UNIVERSITY OF NAIROBI

SCHOOL OF THE BUILT ENVIRONMENT

DEPARTMENT OF REAL ESTATE AND CONSTRUCTION MANAGEMENT

MASTER OF ARTS IN CONSTRUCTION MANAGEMENT

An Investigation of the Preference of Conventional over Scientific Methods in Determining Construction Contingency Sums

PRESENTED BY:

SIMIYU WANJALA ERICK

B53/81541/2012

A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR AWARD OF MASTER OF ARTS DEGREE IN CONSTRUCTION MANAGEMENT

DECLARATION

Declaration by the Candidate

I Simiyu Erick Wanjala, hereby declare that this thesis is my original work and has not been presented for award of degree in this university or any other institution.

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

Simiyu Erick Wanjala
(BQS, RQS, CIQSK)

Declaration by the Supervisor

This Project Report has been submitted for examination with my approval as a University of Nairobi Supervisor.

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

Christopher M. Mbatha

(BA Bldg. Econ, MA (Build. Mgt) (Nairobi) Dr.-Ing. (Wuppertal)

DEDICATION

In memory of my late dad Mr. Joseph Simiyu

ACKNOWLEDGEMENT

This thesis marks the end of a fairly short but extremely onerous and exciting journey. Though only my name appears on its cover, the fact is that I never did it alone. It was kept on track and seen through to completion via prayers, support and encouragement of numerous people that I wish to acknowledge.

Foremost I thank the Almighty God for granting me perfect health, wisdom, favour and perseverance during the research and throughout my entire life: "I can do all things through Christ who strengthens me." (Philippians 4: 13).

Special accolades to my supervisor Dr.-Ing. Christopher M. Mbatha. I was very fortunate to have a supervisor who gave me the freedom to explore on my own and at the same time guided me to recover when my steps faltered. I am extremely grateful to him for holding me to a high research standard and enforcing strict validations for each step thus teaching me how to do research. He taught me how to structure thoughts and express ideas in a simple but straight forward way. His insightful comments, patience and support which on most occasions consumed his lunch hour break, helped me to focus thoughts on important ideas.

I am also indebted to my colleagues at Masterbill Integrated Projects Limited who willingly shared their ideas and thoughts especially on the methods used to predict contingency sum for construction projects.

Most importantly this thesis could not have been successfully completed without the love, concern, support and patience of my family. In spite of the biggest loss and subsequent misfortune that befell us when our dad passed away during the study, my family's support and care helped me overcome setbacks and stayed focused on my graduate study. May God bless you all.

Finally, I appreciate all my classmates and lectures at the department of Real Estate and Construction Management for their teamwork, support and cooperation which in addition to helping me complete this thesis also enabled me serve as a class representative with joy and peace.

SPECIAL ACKNOWLEDGEMENTS

My special acknowledgements go to Qs. Eli Asura who supported me financially during the study and also allowed me to use his car especially on rainy days. In equal measure a similar appreciation to Eng. Monica Abonyo.

My warm appreciation to Qs. Esther Macharia, QS. Bellis Ochieng, Eng. Mwangi Wairagu and Eng. Levy Munyei for promptly responding to my questionnaires and for helping me follow up on other respondents.

Erick Wanjala

TABLE OF CONTENTS

CHAPTER ONE

INTRODUCTION AND BACKGROUND

CHAPTER TWO

REVIEW OF RELEVANT LITERATURE

CHAPTER THREE

RESEARCH METHODOLOGY

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

List of Figures

List of Tables

List of Charts

Acronyms

PERT - Programme Evaluation Review & Technique

**RBS - ** Risk Breakdown Structure

WBS - Work Breakdown Structure

ABSTRACT

The process of predicting contingency sum on most construction projects lacks a well defined framework since most cost experts to date continue to use conventional methods such as percentage addition and lump sum allowance methods that lack scientific justification since they are based on past experience, historical data, intuition, personal feelings and organizational culture. As a consequence, this has resulted in cost overruns on construction projects since risk and uncertain events inherent on a project are not appropriately analyzed, assessed and estimated.

This study therefore sought to establish significant weaknesses of conventional methods of contingency determination and to find out why construction cost experts continue to use conventional methods in spite of the existing scientific methods which are perceived to predict accurate contingency sum. In addition the study also attempted to ascertain whether construction cost experts had formal policies and management guidelines for estimating, controlling and reviewing the use of contingency sum and also to find out ways in which construction cost experts can continuously improve on their prediction methods and skills when determining contingency sum.

The findings of this study revealed several weaknesses of conventional methods of contingency sum determination. These included inability to analyze risk elements on projects, arbitrariness, lack of scientific basis, highly based on estimator's feelings, double counting of risk, predicts unrealistic contingency sum, promotes poor management of projects, lacks theoretical justification and creativity, results in many litigations and application restricted to similar projects. Out of the eleven weaknesses only one was found to be significant i.e. application restricted to similar projects.

Regarding the reasons for continued use of conventional methods in spite of the existing new scientific methods the study established that the most important reasons were; simplicity in application, heavy reliance on historical data, less research on scientific methods in Kenya and limited knowledge on use of scientific methods. Other reasons though not found to be important included; lack of reliable data on scientific methods, complexity of scientific methods and resistance to change. The following reasons though not tested in the study were however mentioned by the respondents to be also important; limited time in preparation of estimates for construction projects, corruption among the cost experts, inadequate training in tertiary institutions on diverse methods of contingency sum determination and simplicity in scope and specifications of projects which does not warrant the use of scientific methods. The study also established that the above reasons were not related to the professional background of cost experts.

Concerning the policies and guidelines for proper management of contingency sum, the study ascertained that most cost experts had policies for filling and signing contingency sum forms by Client & Project Manager, allocation of contingency sum to specific risk elements and outlining standard templates for plan on use of contingency sum. In addition, most cost experts did not have policies for assessing potential risks inherent on a project, accountability on the usage of contingency sum, continuous training on proper management of contingency sum and procedures for reviewing and updating contingency plan templates.

On the strategies for cost experts to continuously improve their prediction skills and methods when determining contingency sum the study established the following to be important; formulation of policies and guidelines for proper management of contingency sum, proper understanding of the process of budget making, gaining experience on application of diverse methods of contingency sum determination, generation and continuous update of historical data, adoption of risk management process, integration of risk education in built environment courses, enhanced project integration and communication, exploration of scientific methods of contingency sum determination and adoption of risk breakdown structure.

In view of the above findings cost experts should aim at learning, adopting and using diverse methods of determining contingency sum that have a scientific basis and are capable of assessing and managing risks associated with uncertain events on construction projects. This will help to minimize cost overruns on construction projects and also to effectively manage and control expenditure on contingency sum. In addition, researchers in the Construction Industry and cost experts must endeavor to simplify scientific methods in order to reduce their perceived complexity in application. Tertiary institutions such as universities and technical colleges that train cost experts must integrate risk management education in their built environment courses so as to make future cost experts graduating from these institutions aware of the tools and techniques of managing risks and uncertainties which if not properly managed can result in cost overruns.

.

CHAPTER ONE

INTRUDCUTION AND BACKGROUND

1.0 Background of the study

1.01 What is contingency?

Contingency as defined in the Oxford English Dictionary is "a future event or circumstance which is possible but cannot be predicted with certainty". According to the Investopedia Dictionary Contingency is "a potential negative economic event which may occur in the future". As a consequence finance managers often attempt to identify and plan for any contingencies that they feel may occur with any significant likelihood. In planning for contingencies, financial managers normally assume slightly worse-than expected outcomes and set aside significant reserves of money to manage and contain negative effects of contingencies with minimum distress possible (Matt Stelzman, 2014).

1.02 What is Construction Contract Contingency Sum?

Construction projects require budgets to enable developers and investors set their financial commitment and also provide a basis for cost control and measurement of cost performance (Baccarini, 2005). A key component of project budget is Contingency Sum.

According to the Architect's Handbook of Professional Practice (2008), contingency sum is the amount or percentage included in the project budget to cover for unforeseeable or unpredictable changes and uncertainties during construction. Allocation of contingency sum according to Touran (2003) is a common practice on construction projects because uncertainties if not well managed have the potential of adversely affecting the project thus resulting in escalation of the contract price beyond the predicted contingency sum. Therefore the estimation of contingency sum and its ultimate adequacy is of critical importance to projects.

As an overall risk management strategy prior to commencement of construction work, contingency sum is normally estimated and added to the contract price to represent the predicted final cost of the project (Baccarini David, 2004). However, the actual final cost of a project is the sum of the contract price plus approved contractual variations. Hence the accuracy and effectiveness of contingency sum can be measured by comparing the predicted final cost against the actual final cost (Baccarini David, 2004).

1.03 Objectives of Contingency sum

The main objective of contingency sum according to Boukendour (2005) is to prevent a project from experiencing cost overrun due to variations. This is in agreement with Bello & Odusami (2012) who posited that "the ambition of building clients and consultants is to keep the final construction cost within the initial budget estimate that includes a justified additional amount that caters for contingency sum". Thus allocation of contingency sum to projects ensures that the estimated project cost is realistic and sufficient to contain any variations linked to risks and uncertain events (Mak, Wong and Picken, 1998).

1.04 Cost Overruns on construction projects

One of the major challenges facing the Construction Industry in developing countries like Kenya is the chronic problem of cost overruns (Kasimu, 2012) in spite of the allocation of contingency sum to avert the overruns. As defined by Jomah (2008), cost overrun is the excess of actual project cost over the set budget and is sometimes called "cost escalation," "cost increase," or "budget overrun." It usually occurs whenever the initial contract price at the time of signing the contract is exceeded due to variations thus resulting in a higher final project cost than the initial estimated contract price. For ease of comparison, cost overrun can be expressed as a percentage of change in contract amount over the original contract amount awarded (Jackson 1999). As aforementioned and further substantiated by JaneCameron (2012) contingency sum is meant to cover for variations emanating from unforeseen events occurring on a construction project. Thus the estimated final contract price of a construction project is composed of the predicted contingency sum and contract price at the time of signing the contract (ACQS, 2012). However, at completion the difference between the final contract price and the initial contract price gives the total approved variations which in theory is expected to be equal to the predicted contingency sum (David Baccarini, 2004). However, in Kenya this is rarely achieved on most construction projects thus resulting in escalation of the contract price in spite of the inclusion of contingency sum in the contract price. As found out by Abwunza (2006), contingency sums allocated on most construction project are too inadequate to provide sufficient cover against escalation of contract price. The major causes of escalation of contract price in Nigeria as identified by Kasimu (2012) include inflation in prices of materials, labour and machinery, incomplete designs at the time of tendering, additional work request by clients, changes in owner's brief, poor ground conditions, adjustment of prime cost and provisional sums, re-measurement of provisional sums, technical omissions, contractual claims, tendering maneuvers by contractors such as front loading of rates among others.

