Ethno genic research

Ethno genic research theorises the researcher behaviour because the researcher is more interested in the subject of the research than imposing a theory from outside. The success of

ethno genic research is that the subjects themselves recognise the description of familiar features of their culture with the researcher. Ethno genic research is identified as a difficult research because the subjects studied will hide their culture unless the researcher is delving deep into the language and behaviour of the subjects of the study and of the environment in which they live (Walliman, 2006).

3.6.9 Feminist research

Feminist research is a model designed for social research involving theory and analysis that highlight the differences between men's and women's lives. Findings indicated that feminist research is undertaken with a political commitment to the identification and transformation of gender relations (Walliman, 2006). Likewise, Hartsock (1983) reported that feminist research is the study of social relations of women and men, and views the characteristics of male and female activities.

3.6.10 Cultural research

Cultural research is concerned with the study of subject language and cultural interpretation. The need of the study allows analysis of cultural texts to be compared, replicated, disproved and generalised (Walliman, 2006). Hill (1999) described cultural research as process in which transitional tertiary educational institutions develop a research culture, or incorporate research into an organisational culture that has not previously considered research as part of its culture.

3.6.11 Summary

This chapter describes the methodologies adopted for this study. This study involved the use of both quantitative and qualitative methods to investigate the effective management of cost constraint on building project delivery. Data collection techniques involved the use of both primary and secondary data. The large population involved in the study justify the need for employing quantitative and qualitative study, these allow both statistical analysis and face to face interview.

CHAPTER FOUR

4.0 DATA ANALYSIS

4.1 Introduction

The chapter analyses the data collected in the survey through closed-ended questionnaires. It discusses the exploratory study conducted, respondent details, project distinguishing, administrative management rules and practices, and reliability testing. In addition, the chapter discussed factors that affect cost during the building production process, modality of achieving a quality building project during the production process, the effect of changes in building design on a budget, the impact of budgeted costs on management of construction resources and efficient utilisation of cost without affecting delivery time and quality expected during the building production process. The results obtained were interpreted and discussed before conclusions and recommendations are drawn in chapter five.

4.2 Exploratory study

The aim of the exploratory study is to determine the level of the phenomena in construction industry. The exploratory study was conducted in Cape Town, South Africa. To ascertain if these problems exist or not, investigation revealed that the problems do indeed exist. The population used in this study were architects, clients, site engineers, project managers, contract managers, quantity surveyors, structural engineers and contractors. Population sampling techniques used were non-probability and purposive sampling in order to carry out the exploratory study. 'Observer as participant' is one of the techniques employed for gathering information and data for the study. Data was collected through closed-ended questionnaires: 30 questionnaires were administered by hand delivery to stakeholders. Twelve of the questionnaires were retrieved after many phone calls and visitations to construction sites and consultants' offices. The purpose of the exploratory study conducted was achieved; results were used to design a questionnaire for the main study.

4.3 Responses to the main study questionnaires by the respondents

Data was collected through a questionnaire survey method and a total of 319 questionnaires were administered by hand to construction stakeholders (architects, clients, project managers, contract managers, site managers, structural engineers, quantity surveyors, site engineers and contractors) in the Gauteng and Western Cape provinces. The questionnaires were administered, yet 50 of the questionnaire were returned without being answered. Out of the 269 questionnaires accepted by respondents, only 54 were properly completed and returned (after many phone calls). The percentage of the returned responses is 20%.

4.4 Respondent details

The results in Tables 4.1 and 4.2 represent the respondents from different firms that participated in the study. 77.8% of the respondents were from construction firms, 7.4% were from quantity surveying firms, 5.6% were from project consultant firms and 5.6% were from structural design firms. The respondents from construction firms had the highest number of respondents in the study. The years of experience of the respondents who partook in the study ranged from 72.2% in 1-10 years, 18.5% in 11-20 years, 7.5% in 21-30 years and 1.9% in 31-35 years. The age of the respondents involved in the study ranged from 70.4% in 21-35 years, 20.4% in 36-45 years and 9.3% in the 46 + range. The experience of the respondents in their current positions at the site of work were 87% in 1-10 years, 9.3% in 11-20 years, 1.9% in the 21-30 years range and 1.9% in 31-35 years. Respondents having 1-10 years of experience at their present position of work was the highest at 87%.

Table 4.1: Respondent details

Factors	Respondents	Questionnaire retrieved	Percentages
Professional firm of the respondents	Architectural firm	2	3.7%
	Construction firm	42	77.8%
	Quantity surveying firm	4	7.4%
	Project consultant firm	3	5.6%
	Structural design firm	3	5.6%
Years of experience	1-10 years	39	72.2%
	11-20 years	10	18.5%
	21-30 years	4	7.5%
	31-35 years	1	1.9%
Age of respondents	21-35 years	38	70.4%
	36-45 years	11	20.4%
	46 years +	5	9.3%
Years of experience in current position	1-10 years	47	87%
	11-20 years	5	9.3%
	21-30 years	1	1.9%
	31-35 years	1	1.9%

Table 4.2: Respondent details (continue)

Factors	Respondent	Questionnaire retrieved	Percentage
Position in the firm	Architect	2	3.7%
	Project manager	9	16.7%
	Quantity surveyor	22	40.7%
	Site engineer	16	29.6%
	Contract manager	3	5.6%
	Contractor	1	1.9%
	Client	1	1.9%

4.5 Project characteristics

4.5.1 Project type

Table 4.3 presents project characteristics and the findings indicate that 81.5% of the respondents were involved in construction of new projects, while 16.7% of the respondents took part in renovation and restructuring, and 1.9% of the respondents were involved in conversions. 53.7% of the projects were for public utilisation, while 46.3% of the projects were constructed for private residences.

4.5.2 Budgeted costs

The respondents that indicated the cost of the projects in which they were involved ranged from 50% at R1.1M-50M, 44% at R51M-R500M and 5.6% of the respondents indicated that the cost of the project in which they are involved was from R100,000-R1.0M. Findings indicate that the majority of the projects in this study had budgeted costs ranging from R1.1M-R500M, while several of the projects had budgeted costs at R100, 000-R1.0M.

4.5.3 Actual costs

The respondents that indicated cost increases in a project in which they were involved, as a result of variation, was 77.8%, while 22.2% of the respondents signified that there was no cost increase in the project in which they are involved. Findings indicated that the majority of the projects surveyed in this study were completed at construction costs greater than the budgeted costs specified.

4.5.4 Time frame for completion of projects

42.6% of respondents indicated that their projects had a 3 year completion time, 42.6% indicated their projects had a 2 year completion time, 11.1% indicated 1 year completion time, and 3.7% indicated more than 3 years. Findings indicated that the majority of the projects surveyed in the study had a time frame of 2 to 3 years for completion.

4.5.5 Time for projects completed

Respondents that indicated their project was completed within the time frame was 57.4%; 33.3% of the respondents indicated that they completed their project above specified time; 5.6% of the respondents indicated that they completed their projects before the stipulated time; and 3.7% of the respondents specified that their project was not yet completed. Findings confirmed that most projects were completed within the time frame, while a few of the projects were completed above time stipulated and some were still under construction.

4.5.6 Contracting procedure used

This section represents how respondents indicated the procurement methods used in securing a contract: 27.8% of the respondents indicated that their contract was obtained through a design and build contract; while 27.8% of the respondents indicated that their contract was obtained through a construction management contract; 27.8% of the respondents secured their contracts through traditional cost plus contract; 9.3% of the respondents obtained their contract through the process of design and management contract; and respondents who got their contract through a traditional lump sum contract was 7.4%. Findings in this study indicated the popular methods employed for securing a contract were design and build contracts, construction management contracts and traditional cost plus contracts.

4.5.7 Area covered by project

Respondents indicated the area covered by their project: 90.7% of the respondents signified that the area covered by their project was above 100m²; 5.6% of the respondents indicated that the area covered by their project was 100m²; and 3.7% of the respondents indicated that the area covered by their project was 50m². Findings indicated that the majority of the projects covered an area of 100m² and above.

4.6 Testing for the reliability of questions used for the study

The purpose of using Cronbach's alpha co-efficient in this study was to check the reliability of the scale questions. The Cronbach's alpha co-efficient of the scale questions for the study was 0.8%, thereby confirming the reliability of the scale questions as shown in Table 4.4.

Table 4.3: Project characteristics

Description	Respondents	Collection pattern of questionnaires administered	Percentages
Project type	New project	44	82%
	Renovation and restructure	9	17%
	Conversion	1	2.0%
The uses of the project involved	Public utilisation building	29	54%
	Private residential building	25	46%
Budgeted cost	R100,000-R1.0m	3	6.0%
	R1.1m-R50m	27	50%
	R51m-R500M	24	44%
Actual cost	Cost increase as a result of variation	42	78%
	No cost increase	12	22%
Time frame	1 year	6	11%
	2 years	23	43%
	3 years	23	43%
	Above 3 years	2	4.0%
Time taken for project completion	Within time frame	31	57%
	Above time frame	18	33%
	Below time specified	3	6.0%
	Not yet completed	2	4.0%
Contracting procedure	Design and build contract	15	28%
	Construction management contract	15	28%
	Traditional cost plus contract	15	28%
	Design and manage contract	4	9.0%
	Traditional lump sum contract	5	7.0%
Area covered by project	50m ²	2	4.0%
	100m ²	3	6.0%
	Above 100m ²	49	91%

Table 4.4: Testing for reliability of Likert scale questions

Questions No	Statement	Number of items	Cronbach's alpha co-efficient
Section C1	Standard practice in your firm	5	0.6
Section C2	Learning process	6	0.8
Section D	Factors that affect cost during building production process	20	0.9
Section E	Modality of achieving quality building project during production process	22	0.9
Section F	Effect of changes in building design during production process on budgeted cost	25	0.9
Section G1	The impact of budgeted cost on management of construction resources: human resources effect	10	0.9
Section G2	The impact of budgeted cost on management of construction resources: management of machinery effect	11	0.9
Section G3	The impact of budgeted cost on management of construction resources: effect of building materials	13	0.8
Section H	Efficient utilization of cost without affecting delivery time and quality expected during production processes	15	0.9
	All questions used in the study	127	0.8

4.7 Administrative management rules and practices

4.7.1 Standard practice in your firm

The respondents indicated the administrative rules and practices in which they were involved and the system was studied using 5-point Likert scale: 1-extremely inapplicable, 2-inapplicable, 3-moderately applicable, 4-applicable, and 5-extremely applicable. Ranking by the mean of responses as indicated in Table 4.5 (safety procedure on site) was ranked first with a mean score of 4.7, while total quality management procedure ranked second with a mean of 4.6, assurance quality manual ranked third with mean of 4.5, procedure for standard cost control ranked fourth with a mean of 4.5, and compliance to international standard organisation practice ranked fifth with a 4.0 mean. The findings implied that safety procedure practices, total quality management procedure, assurance quality manual, procedure for standard cost control practice and compliance to international standard organisation were the administrative rules and practices applicable for effective building production processes.

Table 4.5: Administrative rules and practices

Significant factors	N	Min	Max	Mean	Std. D
Safety procedure on site.	54	2.00	5.00	4.7968	.56233
Total quality management procedure	54	1.00	5.00	4.6296	.73449
Assurance quality manual	54	3.00	5.00	4.5370	.60541
Procedure for standard cost control	54	2.00	5.00	4.5000	.72032
Compliance to international standard organisation	54	1.00	5.00	4.0370	.98982

4.7.2 Learning process

Table 4.6 presents the learning processes of the respondents using a 5-point Likert scale: 1-extremely inapplicable, 2-inapplicable, 3-moderately applicable, 4-applicable and 5-extremely applicable. Responses were ranked by the mean score. Knowledge transfer from past projects ranked first with a mean of 4.4, learning through training ranked second with a 4.1 mean, learning through group work ranked third with a mean of 3.9, learning through workshops and seminars ranked fourth with a 3.6 mean, learning through conferences organised for skill innovation ranked fifth with a 3.4 mean, and learning through research programmes rank sixth with a 3.1 mean. After assessing the means obtained, the respondents were learning through all the processes identified as all the mean scores were greater than 3.

Table 4.6: Learning processes

Significant factors	N	Min	Max	Mean	Std. D
Knowledge transfer from past projects	54	2.00	5.00	4.4815	.74582
Learning through training	54	1.00	5.00	4.1481	.97917
Learning through group work	54	2.00	5.00	3.9630	.88941
Learning through workshops and seminars	54	1.00	5.00	3.6852	1.0608
Conferences organised for skill innovation	54	1.00	5.00	3.4630	1.0588
Learning through research programmes	54	1.00	5.00	3.1481	1.1881

4.8 Factors that affect cost during building production process

Table 4.7 presents the factors that affect cost during the building production processes. These factors were assessed by the respondents using a four point Likert scale: 1-strongly disagree, 2-disagree, 3-agree and 4-strongly agree. Respondents identified additional work without contractual procedure, inadequate co-ordination of the design phase and construction phase during production by the project manager, financial mismanagement and frequent changes in design as the major factors affect costing during production processes. The mean score of the major factors identify were 3.5, 3.4, 3.3, and 3.3 respectively. This signified that the respondents agreed on the major factors affecting cost during production processes. Finding indicated that respondents disagreed on duration of contract, government policies and insurance costs as factors that can affect cost during production processes. Mean scores of these factors were 2.9, 2.7 and 2.7 respectively.

4.9 Modality of achieving quality building project during production processes

Table 4.8 shows the modality of achieving quality building projects during the production process using a Likert scale: 1-strongly disagree, 2-disagree, 3-agree and 4-strongly agree. The respondents were asked to identify the modality of achieving quality building projects during production processes from twenty-two factors. Findings are proper monitoring and control at stages, procurement of competent contractors and subcontractors, involvement of experienced professionals in production, proper briefing by the client during production, targeting of quality project delivery during production process, prompt decision taking during production, establishment of effective communication system on site during production, and adequate project planning at the initiating stage. These are the major factors identified by the respondents. The mean scores of the major factors identified were 3.5, 3.5, 3.5, 3.5, 3.5, 3.5,

3.4 and 3.4 respectively. This signified that the respondents agreed that the major factors identified can be considered as a modality to achieve quality project delivery during production.

Table 4.7: Factors that affect cost during building production process

Significant factors	N	Min	Max	Mean	Std. D
Additional work without contractual procedure during production	54	1.00	4.00	3.5556	.74395
Inadequate co-ordination of design phase and construction phase during production by project manager	54	1.00	4.00	3.4074	.76525
Financial mismanagement	54	1.00	4.00	3.3889	.89899
Frequent changes in design	54	1.00	4.00	3.3704	.89646
Cost of materials in the market	54	1.00	4.00	3.3333	.75235
Fluctuation of price of materials	54	1.00	4.00	3.3333	.75235
High cost of machinery	54	1.00	4.00	3.2222	.71814
Misunderstanding between design and construction team on site during production	54	1.00	4.00	3.2037	.89821
Economic stability	54	1.00	4.00	3.1852	.93312
Contract management during production	54	1.00	4.00	3.1667	.86330
Contractual procedure	54	1.00	4.00	3.1667	.86330
Inadequate planning during production	54	1.00	4.00	3.1296	.84778
Inadequate materials for production	54	1.00	4.00	3.0926	.83029
Currency exchange rate	54	1.00	4.00	3.0926	.87456
Absence of construction cost control	54	1.00	4.00	3.0926	.91669
Inadequate labour availability	54	1.00	4.00	3.0741	.92862
High cost of labour	54	1.00	4.00	3.0556	.83365
Duration of contract specified	54	1.00	4.00	2.9630	.10272
Government policies	54	1.00	4.00	2.7778	.76889
Insurance cost during production	54	1.00	4.00	2.7222	.94003

Table 4.8: The modality of achieving quality building project during production processes

Significant factors	N	Min	Max	Mean	Std. D
Proper monitoring and controlling at stages during production	54	2.00	4.00	3.5556	.60397
Procurement of competent contractors and subcontractors	54	2.00	4.00	3.5556	.63444
Involvement of experienced professionals in production	54	1.00	4.00	3.5185	.63664
Proper briefing by the client during production process	54	2.00	4.00	3.5185	.57432
Targeting quality during production	54	1.00	4.00	3.5185	.63664
Prompt decision taking during production	54	1.00	4.00	3.5185	.63664
Establishment of effective communication system on site during production	54	1.00	4.00	3.4815	.63664
Adequate project planning at initiating stage	54	2.00	4.00	3.4444	.60397
Proper cost estimates for production process	54	1.00	4.00	3.4444	.66351
Proper define of scope during planning	54	2.00	4.00	3.4444	.60397
Draw out programme of work for time delivery	54	1.00	4.00	3.4074	.63002
Establishment of financial control team	54	1.00	4.00	3.3889	.68451
Establishment of team work for production	54	2.00	4.00	3.3519	.61911
Allow for free flow of information among construction team during production	54	1.00	4.00	3.3519	.67733
Effective management of equipment and materials to achieve timely delivery of project	54	1.00	4.00	3.3519	.64887
Establishment of construction professionals that will actualize client's interest during production process	54	2.00	4.00	3.3519	.61911

Prompt payment to contractors by the client during production	54	1.00	4.00	3.3333	.75235
Adequate preparation for project financing by client	54	1.00	4.00	3.3148	.74793
Proper management of procurement procedure during production	54	2.00	4.00	3.1852	.67500
Avoiding mistake during construction	54	1.00	4.00	3.1667	.77093
Discourage absenteeism for continuity of responsibility at work	54	1.00	4.00	3.1481	.81048
Use of penalties for wrong job done in order to keep cost of construction steady	54	2.00	4.00	3.1111	.63444

4.10 Effect of changes in building design during production processes on budgeted cost

Respondents were asked to measure the effect of changes in building design during production processes on budgeted cost using a Likert scale: 1-strongly disagree, 2-disagree, 3-agree and 4-strongly agree. Table 4.9 shows that inadequate design affected budgeted cost, frequent changes in building design by client during production affected construction cost, frequent changes to building design during production caused rework, additional work during production caused changes in building design, changes in building design during construction caused by errors and omission detected affects of quality of project delivered, specification due to procurement of new materials during construction caused changes in building design, frequent changes to design during construction caused variation, and improper design leading to failure to achieve the client objectives caused constant changes in building design. The foremost factors identified had a mean score ranging between 3 and 4 respectively. Findings included inadequate design, frequent changes in building design by client during production affected construction cost, frequent changes in building design during production caused rework, additional work during production caused by changes in building design, changes in building design during construction caused by errors and omission detected affected quality of project delivered, specifications due to procurement of new materials during construction caused changes in building design, frequent changes to design during construction caused variation, and improper design leading to failure in achieving client objectives caused constant changes in building design. Respondents agreed that all the foremost factors affected delivery of building projects at budgeted cost specified during building production processes. The findings from this study also indicated that respondents disagreed with non-involvement of contractors in building design at the design stage as that caused changes in design during production, and also conditions of the project location not being considered during design stage caused change in building design, having a common mean score of 2.8 respectively, which signified their disagreement.

Table 4.9: Effect of changes in building design during production process on budgeted cost

Significant factors	N	Min	Max	Mean	Std. D
Inadequate design has effect on construction cost	54	3.00	4.00	3.6667	.47583
Frequent changes into building design by client during production affect construction cost	54	2.00	4.00	3.5741	.60194
Frequent changes in building design during production causes rework	54	1.00	4.00	3.5370	.66483
Additional work during production caused by changes in building design	54	1.00	4.00	3.5185	.63664
Changes in building design during construction caused by errors and omission detected affects quality of project delivered	54	1.00	4.00	3.5000	.72032
Specification due to procurement of new materials during construction causes changes in building design	54	1.00	4.00	3.4074	.65929
Frequent changes to design during construction causes variation	54	1.00	4.00	3.3333	.61430
Improper design lead to failure in achieving client objectives causes constant changes in building design	54	1.00	4.00	3.3148	.66798
Inadequate define scope of work for contractors causes change in building design during production	54	1.00	4.00	3.2963	.69035
Changes in specification by consultant causes changes in building design	54	1.00	4.00	3.2963	.66246
Coordination of design changes during production	54	2.00	4.00	3.2963	.69035
Ambiguous design details causes changes in building design	54	1.00	4.00	3.2593	.78151
Decision taking during design stage causes changes in design	54	1.00	4.00	3.2593	.78151
Budgeted cost is affected by value engineering as a result of changes in building design at implementation stage	54	1.00	4.00	3.2593	.64968
Replacement of building materials during construction as a result of changes in design has effect on budgeted cost	54	1.00	4.00	3.2593	.82839
Design discrepancies between drawing and specification affect budgeted cost	54	1.00	4.00	3.2407	.77545
Design complexity causes changes in building design	54	1.00	4.00	3.2037	.76182
Non-compliance design with government regulation causes changes in design at implementation	54	1.00	4.00	3.1481	.73734
Safety consideration during construction causes changes in building design	54	1.00	4.00	3.1111	.71814
Prolonged procedure for management of design changes causes delay	54	1.00	4.00	3.0741	.84344
Inadequate communication among design team during design stage lead to ineffective design causes changes in building design	54	1.00	4.00	3.0370	.93087
Non-involvement of contractors in building design at design stage causes changes in design during production	54	1.00	4.00	2.8704	.91211
Condition of the project location not considered during design stage causes change in building design	54	1.00	4.00	2.8704	.91211

4.11 The impact of budgeted cost on management of construction resources

4.11.1 - G 1: Effect of human resources on budgeted cost during production process

The survey requested that the respondents assess how management of human resources affected budgeted costs during the production process, using Likert scale: 1-perfectly unacceptable, 2-unacceptable, 3-quite acceptable, 4-acceptable, and 5-perfectly acceptable. Table 4.10 shows that regular meetings on site will promote efficient productivity of human resources with a mean score of 3.8, labour productivity with a mean of 3.5, time wastage by manpower with a 3.5 mean, and wrong job allocation to workers with a mean score of 3.5. The major findings show that the respondents agreed that regular meetings on site will

promote efficient productivity of human resources; labour productivity affected budgeted costs; time wastage by manpower will affect budgeted costs; and wrong job allocation to workers will affect budgeted cost since their mean score was above 3.

Table 4.10: Effect of human resources on budgeted cost during production process

Significant factors	N	Max	Min	Mean	Std. D
Regular meeting on site will promote efficient productivities of human resource	54	1.00	5.00	3.8519	.99825
Labour productivities has effect on budgeted cost	54	1.00	5.00	3.5556	1.1762
Time wastage by manpower will affect budgeted cost	54	1.00	5.00	3.5185	1.1449
Wrong job allocation to worker	54	1.00	5.00	3.5185	1.2091
Training of workers enhance skill and delivery time of project	54	1.00	5.00	3.5000	1.1116
Manpower wastage during production	54	1.00	5.00	3.4444	1.1102
Reduction on overtime of workforce by project manager during construction has effect on budgeted cost	54	1.00	5.00	3.3704	1.2928
Shortage of skill worker affect budgeted cost	54	1.00	5.00	3.3519	1.2612
Improper planning of human resource activities on site	54	1.00	5.00	3.3333	1.2438
Delay in payment of wages by contractor causes industrial action	54	1.00	5.00	3.2222	1.2387

4.11.2 - G 2: Effect of management of machinery on budgeted cost during production

Table 4.11 indicates that the respondents were asked to measure the effects of management of machinery on budgeted costs during production process using a Likert scale: 1-strongly disagree, 2-disagree, 3-agree and 4-strongly agree. Findings signified that wrong planning for machine usage on site had a 3.4 mean score, late delivery of equipment during production had a mean score of 3.4, inefficient management of machinery affected budgeted score with a 3.4 mean and idleness of hired machines on site affect budgeted cost through a mean score of 3.4. Major results from the survey were wrong planning for machine usage on site, late delivery of equipment, in efficient management of machinery and idleness of hired machinery on site. The respondents agreed that the major findings would affect budgeted cost.

4.11.3 - G 3: Effect of building materials on budgeted cost during production process

The survey findings were recorded in Table 4.12 using a Likert scale: 1-strongly disagree, 2-disagree, 3-agree and 4-strongly agree. These results indicated that an increase in price of materials affected construction costs with a mean of 3.4; late delivery of materials affected production process with a mean score of 3.4; insufficiency of building materials on site affected efficient delivery of the building project with mean of 3.2; and scarcity of materials in the market affected budgeted cost score with a 3.2 mean. The respondents agreed that an increase in price of materials affected construction costs; late delivery of materials affected

production; insufficient supply of building materials on site during construction and scarcity of building materials in the country lead to importation of building materials (with a high price) from another country; changes in building material specifications during production and an increase in price of original materials specified caused the use of alternative materials.

Table 4.11: Effect of management of machinery on budgeted cost during production process

Significant factors	N	Max	Min	Mean	Std. D
Wrong planning for machine usage on site	54	2.00	4.00	3.4259	.60194
Late delivery of equipment during production	54	2.00	4.00	3.4259	.60194
Inefficient management of machinery	54	2.00	4.00	3.4074	.59932
Idleness of hiring machine on site	54	1.00	4.00	3.4074	.65929
Increase in price of machinery	54	2.00	4.00	3.4074	.53265
High cost of machinery maintenance during production	54	2.00	4.00	3.3889	.56357
Procurement of appropriate machine to site during production	54	2.00	4.00	3.3889	.62696
Fault equipment on site during production	54	2.00	4.00	3.3519	.55482
Frequent changes of hiring price of machine during construction	54	1.00	4.00	3.2963	.71717
Different site soil condition where machine has worked	54	1.00	4.00	3.0370	.77613

Table 4.12 - G 3: Effect of building materials on budgeted costs during production process

Significant factors	N	Max	Min	Mean	Std. D
Increase in price of building materials affect construction cost	54	1.00	4.00	3.4815	.60628
Late delivery of materials affect production process	54	2.00	4.00	3.4259	.56974
Insufficient building materials on site during construction	54	1.00	4.00	3.2963	.81564
Scarcity of building materials in the country lead to importation of building materials with high price from other country	54	2.00	4.00	3.2778	.62696
Change in building materials specification during production	54	1.00	4.00	3.2778	.73758
Increase in price of original material specified causes the use of alternative materials	54	1.00	4.00	3.1667	.72032
Delay in importation of building materials	54	1.00	4.00	3.1296	.75351
Use of foreign materials has effect on budgeted cost	54	1.00	4.00	3.0926	.89587
Currency instability in the country affects prices of building materials	54	1.00	4.00	3.0370	.89542
Currency instability in the country causes scarcity of building materials during construction	54	1.00	4.00	3.0000	.84575
Government regulations on building materials usage on site	54	1.00	4.00	2.6667	.95166
Increase in price of material affect time delivery	54	1.00	4.00	2.5185	.96624

4.12 Efficient utilisation of cost without affecting delivery time and quality during production process

Table 4.13 indicates how cost can be efficiently utilised without affecting the delivery time and the quality that is expected during the production process. The survey was conducted using a Likert scale: 1-ineffective, 2-slightly ineffective, 3-slightly effective, 4-effective, and 5-

perfectly effective. The major survey results were team work on site during production, general progress reports on site, project schedules/timetable for production, work programmes for site activities, and proper design and construction co-ordination were all the major factors identified, each having mean score of 4. This signifies that the respondents indicated that team work on site during production, general progress reports on site, project schedules/timetables for production, work programmes for site activities, work progress reports, constructive feedback on site activities, and design and construction co-ordination were the major effective factors to be improved in order to achieve efficient utilisation of cost without affecting delivery time and quality expected during production processes.

Table 4.13: Efficient utilisation of cost without negatively affecting delivery time during production process

Significant factors	N	Min	Max	Mean	Std. D
Team work on site during production	54	2.00	5.00	4.2222	.81650
General progress report on site during production	54	2.00	5.00	4.1667	.90596
Projects schedule/timetable for production	54	2.00	5.00	4.1667	.79503
Work programme for site activities	54	2.00	5.00	4.1481	.83344
Proper design and construction co-ordination	54	2.00	5.00	4.0741	.92862
Establishment of project funding procedure during production	54	2.00	5.00	4.0000	.91115
Sources of estimates on site for calculating cost	54	2.00	5.00	3.9259	.82076
Project management plan for production	54	3.00	5.00	3.9074	.78352
Site activities plan for cost estimate	54	2.00	5.00	3.9074	.80724
Project log books for records during production	54	2.00	5.00	3.8889	.96476
Establishment of cost control base for site activities	54	2.00	5.00	3.8889	.94503
Cost control plan for production	54	2.00	5.00	3.8704	.97218
Risk inventory on site during production process	54	2.00	5.00	3.8333	.84116
Human resources usage plan during production process	54	2.00	5.00	3.8333	.88488
Contract agreement by law for production process	54	1.00	5.00	3.8333	1.0047

4.13 Discussion of findings

This section presents the findings obtained from the investigation of factors that affect cost during production processes, modality of achieving quality building projects during production process, the effects of changes in building design during production processes, on budgeted cost, the impact of budgeted costs on management of construction resources, and efficient utilisation of cost without negatively affecting delivery time and the quality expected during production process.