1.05 Contractual basis of Need for Contingency sum

(a) Types of contracts

The contractual basis of the need for contingency sum on a construction contract stems from the use of various types of contracts favored by circumstances peculiar to a given construction project. Most construction projects are normally procured on either a firm price or fluctuating price contract (Kwakye, 1997). Firm price contracts are those where the contractor's claim for reimbursement of changes in costs is limited to those relating to statutory contributions, levies and taxes while in fluctuating price contracts the contractor can claim for reimbursement of changes in cost to cover a wide range of items such labour, material and plant costs as well as statutory contributions. Since there is a possibility of contractors making claims in both types of contracts, contingency sum is normally allowed to pay for such claims whenever they occur.

(b) Variations

In addition, the need for contingency sum on construction projects is necessitated by the inclusion of variation and fluctuation clauses in the various standard conditions of contracts used in Kenya. The inclusion of these clauses is due to the fact that it is almost inevitable to have changes or additional works to the original scope of the project JaneCameron Architects (2012) thus most building contracts allow for variations and adjustments to the contract price. Variations as defined in the JCT standard forms (2011) are alterations or modifications of the design, quality or quantity of the works. This includes the addition, omission or substitution of any work or the alteration of the kind or standard of any materials or goods to be used in the works or the removal from the site of any work executed or materials or goods brought thereon by the contractor for the purposes of the works other than materials or goods which are not in accordance with the contract. For instance clauses 30 and 35 of the JBC contract (1999) give provisions for variations and fluctuations respectively while clauses 22 and 25 of the PPOA (2006) conditions of contract gives provisions for variations and price adjustments respectively. Contingency sums are therefore allowed for in construction contracts to cushion the project from experiencing escalation of contract price due to factors favoured by variations and fluctuations clauses in the various conditions of contract.

(c) Size of project

On smaller projects as established by Gary Jackson (2012), the application of formal risk management processes under relevant clauses in the conditions of contract such risk transfer to insurers takes a longer time to implement thus considered unpractical and unfeasible due to time constraints. Since the practice of contingency sum allocation is not restricted by time, it therefore becomes a more credible risk management tool especially on smaller projects.

1.06 Determinant Factors of contingency sum

There are several influential factors that affect the estimating process and the amount of predicted contingency sum (Baccarini David, 2004). These are quite varied and hence grouped into technical, economic and institutional factors (Owusu Tawiah, 1999). Technical factors include Project specification, Form of procurement/contract, Site characteristics, Project duration, Project management, Design considerations, Unexpected ground conditions, Material and plant among others. Economic factors include; Tax liabilities, Inflation and Exchange rates while Institutional factors include; Location, Land acquisition, Force Majeure, organizational policies and estimator's cognitive bias.

1.07 Methods of contingency sum determination

There are various methods used to determine contingency sum for construction projects. One of the most common methods used is the percentage addition of the estimated price based on previous experience with similar projects. According to Baccarini (2004) contingency sums are often calculated as a percentage addition to the base estimate, typically derived from intuition, past experience and historical data. This approach is however considered arbitrary since quite often risk is either ignored or dealt with in an arbitrary way by simply adding an impulsive percentage onto the estimated cost of a typical project as a contingency sum. Other non scientific methods include Lump sum amount allowance and Cost item allocation. Over time researchers have also developed other scientific and statistical methods of predicting contingency sum such as Probabilistic itemized allocation, Programme evaluation review and technique (PERT), PERT with modified variance, Monte Carlo simulation, Fuzzy set theory as identified by (Moselhi, 1997) and Network approach to risk assessment and allocation developed by Chen & Hartman, (2000) with the use of Artificial Neural Network. The most recent method of predicting contingency sum is the Contingency Tracking System (CTS).

1.08 Effectiveness of Contingency Sum

At the pre-contract stage during the preparation of estimates for construction projects, it is often expected that the contingency sum allocated to a project would be sufficient to cover for escalation of contract price. However, Bello and Odusami (2008) observes that the effectiveness of contingency sum allocated is dependent on adequate consideration given to the factors that are responsible for the changes in scope of works. Effectiveness of contingency sum according to Baccarini (2005) can be expressed in terms of a comparison between the predicted final cost and the actual final. Broadly, the smaller the difference between these two costs the more accurate the contingency value and thus the more effective the methodology used in determining contingency.

1.09 Observations about the inadequacy of Contingency sum

However, it has been observed that quite often contingency sums allocated to construction projects in Kenya are not adequate to provide sufficient cover against escalation of contract price. This observation is substantiated further by Abwunza A (2006) who in his research thesis established that the allowances made for contingency sums in construction projects were too inadequate to cater for all unforeseen risk events.

The inadequacy of the contingency sum allocated to construction projects could be attributed to the inappropriate methods used to predict the required amount as suggested by David

Baccarini (2005). Most construction cost experts use a deterministic percentage addition method. This method according to Mak at al (1998) is a single figure prediction of the estimated cost which implies a degree of certainty that cannot be justified. In addition, the method is said not to encourage creativity in estimation practices thus promoting a routine and mundane administrative approach requiring little investigation and decision making which may propagate oversight (Yoe 1990, Mak et al 1998). Woollett (1998) warns that a contingency sum based on a percentage of the total project cost does not allow accountability for its expenditure as all parties normally assume that the contingency sum is their own and that because it is unforeseen, it is without limit.

1.010 Management of Contingency Sum

Once contingency sum has been established it is good management practice by the cost experts consulting on a project to constantly monitor, control, reassess and scrutinize its use throughout the project life cycle (CIRIA 1996, Lorance 1992). As a consequence it is prudent for the consulting firm to have a formal documented policies and management guidelines for estimating, defining and controlling the scope of contingency sum usage (Hamburger, 1994). In addition, as part of their quality management process they should undertake a post project review to establish the accuracy and effectiveness of the contingency sum in averting variations (David Baccarini, 2005). The findings of the review should therefore enable them to constantly and continuously improve on their estimation methods in predicting the correct required contingency sum (David Baccarini, 2005).

1.2 Statement of the Problem

One of the major challenges facing the Construction Industry in developing countries like Kenya is the chronic problem of cost overruns (Kasimu, 2012). This is in spite of the addition of contingency sum to the contract price to avert the overruns. As observed by Masu S.M

(2006), over 50% of projects in Kenya were likely to escalate in cost. In addition, Nyamoki (2012) observed that many construction projects in Kenya whether in the public or private sector experience cost overruns notwithstanding the inclusion of contingency sum in the contract price to avert the overruns.

Since the occurrence of cost overruns, as posited by Merrow & Schroeder (1991) and cited by Baccarini (2006), is considered as inadequate contingency sum within the cost estimates, the frequent occurrence of cost overruns in Kenya as reported above suggests a possible underestimation of the required contingency sum for construction projects. This is further substantiated by Abwunza (2006) who in his research report established that the allowances made for contingency sums on construction projects in Kenya were too inadequate to cater for all unforeseen risk events thus resulting in cost overruns. Inappropriate contingency sums as posited by Oduro et al (2013) have quite often resulted in poor management of risk leading to underestimation or overestimation of project budget, delay in the completion of projects and abandonment of projects altogether in Ghana. In particular, overestimated contingency sums limit the cash-flow to contractors.

The adequacy of contingency sum allocated to construction projects according to Bello & Odusami (2009) is dependent on the methods used and factors considered in predicting the required contingency sum. Most construction cost experts according to Ali (2005) have adopted conventional methods of estimating the required contingency sum to take care of uncertain events that might occur on a construction project. Thus the frequent occurrence of cost overruns on construction projects in Kenya implies a potential weakness in the conventional methodologies used by cost experts in determining the required contingency sum.

One of the most common and simplest conventional method of estimating contingency sum for Construction Projects is the percentage addition method which considers a percentage of the estimated contract value such as 10% across the entire project typically derived from intuition, past experience and historical data (Baccarini, 2004 and Gunman & Arditi, 2007). Other conventional methods include Lump sum amount allowance and Cost item allocation (Bello & Odusami, 2008). These methods according to Baccarini (2004) are subjective and arbitrary since they are based on intuition and past experience. Hence quite often they result in risk being either ignored or dealt with in an arbitrary way by simply adding an impulsive percentage or amount onto the estimated cost of a typical project as contingency sum. In addition, the conventional methods according to Mak et al (1998) lead to a single figure prediction of estimated cost which implies a degree of certainty that cannot be theoretically justified. It is against this background that it has become necessary for this study to find out the weaknesses in the conventional methods of contingency sum determination as applied by cost experts in the Kenya's Construction Industry.

Alternative scientific methods have been developed by researchers to address problems associated with inappropriate contingency sum (Oduro et al, 2013). These methods include; Probabilistic itemized allocation, Programme evaluation review and technique (PERT), PERT with modified variance, Monte Carlo simulation, Fuzzy set theory (Moselhi,1997) and Network approach to risk assessment and allocation developed by Chen & Hartman,(2000). The above methods according to Oduro et al (2013) are devoid of subjectivity and give more accurate contingency figures thus enabling cost experts minimize cost overruns on construction projects and also effectively manage and control expenditure on contingency sum. However, in spite of the efforts by researchers in developing scientific and statistical methods of estimating and management of contingency, cost experts and practitioners in the construction industry continue to use the conventional method of lump sum or percentage addition (Bello and Odusami, 2008). This study therefore seeks to find out why construction cost experts continue to use the conventional methods of contingency sum determination in spite the development of new scientific methods that are perceived to predict more accurate contingency sums.

Two ways of improving the prediction of contingency sum as suggested by David Baccarini (2005) are; one by cost experts having formal policies and management guidelines for estimating and two by controlling the use of contingency sum and by continuously improving their prediction skills by undertaking a post project review to assess the accuracy and effectiveness of the contingency sum in averting variations. In view of the frequent cost overruns on most construction projects in Kenya, the study will seek to establish whether construction cost experts have formal policies and management guidelines for estimating, controlling and reviewing the use of contingency sum.

In addition, Adafin et al (2013) observes that most cost experts do not show any sign of improving their approach in contingency sum determination and management as they are stuck to the conventional methods of lump sum and percentage addition to project base estimate. This study will therefore attempt to find out ways of improving the current conventional methods of predicting contingency sum for construction projects.

The findings in this study will form a matrix for making recommendations geared towards improving the methodologies of predicting contingency sums for construction projects in Kenya.

1.3 Research Objectives

(i) To establish significant weaknesses of conventional methods of contingency sum determination.

(ii) To find out why construction cost experts continue to use the conventional methods of contingency sum determination in spite of the existing new scientific methods?