4.13.1 Factors that affect cost during building production process

The exploratory study conducted revealed that cost was highly significant during the production process; costs have also proven to be integral to all related construction

activities. Cost is established as central to construction activities and linking other construction processes in delivery of a project. Cost is a driving force for success in building production processes and cost is considered very important throughout construction management and the production process life cycle. Literature affirms that there are certain factors that hinder effective performance of cost during the building production process. Literature on the management of costs has also revealed that these factors serve as an impediment to proper functioning of costs in the delivery of projects at the time specified and the quality expected. Based on this information, the study investigated factors that affected cost during the production process. The results obtained from findings showed that additional work, without contractual procedure, was used to assess cost implications during production. This was in fact the major factor that hindered delivery of the project at budgeted cost and this signified that the stakeholders did not properly consider the cost implications of additional work rightly from the initiating and implementation stages. The sources of additional work may be from improper planning at the initiating stage, changes in building drawings and defects as a result of poor construction. This finding is supported by Azhar *et al.* (2008) who identified cost as a prime factor, confirmed as a significant factor for the production process. Also, it was discovered that the top seven factors affecting cost as additional work were as follows: 1) improper planning, 2) poor project management at site, 3) poor cost control, 4) delay between design and procurement phases, 5) high costs of machinery, 6) the lowest bidding procurement, and 7) fluctuation in the price of raw materials. It was concluded in the study these identified factors were affecting cost in delivery of project at the budgeted cost specified.

Another major finding from the study indicated that inadequate co-ordination of the design phase and construction phase by the project manager were identified as factors affecting the cost during the production process. This inferred that the design team, construction team and project manager were not relating properly from the concept stage to the planning stage, and from the implementation stage to the close-out phase due to lack of proper planning and management of the interface relationship during production process. This resulted in wrong designs and defects in construction which in turn caused demolition, rework and delivery of project at a construction costs higher than budgeted cost. This finding is backed by Dibonwa (2009) who claimed that project managers and owners were found to be responsible for the activities that result in cost increases in a project at the initiating/planning and design stage. This further clarified the claim by Dibonwa (2009) who explained that the project implementation stage had the contractor, architects and quantity surveyors to blame for the construction cost increases during the production process, while the quantity surveyors and

contractors were discovered to be responsible for budget cost increases at the completion/commissioning stage. The responsibility of the stakeholders during the building production process was to be involved in *all* stages of construction and relate properly with one another for enhancement of effective production; this was to avoid blame for a particular group. Other major findings were financial mismanagement, frequent changes in design, cost of materials in the market, fluctuation of price of materials, high cost of machinery, misunderstanding between design and construction teams on site during a production process, economic stability, contract management during production, currency exchange rate, absence of construction cost records, inadequate labour availability and high cost of labour. The respondents disagreed on duration of contract, government policies, and insurance cost during production as factors that affect the costs during building production processes.

4.13.2 Modality of achieving quality building projects during production processes

Literature reveals that the delivery of a quality project at budgeted cost in the construction industry has been a constant problem hindered by cost limitation. Cost affects delivery time and construction resources earmarked for the production process. Quality achievement depends on stated requirements at the initiating stage of a project and the project delivered must measure up to the initial requirements described at the planning stage. This statement is supported by Arditi and Gunaydin (1997) who described quality attainment during a production process as a longstanding problem: wasting time, money and construction resources as a result of inefficient use of the quality management procedure. The demand for quality achievement during the production process signifies the need to investigate the modality of achieving quality building projects during the production process. The major findings discovered in this study are proper monitoring and control at various stages, procurement of competent contractors and subcontractors, involvement of experienced professionals in production, proper briefing by client during production, targeting of quality project delivery during production processes, adequate and prompt decision making during production, effective communication during production, adequate project planning at the initiating stage and proper defining of scope during planning. All other factors identified for modality of achieving quality in this study are significant factors to be considered for effective production processes as they all rank above the mean score of 3. This implies that the respondents agreed that the factors are very important during the production process.

Proper monitoring and control at stages of construction is the modality for achieving quality building projects during the production process. This suggests that proper monitoring and control must be established at the initiating and planning phases and this should be

implemented at construction phases to achieve quality building projects during the production process. Proper monitoring and control must be measured to achieve the desired objectives. Rena (2012), in support, claimed that project objectives cannot be achieved unless proper monitoring and controlling of construction processes are implemented – effective planning, budgeting, safety and quality control of the project – which are quite significant during building the production process. Involvement of competent contractors and subcontractors was one of the major factors discovered as modality for achieving quality of building projects during the production process. This signifies that proper procurement of contractors during the contractual procedure must be implemented to identify the most experienced contractors to be involved in the delivery of project at budgeted cost, in the time specified and at quality the expected. This is supported by Arain and Pheng (2005) who counselled that inclusion of experienced contractors at the design stage will allow the contractor to infuse his professional knowledge, skilful ideas and originality into the process. This process will enhance efficient delivery of project at the quality expected and within the budgeted costs specified. Involvement of experienced professionals at various stages of construction is among one of the major findings, as the involvement of skilled professionals will assist in the proper planning needed to achieve quality requirements and satisfaction of all client requirements. This statement was confirmed by Emuze and Smallwood (2011) who advised that the construction industry in South Africa should ensure that only experienced construction professionals are assigned the responsibility of construction planning and implementation.

4.13.3 Effect of changes in building design during production process on budgeted cost

The literature reviewed and the exploratory study conducted for this investigation indicated that changes in building design during production process affect the delivery of project at the budgeted cost specified. This denotes the reason to investigate the effect of changes in building design during the production process on budgeted cost. Results obtained in this investigation include inadequate design affecting construction cost; frequent changes in building design by the client during the building production process and its effect on construction cost, frequent changes in building design during production causing rework; additional work during production causing changes in building design; changes in building design during construction caused by errors and omissions detected that affect the quality of the project delivered; inadequate specification causing changes in building design that affect budgeted cost; frequent changes to building design during construction causing variation; non-compliance with government regulations causes change in design at the implementation stage with a negative effect on budgeted cost; inadequate definition of the scope of work for

contractors causes changes in the building design at construction stage; and specification due to procurement of new materials during the construction stage causes changes in building design. The respondents also indicated that budgeted cost is affected by ambiguous design details; decision making during design stage that results in design alterations, replacement of building materials during construction as a result of changes in design effects budgeted cost; design complexity causes changes in building design; safety considerations during construction causes changes in building design; and inadequate communication among design team during design stage causes ineffective design that leads to changes in building design. All these factors identified have a mean score of 3, signifying that the respondents agreed that the identified factors have an effect on budgeted cost.

Inadequate designs during production process were identified as a significant factor impacting the delivery of a project at the construction cost, making the costs higher than the budgeted cost specified. This indicated that there was no proper planning for design detailing by the design team which may have been caused by a lack of proper briefing by the client and unclear objectives. Also, errors and omissions as a result of incompetency on the side of the designer may be yet another reason. Findings were supported by Arain and Pheng (2006) and confirmed that constant changes to design during construction phases were a result of inefficiency on the side of designers: this has constituted many problems that lead to rework, delay, variation, claim, and construction cost increase.

Lam *et al.* (2007) counselled that designers should be more accurate in design detailing if it is discovered that there will be conflicts between design and construction – this should be resolved *before* the commencement of the construction process. The frequent change to designs by the client during production is yet another major factor affecting the delivery of a project above the budgeted cost specified. The reason may be the swaying of a design away from the client requirements or failure by the design team to consider new technology which could be integrated into the design. This may cause changes in the design by the client. Supporting this assertion is Alsuliman *et al.* (2012) who confirmed that clients initiate the majority of changes in building design at the design phase and construction phases, changes which extend the delivery of project at construction cost higher than budgeted cost. The changes attract reworking, claims and variation during the production process.

4.13.4 The impact of budgeted cost on management of construction resources

4.13.4.1 - G 1: Effect of human resources on budgeted cost during production process

The exploratory study conducted and the literature reviewed discloses that the management of human resources has an effect on delivery of quality projects at the budgeted cost specified and within the time stipulated. This information suggests the main reason to embark on the investigation of the effect of human resources on the budgeted cost during the production process. Findings reveal the following: regular meetings on site will promote increasingly efficient productivity of human resources and labour; time wastage by manpower will be reduced; the wrong job allocation to workers will be reduced; training of workers will enhance their skills and delivery of the project; overtime of workforce by project manager during construction will be reduced; and the shortage of skilled workers are all identified factors affecting budgeted costs during the building production process with a mean score of 3. Other factors identified were improper planning of human resource activities on site, delay in payment of wages by contractor (causing industrial action) and shortages of skilled workers as additional factors affecting the budgeted cost.

The major findings indicate that regular meetings on site will promote efficient productivities of human resources. The implication of this result is that all stakeholders involved in the production process must have a meeting place to resolve issues affecting production. Feedback about site operations must be reported and discussed, conflicts concerning design and construction that cause rework and cost increase must be resolved at the meeting place, and progress reports about site and welfare of the workforce are the reason for regular meetings. Regular meetings on site are essential in discussing issues affecting the production process. These will enhance the delivery of the project at construction costs equal to the budgeted cost specified. This statement is supported by Alwi (2003) who advised that the construction operator should inaugurate co-operation and regular meetings amongst the construction team from different levels, mainly pertaining to trust and working together with harmony and unity.

Labour productivity is the second most significant factor that has an effect on budgeted cost during the building production process. This implies that an increase in the output of a workforce through efficient management during the building production process will enhance the delivery of a project at the budgeted cost specified. Regular monitoring of the labour force at the point of operation will increase the chances of a job being completed within the time allocated and it will also augment productivity. Dardyev *et al.* (2012) argued that it is

very important to outline a human resources management system during the initiation of construction project in order to achieve maximum productivity.

4.13.4.2 - G 2: Effect of management of machinery on budgeted cost

The preliminary exploratory study and literature review explain that use of machines is significant during the production process as the uses and selection depend on the type of contract won by the construction firm. The exploratory study also indicated that machines are extremely costly to maintain and repair during building production processes, and proper management of machines on site has an effect on the budgeted cost. This suggests the need to explore the effects of machinery management on budgeted cost during production processes. Results obtained from the study include wrong planning for machine usage on site, late delivery of equipment during construction, inefficient management of machinery, idleness of hiring machines on site, increases in price of machinery, schedule of work, equipment availability and failure to secure, procurement of machines to site, high costs of machine maintenance, equipment faults while on site, changes in hiring price of machines, and different site soil conditions where machines have worked each has an effect on the budgeted cost. The identified factors rated above a mean score of 3, indicating that all these factors must be considered for the management of machines during the production processes in the construction industry to achieve delivery of project at budgeted cost.

Planning for machine usage on site is the primary factor identified that has an effect on budgeted cost. The cost implication of this factor starts at the initiating stage of the project, when a work programme does not actually identify types of equipment needed on site, time of arrival on site, working hours, and periods of usage. The management of machines is supposed to be assigned to a particular manager on site, starting from the initiating stage to the time of project completion. The problem of machine management begins when there is no actual person on site responsible for the programme of work, the maintenance and the safeguarding of the machinery. This job is sometimes assigned to equipment operators who have not been taught basic principles of management. Machines at the wrong place of work as a result of a lack of proper planning cause time wastage, so the cost of maintenance will increase and the human resources of the operator will be wasted. All these are indicators that have an effect on budgeted cost. This finding is supported by Rahman *et al.* (2012), who argued that the selection of machines to be used on site must be an integrated part of the total plan. The management and the usage of machines must be well-planned to avoid redundancy and construction cost increase.

Late delivery of machines is the second major factor identified in this study that affects budgeted cost. This means if a machine fails to arrive on site at the stipulated time, all other

processes are delayed. Mainly this will delay work progress, waste resources and generate idleness of the work force on site. The identified problems are the effect of late delivery of machine on site impacting budgeted cost. This statement is buttressed by Fugar and Agyakwah-Baah (2010) who studied delays in the Ghanaian construction industry and who identified the machinery group factor as one of the major factors causing delays and impacting budgeted cost.

4.13.4.3 Effect of building materials on budgeted cost during production process

The management of building materials during the production process was identified during an exploratory study as one of the problems affecting the delivery of projects at a high construction cost. Literature also reveals that management of building materials can affect budgeted cost. This study investigates the effect of building materials on budgeted cost during the production process. The findings include the following: increases in the price of building materials, late delivery of materials, insufficiency of building materials on site, scarcity of materials in the market, changes in building materials specification, increases in price of the original materials specified to bring about the use of alternative materials, delays in importation of materials, delays in payments for the building materials, use of foreign materials and currency instability in the country were the major factors identified to have seriously affected the delivery of projects at high construction cost. These factors were ranked with 3 as the mean score, respectively. The standard of materials, government regulations, and increase in the price of building materials were identified as factors that cannot affect budgeted cost during production processes, with mean scores below 3.

The study reveals that an increase in the price of building materials ranked first among the major factors that can affect delivery of project at a construction cost higher than budgeted cost. This showed that an economic predicament in the country affected the industry that produces building materials and therefore forced the industry to increase the price of their product above the reach of the construction industry. Also, the import duty and tariff on building material importation is increased and these increases also affect the price of building materials. The consequences of this will affect the construction cost, will cause delay in delivery time and will destabilised the programme of events during the production process. Desai and Desale (2013) counselled that stakeholders should have a well-developed plan for material in advance to avoid the effects of increases in building material prices in the market, and have a structured system of standard material procurement management to avoid wastage of other construction resources during production processes.

Late deliveries of materials were identified as the second major factor that affected the delivery of the project at high cost of construction. This advocated that the programme of

events, such as cost and time scheduling during production processes, will be disrupted and construction costs will be affected. Raman *et al.* (2012) argued that an efficient material management system is significant during construction and advised that identification of materials be made prior to the time of using, acquiring, storing, distributing and disposing of materials as an important step for avoiding late delivery of materials.