(iii) To ascertain whether construction cost experts have formal policies and management guidelines for estimating, controlling and reviewing the use of contingency sum?

(iv) To find out ways in which construction cost experts can continuously improve on their prediction methods and skills when determining contingency sum?

1.4 Research Questions

(i) What are the significant weaknesses of conventional methods of contingency sum determination?

(ii) Why do construction cost experts continue to use the conventional methods of contingency sum determination in spite of the existing new scientific methods?

(iii) Do construction cost experts have formal policies and management guidelines for estimating, controlling and reviewing the use of contingency sum?

(iv) How can construction cost experts continuously improve on their prediction skills when determining contingency sum?

1.5 Research Hypothesis

Main Hypothesis

H_0: The important reasons for continued use of deterministic conventional methods of contingency sum determination in spite of existing new scientific methods are not simplicity in application, limited knowledge on application of scientific methods, lack of credible local research on scientific models, complexity of scientific methods, heavy reliance on historical data, resistance to change and lack of reliable data.

H_A: The important reasons for continued use of deterministic conventional methods of contingency sum determination in spite of existing new scientific methods are simplicity in application, limited knowledge on application of scientific methods, lack of credible local research on scientific models, complexity of scientific methods, heavy reliance on historical data, resistance to change and lack of reliable data.

Sub Hypothesis 1

H_0: The significant weaknesses of conventional methods of contingency sum determination are not; prediction of unrealistic contingency sum, arbitrariness, lack of scientific basis & theoretical justification, restricted to similar projects, dependant on estimator's feelings, unable to analyze risk, double counting of risk, promotion of poor management of the project, lack of creativity and many litigations.

H_A: The significant weaknesses of conventional methods of contingency sum determination are prediction of unrealistic contingency sum, arbitrariness, lack of scientific basis & theoretical justification, restricted to similar projects, dependant on estimator's feelings, unable to analyze risk, double counting of risk, promotion of poor management of the project, lack of creativity and many litigations.

Sub Hypothesis 2

H_0: Most construction cost experts do not have a policies and guidelines for formulation and management of contingency sum.

H_A: Most construction cost experts have a policies and guidelines for formulation and management of contingency sum.

Sub Hypothesis 3

H_0: The important strategies for continuously improving the methods and skills predicting contingency sum are not formulation of policies and guidelines for estimating and management of contingency sum, exploration of scientific methods, proper understanding of the process of making budget, risk management process, use of historical data on projects, integration of risk education in built environment courses, project integration and communication and use of risk Breakdown Structure.

H_1: The important strategies for continuously improving the methods and skills predicting contingency sum are formulation of policies and guidelines for estimating and management of contingency sum, exploration of scientific methods, proper understanding of the process of making budget, risk management process, use of historical data on projects, integration of risk education in built environment courses, project integration and communication and use of risk Breakdown Structure.

1.6 Study Area and Scope

The main study area adopted in this research is resource planning which is a tool for Project Cost Management and one of the main knowledge areas of Project Management. This study explores more on the methods of contingency sum determination both scientific and conventional and in particular retrospects reasons for continued us of conventional methods in spite of the existing scientific methods in view of their advantages and weaknesses.

The study also reviews policies and guidelines for proper management of contingency sum use during the execution of a construction project.

1.7 Justification of the Research

As observed by Nyamoki (2012) many construction projects in Kenya whether in the public or private sector experience cost overruns notwithstanding the inclusion of contingency sum in the contract price to offset any cost overruns. This has become a major problem in Kenya's construction industry and it indicates a possible failure in the methods of predicting contingency sum on construction projects. Hence, an investigation into the preferred use of conventional methods of contingency sum determination over scientific methods on construction projects in Kenya will reveal weaknesses of conventional methods of contingency sum determination that will help recommend and suggest possible strategies for improving methods and skills of predicting contingency sum.

Thus the findings of this study will enable cost experts predict accurate contingency sum so as to minimize frequent occurrence of cost overruns on construction projects.

1.8 Organization of the Study

The research report is organized into five chapters structured as follows;

- **Chapter one** gives a brief introduction of the study and further explains the problem statement, research questions, objectives, hypothesis, scope and justification of the study.
- **Chapter two** reviews relevant literature and provides information about the main subjects such as methods of contingency sum determination, their advantages, weaknesses, reasons for continued of conventional methods, policies and guidelines for proper management of contingency sum.
- **Chapter three** provides a research plan. It explains the research paradigm, approaches and strategies for collection, analysis, interpretation and presentation of data.
- **Chapter four** provides results from the survey that are essential for confirming or rejecting the hypotheses and also for making comparison with the reviewed literature.
- **Chapter five** summarizes the main issues highlighted in the thesis and also provides an overview of the main findings. It also confirms whether the research project met its proposed objectives by confirming or rejecting the respective hypotheses and gives recommendations arising from the foregoing analysis.

CHAPTER TWO

REVIEW OF RELEVANT LITERATURE

2.0 Concept of Construction Contingency Sum

2.1Introduction

According to The Architect's Handbook of Professional Practice, (2008), construction contingency sum is the amount of money or percentage included in the project budget to cover unpredictable changes in the work or items of work. It is the amount of money set aside to cope with uncertainties during construction (Wasiu & Koleola, 2012). It serves three core purposes;

(a) To account for errors and omissions in the construction documents.

(b) To modify or change the scope of the project.

(c) To pay for unknown conditions.

As articulated by Hart (2007) the main aim of contingency sum allowance, as a risk management tool on construction projects, is to facilitate the completion of a project within the set budget. This is achieved by funding additional work that could not reasonably have been foreseen at the design stage (Mark Hackett, 2007).

2.2 Distinction between contingency allowance and provisional sums

Provisional sum as defined in the JBC (1999) conditions of contract is a sum included in the contract bills for the execution of work whose scope cannot be entirely foreseen, defined or detailed at the time the tender documents are issued while contingency sum is the amount of money added to the base estimate to account for work that is difficult or impossible to identify at the time a base estimate is being prepared (Peurifoy & Oberlender, 2004).

2.3 Risk and uncertainty on construction projects

Kwakye (1999) observes that construction projects are complex, have long production cycle and involve input from a multitude of participants. They are therefore associated with risks and uncertainties. The extent of risk and uncertainty depends on the size, complexity, novelty and technical sophistication of the project.

However, risks and uncertainty do not refer to the same concept and it is useful at this stage to clarify the difference between them. Risk may be described as unwanted negative consequence of an event whose possible outcome can be identified, predicted and quantified while uncertainty is an unknown situation whose possible outcome cannot be analyzed or predicted hence not transferred to a third party (Kwakye, 1999). This therefore necessitates the allocation of contingency sums on construction projects to cover for the eventuality of uncertain events (Kwakye, 1999).

2.4. Contingency sum and Uncertainty

Contingency sum is normally allocated on construction projects on the basis of uncertainty (Peurifoy & Oberlender, 2004). Uncertainty as defined by Kwakye (1997) is an unknown situation whose possible outcome cannot be analyzed or predicted and hence cannot be transferred to a third party. Uncertainties occur on construction projects due to the fact that works on construction projects are normally executed within the constraints of time, resources, performance and are further exacerbated by conflicting objectives of the parties involved.

2.5 Objectives of Contingency sum

The main objective of contingency sum according to Boukendour (2005) is to prevent a project from experiencing escalation of contract price due to variations and fluctuations. This is in agreement with Wasiu & Koleola (2012), who posits that "the ambition of building clients and consultants is to keep the final construction cost within the initial budget estimate that includes a justified additional amount that caters for contingency". This is aimed at ensuring that the estimated project cost is realistic and sufficient to contain any cost incurred by risks and uncertainties (Mak, Wong and Picken, 1998).

It has quite often been stated that construction is more of an art than a science (Newell, 2011). As a result it is impossible to know in advance every issue or challenge that will be encountered once construction commences. The guarantee that the construction team has before beginning construction is that they will discover unplanned items during the process. This is in agreement with a statement by Risner (2010) who postulated that contingency sum for construction projects is necessitated by the fact that "no matter how hard Architects and Engineers try to develop a set of construction drawings that are infallible, there are always errors or omissions embedded in their drawings." Thus Quantity Surveyors and Services Engineers normally include an allowance for contingency sum to account for change order growth or variations (Wasiu and Koleola, 2012) and also to improve the accuracy of cost estimates by compensating for inherent inaccuracies.

According to Wasiu & Koleola (2012), contingency sums are crucial in achieving the project's objectives and are of essence when included in the development budgets since they provide managers with flexibility required to address uncertainties and deviations that may threaten the achievement of the Project's objectives. As noted above, uncertainty on a project cannot be transferred to a third party since it is unknown. This therefore makes the allocation of contingency sum a must for most projects.

Yeo (1990) states that contingency sum ensures that the budget set aside for the project is realistic and sufficient to contain the risk of unforeseen cost increases. As a result contingency sum serves as a basis for decision making concerning financial viability of the variations and also is a baseline for their control (Akinsola, 1996).

2.6 Contractual basis of the need for contingency Sum

2.6.1 Types of contracts

The contractual basis of the need for contingency sum on a construction contract stems from the use of various types of contracts favoured by circumstances peculiar to a given construction project. Most construction projects are normally procured on either a firm price or fluctuating price contract (Kwakye, 1999). Firm price contracts are those where the contractor's claim for reimbursement of changes in costs is limited to those relating to statutory contributions, levies and taxes while in fluctuating price contracts the contractor can claim for reimbursement of changes in cost to cover a wide range of labour, material and plant costs as well as statutory contributions. Since there is a possibility of contractors making claims in both types of contracts, contingency sum is normally allowed to pay for such claims whenever they occur.

2.6.2 Variations

In addition, the need for contingency sum on construction projects is necessitated by the inclusion of variation and fluctuation clauses in the various standard conditions of contracts used in Kenya. Variations as defined in the JCT standard form (2011) are alterations or modifications of the design, quality or quantity of the works. This includes the addition, omission or substitution of any work or the alteration of the kind or standard of any materials or goods to be used in the works or the removal from the site of any work executed or materials or goods brought thereon by the contractor for the purposes of the works other than materials or goods which are not in accordance with the contract. For instance clauses 30 and

35 of the JBC contract (1999) give provisions for variations and fluctuations respectively while clauses 22 and 25 of the PPOA (2006) conditions of contract gives provisions for variations and price adjustments respectively. Contingency sums are therefore allowed for in construction contracts to cushion the project from experiencing escalation of contract price due to factors favoured by variations and fluctuations clauses in the various conditions of contract.

2.6.3 Size of project

On smaller projects as established by Gary Jackson (2012), the application of formal risk management processes under relevant clauses in the conditions of contract such risk transfer to insurers takes a longer time to implement thus considered unpractical and unfeasible due to time constraints. Since the practice of contingency sum allocation is not restricted by time, it therefore becomes a more credible risk management tool especially on smaller projects.

2.7 Significance of contingency sum in Contract Price

Most construction projects whether public or private normally make contingency sum as part of the contract price. Occasionally a developer might elect not to make contingency sum as part of the general construction contract, but may designate some arbitrary sum of money separate from the construction contract to cover for any additional costs in the work. However, on most occasions it is preferable to include contingency sum in the contract sum because of the following reasons (Newell, 2011);

(a) To prevent escalation of contract price.
(b) To shield the developer from sourcing for additional funds to cater for variations in case they arise since such works will utilize funds already provided for in the contract price as contingency sum.

(c) In case contingency sum is not consumed it is a bonus to the developer.

However, it must be clearly understood that construction contingency sum is not an open account for the contractor to use at his discretion. All expenditures from the contingency fund must be proposed by the contractor and then approved be the client and project manager prior to being authorized.

2.8 Attributes of contingency sum

The key attributes of contingency sum are as follows:

***(a)* Reserve**

Contingency sum is a reserve of money which is a provision in the project plan to mitigate escalation of contract price (PMI 2000).

***(b)* Risk and Uncertainty**

The need and amount of contingency sum reflects the existence of risk and uncertainty in projects (Thompson and Perry 1992). Contingency sum caters for events within the defined project scope that are unforeseen (Moselhi 1997, Yeo 1990), unknown (PMI 2000), unexpected (Mak et al 1998), unidentified (Levine 1995), or undefined (Clark and Lorenzoni 1985, Thompson and Perry 1992).

***(c)* Risk Management tool**

There are a range of risk management strategies for managing risks on construction projects such as risk transfer, risk reduction and financial treatments for retained risks. Contingency sum provides means of reducing the impact of retained risks in case they occur and therefore is an antidote to risk (Rosenau, 1992 cited in Baccarini, 1998a, P7). However, in as much as contingency sum allocation is a valid risk treatment strategy it should never be a substitute for proper risk analysis (Martin and Heaulme, 1998 cited in Baccarini, 1998a, P7). It should however be applied in conjunction with other risk treatment strategies.

***(d)* Total Commitment**

Cost estimates are normally prepared and contingency sum added in order to indicate the likely total cost of the project. The inclusion of contingency sum within a budget estimate means that the estimate represents the total financial commitment for a project. Contingency sum must avoid the need to appropriate additional funds and hence reduce the impact of overrunning the cost objective (Gary Jackson, 2012).

***(e)* Project Outcomes**

Contingency sum can have a major impact on project outcomes for a project sponsor. If it is too high it might encourage haphazard cost management causing the project to be uneconomical and aborted and may also lock up funds making them unavailable for other investment options (Baccarini, 2004). However, if too low it may be too rigid and set an unrealistic financial environment resulting in unsatisfactory performance outcomes (Dey et al 1994).

2.9 Types of Contingency sums on construction projects

There are three major categories of contingency allowance for construction projects;

(a) Design contingency.

(b) Construction Contingency.

(c) Special risk contingency.

2.9.1 Design contingency sum

Design contingency sum is normally for changes during the design process for such factors as incomplete scope definition and inaccuracy of estimating methods and data (Clark and Lorenzoni, 1985). During the design stage when many aspects of the project are unresolved or perhaps not yet fully understood the contingency sum is normally higher as a proportion of the total budget. A Quantity Surveyor, who is a professionally trained cost expert, is normally consulted to provide realistic cost estimates and advice in accurate cost planning and establishment of a project budget at the commencement of a project (JaneCameron Architects, 2012).

2.9.2 Construction contingency sum

Construction contingency is for changes during the construction (Akinsola, Potts, Ndekugri and Harris (1997); Mak et al (1998); Mak and Picken (2000) and Baccarini, 2005). Once the design is finalized and construction is about to begin contingency sum serves a different purpose. Unlike the design contingency, which is provided to enable the developer and the design team develop the design in the most appropriate way, construction contingency sum is normally reserved for expenditure on unforeseen items that arise during the construction stage. It may either be included in the construction contract as a provisional sum or be held by the client outside the construction contract. It is designed to cover costs that are incurred when the project is under construction and might include latent conditions, belated authority requirements or minor costs flowing from the contract documentation (JaneCameron Architects, 2012).

2.9.3 Special risks contingency sum

Special risks contingency sum covers risks arising from higher land acquisition costs, changes in external factors such as the availability of funds, statutory requirements and force majeure (European Commission, 1997). It also covers risks arising from a project sponsor changing his mind about the project specification which is a fairly common occurrence.

2.10 Methods of Estimating Contingency sum

Contingency sum on construction projects is calculated in various ways depending on the type of organization and level of project sophistication (Adafan et al, 2013). The common methods as identified by Bello and Odusami (2008) can be broadly categorized into two groups;

(a) Conventional Methods.

(b) Scientific Methods.

2.10.1 Conventional Methods.

Conventional methods according to Adafan et al (2013) are the traditional methods of predicting contingency sum for construction projects and are based on intuition, past experience and historical data. As a consequence they are considered to be deterministic and arbitrary since quite often risk is either ignored or dealt with in an arbitrary way (Thompson & Perry, 1992). Mak and Picken (2001) maintained that the practice of presenting project cost plan estimate as a deterministic figure comprising a base estimate and the addition of a single contingency amount i.e. percentage addition or lump sum has been adopted in the construction industry for a long time for budgeting purposes.

Thus on most projects, contingency sum has been formulated as a single lump sum with no attempt to identify, describe and value various categories and possible areas of uncertainty and risk. This has quite often resulted in contingency sum amounting to an educated guess at best (Adafan et al, 2013). Despite the efforts by researchers in developing scientific and statistical methods of estimating and management of contingency, cost experts and practitioners in the construction industry continue to use conventional method of lump sum or percentage addition (Bello and Odusami, 2008). Some of the conventional methods of determining contingency sum for construction projects according to Bello & Odusami (2008) are;

(a) Lump sum allowance

(b) Percentage addition

(c) Cost Item Allocation

2.10.1.1 Lump Sum Amount Allowance

Hogg (2003) reported 'intuitive perception' as the most adopted method of assessing the amount of contingency sum whereby the consultant Quantity Surveyor allows a single figure for risk that reflects the overall perception of the project. Other researchers like Adafin et al (2013) reported this method but Hogg (2003) distinguished it from percentage addition in his findings.

2.10.1.1.1 Reasons for continued use of Lump Sum Allowance

(a) Simplicity in application

Teye et al (2012) established that the percentage addition method is the simplest and easiest method in application since contingency sum is well expressed as a lump sum amount which is quite convenient for comparative purposes.

(a) Limited knowledge in application of scientific methods

The knowledge about comprehensive risk modeling including statistical and probabilistic analysis in the industry is low thus limiting their application (Teye et al, 2012). This has resulted in the preferred use of conventional methods of contingency sum determination such as lump sum amount allowance.

(b) Lack of credible research on scientific models

As established by Teye et al (2012), there is lack of credible research on the formulation and application of scientific models to rely on by cost experts when predicting contingency sum. As a consequence cost experts lack confidence in the application of foreign scientific methods thus resulting in the frequent use of conventional methods such as lump sum amount allowance. In addition, external research undertaken is based on information from other countries and hence cannot be applied locally. Teye et al (2012) also observes that the industry players do not have enough time for such research and would rely on the academics for new ideas.

(c) Complexity of scientific methods

Some of the scientific methods of determining cost contingency are cumbersome and too mathematical hence difficult to comprehend and apply Teye et al (2012). This has resulted in the preferred used of conventional methods such as lump sum amount allowance.

(d) Heavy reliance on historical project data.

Most cost experts perceive lessons learned and experience from previous projects and improvement or modification of the same on subsequent projects to be the best method of predicting contingency sum. This has favoured the use of conventional methods such as Lump sum amount allowance since they heavily rely on historical data when predicting contingency sums (Teye et al, 2012).

(e) Resistance to change

Most cost experts have over the years adopted conventional methods of determining contingency sum such as percentage addition and Lump sum amount allowance with a strong perception that it has worked for them. As a consequence they are adamant to change and not ready to embrace new scientific methods which have been tested and proven to be accurate (Teye et al, 2012).

(f) Lack of reliable data

The Construction Industry lacks a cogent and reliable data for use by cost experts when predicting contingency sums for construction projects (Teye et al, 2012)

2.10.1.1.2 Advantages of Lump Sum Allowance method

Some of the advantages of Lump sum allowance method as outlined by (Oduro, 2008) include the following;

(a) Simple to determine and ease to understand.

(b) The method avoids the need to request for additional funding.

2.10.1.1.3 Weakness of Lump sum Allowance method

(a) **Prone to predicting unrealistic contingency sum**

The main challenge associated with Lump sum allowance method according to Baccarini (2004) is the complete disconnect between the magnitude of contingency sum predicted and the magnitude of risk inherent on a project. According to Alaa et al (2006) cited in Oduro (2008) the method is quite rigid thus prone to set low and unrealistic contingency sum which may result in unsatisfactory project outcome and losses on the capital invested on the project. In addition, if contingency sum is over estimated it locks up funds that might be needed for other organizational activities.

(b) **Arbitrariness**

The arbitrariness of the Lump sum allowance method stems from the fact that it is solely based on past experience, intuition (Teye at al, 2012) and historical data (Bello and Odusami 2008). As a consequence this method according to Adafin et al (2013) is unscientific and ineffective to predict the correct contingency sum thus resulting in cost overruns.

(c) **Lack of scientific basis**

Conventional methods are said to be unscientific and quite often result in project cost overruns (Hartman, 2000). Teye at al (2012) agrees with Hartman (2000) and further posits that these methods are devoid of a scientific basis of determining contingency sum thus prone to unstable price indicators. In addition, these methods are further saddled with the challenge of lack of a well aggregated scope definition and a proper preliminary risk assessment of cost.

The challenge for lack of basis for the determination and provision of adequate contingency sum results in:

- Cost overruns in the project
- Time overruns due to the delays in payment resulting from disputes over the contractors' claims
- Lack of proper basis for contingency management
- Abandonment of the project due to lack of adequate funds
- Delay in the use of the project for downstream business or social benefit
- Characterization of the construction industry as a high risk industry due to loan defaulting by contractors and client.

(d) **Lacks theoretical justification**

Contingency sum formulated by percentage or lump addition still results in a single-figure prediction of estimated cost which theoretically implies a degree of certainty that cannot be justified (Teye et al, 2012).