4.13.5 Efficient utilisation of cost without affecting delivery time and quality expected during building production process

The cost restraints that challenge construction in terms of delivery of the projects above budgeted cost and the time stipulated signify the need to investigate the efficient utilisation of cost without negatively affecting delivery time and the quality expected during the building production process. A preliminary survey was conducted and literature was reviewed to disclose the uses of cost management principles as methods for utilisation of costs during the production process without negatively affecting time of delivery and quality expected. The outcome of the investigation showed the following results: team work on site during production process, general progress reports on site, project schedules/timetables for production, work programmes for site activities, work progress reports and constructive feedback on site activities, designs and construction co-ordination were the major factors that ranked with a mean score of 4. This denotes that they are the first eight factors that can be examined as cost management ethics for efficient utilisation of cost without negatively affecting delivery time and quality expected during production process. The additional factors which ranked above a mean score of 3 are sources of estimates on site for calculating cost, formation of project management plans at initiating and construction stage, site activities plan for cost estimates, project log books for records during production and establishment of cost control bases for site activities. These were factors that can be used as cost management principles for efficient utilisation of cost without affecting delivery time and quality expected during production process.

Team work on site was identified as useful in achieving efficient utilisation of cost without affecting delivery time and quality expected during production process. Team work among the site workers indicated that group work can be used to achieve common goals and objectives during the production process. Teams are groups of people coming together from different cultures, orientations, languages and educational backgrounds to carry out the production process in the construction industry. Team work should involve people who have trust, respect, common principles and similar ideas during the production process in order to achieve effective productivity. This will promote efficient production and delivery of a project at budgeted cost to satisfy client interest. Findings supported by Cohn and Ralston (2005)

described team work as an effective team that shares a common purpose, goals, leadership and ground rules for interactions and meetings, with trust and openness, to achieve efficient utilisation of cost without negatively affecting delivery time and quality expected during the production process.

General progress reports on site was the second major factor identified as necessary for efficient utilisation of cost without negatively affecting delivery time and quality expected during the production process. This suggests that all stakeholders must meet at a given time to deliberate on work completed, achievements, difficulties, conflicts, issues at stake, management problems, relationships among workers, welfare of staff, completion time and the programme of events. These identified issues on site, if properly addressed during general progress report meetings among stakeholders, will enhance efficient utilisation of cost without affecting delivery time and quality expected during the production process. This statement is supported by Alsuliman *et al.* (2012) who discovered that progress reports on site activities, good contract documentation, good communication, and cooperation among construction teams are major elements making management systems more effective on site.

4.14 Validity assurance of the research outcome

Validity assurance is the process for checking how a research instrument measures what it claims to measure. It is critical for a study to be valid so that the results obtained will be accurately applied and interpreted. Teddlie and Tashakkori (2009) and Fapohunda (2010) confirmed that validity is the level to which the data accurately measures what they were intended to measure. Simply defined, validity is authenticity of data collected to produce a desired result. The following steps were taken to ensure that this research outcome is valid and reliable:

- a) *Population*: sampling of population is considered in order to achieve reliable results. The population considered for this study was comprised of construction stakeholders in the construction industry in South Africa (Section 3.3 and Figure 1.2)
- b) *Participants*: experienced stakeholders within the construction industry (Section 3.3)
- c) *Time*: a reasonable length of time was considered for data collection (5 months)
- d) *Instruments*: the most accurate instruments were used (Section 3.2)
- e) *Exploratory study*: an exploratory study was conducted to determine that methods and techniques adopted to investigate the study were accurate and reliable for the data collection (Section 4.0)
- f) *Cronbach's alpha coefficient*: Cronbach's alpha coefficient was used to test for the reliability of all the scale questions in this study (Section 3.5)
- g) *Purposive sampling approach*: the use of a purposive sampling approach technique for collecting data and the selection of Western Cape and Gauteng provinces with

high concentrations within the construction industry and of experienced professionals were the steps taken to ensure validity and reliability of outcome of findings (Section 3.5)

- h) *Triangulation methods*: triangulation methods that involve the research techniques and methods given were used for data and information collection (Sections 3.2 and 3.4).
- i) *Recording Instruments*: Instruments used for recording and analysis of data collected included the statistical package software analyses version 22, and the Samsung Galaxy Tab 3 Tablet PC Android 7-inch High Resolution was used to record the interviews conducted (Sections 3.0, 4.0 and 5.0)

4.14.1 Validation of results

Construct validity is used to ensure that the findings obtained in this study measured what they were supposed to measure. The results from the analysed data were taken to construction sites for confirmation to determine if the results actually answered what they were intended to answer (concerning the aim and objectives of the study). A date was fixed for each interview between the researcher and the professional stakeholders working on site. Four professionals were interviewed in construction site A, B, C, D. The professionals that were interviewed on construction site are discussed presently.

4.14.2 Interview with respondent A

On the 13th of May 2014, interviews were conducted with an experienced architect at 1:30 pm and lasting for 45 minutes on construction site A. The discussion was recorded using Samsung Galaxy Tab 3 Tablet PC Android 7-inch High Resolution. The architect working on construction site A was asked to comment on each question after it was read by the interviewer from a printed copy. These questions are recorded in Appendix B-semi-structured interview for the validation of the results obtained from the data analysis.

The architect stated that the effect of additional work was minor on the budgeted cost but it can become major if the volume of work to be added is large and will have a bulk weight on budgeted cost specified. The respondent stated that architects always make sure that what is in the design is implemented at the construction stage correctly to avoid demolition, as this can cause rework, and has a great influence on construction cost. The architect explained that mismanagement of contract funds affects the cost of production but the occurrence is rare because architects make sure that the contract funds are released throughout the stages of the production process in order to avoid wasting resources. The respondent stated that monitoring and controlling at stages were the techniques used to make sure that the

correct objectives are completed and requirements met. This helps in achieving a quality project delivery. The architect indicated that their involvement in the building production process is to make sure that experienced contractors are employed at the procurement stage to deliver a quality project, and likewise, that experienced professionals are involved to reduce construction resources being wasted. The respondent indicated that an inadequate design affects the construction cost. The respondent added that their duty is also to make sure that design details are reviewed to establish designs that are free from errors and omissions that could cause delays, claims and variation. He explained that client objectives can be achieved if the architect has adequately taken care of client's interest correctly from the design stage and followed through to the implementation stage. The architect added that failure to achieve the client objectives will have cost implications and add unnecessary arguments. The respondent explained that regular meetings on site will allow the work to be reviewed and planning for other stages of work is possible. He further explained that regular meetings on site will give the workers an understanding of their progression -- it is used as progress assessment during the production process. The architect gave the reasons for efficient management of construction resources on site as a technique that enhances the labour productivity and allows for effective project delivery. The architect explained that mismanagement of labour productivity causes time wastage, reduces labour productivity, and has an effect on the delivery date of the project. The respondent stated that team work is significant among construction teams and helps to address common issues and goals while meeting the clients' requirements. The architect explained that a progress report from each group during the production process helps in monitoring the quality of the job done and is an efficient use of the budgeted costs. The respondent stated that quality management helps to achieve client requirements during the building production process. The architect explained that a minor change in a client's requirements will not affect delivery date of project. If it is major, though, this will affect construction cost (not delivery date) because the contractor needs to increase workers' productivity to meet the delivery date. The respondent described quality checks as a part of the architect's responsibility: to see that the project is built according to specifications and that the quality is as expected. He added that quality checks can reveal inadequacies in the building production process.

4.14.3 Interview with respondent B

The interview with an experienced site engineer on construction site B was conducted on Tuesday, the 14th of May 2014 at 1:30pm, in the site engineer's office for a period of 47 minutes. Discussions were recorded using Samsung Galaxy Tab 3 Tablet PC Android 7-inch High Resolution. The site engineer working on construction site B was asked to comment on each question after being read the questions by the interviewer, from a printed copy. These

questions are in Appendix B-semi-structured interview for the validation of results obtained from data analysis.

The site engineer explained that additional work without due regards to contractual procedure can have major effects on costs of construction, but not always. If this happens, it has significant effects on the project delivery. The respondent stated that there is a need to have proper co-ordination of the design and construction phases in order to avoid claims and variations that cause increases in construction costs during the production process. The site engineer stated that if the contract fund is not properly managed during the construction, this has resultant effects on construction costs. Engineers make sure that site activity expenses during production correspond with budgeted costs specified. This can be achieved through proper reconciliation of site expenditure with the budget. The respondent explained that one of the most effective steps considered for management of cost is proper monitoring and controlling of the production process at each stage. It enhances the delivery of the project at the specified budgeted cost and quality. He indicated that the involvement of competent contractors and experienced professionals in the building production process has a great influence on the delivery of a quality project, provided the professional adheres to quality rules specified in the contract documents. The site engineer pointed out that an unclear design is a common case but not every drawing has these vague attributes. When this is noticed during construction, this often slows down the building production process and the consequential effect is an increase in construction costs. The respondent indicated that errors and omissions do occur in drawings, but not always. In a situation where an error is discovered, engineers will amend it to avoid delay in the building production process. Site engineers explained that failure to achieve the client's objective results in arguments, delays in the production processes and changes in the building designs, which cause claims and increases in construction costs. The site engineer revealed that regular meetings on site help resolve rancour among professionals and are significant for management of construction resources. This has a greater effect on labour productivity. The respondent explained that efficient management of materials, labour and machinery increase labour productivity and affect delivery date of a project. The site engineer clarified that time wastage by a workforce does not often affect delivery date of a project but it always affects construction cost. The respondent explained that team work is important during the building production process and has a great influence on delivery date and the construction costs. The site engineer edified that a constant general progress report on the site activities reveals ineffectiveness in the management of the building production process. General progress reports on site activities uncovered inefficient management of the budgeted costs. The respondent made it clear that the administration of building quality can only be achieved when it is incorporated at the planning stage of the building production process and

implemented at the construction stage. He said, "I assure you that if quality is not properly managed during the production process, it will definitely affect requirements and project delivery date". The site engineer clarified that quality checks are very important during production and always have negative impact on the project delivery if not properly managed.

4.14.4 Interview with respondent C

Interview with an experienced quantity surveyor working on construction site C was conducted on Tuesday, the 15th of May 2014 at 1:30pm in the site office for a period of 40 minutes. Discussions were recorded using Samsung Galaxy Tab 3 Tablet PC Android 7-inch High Resolution. The quantity surveyor working on construction site C was asked to comment on each question after being read questions by the interviewer from a printed copy. These questions are in Appendix B-semi-structured interview for the validation of results obtained from data analysis.

The quantity surveyor stated that additional work does not often have a major effect on costs during the production process, but it all depends on the level of magnitude of additional work requested by the client. Major changes will certainly affect cost. The respondent explained that lack of proper planning for co-ordination of designs and construction at initiating stages can affect the implementation stage and consequently it will affect construction costs. It all depends on the calibre of professionals who are involved in the building production process. The quantity surveyor expounded that methods of financial management during production have both positive and negative effects on the cost. This can be attributed to the competency of quantity surveyors involved with the other professionals on site. The respondent counselled that proper monitoring and controlling of cost, time and the production process can affect the delivery date. Budgeted cost and quality are expected to have a positive effect because every stage of the production process needs proper monitoring. The quantity surveyor explained that to achieve a quality delivery, experienced contractors must be employed. Likewise, skilled professionals must also be involved in the building production process. The respondent described inadequate designs as a common case on site that affects the preparation of the bill of quantity. Amendments are usually carried out by the design team but the effect of inadequate designs cause delays in preparation of the bill of quantity. The quantity surveyor stated the effect of errors and omissions on contract documents as a regular problem that affects the accurate preparation of estimates. If not discovered at an early stage, they frequently generate arguments between the contractor and the client's QS on site. The quantity surveyor stated that the achievement of client objectives during the production process starts from the design stage after the client briefing. Failure by the design team to incorporate client requirements into

design detailing will be transferred to the preparation of the bill of quantity, which then impacts budgeted costs. The respondent stated that while regular meetings are significant to the management of construction resources, they do not influence the greater labour productivity. The quantity surveyor stated that increases in labour productivity have an influence on project delivery date and likewise, time wastage by workforce has a greater impact on project delivery. The respondent clarified that team work techniques are a major aspect of managing the building production process; this helps achieve project objectives and the delivery of a project at budgeted cost, time and quality expected.

The respondent clearly pointed out that a general progress report on site activities is very important in the management of specified costs. The report will give insight on how efficiently the specified costs have been spent. The quantity surveyor specified that client requirements can only be achieved through the administration of quality procedures during the building production process. The respondent stated clearly that inadequate designs by the design team cause changes in client requirements and usually attract claims and variations that increase construction costs. The quantity surveyor remarked that quality checks have a great impact on project delivery and can only be achieved through checking work done while conforming to the requirements specified.

4.14.5 Interview with respondent D

Interview with a contract manager commenced at 1.30 pm on construction site D on the 13th of May, 2014, in the contract manager's office and lasted 45 minutes. Discussions were recorded using a Samsung Galaxy Tab 3 Tablet PC Android 7-inch High Resolution. The contract manager working on construction site D was asked to comment on each question after being read the questions by the interviewer from a printed copy.

The contract manager explained that additional work without due regard to contractual procedure at the planning and construction stages will have a major effect on both construction cost and delivery time. The contract manager clarified that proper co-ordination of the design and construction phases can be used to achieve effective construction costs that match the client objectives. The respondent further explained that inadequate co-ordination of the design stage with the construction stage causes delays during production processes and also causes an increase in construction costs. The contract manager argued that mismanagement of the contract funds through resource wastages will cause delays and retard the production process. The contract manager counselled that in order to achieve an efficient building production process, stakeholders should embrace methods of proper monitoring and controlling of the project at all stages during production to avoid increases in

construction costs that are always characterised as project delivery that is above budgeted cost specified. The respondent stated that he recommends the procurement of competent contractors during the contractual stage. This will influence the delivery of quality projects at budgeted cost specified and likewise, the involvement of experience professionals in production will have a positive effect on the construction costs. The contract manager, in his opinion, describes inadequate design as a constant recurring problem associated with drawings and slowed production. The respondent stated that errors and omissions sometimes occur in contract documents and tend to spring up arguments among professionals on site, causing delays. The contract manager observed that constant changes in design during construction happen as a result of failure by the design team to incorporate the client requirements into design. To elaborate, if such situations arise, this causes delays and increases in construction costs. The respondent advised that in order to achieve optimal utilisation of construction resources, regular meetings on site need to be organised as this will help gain worker productivity during the production process. The contract manager suggested that reductions in time wastage will have a positive effect on labour productivity during construction. He stated that proficient use of cost can be achieved through team work during production and general progress reports on site that will influence the resourceful use of cost in delivery of the project at budgeted cost. The respondent stated that administration of quality can only be achieved if there is clarity in the client requirement at the initiating stage during production. The contract manager added that quality management is properly planned at the initiating stage will aid in achieving the client requirements during the production process. The respondent explained that quality checks during the production process will help in meeting the client's requirements and the delivery of the project at a quality that is expected by the client.