(e) **Application restricted to similar comparable projects.**

One of the difficulties in using the percentage addition method to estimate new contingency sum is that the projects should be of the same type and kind in many aspects so that they can be comparable easily and effectively (Ergin A.A, 2005).

(f) **Highly related with the estimators feelings**

Another problem of using conventional methods of contingency sum determination is that it is highly based on the estimator's feelings at the time of estimating (Ergin A.A, 2005). For example it's possible for the same person to use different values of contingency sum for a similar project. In addition, the method is heavily dependent on an estimator's faith in his or her own experience (Yeo, 1990).

(g) Unable to analyze uncertainty and risk inherent on construction projects

Adafin et al (2013) observed that Lump sum allowance method does not attempt to identify, describe and value various categories and possible areas of uncertainty and risk inherent on a project. Oduro (2008) concurs and further criticizes the method for not being analytical in assessing risk factors which quite often encourage poor cost management causing projects to be uneconomical and sometimes aborted.

(h) Double counting of risk

There is a tendency to double-count risk because some cost experts for instance services engineers are inclined to include contingency sums in their base/ initial estimate (Teye et al, 2012).

(i) Promotes poor management of the project

The arbitral contingency sum amount added to the initial base estimate indicates a potential for detrimental or downside risk. However, it does not indicate any potential for cost reduction and may therefore hide poor management of the execution of the project (Teye et al, 2012). In addition, a deterministic percentage or lump sum contingency amount tends to direct attention away from time, performance and quality risks.

(j) Lacks creativity

Conventional methods such as lump sum allowance do not encourage creativity in the practice of estimating contingency sum for construction projects. As a consequence (Teye et al, 2012) the practice has become routine and mundane hence propagating oversights. Conversely Adafin et al (2013) also observed that "cost experts do not show any sign of improving their approach to contingency sum estimation and management as they are stuck to the conventional methods of lump sum and percentage addition to project base estimate".

(k) **Many Litigations**

Unrealistic contingency sums formulated by conventional methods are subject to many claims which if not properly managed can result in many acrimonious litigations (Oduro, 2008).

2.10.1.1.4 Ways of improving the Lump Sum Allowance Method.

(a) Cost expert to gain more experience in estimating

In order to make a fine and accurate contingency sum estimation using the lump sum allowance method cost experts should gain more experience in estimating construction costs and be in a position to remember and apply crucial cost details of past projects on current projects.

(b) Policies and guidelines for estimating contingency sum

Baccarini (2005) stated that many organizations in Australia do not have policies or guidelines for the estimation and management of project's contingency sum. He therefore recommended for the formulation of clear policies and guidelines for predicting and use of contingency sum.

(c) Exploring scientific methods of contingency sum determination

Hobbs (2010) observes that the first point of consensus for improving the conventional methods is to connect the magnitude of the contingency sum with the magnitude of project risk. As consequence scientific methods should be used to qualitatively characterize project risks using a structured and hierarchical model such as a risk taxonomy or risk breakdown structure. Oduro (2013) agrees with Hobbs (2010) and also recommends the consideration and use of scientific methods since they are comprehensive in analyzing uncertain risky parameters that have the potential of adversely affecting the project.

(d) Proper understanding of the process of making budget

Determination of an appropriate contingency sum requires an understanding of how estimators make budget contingency sum decisions and the impact on the level of accuracy of the included contingency sum (Oduro, 2013).

(e) Adoption of risk management process

To determine a realistic contingency margin, Ali (2005) holds that this must be estimated using risk management process.

(f) Generation and continuous update of historical data

Lessons learned including data and experiences from previous projects should be used as basis for improvement on subsequent projects when determining contingency sum (Teye, 2012). Cost experts therefore have a duty to develop a data base of project information on previous projects to provide a rich stock of cost information which will be valuable when predicting contingency sum for future projects.

(g) Integration of risk education in built environment courses

The gradual shift in approach of determining contingency sum can begin with the introduction of risk analysis and management education into the curricula of built environment programmes (Teye, 2012). This would make future graduates aware of the use of risk tools for managing uncertainties in projects. The use of risk management process as a better tool to predicting project “known unknowns” and “unknown unknowns” should gradually begin through competency based training programmes and professional enhancement courses in the built environment.

(h) Project integration and communication

One of the best approaches of improving the process of predicting the required contingency sum is through enhanced project integration and communication (Teye, 2012). The disintegrated nature of the design process leaves many risk uncovered and project coordination poor. The isolated nature of the design team actors results in the impeded flow of design information. Thus through the process of coordination the supply chain of information flow is enhanced to help uncover all risk.

Integrated Cost Contingency Model

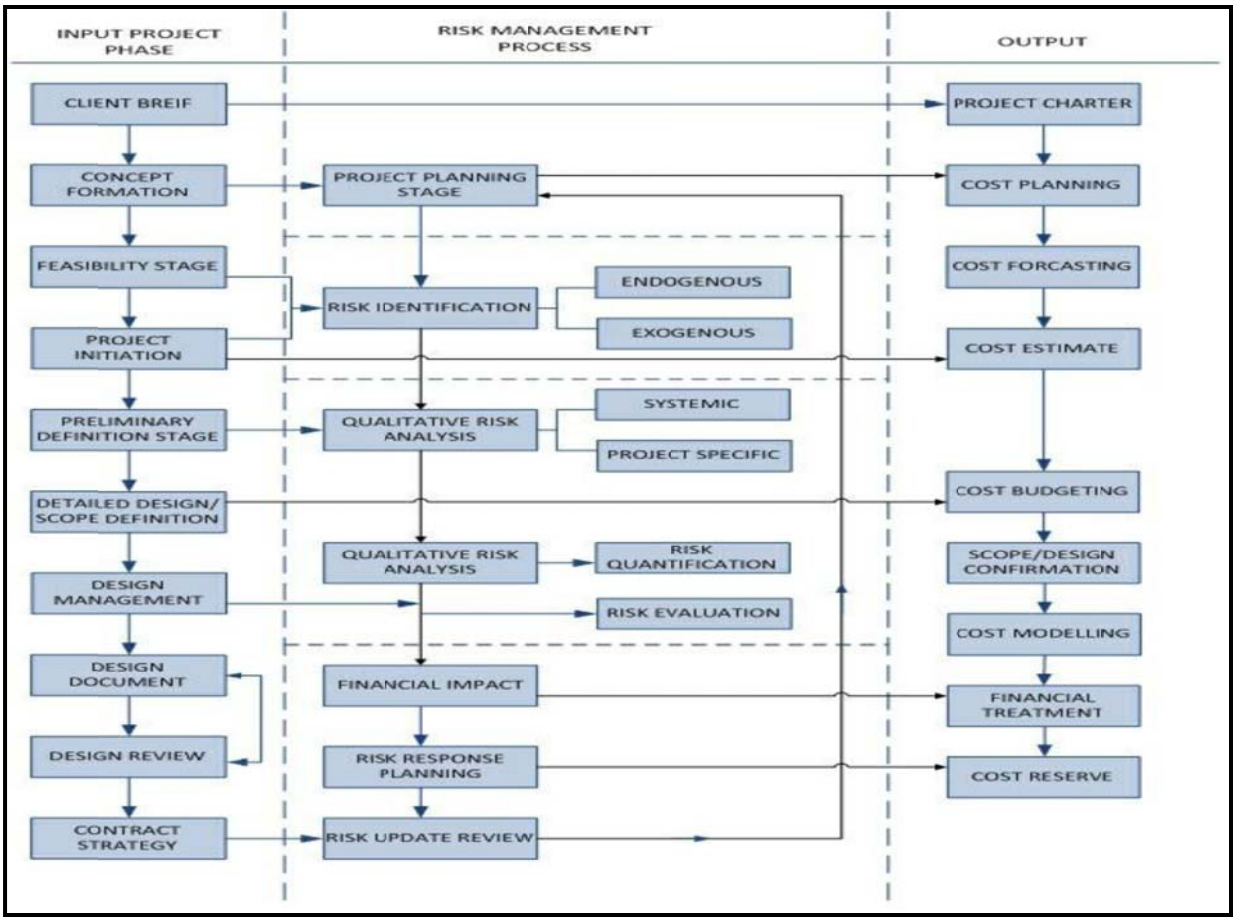


Figure 2.11.1.4: ***Integrated Contingency Model***

Source: ***Science Journal of Civil Engineering and Architecture***

An integrated risk management approach for the estimation of project cost contingency is displayed in the figure above. The model synchronizes the design phase by the project team actors with a risk management process and the cost management phase. The design and planning phase of the project commences simultaneously with risk planning and cost management planning process. The process of design planning commences with the design brief, concept formation and project feasibility. The above process thus gives way to cost planning to agree on the cost parameters to use for the cost estimation, budgeting and cost modeling. Due to the importance of the risk identification process, this process should begin at the project planning phase to help with the early identification of potential risk on the project.

The process of risk identification would help in the further categorization of risk to enable a risk break down structure to be developed for qualitative risk analysis to commence. Qualitative risk analysis enables the likelihood and severity of risk to be analyzed to enable risk prioritization to take place. The process of quantitative risk analysis gives rise to the estimation of the probabilistic impact of the high priority risk to enable a risk response planning strategy to be prepared to help mitigate the selected risk.

Simple qualitative methods such as the failure mode effect analysis (FMEA), Pareto diagrams and risk probability and impact assessment can be used to select high priority risk for further risk analysis to take place. With respect to quantitative risk analysis, decision tree analysis and the expected monitory values can be used. To help estimate risk for the purpose of cost contingency, a systematic process of project design is crucial to enhance scope definition through a design management effort of the project team to help unveil hidden risk.

(i) Risk Breakdown Structure (RBS)

The process of cost budgeting and prediction of contingency sum would be enhanced by the development and use of the Risk Breakdown Structure (RBS) and the Work Breakdown Structure (WBS) by the cooperate effort of the project team actors. The process of cost modeling determines the final shape in which the cost data should be presented, packaged and rolled up. The financial impact of risk at the terminal stages of the risk management process determines the financial treatment to be adopted for these risk and hence

the risk response planning strategy.

2.10.1.2 Percentage Addition Method

This is a subjective method which considers a percentage of the base estimate as project's contingency sum based on intuition, gut feeling, past experience and historical data (Ergin A. A, 2005). Generally the contingency sum estimated with this approach ranges from 1 to 5 percent and rarely exceeds ten percent (Moselhi, 1997). Many authors have described this approach as arbitrary and unscientific including Thompson and Perry (1992), Hartman (2000), Baccarini (2004), Kerlsen and Lereim (2005), (Bello and Odusami, 2008, 2009).

2.10.1.2.1 Reasons for continued use of Percentage Addition Method

(a) Simplicity in Application

Teye et al (2012) established in his research that the percentage addition method is the simplest and easiest method in application since contingency sum is well expressed as a percentage of the base estimate which is quite convenient for comparative purposes.

(b) Limited knowledge in application of scientific methods

The continued us of percentage addition method is favoured by the limited knowledge on application of other comprehensive modeling techniques such as statistical and probability models (Teye et al, 2012).

(c) Lack of credible research and reliable scientific models

As established by Teye et al (2012), there is lack of credible research and reliable scientific models to rely on by cost experts when predicting contingency sum thus deterring the application and use of scientific methods while at the same time encouraging and promoting the use of percentage addition method.

(d) Complexity of scientific methods

Some of the risk analysis methods of determining contingency sum are quite cumbersome to apply due to complex mathematical models that make them difficult to comprehend and use when determining contingency sum Teye et al (2012). This thus promotes the common use of percentage addition method.

(e) Heavy reliance on historical data

Most cost experts perceive lessons learned and experiences from previous projects and improvement/ modification of the same on subsequent projects to be the best method of predicting contingency sum. This favours the common use of percentage addition method since it makes reference to historical data especially on similar projects when predicting contingency sum for subsequent projects (Teye et al, 2012).

(f) Resistance to change

Teye et al (2012) observed that most cost experts and other industry players are adamant to change since they are not ready to embrace new methods which have not been tested locally and proven to accurate.

(g) Common Industry Practice

Most construction cost experts perceive the percentage addition method to be a common practice of contingency sum determination which has worked for them over the years. This has resulted in its continued use in spite of the existing scientific methods (Teye et al, 2012).

(h) Non applicability of foreign scientific methods

External research undertaken on scientific methods of contingency sum determination is based on information from other countries which in most cases may not be useful when applied locally (Teye et al, 2012).

(i) Heavy reliance on academics for new ideas

The industry players do not have enough time for research on new methods hence they quite often rely on the academics for new ideas (Teye et al, 2012).

(j) Lack of reliable data

The Construction Industry lacks a cogent and reliable data on scientific methods for use in the estimation of cost contingency (Teye et al, 2012).

2.10.1.2.2 Advantages of percentage addition method

The main advantages of percentage addition method as observed by Oduro (2008) include the following;

(a) Simplicity in application.

(b) Easy to understand.

(c) Predicts reasonable contingency sums.

2.10.1.2.3 Weaknesses of Percentage Addition Method

(a) Arbitrariness

Teye at al (2012) holds that the practice of allocating contingency sum as a percentage of the base estimate is an overly simplistic approach based solely on experience and intuition. In addition, the very act of assigning some preset percentage denotes the arbitrariness of the conventional methods hence making them ineffective to predict the correct contingency sum.

(b) Lack of scientific basis

Conventional methods, such as percentage addition method, are said to be unscientific and quite often result in project cost overruns (Hartman, 2000). Teye at al (2012) agrees with Hartman (2000) and further posits that these methods are devoid of a scientific basis of determining contingency sum thus prone to unstable price indicators, saddled with the challenge of a well aggregated scope definition and a proper preliminary risk assessment procedure. This is said to result in cost and time overruns on the project.

(c) Lacks theoretical justification

Contingency sum formulated by percentage addition method normally results in a single-figure prediction of estimated cost which theoretically implies a degree of certainty that cannot be justified (Teye et al, 2012).

(d) Application restricted to similar projects.

One of the difficulties in using the percentage addition method to estimate new contingency sum is that the projects should be of the same type and kind in many aspects so that they can be easily and effectively comparable (Ergin A.A, 2005).

(e) Highly based on estimators feelings

Another challenge in using the percentage addition method is that it's highly based on the estimator's feelings at the time of estimating (Ergin A.A, 2005). For instance it's possible for the same cost expert to use different values of contingency amount for a subject project from morning to evening. In addition, the method is heavily dependent on an estimator's faith in his or her own experience (Yeo, 1990).

(f) Loss of capital (Oduro, 2008)

According to Alaa et al (2006) cited in Oduro (2008) the method is quite rigid thus prone to setting low and unrealistic contingency sum which may result in unsatisfactory project outcome which results in losses on the capital invested on the project.

(g) Unable to analyze risk elements of a project

Since the method is not analytical in assessing the risk factors inherent a project, Oduro (2008) reported that the percentage method might encourage poor project cost management, causing project to be uneconomical and sometimes aborted. While agreeing with Oduro (2008) Kamalesh, Ahmed, & Ogunlana (2009) further stated that the over simplistic nature of the percentage addition method fails to explicitly acknowledge the underlying project risks that drive the need for contingency in the first place and therefore exposes the organization to the problem of either radically overcompensating for risk or more likely of radically underestimating risk.

(h) Loss of profit

Oduro (2008) also noted that if the method predicts unrealistically large contingency sums then its might result in locking up of funds which may be need for other investments and organizational activities.

(i) Double counting of risk

There is a tendency to double-count risk and uncertainty inherent on a project since other cost experts such as the Services and Civil/Structural engineers normally allow a contingency percentage in their estimates in addition to the Quantity Surveyors overall contingency percentage allowance to the entire project (Teye et al, 2012).

(j) Promotes poor management of the project

The arbitral percentage amount added to the initial base estimate indicates a potential for detrimental or downside risk. However, it does not indicate any potential for cost reduction and may therefore hide poor management of the execution of the project (Teye et al, 2012). In addition, a deterministic percentage contingency amount tends to direct attention away from time, performance and quality risks.

(k) Lacks creativity

Conventional methods such as percentage addition method do not encourage creativity in practice of estimating contingency sum thus making them routine and mundane which further propagates costly oversights on projects (Teye et al, 2012).

2.10.1.2.4 Ways of improving the Percentage Addition Method.

(a) Cost expert to gain more experience in estimating

In order to make a fine and accurate contingency sum estimation using the percentage addition method, cost experts should gain more experience and be in a position to remember and apply crucial cost details of past projects.

(b) Policies and guidelines for estimating contingency sum

Baccarini (2005) stated that many organizations in Australia do not have a policies and guidelines for the estimation and management of project contingency sum. He therefore recommended for the formulation of clear policies and guidelines to provide a credible framework for predicting and use of contingency sum.

(c) Exploring scientific methods of contingency sum determination

Hobbs (2010) observed that the first point of consensus in improving the conventional methods such as percentage addition method is to connect the magnitude of the contingency sum with the magnitude of project risk. As consequence scientific methods should be used to qualitatively analyze project risks using a structured, hierarchical model such as a risk taxonomy or risk breakdown structure.

(d) Proper understanding of the process of making budget

Determination of an appropriate contingency sum requires an understanding of how estimators make project budget, contingency sum decisions and the impact on the level of accuracy of the included contingency sum (Oduro, 2013).

(e) Risk management process

To determine a realistic contingency margin, Ali (2005) holds that this must be estimated using risk management process.

(f) Historical data

Lessons learned and experience from previous projects is the best way to improve on the application of conventional methods such as percentage addition method in predicting contingency sum on subsequent projects (Teye, 2012). Cost experts therefore a duty to develop and update a data base of previous project information to provide a rich stock of historical data for use on future projects.

(g) Integration of risk education in built environment courses

The gradual shift in approach of determining contingency sum can begin with the introduction of risk analysis and management education into the curricula of built environment programmes (Teye, 2012). This would make future graduates aware of the use of risk tools for managing uncertainties in projects. The use of risk management process as a better tool to predicting project "known unknowns" and "unknown unknowns" should gradually begin through competency based training programmes and professional enhancement courses in the built environment.

(h) Project integration and communication

One of the best approaches of improving the process of predicting the required contingency sum is through enhanced project integration and communication (Teye, 2012). The disintegrated nature of the design process leaves many risks and uncertain events uncovered and project coordination poor. The isolated nature of the design team actors results in the impeded flow of design information. Thus, through the process of coordination the supply chain of information flow is enhanced to help uncover all inherent risks and uncertain events on a project.

2.10.1.3 Cost Item Allocation

This method involves the creation of Work Breakdown Structure (Karlsen and Lereim, 2005) or several work packages (Ahmad, 1992) in a project and the subsequent allocation of contingency percentage to each cost item (Moselhi, 1997). The project overall contingency sum is then estimated as a weighted average contingency of each cost item. According to Ahmad (1992) each work package can be treated as a risk center and the amount of contingency sum to be allocated to each will be different.

2.10.1.3.1 Advantages of Cost Item Allocation

(a) Ergin A.A (2005) observed that this method deals with every cost item separately and assigns different contingency amounts to each cost items.

(b) The estimator is able to analyze every cost item in terms of contingency sum thus enabling him/her draw a free body diagram of the cost items and visualize the effects of every cost item on the entire project cost (Ergin A.A, 2005). In addition, Hobbs (2010) opined that the method disaggregates contingency into a more granular format and thereby attempts to construct a more cause-and-effect relationship between risk and contingency.

(c) The method also helps decision-makers set contingency reserves based upon their preferred risk tolerance rather than setting a contingency sum as an arbitrary percentage of construction costs (Hobbs, 2010). Thus contingency sum can be set so that there is a given probability that the overall project cost will fall below budget.

(d) In many respects the method presents a concept that is easier for senior non-technical executives to understand (Hobbs, 2010).

(e) When compared with the percentage addition method, Ergin A (2005) observes that this method is more detailed since it deals with individual cost items of a project as opposed to giving a blanket contingency sum to the entire project.

2.10.1.3.2 Weaknesses of the Cost Item Allocation Method

(a) This method on the other hand is time consuming since it entails the creation of a Work Breakdown Structure and the subsequent allocation of contingency percentage to each cost item (Ergin A.A, 2005).

(b) In addition, by analyzing every cost item separately to give different contingency sums may disturb the overall unique behavior of the entire project (Ergin A.A, 2005).

(c) Hobbs (2010) observed that the cost item allocation method focuses on project cost elements rather than on risks and their effect. In other words, the connection between the actual risk and its effect on cost is lost. All that remains is the variability in the cost of the line item. While this provides insight into the overall cost it is not helpful in understanding the most impactful risk drivers nor does it guide the analyst on how best to manage the risk (Hobbs, 2010).

2.10.1.3.3 Ways of improving the Cost Item Allocation method.

(a) Formulation of policies and guidelines for estimating contingency sum

Many organizations do not have documented policies and guidelines for estimation and management of contingency sum (Baccarini, 2005) allocated on construction projects. Thus to improve Cost Item Allocation method of contingency sum determination these policies must be formulated and implemented by cost experts.

(b) Application of Scientific methods in Creating Work Breakdown Structure

Hobbs (2010) observes that the first point of consensus in improving the conventional methods such as Cost Item Allocation is to connect the magnitude of the contingency sum with the magnitude of project risk. As consequence scientific methods should be used to qualitatively characterize project risks using a structured, hierarchical model such as a risk taxonomy or risk breakdown structure. Oduro (2013) agrees with Hobbs (2010) and also recommends the consideration and use of scientific methods since they are comprehensive in analyzing uncertain risky parameters on a project.