Table 4.14: Summary of qualitative interview

Content	Respondent A	Respondent B	Respondent C	Respondent D
Factors that affect cost	Additional work can either be minor/major on budgeted cost depending on volume of work to be added	Additional work will have a major effect on cost but not always	Additional work does not often have a major effect on budgeted cost but it depends on level of magnitude of additional work	Additional work will have a major effect on construction cost and delivery time importantly
Achieving quality project	Monitoring and controlling at stages will help achieving quality project delivery	Monitoring and controlling at stages will enhance delivery of project at specified budgeted cost and quality	Monitoring and controlling at stages will affect delivery date, budgeted cost and quality expected	Monitoring and controlling at stages of production will help avoid increase in construction cost
Effect of changes in design	Inadequate design will affect construction cost	Unclear design is a common cases but not every drawing has such attributes. Unclear design slows production and increases construction cost	Inadequate design is a common case affecting preparation of bill of quantity and causing delay	Inadequate design is a constantly occurring problem and slows down production processes
Management of construction resources	Regular meetings on site will give insight into the construction team if they are progressing on productivity	Regular meetings on site will help resolve rancour among professionals; it has a great effect on labour productivity	Regular meetings are significant to management of construction resources but not to the extent of having greater influence on labour productivity	Regular meetings will help achieve optimal utilisation of construction resources and help accomplish workers' productivity
Efficient utilisation of cost	Team work is significant among construction teams; it helps in achieving common goals	Team work is significant, always affecting cost and delivery date importantly	Team work is a major technique of management during production; it helps in achieving project objectives	Team work will be used to achieve proficient uses of cost
Quality management	Quality management will help achieving client requirement during production	Quality management can only be achieved if it is incorporated at the initiating stage and if not properly managed, it affects requirements and delivery date	Administration of quality procedures can be used to achieve client requirements	Quality management helps achieve client requirements during production

4.15 How the objectives of the research study were achieved

The first objective of this study concerned determining the factors that affect cost during the building production process. The objective was achieved after analysis of the data collected. The major findings are centred around additional work during production processes without contractual procedures, inadequate co-ordination of the design phase and construction phase during production, financial mismanagement, frequent changes in design, cost of materials in the market, fluctuation of the price of materials, high costs of machinery, misunderstanding between the design and construction teams on site during production,

economic stability/instability, contract management during production, contractual procedure, inadequate planning during production, inadequate materials for production, currency exchange rate, absence of construction cost control, inadequate labour availability and the high cost of labour.

The second objective of this research study is to examine the modality of achieving a quality building project during the production process and this objective was also achieved. Findings obtained from data analysis include the following: proper monitoring and control at various stages during production, procurement of competent contractors and subcontractors, the involvement of experienced professionals in production, proper briefing by the client during production, targeting quality during production, prompt decision making during production, the establishment of an effective communication system on site during production, adequate project planning at initiating stage, proper cost estimates for production process, proper definition of a scope during planning, drawing out a programme of work for time delivery, establishment of a financial control team, establishment of team work for production, allowing for the free flow of information among construction teams during production, effective management of equipment and materials to achieve timely delivery of project, hiring of construction professionals who will actualise client interest during the production process, prompt payment to contractors by the client during production, adequate preparation for the financing of the project by client, proper management of the procurement procedure during production, avoiding mistakes during construction, discouraging absenteeism for continuity of responsibility at work, and the use of penalties for doing an erroneous job in order to keep the cost of construction steady.

The third objective of this study was to examine the effect of changes in the building designs during the production process on budgeted cost. The objective was achieved and findings obtained are as follows: inadequate designs have an effect on construction cost, frequent changes into building design by client during the production affect construction cost, frequent changes in building design during production causes reworking, additional work during production caused by changes in building design, changes in the building design during construction caused by errors and omissions detected affects the quality of the project delivered, specifications due to procurement of new materials during construction causes changes in building design, frequent changes to design during construction causes variation, improper designs lead to failure to achieve the client objectives that cause constant changes in building design, inadequate definition of scope of work for contractors causes change in building design during production, changes in specification by consultant that cause changes in building design, co-ordination of design changes during production, ambiguous design

details cause changes in building designs, decision making during design stage causes changes in design, budgeted cost is affected by value engineering as a result of changes in building design at the implementation stage, replacement of building materials during construction as a result of changes in design has an effect on the budgeted cost, design discrepancies between drawing and specification affect budgeted cost, design complexity causes changes in building design, non-compliance design in terms of government regulation causes changes in design at implementation, safety considerations during construction cause changes in building design, prolonged procedure for management of design changes causes delay and inadequate communication among the design team during design stage which leads to ineffective designs.

The fourth objective is the impact of budgeted cost on management of construction resources. This is comprised of three sub-questions known as G1: effect of human resources management on budgeted cost during production processes; G2: effect of management of machinery on budgeted cost during production processes; and G3: effect of building materials management on budgeted cost during production processes. The objective was achieved through the investigation on the effect of human resources on budgeted cost during production processes. The findings obtained from analysed data include the following: regular meetings on site will promote efficient productivity of human resources, labour productivity has an effect on budgeted cost, time wastage by manpower will affect budgeted cost, wrong job allocation to workers, training of workers to enhance skills and decrease delivery time of project, manpower wastage during production, reduction of overtime of workforce by project manager during construction has an effect on the budgeted cost, shortage of skilled workers affects budgeted cost, improper planning of human resource activities on site and delays in payment of wages by contractor which cause industrial action.

This study investigated the effects of machinery management on budgeted cost during production processes. The objective was achieved. Findings obtained from analysed data are as follows: wrong planning for machine usage on site, late delivery of equipment during production, inefficient management of machinery, idleness of hired machines on site, increase in price of machinery, high cost of machinery maintenance during production, procurement of appropriate machines to site during production, faulty equipment on site during production, frequent changes of hiring prices of machines during construction, and different site soil conditions where machines have worked.

The effect of building materials management on budgeted cost during production processes was achieved through this investigation and the data collected were analysed. Findings are

that increases in the price of building materials will affect construction costs, late delivery of materials will affect the production process, insufficient building materials on site during construction, scarcity of building materials in the country lead to importation of building materials with high prices from other countries, changes in building material specifications during production, increase in the price of original materials specified that causes the use of alternative materials, delay in importation of building materials, use of foreign materials, currency instability in the country affects the prices of building materials, and currency instability in the country causes a scarcity of building materials during construction.

The fifth objective studied efficient utilisation of costs without negatively affecting delivery times and the quality expected during building process was achieved through the investigation conducted. Findings obtained after the analysed data relate to the following: team work on site during production, general progress reports on site during production, project schedules/timetables for production, work programmes for site activities, proper designs and construction co-ordination, establishment of project funding procedures during production, sources of estimates on site for calculating costs, project management plans for production, site activities plan for cost estimate, project log books for records during production, establishment of cost control bases for site activities, cost control plans for production, risk inventory on site during production process, human resources usage plans during production processes, and contract agreement by law for production processes.

The sixth objective of this research study was to establish an operational technique for management of construction costs in order to be within the limit of the budgeted cost'. The objective was achieved through the identified factors that affect budgeted costs during the building production process, through the identified modality of achieving a quality building project during the production process, the effect of changes in building designs during production process on budgeted cost, assessed the impact of budgeted costs on management of construction resources, ascertained how costs can be efficiently utilised without negatively affecting delivery time and the quality expected during the production process. The findings obtained from data analysis are indicated in Tables 4.7, 4.8, 4.9, 4.10, 4.11, 4.12 and 4.13. Findings are used to establish an operational technique for management of construction costs in order to stay within the limit of budgeted cost. Figure 4.1 shows how the summary of key findings.

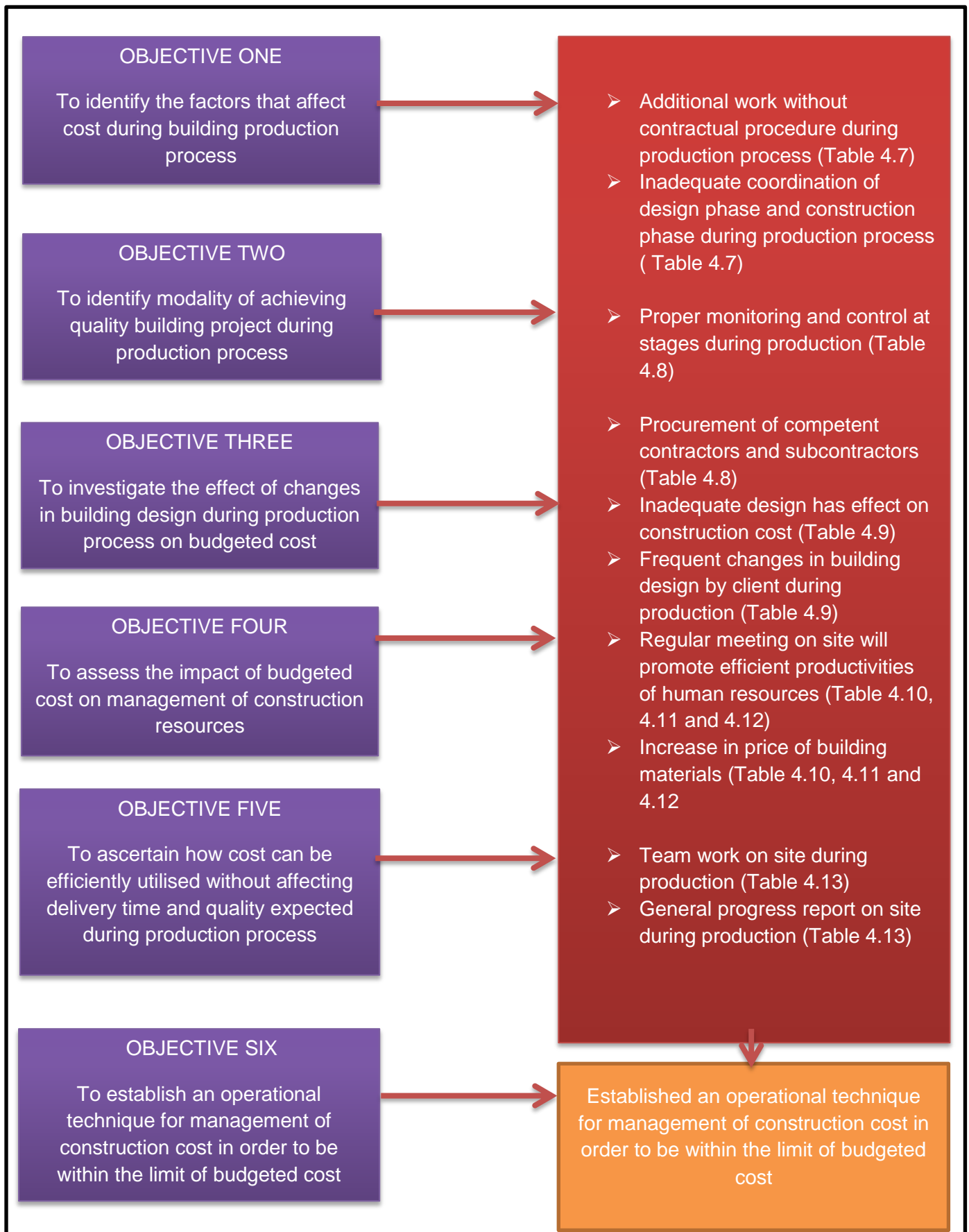


Figure 4.1: Summary of key findings

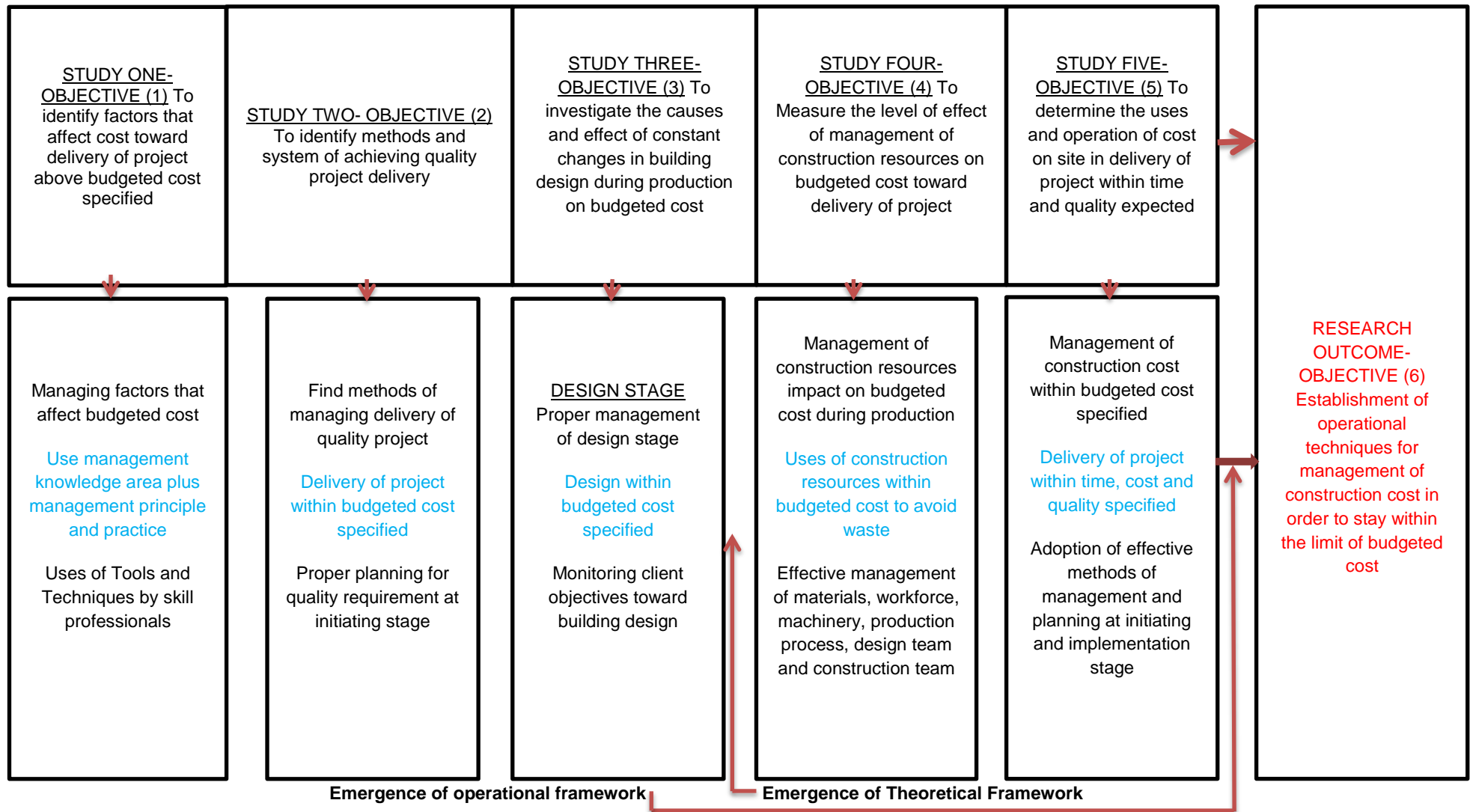


Figure 4.2: Establishment of operational techniques for management of construction cost in order to be within the limit of budgeted cost framework