(c) Application of historical data on similar projects.

Lessons learned and experiences from previous projects are key in improving the prediction of contingency sum (Teye, 2012). Cost experts therefore have a duty to develop a database of project information from previous projects so as to provide a rich stock of historical data for use in determination of contingency sum for subsequent future projects.

(d) Integration of risk education in built environment courses

The gradual shift in approach of determining contingency sum can begin with the introduction of risk analysis and management education into the curricula of built environment programmes (Teye, 2012). This would make future graduates aware of the use of risk tools for managing uncertainties in projects. The use of risk management process as a better tool to predicting project "known unknowns" and "unknown unknowns" should gradually begin through competency based training programmes and professional enhancement courses in the built environment.

2.10.2 Scientific Methods

Besides the conventional methods researchers have also developed scientific and statistical methods of contingency sum determination and management (Adafan et al, 2013). However, (Bello and Odusami 2008) concluded that most cost experts and practitioners in the construction industry are yet to explore the benefits of these methods as they are still glued to the conventional methods of lump sum and percentage addition to project base estimate. The scientific methods as outlined by Bello and Odusami (2008) include the following;

(a) Probabilistic Itemized Allocation

(b) Programme Evaluation Review and Technique (PERT)

(c) Monte Carlo Simulation

2.10.2.1 Probabilistic Itemized Allocation

This method is similar to cost item allocation method but it uses Pareto's law, also known as the 80/20 rule, that is the law of significant few and insignificant many (Moselhi, 1997). This method is also reported by Ergin A.A (2005) who observed that in the estimation of contingency sum 80% of uncertain events triggering contingency sum are associated with 20% of the defined cost items. This method examines closely each item being considered significantly and allocates a probability value to each item rather than percentage contingency sum for not exceeding its estimated cost. Touran (2003) also developed a probabilistic model for the calculation of project cost contingency by considering the expected number of changes and the average cost of change orders.

These significant cost items in an estimate can be defined as a cost element whose actual value may vary from its target cost either as an increase or decrease by such a magnitude that the bottom line cost of the project would change by an amount greater than the critical variance Ergin A.A (2005).

2.10.2.1.1 Advantages of Probabilistic Itemized Allocation Method

(a) Hobbs (2010) observed that probabilistic methods are able to quantify risk and impact in addition to clearly describing inherent uncertainty of risk on a project. In other words if the probability of occurrence of risk was known it wouldn't really be uncertain.

(b) This method according to Oduro (2008) is considerably accurate thus fairly avoiding the need to request for additional funding.

(c) It is also quick and easy to understand and apply (Oduro, 2008).

2.10.2.1.2 Weaknesses of the Probabilistic Itemized Allocation Method

(a) Curran (1989) however observes that it is not always easy to quantify the probability values.

(b) According to Oduro (2008) the method has the following weaknesses;

- It encourages formulation of high probability values which set inflated contingency sums to cover for overspending.
- There is a tendency of double counting of risk.
- The method does not facilitate proper monitoring of project performance and risk.
- The method also fails to highlight specific aspects/elements of a project to be considered for cost reduction.

2.10.2.1.3 Ways of improving the Probabilistic Itemized Allocation method.

(a) Curran (1989) proposes a qualitative assessment to quantify the probability values and then transferring the input into a qualitative form.

2.10.2.2 Programme Evaluation Review and Technique (PERT)

The method calls for some judgment about the probability density function which describes each cost item as a random variable taking on values between its estimated lowest and highest costs. Yeo (1990) suggested using formulae similar to PERT according to a 5-95th percentile. Three estimates of costs are needed for each item being considered i.e. lowest cost (optimistic), highest cost (pessimistic) and the most likely cost (modal value). The three estimates of cost can be made based on judgment and experience or on data collected from previous projects.

2.10.2.2.1 Advantages of PERT

According to Oduro (2008) the method has the following advantages;

(a) Avoids the tendency of double counting risk.

(b) Facilitates proper monitoring of project performance and risk.

(c) Outlines the possible aspects/elements of a project to be considered for cost reduction.

(d) Encourages creativity in estimating contingency sum.

(e) The method enables involvement of every member of the building team.

2.10.2.2.2 Weaknesses of PERT

(a) Ergin A.A (2005) observed that the main problem associated with this method is that it is based on independent variables which do not relate at all.

(b) In addition the method requires a huge and correct database (Ergin A.A, 2005).

(c) The method requires more time and resources in its application when determining contingency sum (Oduro, 2008).

(d) It predicts ambiguous contingency sums since it uses three subjective estimates that are prone to human errors (Rao et al, 2013).

2.10.2.2.3 Ways of improving PERT

(a) One possibility of improving the robustness of PERT in predicting correct contingency sums is to allow for a margin of error in order to absorb any deviations from the correct contingency figure caused by using subjective point estimates (Rao et al, 2013).

(b) Use of PERT with modified variance technique that models any correlation that may exist among the project cost items (Moselhi, 1997). Based on probability distribution used for each cost item the mean of the project cost is the sum of those calculated for the individual items as in PERT and the variance of the project cost is calculated in a manner different from that used in PERT. Moselhi (1997) reported that this method is accurate and reliable.

2.10.2.3 Monte Carlo Simulation

Monte Carlo simulation was developed by a mathematician called Stanislaw Ulan while working on nuclear physics (Ergin A.A, 2005). Monte Carlo analysis is mainly used to determine risks/opportunities for projects and also for contingency sum estimation (Clark 2001 & Lorance 1992). The technique develops data through the use of random number generator. In this approach a simulation model is created. The model is basically a cost breakdown structure (Karlsen & Lereim, 2005) or work package (Ahmad, 1992) where each cost item in the structure is a single point estimate. A triangular distribution is normally used (Karlsen & Lereim, 2005) or assumed (Ahmad 1992; Moselhi, 1997). The triangular distribution can be described as an approximation of typical risk distribution. This is for simplicity (Ahmad, 1992) but not to simplify the math (Beardsall, 2005). There are several computer programs that can be used for simulation purposes such as spreadsheet (Ahmad, 1992) and definitive scenario (Karlsen &Lereim, 2005).

2.10.2.3.1 Advantages of Monte Carlo Simulation

(a) One of the advantages of the Monte Carlo simulation is that this model can be used with correlation (Touran & Wiser 1992).

(b) The results of a simulation using Monte Carlo risk analysis allow the quality of the estimate to be determined based on a specified quality requirements if the expected accuracy ranges are achieved (Oduro, 2008).

(c) Smith, Merna and Jobling (2006) contended that this method attempts to quantify risk in the early stages of a project when there is no enough information available to more thoroughly characterize the risk.

(d) Monte Carlo simulation offers an attractive approach because it does not rely on enormous amounts of actual project data in the way neural networks or linear regression models do. As a result with the informed opinion of a cost expert and a readily available software tool like Palisade's @Risk, Monte Carlo simulation of risks and project costs is now within the reach of many smaller organizations.

(e) According to Oduro (2008) the Monte Carlo simulation method has the following advantages;

- Avoids the tendency to double count risk.

- Facilitates proper monitoring of project performance and associated risks.
- Outlines possible aspects/elements of a project to be considered for cost reduction.
- Does encourage creativity in the practice of estimating contingency sum.
- The method facilitates involvement of every member of the building team.
- It serves as a cost and quality control mechanisms.

2.10.2.3.2 Weaknesses of the Monte Carlo Simulation

(a) The method requires effective computational software and a knowledgeable person when large numbers of simulations are carried (Ergin A.A, 2005).

(b) The method is not well suited for small projects because of time and complexity of the techniques used in the contingency sum estimation (Ergin A.A, 2005).

(c) Oduro (2008) also observed the following weaknesses of Monte Carlo Simulation;

- It requires more time and technical experts to work with.
- The method is not easy to understand by the layman.
- It requires more technical and financial resources.

(d) Hobbs (2010) opined that the method assumes all cost components or system variables to be independent thus ignoring any slight or strong correlation that may exist between variables. Wall (1997) agrees with Hobbs (2010) and further argues that the effect of correlation is more significant than the effect of the choice of distributions. This weakness is also observed by Isidore, Back and Fry (2001) and Chau (1995).

2.10.2.3.3 Ways if improving Monte Carlo Simulation method

- Sonmez (2004) opined that Monte Carlo Simulation method should be made sophisticatedly simple and fit the data adequately without using any unnecessary parameters.

- To improve Monte Carlo method Wall (1997) outlined the need to develop a correlation matrix that related the cost component variables together so that values chosen by the Monte Carlo software in the course of a simulation are appropriately correlated.

2.10.2.4 Estimating Using Risk Analysis (ERA).

Another method of determining contingency sum for construction projects as documented by Bello and Odusami (2008) and Mak et al (1998, 2000) is the risk analysis method. This method is also reported by Ergin A.A (2005). In addition, it has also been documented in Treasury HM (1993) as used by a government agency in the United Kingdom. Hong Kong Government also introduced this method in all public works project by identifying and costing risk events associated with a project (Mak and Picken, 2000).

2.10.2.4.1 Advantages of Risk Analysis Method

(a) The method is able to model and take into account any correlation existing between significant factors that have a direct bearing on the magnitude of contingency sum to be determined for instance the effects of delay on costs and the correlation between them (Touran, 2003).

(b) Other advantages as postulated by Oduro (2008) include the following;

    - The method imposes a discipline from the outset of systematically identifying, costing and considering the likely significance of any risks associated with the project.
    - It serves as financial control in having risk and uncertainty costs identified before action is taken to determine precise requirements.
    - The method reduces the level of uncertainty on a construction project
    - It avoids the tendency of double counting risk.
    - Promotes proper monitoring of project performance and risk.

- It outlines possible aspects/elements of a project to be considered for cost reduction.
- It encourages creativity in the practice of estimating contingency sum.
- Facilitates the involvement of every member of the building team.
- It serves as cost and quality control mechanism.
- It acts as a mechanism for accounting especially for public funds.

2.10.2.4.2 Weaknesses of the Risk Analysis Method

(a) If a project is not defined well then the risk analysis method can possibly give exaggerated contingency sums (Burroughs & Juntima 2004).

(b) Smith & Bohn (1999) in their study concluded that most of the risk modeling techniques does not consider the effect of competition among contractors in their calculation steps.

(c) This method according to Oduro (2008) requires more time and resources.