Table 4.15: To identify factors that affect construction cost in delivery of project above budgeted cost specified

Concept	Issue addressed	Findings
To identify factors that affect construction cost during production process	Identified factors that causes increase in construction cost above budgeted cost specified	<ol style="list-style-type: none"> 1. Additional work without contractual procedure during production process 2. Inadequate co-ordination of design phase and construction phase 3. Financial mismanagement 4. Frequent changes in design 5. Cost of materials in the market 6. Fluctuation of price of materials 7. High cost of machinery 8. Misunderstanding between design and construction team on site during production 9. Economic stability 10. Contract management during production 11. Contractual procedure 12. Inadequate planning during production 13. Inadequate materials for production 14. Currency exchange rate

Table 4.16: To identify methods and systems of achieving quality project delivery within budgeted cost specified

Concept	Issue addressed	Findings
Find methods of management in delivery of quality project	Identified methods and systems of achieving quality project delivery within budgeted cost specified	<ol style="list-style-type: none"> 1. Proper monitoring and control at stages during production 2. Procurement of competent contractors and subcontractors 3. Involvement of experience professionals in production 4. Proper briefing by client during production process 5. Targeting quality during production 6. Prompt decision taking during production 7. Establishment of effective communication system on site during production 8. Adequate project planning at initiating stage 9. Proper cost estimate for production process 10. Proper define of scope during production 11. Draw out programme of work for time delivery 12. Establishment of financial control team 13. Allow for free flow of information among construction team during production 14. Effective management of equipment and materials to achieve timely delivery of project

Table 4.17: To investigate the causes and effects of constant changes in building design during production on budgeted cost

Concept	Issue addressed	Findings
To investigate the causes and effect of constant changes in building design during production process on budgeted cost	Identified the causes and effects of constant changes in building design on budgeted cost during production	<ol style="list-style-type: none"> 1. Inadequate design has effect on construction cost 2. Frequent changes into building design by client during production affect construction cost 3. Frequent changes in building design during production causes rework 4. Additional work during production caused by changes in building design 5. Changes in building design during construction caused by errors and omission detected affects quality of project delivered 6. Specification due to procurement of new materials during construction causes changes in building design 7. Frequent changes to design during construction causes variation 8. Improper design lead to failure in achieving client objectives causes constant changes in building design 9. Inadequate define scope of work for contractors causes change in building design during production 10. Changes in specification by consultant causes changes in building design 11. Coordination of design changes during production 12. Ambiguous design details causes changes in building design 13. Decision taking during design stage causes changes in design 14. Budgeted cost is affected by value engineering as a result of changes in building design at implementation stage

Table 4.18: To identify the impact of management of construction resources on budgeted cost toward delivery of project

Concept	Issue address	findings
<p>To identify the effect of management of construction resources on budgeted cost toward delivery of project</p>	<p>Issue 1: Identified the effect of human resources management on budgeted cost during production process</p> <p>Issue 2: Identified the effect of management of machinery on budgeted cost during production process</p>	<ol style="list-style-type: none"> 1. Regular meeting on site will promote efficient productivities of human resource 2. Labour productivities has effect on budgeted cost 3. Time wastage by manpower will affect budgeted cost 4. Wrong job allocation to worker 5. Training of workers enhance skill and delivery time of project 6. Manpower wastage during production 7. Reduction on overtime of workforce by project manager during construction has effect on budgeted cost 8. Shortage of skill worker affect budgeted cost 9. Improper planning of human resource activities on site 10. Delay in payment of wages by contractor causes industrial action <ol style="list-style-type: none"> 1. Wrong planning for machine usage on site 2. Late delivery of equipment during production 3. Inefficient management of machinery 4. Idleness of hiring machine on site 5. Increase in price of machinery 6. High cost of machinery maintenance during production 7. Procurement of appropriate machine to site during production 8. Fault equipment on site during production 9. Frequent changes of hiring price of machine during construction 10. Different site soil condition where machine has worked

Table 4.19: To determine the uses and operation of cost on site in delivery of project within time and quality expected

Concept	Issue addressed	Findings
To determine the uses and operation of cost on site in delivery of project within time and quality expected	Determined the procedure and uses of cost on site in delivery of project within time and quality expected	<ol style="list-style-type: none"> 1. Team work on site during production 2. General progress report on site during production 3. Projects schedule/timetable for production 4. Work programme for site activities 5. Proper design and construction co-ordination 6. Establishment of project funding procedure during production 7. Sources of estimates on site for calculating cost 8. Project management plan for production 9. Site activities plan for cost estimate 10. Project log books for records during production 11. Establishment of cost control base for site activities 12. Cost control plan for production 13. Risk inventory on site during production process 14. Human resources usage plan during production process

4.16 Chapter summary

This chapter discussed findings obtained from the questionnaire survey data collected through quantitative methods for the study of a framework for effective management of cost constraint on building project delivery in South Africa. The data collected were analysed using the Statistical Package for Social Science (SPSS) version 22 for computing frequency and descriptive statistics. were employed to interpret the data collected. The scale questions were tested for reliability using Cronbach's alpha coefficient. Results obtained for the scale questions were 0.8, signifying that all the scale questions are reliable. The result obtained from findings show that additional work without contractual procedure to assess cost implication during production was the first major factor that hindered delivery of project at construction cost equal to budgeted cost specified. This signifies that stakeholders did not duly consider the cost implications of additional work rightly from the initiating and implementation stages. The sources of additional work can be from wrong planning at the initiating stage, changes in building drawings, or defects as a result of poor construction. The majority of the respondents agreed that additional work without contractual procedure will affect budgeted cost.

Proper monitoring and control at all stages of construction is the modality of achieving a quality building project during the production process, suggesting that proper monitoring and control must be established at the initiating and planning phase. This should be implemented at the construction phase to achieve quality building project during the production process. There two astute points to be noted: one, that project objectives cannot be achieved unless proper monitoring and controlling of the construction process is implemented, and two, effective monitoring and control are significant on budgeting, safety, and quality control of projects. The interview respondents agreed that he effects of changes in building design on budgeted cost are caused by inadequate design and by frequent changes to design by client who brings about rework, and concurrent leads to increase in the cost of construction as a result to claims, variation, and delay. The impact of budgeted cost on management of construction resources was investigated. Respondents indicated that regular meetings on site will promote efficient productivities of human resources; likewise, wrong planning for machine usage on site affects budgeted cost, and increases in prices of building materials has an effect on construction cost. These were the major problems identified that affect budgeted cost through the management of construction resources. Findings indicate that efficient utilisation of cost without negatively affecting delivery time and quality during production process can be achieved through team work on site during production, general progress reports on site, and a clear project schedule/timetable for production.

The validity of the questionnaire was tested through semi-structured and unstructured qualitative interview. Stakeholders were asked to confirm if these identified problems were actually the real problems confronting the construction industry. All the findings were identified by professionals to be the real problems challenging delivery of a project at construction cost higher than budgeted cost specified.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The findings obtained from this study on a framework for effective management of cost constraint on building project delivery in South Africa were analysed and discussed, and conclusions and recommendations were based on results obtained.

The aim of this study is to establish a framework for effective management cost constraint on building project delivery in South Africa.

5.2 Conclusion and recommendations

The proper adoption of these findings by the South African construction stakeholders during production processes will enhance delivery of building projects at reduced construction resources, at quality expected, time stipulated, budgeted cost specified and to the satisfaction of the client. These factors will be achieved, as illustrated under each objective of the research study.

5.2.1 Factors that affect cost during building production process

Twenty factors that affect cost during production process were identified from the survey distributed. Additional work without contractual procedures to assess cost implication during production was the first major factor identified that hinders delivery of a project at budgeted cost, signifying that stakeholders did not duly consider the cost implication effects of additional work rightly from the initiating and implementation stages. Sources of additional work are from wrong planning at initiating stage, changes in building drawings, and defects as a result of poor construction. All these are the aspects of additional work that influence the climbing increments in construction cost.

The second major finding indicated inadequate co-ordination between design and construction phases: the design team and construction team are not relating properly from concept stage to planning stage, and also from the implementation stage to close-out phase, due to lack of proper planning and management of relationships during production process. This may lead to wrong designs and defects in construction that cause demolition and rework and ultimately, delivery of project at construction costs higher than budgeted cost. This finding is backed by Dibonwa (2009) who claimed that project managers and owners were found to be responsible for activities that result in cost increase in a project at initiating/planning and design stage. Further, Dibonwa (2009) explained that in the project

implementation stage, blame rests on the contractors, architects and quantity surveyors for construction cost increment during production process, while quantity surveyors and contractors were considered responsible for budgeted cost increases at the completion/commissioning stage.

5.2.2 Modality of achieving quality building project during production process

Findings obtained showed 22 factors identified as the modality of achieving a quality building project. Proper monitoring and control at stages of construction is the modality of achieving quality building projects during production processes. This suggests that proper monitoring and control must be established at the initiating and planning phase. This should also be implemented at the construction phase to achieve quality building projects during production processes, and also, proper monitoring and control must be measured toward project goals. Calvert *et al.* (1995) confirmed that controlling processes are charged with the responsibility of guaranteeing that the objectives are met. To this end, building production processes must be frequently monitored and the progress measured against the construction plan to ensure corrective activities are taken when necessary.

Controlling processes comprise performance and status reviews during production processes. Controlling processes were used to monitor and identify changes and managed in agreement with the construction plan. Similarly, PMBOK (2008) confirmed that monitoring and controlling process groups are processes needed to track, review and regulate the progress and performance of the building production processes. Involvement of competent contractors and subcontractors is one of the major findings discovered as a modality for achieving quality of building projects during production processes, signifying that proper procurement of contractors during the contractual settings must be carried, identifying the most experienced contractors who will be involved in delivery of project at budgeted cost, time specified and at quality expected. Arain and Pheng (2006) counselled that inclusion of experienced contractors at the design stage will allow the contractor to infuse his professional knowledge, skilful ideas and originality into the process.

5.2.3 Effect of changes in building design during production process on budgeted cost

This study investigated the effect of changes in the building design during production process on budgeted cost. 23 factors were investigated. The findings show that inadequate design during the production process was identified as a major factor that affects delivery of project above budgeted cost specified. This indicates that there was no proper planning for design detailing by the design team, causes of which may be from lack of proper briefing by

the client or unclear objectives. Errors and omissions as a result of incompetence on the side of design team may be another major reason. Findings supported by Arain and Pheng (2006) confirmed that constant changes to design during construction stage, as a result of inefficiencies by the design team, caused numerous problems leading to rework, delay, variation, claim, and construction cost increase. The frequent change to design by client during production is another major factor that affects delivery of project above budgeted cost specified. Other reasons may be non-compliance with client requirements, and failure by the design team to consider new technology application into design; these may be reasons for frequent changes in design by the client. Supporting this assertion, Alsuliman *et al.* (2012) confirmed that clients initiate most changes during the design and construction stage, changes which influence delivery of project at construction costs higher than budgeted cost as changes require rework, claims and variation during the production process.

5.2.4 The impact of budgeted cost on management of construction resources

The impact of budgeted cost on management of construction resources was investigated and finding obtained show that regular meeting on site will promote efficient productivities of human resources; the implication of this result is that all stakeholders involved in the production process must have an on-site meeting place to resolve all issues affecting production. Feedback about site operation must be reported and discussed, and conflicts concerning design and construction that causes rework and cost increase must be resolved at this meeting place. Progress reports about site and welfare of the workforce are also reasons for regular meetings. Regular meetings on site are essential in discussing issues affecting production processes; such meetings will enhance delivery of project at budgeted cost specified. In support, Alwi (2003) advised that construction operators should inaugurate cooperation and regular meetings amongst the construction team from different levels, encouraging trust, harmony and unity when working together.

Wrong planning for machine usage on site is one of the major factors identified that has an effect on budgeted cost. The cost implication of this factor starts at the initiation of the project, if the programme of work does not actually identify types of equipment needed on site, time of arrival on site, working hours, and period of usage. The management of a machine is supposed to be assigned to a specific manager on site, starting from the initiating stage to the time of project completion. The problems of machine management stemming from when there is no actual person on site responsible for machinery management concern issues of machine maintenance and safeguarding. The management of the machine is sometimes assigned to the equipment operator who does not have even basic knowledge of management. Machines assigned to the wrong place of work as a result to lack of proper

planning will lead to time wastage, increases in cost of construction and wasted operator time. These are all indicators of poor machine management on increases in budgeted cost.

5.2.5 Efficient utilisation of cost without negatively affecting delivery time and quality expected during building production process

Team work on site is one of the major findings identified that will enhance efficient utilisation of cost without negatively affecting delivery time and quality expected during the building production process. Team work among site workers indicates positive group for achieving common goals and objectives during the production process. It involves group of people coming together from different cultures, orientations, languages and educational backgrounds to carry out building production processes in the construction industry. Team work should involve people who have trust, respect, common principles and ideas during the production process in order to achieve effective productivity. Team work will promote efficient production and delivery of the project at budgeted cost with satisfaction of the client.

Another major finding identified is that general progress reports are necessary for efficient utilisation of cost without affecting delivery time and quality expected during the building production process. This suggests that all stakeholders must meet at a given period of time to deliberate on work completed, achievements, difficulties encountered, conflicts, issues at stake, management problems, relationships among workers, staff welfare, completion time and the programme of events. These identified issues on site, if properly addressed during general progress report meetings among stakeholders, will escalate achievement of efficient utilisation of cost without affecting delivery time and quality expected during the building production process.

5.3 Limitations

This study's survey was disseminated within the Western Cape and Gauteng provinces. The study was affected by difficulties in not having direct contact with some of the respondents. Those respondents, who accepted the tasks of completing the questionnaire, later complained of being too busy attending contract meetings, having no time to complete the questionnaire. Some respondents returned uncompleted questionnaires back through their office secretary, giving the excuse of being transferred to a new site. Those of the respondents who completed the questionnaire also complained of being too busy on site, so the completion of questionnaires took some of stakeholders six weeks to complete. The questionnaires were retrieved by hand after several visitations to sites following phone calls. This research study was unable to retrieve, through direct access, the information concerning management of building material supply during production processes in the

construction site studied. This work recommends that further research should be conducted on the effect of building material supply management during production processes in the South African construction industry to enable a clearer understanding of the effect of cost implication on price increase of materials on overall construction costs.

5.4 Recommendations

These identified findings that affect cost during building production process, if properly administered by the stakeholders, will improve the contractual procedure at the initiating stage, the procurement process stage, and will also enhance the implementation stage of the construction process. Similarly, additional work caused by constant changes in building design as result of defects and poor construction will be drastically reduced if proper planning can be invoked. Since the factors that affect cost have been identified, planning will improve the interaction between the design team and construction team from conception to planning phase and from implementation to close-out phase. The modality of achieving a quality building product will be attained by proper monitoring and control, but this must be established at the initiating and planning phases. This should also be implemented at the construction phase to achieve quality building projects during the production process and proper monitoring and control must be measured toward the goals established for the project. In addition to modality of achieving a quality building project during production, proper procurement of competent contractors during the contractual procedure must be established. Experienced contractors must be identified to be involved in delivery of project at budgeted cost, time specified and at quality expected.

The identified factors that cause changes in building design during production process on budgeted cost, if adequately considered by stakeholders during the production process, will improve delivery of a project at construction costs acceptable to the client. Inadequate building designs are caused by lack of proper briefing by the client and presentation of unclear objectives. This will be reduced through the establishment of a design monitoring group from initiating to completion stage. Also, errors and omissions as a result of incompetence on the side of the designer can also be reduced through the procurement of competent architects for the building design. Changes in building design by the client during production are caused by non-compliance of design to client requirements. Also new technological applications into building design must be considered by designers in order to avoid frequent changes in building design by the client. To achieve effective design, clear objectives must be obtained from the client by the designer to ensure that the design will be in conformity with the client requirements. Regular meetings on site must be scheduled to

achieve efficient productivities of human resources; every stakeholder involved in the production process must have a meeting place to resolve all issues affecting production. Feedback about site operation must be reported and discussed, and conflicts concerning design and construction that frequently cause rework and construction cost increments must be resolved at this meeting place. Additionally, progress reports about the site and welfare of the workforce are critical reasons for organising regular meetings. Regular meetings on site are essential for discussing issues affecting production process. This will enhance delivery of project at the budgeted cost specified.

Increases in the price of building materials are caused by this country's economic predicament, which consequently affects the industry that produces building materials. The economic problem forces the industry to increase the price of the building materials above the reach of the construction industry for a production process. The import duty and tariff on building material importation should be reduced to enhance the efficiency and productivity of the industry that produces building materials. Government should establish a building material monitoring board. The composition of the board should include selected construction stakeholders, representatives from the industry producing building materials, government representatives from public works, representatives from financial institutions and customs officers in charge of importation to discuss ways to stabilise prices of building materials in the market. Desai and Desale (2013) counselled that stakeholders should have a well-developed plan for material in advance to avoid the effect of increase in building material prices in the market. There must also be a structured standard system of material procurement management to avoid wastage of other construction resources during the production process. Planning for machine usage on site should start at the initiating stage of a project through designing the programme of work, type of equipment needed on site, time of arrival on site, working hours, and period of machine usage. The task of management of machines is supposed to be assigned to a specific manager on site starting from initiating to the time of project completion. The problems of machine management are due to lack of an actual person on site responsible for the programme of work for machine usage, maintenance and safeguarding processes for machines on site. In addition, a professional manager should be assigned the responsibility of machine management on site to avoid wastage of human resources and increases in cost of construction. Rahman *et al.* (2012) argued that the selection of machines to be use on site must be an integral component of the total plan. The management and the usage of the machines must be well-planned to avoid redundancy and construction increase.

Team work on site is one of the major findings identified that can achieve efficient utilisation of cost without negatively affecting delivery time and quality expected during the building

production process. Team work among the site workers involves groups working to achieve common goals and objectives during the production process. Team work should involve people who have trust, respect, and common principles and ideas during the production process in order to achieve effective productivity. Team work will promote efficient production and delivery of project at budgeted cost and satisfy client interest if properly administered. Cohn and Ralston (2005) described team work as an effective team sharing commonalities – purposes, goals, leadership, ground rules for interactions, meetings, trust and openness – to achieve efficient utilisation of cost without negatively affecting delivery time and quality expected during production processes. General progress reports on site is another major finding that will improve efficient utilisation of cost without affecting delivery time and quality expected during building production process. All stakeholders must meet at a given time to deliberate on work completed, achievements, difficulties, conflicts, issues at stake, management problems, relationships among workers, staff welfare, cost involved, time of completion, and programme of events. These identified issues on site, if properly addressed during general progress report meetings among stakeholders, will enhance efficient utilisation of cost without affecting delivery time and quality expected during production process. Alsuliman *et al.* (2012) discovered that progress reports on site activities, good contract documentation, good communication, and cooperation among construction teams are major elements that can make management systems more effective on site.

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APPENDICES

APPENDIX A- QUESTIONNAIRE FOR THE MAIN STUDY



Dear Sir/ Madam

QUESTIONNAIRE SURVEY

FRAMEWORK FOR EFFECTIVE MANAGEMENT OF COST CONSTRAINT ON BUILDING PRODUCT DELIVERY IN SOUTH AFRICA

AIM AND AREA COVERED BY THIS STUDY

The purpose of this study is to collect information from experts working in the construction industry in South Africa concerning a framework for effective management of cost constraint on building product delivery. It is a research study in the Department of Construction Management and Quantity Surveying at Cape Peninsula University of Technology.

This survey is purposely carried out to establish effective management of cost constraint on building product delivery in South Africa. All answers should be linked with new and past projects with which you have been involved. Carefully examine all questions and answer appropriately.

The completed questionnaire should be returned to:

Akinyede Imisioluseyi Julius

Cape Peninsula University of Technology

Telephone: 0219538621, Fax: 0219596656

Email: seyiakinyede@yahoo.co.uk

Mobile +27845407708

Thank you for your friendly assistance and support

SECTION A: RESPONDENT DETAILS

1. Kindly indicate any of the following that are appropriate to your firm?

- Architectural firm Project consultant firm Structural firm
 Construction firm Quantity surveying firm

2. How long have you worked in the construction industry 1-5 6-10 11-15 16-20
21-25 26-30

3. What position are you in your firm? architect project manager QS
Site engineer contract manager contractor client

4. How long have you been in your current position? 1-5 6-10 11-15 16-20
21-25 26-30 31-35 36-40

5. Age: 21-25 26-30 31-35 36-40 41-45 46 and above

SECTION B: PROJECT DISTINGUISHING

6. What project type are you involved in? Tick as many as possible:

- New project Renovation/Restructure
 Conversion

7. What is the use of project you are involved in?

- Public utilisation building
Private residential building

Kindly relate questions 8-13 to projects you have been involved with in the past:

8. What is the budgeted cost? R100,000-R1.0m R1.1m-R50m R51m-R500billion

9. Was there cost increase as a result of variation? Ye No

10. Specify the time frame for the project 6 month 1yr 2yrs 3yrs above 3yrs

11. When was the project actually completed? within time frame above time specify

Below time specified not yet completed

12. What contracting procedure was used for the project?

Design and build contract construction management contract

Traditional cost plus Traditional lump sum contract

Design and manage contract

13. What is the area occupied by the project 50m2 100m2 above

SECTION C: ADMINISTRATIVE MANAGEMENT RULES AND PRACTICE

1. Kindly rate the level at which of the following practice is applicable to your firm.

1-Extremely not applicable, 2-Not applicable 3-Moderately applicable, 4-Applicable, 5-Extremely applicable

Significant factors	1	2	3	4	5
Procedure for standard cost control					
Compliance to international standard organisation					
Assurance quality manual					
Total quality management procedure					
Safety procedure on site					

2. Kindly indicate which of these learning processes is applicable to your firm. **1-Extremely not applicable, 2-Not applicable, 3-Moderately applicable, 4-applicable, 5-Extremely applicable.**

Significant factors	1	2	3	4	5
Learning through training					
Learning through group work					
Conferences organised for skill innovation					
Learning through research programmes					
Knowledge transfer from past projects					
Learning through workshop and seminars					

SECTION D: FACTORS THAT AFFECT COST DURING BUILDING PRODUCTION PROCESS

1. The under listed are the factors that affect cost during building production process, indicate the level at which you agree with the factors: **1- Strongly disagree, 2- Disagree, 3- Agree, 4-Strongly agree**

Significant factors	1	2	3	4
Additional work during production process without contractual procedure				
Absence of construction cost record during production				
Contract management during production process				
Contractual procedure				
Cost of materials in the market				
Currency exchange rate				
Misunderstanding between design and construction team on site during production process				
Duration of contract period				
Economic stability				
Fluctuation of price of materials				
Financial mismanagement				
Frequent changes in design				
Government policies				
High cost of labour				
High cost of machinery				
Inadequate labour availability				
Inadequate materials for production				
Inadequate planning during production				
Insurance cost during production				
Inadequate coordination of design phase and construction phase during production by project manager				

SECTION E: MODALITY OF ACHIEVING A QUALITY BUILDING PROJECT DURING PRODUCTION PROCESS

1. What is modality of achieving quality building? Confirm the level at which you agree with the following under listed statements in achieving efficient building product:
1-Strongly disagree, 2-Disagree, 3-Agree, 4-Strongly agree

Significant factors	1	2	3	4
Proper briefing by the client during production				
Establishment of construction professionals who will actualise client's interest during production process				
Proper define of scope during planning				
Adequate project planning at initiating stage				
Proper monitoring and control at stages during production				
Avoiding mistakes during construction				
Procurement of competent contractors and subcontractors				
Draw out programme of works to achieve time delivery				
Involvement of experienced professionals in production				
Proper cost estimates for production process				
Establishment of financial control team				
Adequate preparation for project financing by client				
Prompt payment to contractors by the client during production				
Establishment of team work for production				
Allowing free flow of information among construction team during production				
Discouraging absenteeism among workers during production process to achieve continuity of job				
Proper management of procurement procedure during production				
Effective management of equipment and materials to achieve timely delivery of project				
Adequate and prompt decision taking during production				
Targeting of quality project delivery during production process				
Establishment of effective communication system on site during production				
Use of penalties for wrong job done in order to keep cost of construction steady				

SECTION F: EFFECT OF CHANGES IN BUILDING DESIGN DURING THE PRODUCTION PROCESS ON BUDGETED COST

1. Please indicate the level at which you agree with effect of changes in building design during building production process on budgeted cost with the following under listed statement: **1-Strongly disagree, 2-Disagree, 3-Agree, 4-Strongly Agree**

Significant factors	1	2	3	4
Frequents changes into building design by client during production affect construction cost				
Inadequate design has effect on construction cost				
Frequent changes to building design during production causes rework				
Changes in building design during construction caused by errors and omission detected affects quality of product delivered				
Frequent changes to design during construction causes variation				
Inadequate design by design team causes changes in building design affect cost of construction				
Government rule on design affect budgeted cost				
Inadequate specification causes changes in design affect budgeted cost				
Additional works during production caused by changes in building design				
Improper design lead to failure in achieve client objectives and causes constant changes in building design				
Replacement of building materials during construction as a result of changes in design has effect on budgeted cost				
Decision taking during design stage causes changes in design				
Inadequate define of scope of work for contractors causes changes in building design at construction stage				
Specification due to procurement of new materials during construction causes changes in building design				
Budgeted cost is affected by value engineering as a result of changes in building design at implementation stage				
Design complexity causes changes in building design				
Ambiguous design details causes changes in building design				
Design discrepancies between drawing and specification causes changes in building design at construction stage				
Non-compliance design with government regulation causes changes in design at implementation stage has effect on budgeted cost				
Changes in specification by consultant during production has effect on budgeted cost				
Prolonged procedure for management of design changes causes delay				
Condition of the project location not consider during design stage causes change in building design				
Safety considerations during construction causes changes in building design				
Non-involvement of contractors in building design at design stage causes errors that lead to changes in design during production				
In adequate communication among design team during design stage causes ineffective design that lead to changes in building design				

SECTION G: THE IMPACT OF BUDGETED COST ON MANAGEMENT OF CONSTRUCTION RESOURCES

G1. Indicate the level at which you accept how human resources has an effect on budgeted cost as listed: **1-Perfectly unacceptable, 2-Unacceptable, 3-Quite acceptable, 4-Acceptable, 5-Perfectly acceptable**

Significant factors	1	2	3	4	5
Shortage of skill worker affect budgeted cost					
Improper planning for human resource activities on site has effect on budgeted cost					
Wrong job allocation to worker during production					
Regular meeting on site will promote efficient productivities of human resource					
Delay in payment of wages by contractor causes industrial action					
Labour productivities has effect on budgeted cost					
Training of worker enhance skill and delivery time of project					
Manpower wastage during production					
Time wastage by manpower will affect budgeted cost					
Reduction on overtime of workforce by project manager during construction has effect on budgeted cost					

G2. Indicate the level at which you agree that management of machinery has an effect on budgeted cost: **1-Strongly Disagree, 2-Disagree, 3-Agree, 4-Strongly Agree**

Significant factors	1	2	3	4
Inefficient management of machinery				
Wrong planning for machine usage on site				
Procurement of appropriate machine to site				
Faulty equipment on site during production				
Increase in price of machinery				
Different site soil condition where machine has worked				
Frequent changes of hiring price of machine during construction				
Idleness of hiring machine on site				
Late delivery of equipment during construction				
High cost of machinery maintenance during production				

G3. Indicate the level at which you agree on the effect of building materials on budgeted cost during production process: **1-Strongly Disagree, 2-Disagree, 3-Agree, 4-Strongly Agree**

Significant factors	1	2	3	4
Insufficient building materials on site during construction				
Increase in price of building materials affect construction cost				
Increase in price of building material affect quality				
Increase in price of building materials causes delay on project delivery				
Increase in price of original material specified causes the use of alternative materials				
Scarcity of building material in the country leads to importation of building materials with high price from other country				
Currency instability in the country affects prices of building materials				
Currency instability in the country causes scarcity of building materials during construction				
Change in building materials specification during production				
Late delivery of materials to site affect production process				
Government regulations on building materials usage on site				
Delay in importation of building materials				
Use of foreign materials has effect on budgeted cost				

SECTION H: EFFICIENT UTILISATION OF COST WITHOUT NEGATIVELY AFFECTING DELIVERY TIME AND QUALITY EXPECTED DURING PRODUCTION PROCESS

1. Identify which of the following cost management principles are used in the project you are involved with. Carefully indicate how effectively the step was without affecting delivery time: **1-Ineffective, 2-Slightly ineffective, 3-Slightly effective, 4-Effective, 5-Perfectly effective**

Significant factors	1	2	3	4	5
Cost control plan for production process					
Human resources usage plan during production process					
Risk inventory on site during production process					
Site activities plan for cost estimate					
Sources of estimates on site for calculating cost					
Projects schedule/timetable for production					
Project log books for records during production					
Contract agreement by law for production process					
Project management plan for production					
Establishment of project funding procedure during production					
Work programme for site activities					
Proper design and construction co-ordination					
Team work on site during production					
General progress report on site					
Establishment of cost control base for site activities					

APPENDIX B-SEMI-STRUCTURED QUESTIONNAIRE FOR THE VALIDATION OF RESULTS OBTAINED FROM DATA ANALYSIS

Factors that affect cost:

1. What was the effect of additional work during production?
2. Do co-ordination of design and construction have any effect on construction cost?
3. What was the effect of financial management during production?

Achieving quality project:

1. What was the effect of monitoring and control during production?
2. Do competent contractors have any effect on quality delivery?
3. What was the effect of skilled workers during production?

Effect of changes in design:

1. What was the effect of inadequate design?
2. What was the effect of error and omission in contract document?
3. What was the implication of failure to achieve client objective?

Management of construction resources:

1. Do regular meetings on site have any effect on worker productivities?
2. Does increase in labour productivity have any effect on project delivery?
3. Does time wastage by labour have any effect on project delivery?

Efficient utilisation of cost:

1. What was the effect of team work during production?
2. Do general progress reports have any effect on budgeted cost during production?
3. Do project schedules affect production?

Quality management:

1. Does administration of quality have any effect on production?
2. What was the effect of changes in requirements on project delivery?
3. What was the effect of a quality check on project delivery?

APPENDIX C LIST OF ABSTRACTS OF PAPERS PRESENTED AT CONFERENCES

Abstract of a paper presented at conferences:

THE IMPACT OF DESIGN CHANGES ON BUDGETED COST OF BUILDING PROJECTS IN SOUTH AFRICA

Akinyede I J, (Corresponding Author)
Department of Construction management and Quantity Surveying
Faculty of Engineering
CPUT
Email: seyiakinyede@yahoo.co.uk

Fapohunda J. A, (PhD)
Department of Construction Management and Quantity surveying
Faculty of Engineering
CPUT
Email: fapohundaj@cput.ac.za

ABSTRACT

Literature reveals that design changes affect budgeted cost, delivery time and quality of building product substantially. This substantiates the need to investigate the impact of design changes on budgeted cost of building projects in South Africa. This study used quantitative questionnaires to collect data. The surveys are conducted within Cape Town, South Africa, and the information was collected from architects, structural engineers, quantity surveyors, project managers, contractors, clients, and contract managers in the construction industry. SPSS software was used for the quantitative data analysis. Based on the findings obtained, the major problems due to design changes include the following: scope of work not well-defined for contractors affect budgeted cost; design detail discrepancies found between drawing and specification affect construction phase has an effect on budgeted cost; decision making on material selection during design stage causing change in design at construction phase has an effect on budgeted cost during production process; changes to new technology affect budgeted cost; and non-compliance design with government regulations affect budgeted cost. Thus, accurate briefings by the client and planning at conception stage will influence effective production process; adequate design and proper checking for error by designers will enhance efficient design; and establishment of design management and readiness of design before the construction phase is a necessity for avoidance of delivery of building product at construction cost greater than budgeted cost. This avoidance will not only lead to efficient construction production process and reduction of resources waste, but will enhanced client satisfaction and delivery of building product at construction cost equal to budgeted cost or at construction cost less than budgeted cost.

Keywords: *Building Product, Budgeted cost, Construction cost, Cost Constraint, Design Team*

Abstract of a paper presented at conference:

FACTORS THAT AFFECT COST DURING BUILDING PRODUCTION PROCESSES IN SOUTH AFRICA CONSTRUCTION INDUSTRY

¹[Imisioluseyi] [Akinyede], seyiakinyede@yahoo.co.uk and

²[Julius] [Fapohunda], fapohundaj@cput.ac.za

¹*Department of construction management and quantity surveying, Cape peninsula University of Technology, Bellville, South Africa*

²*Department of construction management and quantity surveying, Cape peninsula University of Technology, Bellville, South Africa*

ABSTRACT

Literature reveals that construction projects are restrained within budgeted cost. Hence, the operational system is challenged with cost constraint to deliver projects at stipulated time and at a satisfactory quality. This substantiates the need to investigate factors that affect cost during production process. This research explores the use of quantitative questionnaires to collect data. Surveys were conducted among the stakeholders in the construction industry in Cape Town, South Africa. SPSS software is used for quantitative data analysis. Major findings indicate that ineffective planning at project initiating and implementation result into payment for poor job and rework affecting cost; improper reconciliation of operational records and expenditure with budgeted cost during production affect cost and delivery of building project above budgeted cost; inappropriate coordination between delivery dates, project jurisdiction and budgeted cost affect construction cost. Constant reconciliation between site expenditure and budgeted cost will reduce over spending; planning and monitoring in the use of materials will reduce delay; monitoring of design from briefing to construction stage will moderate additional work; stakeholders should be informed about triple-stand, that any adjustment to time, cost and scope will affect others and construction cost. This will also augment delivery of project at budgeted cost, reduction in resources waste and satisfaction of stakeholders' objectives.

Keywords: *Building production, Construction industry, Cost constraint, Delivery time, Production process*

Abstract of a paper presented at conference:

Efficient Utilization of Cost without Affecting Delivery Time during Production Processes

Akinyede, Imisioluseyi¹ and
Fapohunda, Julius Ayodeji²,

¹*Department of construction management and quantity surveying, Cape peninsula University of Technology, Bellville, South Africa, seyiakinyede@yahoo.co.uk*

²*Department of construction management and quantity surveying, Cape peninsula University of Technology, Bellville, South Africa, fapohundaj@cput.ac.za*

Abstract

Literature reveals that cost constraint affects construction and delivery time significantly. This justifies the need to investigate efficient utilisation of cost without affecting delivery time during production process. The study includes a quantitative questionnaire survey to obtain information from construction professionals in the construction industry in Cape Town. SPSS software is used for the quantitative data analysis. The study findings indicated that efficient progress report and constructive feedback on site activities are significantly important towards efficient utilisation of construction costs without affecting delivery time. In addition, establishment of cost control at all construction stages is significantly important for efficient utilisation of cost. Carefully considering the identified factors in this study will not only lead to efficient monitoring of construction costs and delivery time, but will also enhance effective production, reduction of resources waste and perpetuate timely delivery and stakeholders' satisfaction.

Keywords: *Cost, Construction industry, Delivery time, Production process, Stakeholders' satisfaction*

Abstract of a paper presented at conference:

ASOCSA2014-ID9

FACTORS THAT AFFECT BUDGETED COST THROUGH BUILDING PRODUCTION PROCESS IN SOUTH AFRICA CONSTRUCTION INDUSTRY

Akinyede, Imisioluseyi Julius and Fapohunda, Julius Ayodeji
seyiakinyede@yahoo.co.uk, fapohundaj@cput.ac.za

Department of Construction Management and Quantity Surveying' Cape Peninsula
University of Technology Bellville Campus South Africa
(+27845407708,+27740772950)

ABSTRACT

Purpose: Construction industry operational systems are confronted with cost constraint to deliver product at time specified and at quality expected. Thus, this cost restraint predicament generates the need to investigate the factors that affect budgeted cost through building production process.

Design: The study employed a quantitative questionnaire survey method to collect data from stakeholders in the construction industry in South Africa. SPSS software version 22 was used for quantitative data analysis.

Findings: Findings are as follows: an increase in income of workers, increase in output during production, and application of effective techniques during building production process are among the principal factors having a significant effect on budgeted cost. In addition, influence of workers behaviour on site during production process and management of techniques during building production process affect budgeted cost substantially.

Research limitation: Few of the respondents that accepted completing the questionnaire, later returned the uncompleted questionnaires and complained of being too busy.

Original/value of paper: Careful consideration of the identified factors proposed in this study will not only lead to effective management of construction cost and production processes, but will also enhance stakeholders' satisfaction.

Keywords: *Budgeted cost, Cost constraint, Production process, Stakeholders satisfaction, Delivery time*

Abstract of a paper presented at conference:

ICEC IX World Congress

Factors That Affect Budgeted Cost through Achieving Delivery of Quality project in South Africa Construction Industry

Akinyede , I.J.¹ and Fapohunda, J.A.²

¹ Department of Construction Management and Quantity Surveying Cape Peninsula University of Technology, Bellville Campus, South Africa. E-mail: seyiakinyede@yahoo.co.uk, Tel: +27845407708

² Department of Construction Management and quantity surveying Cape Peninsula University of Technology, Bellville Campus, South Africa. E-mail: fapohunda@cput.ac.za, Tel: +27740772950

ABSTRACT

Purpose: Construction operations are confronted with cost restraint during building production process in delivery of project at budgeted cost specified with quality expected. This signifies the need to investigate the factors that affect budgeted cost through achieving design of quality projects in the South African construction industry.

Design: The research includes both qualitative and quantitative methods. The surveys are conducted within Western Cape and Gauteng provinces. The information was collected from architects, structural engineers, quantity surveyors, project managers, contractors, clients and contract managers in the construction industry. SPSS software was used for quantitative data analysis and the findings obtained are validated by qualitative methods.

Findings: Findings are as follows: administration of quality during production process, changes in requirements, performing quality check before delivery of project, considering adequate design and construction during production process, involvement of skill workers, quality training for workers during production, equipment availability during production process, inadequate drawings and specification, design of poor work by stakeholders, methods of measurement during production, objectives of contractor during production and flexibility of team members in adapting to quality changes are the major significant factors that will aid in achieving effective management toward delivery of quality project in the South African construction industry.

Research limitations: This study was affected by difficulties of not having direct contact with some of the respondents, as many complained of being too busy attending contract meetings to complete the questionnaires.

Originality/value of paper: compliance with the use of identified factors will not only lead to efficient construction production processes and reduction of resources waste, but will improve client satisfaction and delivery of building project at quality expected.

Keywords: *Construction industry, Cost constraint, Delivery time, Management, Quality project*

Abstract of a paper presented at conference:

ICEC IX World Congress

Impact of Budgeted Cost on Management of Construction Resources during Building Production Processes in South Africa Construction Industry

Akinyede , I.J.¹ and Fapohunda, J.A.²

¹ Department of Construction Management and Quantity Surveying Cape Peninsula University of Technology, Bellville Campus, South Africa. E-mail: seyiakinyede@yahoo.co.uk, Tel: +27845407708

² Department of Construction Management and quantity surveying Cape Peninsula University of Technology, Bellville Campus, South Africa. E-mail: seyiakinyede@yahoo.co.uk, Tel: +27845407708

ABSTRACT

Purpose: Literature reviewed and an exploratory study conducted reveals that cost limit is a challenge to the construction in delivery of project at construction costs higher than the budgeted cost specified, thus affecting construction production processes, construction resources and delivery time significantly. Hence, this justifies the need to investigate impact of budgeted cost on management of construction resources during production process.

Design: The research explores the issue both qualitatively and quantitatively. The surveys are conducted within Western Cape and Gauteng provinces and the information was collected from architects, structural engineers, quantity surveyors, project managers, contractors, clients and contract managers in the construction industry. SPSS software was used for quantitative data analysis and the findings obtained were validated by qualitative methods.

Findings: The major findings are as follows: regular meetings on site will promote efficient productivity of human resources, increase labour productivity, reduce time waste by workforce as result of inadequate programme of work, reduce wrong job allocation to workers on site and increase effective training of worker to improve skill. Thus, proper planning of activities and efficient cost control is a necessity toward avoidance of this construction as predicaments.

Research limitations: The study was affected by difficulties of not having direct contact with some of the respondents, as many complained of being too busy attending contract meetings.

Originality/value of paper: This avoidance will not only lead to effective construction production process and reduction of resources waste, but will also augment timely delivery of construction product and stakeholders' satisfaction.

Keywords: *Construction industry, Cost constraint, Delivery time, Human resources, Production process*

Effect of Building Control Plan on Cost during Building Production Process in South Africa Construction Industry

Akinyede, I.J.¹ and Fapohunda, J.A.²

¹ Department of Construction Management and Quantity Surveying Cape Peninsula University of Technology, Bellville Campus, South Africa. E-mail: seyiakinyede@yahoo.co.uk, Tel: +27845407708

² Department of Construction Management and quantity surveying Cape Peninsula University of Technology, Bellville Campus, South Africa. E-mail: fapohundaj@cput.ac.za, Tel: +27740772950

ABSTRACT

Purpose: Construction industry operation methods are challenged with cost limitation, projects are delivered above budgeted cost and time specified. This signifies the need to investigate the effect of building control plan on cost during building production process.

Design: This study used quantitative questionnaires to collect data from architects, structural engineers, quantity surveyors, project managers, contractors, clients and contract managers in construction industry. SPSS software version 22 was used to analyse the quantitative questionnaires retrieved.

Findings: Major findings to reduce the effect of building control plan on production process includes proper operational planning toward achieving common goal by professionals and adequate quality control distinctly defined at initiating.

Research limitations: This study was affected by difficulties of having direct contact with some of the respondents and complaint of too busy by the respondents.

Value of paper: Adequate implementation of the findings of this paper will reduce construction resources waste and augment timely delivery of project and stakeholders' satisfaction.

Keywords: Budgeted cost, Cost constraint, Delivery Time, Planning, Stakeholders satisfaction.