2.10.2.4.3 Ways of improving Risk Analysis Method

(a) Use of quantitative/ data driven methods in identifying risks such as decision tree analysis and Monte Carlo simulation which estimates the frequency of risks and magnitude of their consequences (Banaitiene & Banaitis, 2012)

2.11 Contingency Sum Policies & Management Guidelines

Gary Jackson (2012) observes that the attitude of project teams that contingency sum allowances are without limit is a major cause of cost overrun due to mismanagement. The responsibilities for expenditure, monitoring and allocation of allowances in relation to the budget must be made perfectly clear to all parties concerned (Woollett, 1998). The success of contingency sum management according to Gary Jackson (2012) depends on;

- Identifying project uncertainties and relating them to specific reserves.
- Establishing procedures for the proper use of contingency sum.

- Establishing an information system showing each responsible manager what contingency sum apply to the work under their control, how they are being depleted, and how the trends appear for the remainder of the project.

Monitoring of trends will enable assessment of when it may be possible to transfer balances to other less successful areas or to general reserve (Avots, 1989 cited in Baccarini, 1998b).

Management of contingency sum offers the advantage of showing precisely where contingency sum was used including indicating the balance of the available contingency sum (Patrascu, 1988). Consequently unexpended funds can be transferred to a general contingency account (Baccarini, 1998b) or to other projects to accelerate the capital works program.

To avoid any mismanagement of contingency sum allocated on construction projects Hart, (2007) recommends that owners develop an internal process of evaluating project contingency sum with a process of checks and balances while Risner (2010) suggests a contingency sum usage form to be completed and signed by both owner and the Project manager or architect as a way to control usage of contingency sum.

In addition, construction projects can be broken down into different phases to be managed as work packages. Thus it is prudent that portions of the overall contingency sum be assigned against specific project activities or work packages based on the inherent risks.

2.11.1 Management of Contingency Sum

According to Oduro (2008) contingency sum can be managed as follows:

(a) By the Project Manager (Contingency sum put under control of Project Manager)

(b) Sensitivity Analysis (Draw down Plot)

(c) Continuous Issues and Risk Management Communication

2.11.1.1 Monitoring of contingency sum by the Project Manager

This entails contingency sum being held entirely by the Project Manager and not by subsystem managers i.e. Quantity Surveyor, Architect, Civil Engineer and other related professionals (Oduro, 2008). This gives the Project Manager ability to apply midcourse corrections when most needed. Allocation of contingency sum is the decision of the Project Manager upon request of the subsystem managers and with the advice and consent of the Client and concurrence of the relevant funding agency. All risks and uncertainties that will require future use of contingency must be explicitly approved by the Project Manager. Allocation of contingency sum is reflected through a request for funds in excess of the proposed estimate (Hanlon, 1997).

2.11.1.2 Sensitivity Analysis (Draw down plot)

Sensitivity analysis model utilizes the sensitivity features of the simulation software to determine which inputs are most significant (Oduro, 2008). The software calculates sensitivity based upon either of two analytical techniques: regression or correlation. Both techniques give similar results. Figure 2.3 below identifies and ranks the inputs that are most significant. The most significant inputs are identified with longer bars at the top of the graph. Sensitivity analysis allows reviewing of an estimate to concentrate on the specific inputs. Sensitivity analysis identifies where the most promising opportunities exist to perform additional work.

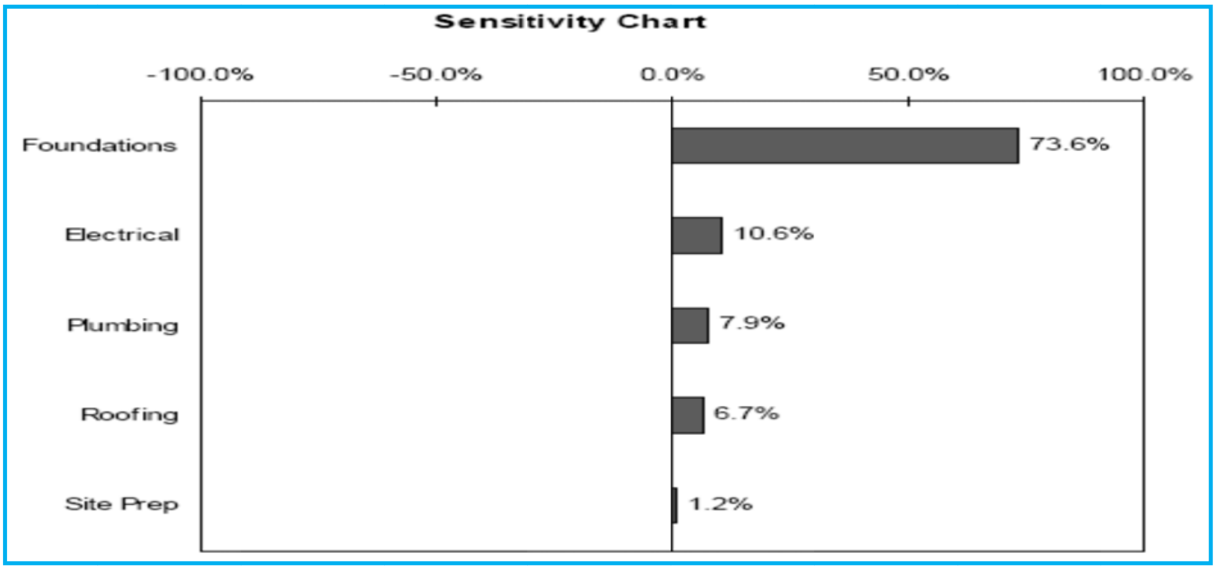


Figure 2.13.2: ***Showing sensitivity chart for building works***

Source***: Iqbal and Robert Tichacek, P.E. 2004***

The data that can be used to determine how much contingency sum to assign to each risk factor as shown in figure 2.13.2. The relative contribution of each risk factor to the overall uncertainty on the project is provided. About 74 % of the total contingency could be applied to foundation. The monitoring of contingency sum using the sensitivity chart provides management with quick and more accurate information regarding the adequacy of the current Contingency Sum. Thus the project management team is at a better position to make decisions regarding redistribution or return of unspent Contingency Sum.

2.11.1.3 Continuous Issues and Risk Management Communication

Project risk management is not a one-time activity that is completed once a contingency sum is determined. The sensitivity chart shown in Figure 2.3 provides funding for continuous management of issues and risks. Figure 2.4 shows a continuous issue and risk management.

Figure 2.13.2: ***The five-step process for continuous assessment and prioritization of risk***
Source: ***Iqbal and Robert Tichacek P.E. 2004.***

2.11.2 Contingency Sum Management Policies

For proper management and accountability in the utilization of Contingency sum a series of contingency plans based on historical data must be developed as templates to be applied to various project types. Templates must be as simplistic as an allowance for each phase of the project (Woollett, 1998) and should be reviewed and updated as definitive information becomes available. The key stakeholder's experience could be used to develop standard contingency plans for each basic project type by assessing the potential risks inherent to each type (Gary Jackson, 2012). Krosch (1995) opined that prediction of contingency sum is best done by examining historical data from completed projects and making adjustments to reflect any changes in the nature of the particular project.

Allocating contingency sum to specific risk elements allows greater control over its usage thus avoiding the contingency sum being treated as a slop fund since there is always a natural tendency (Gary Jackson, 2012) to draw down and exhaust the contingency fund before the project is complete. In addition, the individual allocation of contingency sum offers advantage of showing precisely where contingencies were used and indicates the balance of the available contingency. This would enable unexpended funds to be transferred to other projects or to enhance the capital works program.

In addition, contingency sum must be a separate fund and should not be included in the individual components of an estimate, otherwise the cost to complete the works will expand to fill the budget. To avoid misuse of contingency sum allowance stakeholders need to be accountable and educated on the benefits of proper contingency sum management (Gary Jackson, 2012). The contingency allowance should decrease as the project becomes more defined and known risks subside.

Greater emphasis on effective cost contingency management to address increased risk in minor projects would enable projects to proceed with a greater degree of certainty of the final cost and confidence in the likelihood of successful completion.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

Research methodology is concerned with the overall approach to the research process in terms of theoretical background of the research to the collection and analysis of data. It concerns with the issues of why certain data is collected, what type of data to be collected, from where the data is to be collected, when to collect the data, how to collect the data and how to perform analysis of the data.

3.1 Research Design

Kothari (2004:31) citing Selltiz (1962) defines research design as the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure. It forms a conceptual structure in which research is conducted thus constituting the blue print for the collection, measurement and analysis of data.

In order to achieve the objectives of this study a survey design was adopted. The elements of study were selected based on their direct involvement in the formulation of contingency sum for construction projects.

3.2 Population

The population of study targeted by the researcher was composed of Consulting Quantity Surveying firms, Civil/Structural Engineering firms and Services Engineering firms i.e. Mechanical & Electrical in Kenya. This was based on the fact that in the Kenyan Construction Industry contingency sums for construction projects are normally formulated by professionals working in the above mentioned consulting firms hence they are best placed to provide consultant's opinion regarding concepts and methods of contingency sum determination.

3.2.1 Quantity Surveying Firms

Professionals in Quantity Surveying firms are chiefly involved in the formulation of contingency sums which are normally incorporated in the cost estimates and subsequent contract price of construction projects. The Architects and Quantity Surveying Act Cap 525 of the laws of Kenya requires all practicing Quantity Surveying firms in Kenya to register not only with the Registrar of Companies but also with the Board of Registration of Architects and Quantity Surveyors before being licensed to offer their professional services. Thus the population of Quantity Surveying firms for this study was defined as the entire list of registered firms with the Board. A list of obtained from the Board in April 2014 revealed that there were 197 registered Quantity Surveying firms in Kenya.

3.2.2 Consulting Services Engineering Firms

Professionals in consulting Services Engineering firms i.e. mechanical and electrical also formulate contingency sums for services installations such as power, lighting, fire alarms, security, air conditioning, plumbing, water reticulation, information technology, ventilation and heating among others. These are normally incorporated in the project's cost estimates and subsequent contract price. The Engineers Act Cap 530 of the laws of Kenya requires all consulting Engineering firms with a registered business name or certificate of incorporation to register with the Engineer's Board of Kenya (EBK). The Board is mandated to register all consulting engineering firms in different categories and disciplines of practice. Thus the population of consulting Services Engineering firms for this study was defined by the entire list of registered firms under the category of Building Services with Engineer's Board of

Kenya. A list obtained from the Board in June 2014 revealed that there were 15 registered Services Engineering Firms in the Kenya.

3.2.3 Consulting Civil/structural Engineering firms

Consulting civil/structural engineering firms are also involved in the formulation of contingency sum that is also incorporated in the cost estimates and subsequent contract price of civil/structural works i.e. roads, bridges, drainage systems, communication towers among others. Just like the consulting services engineering firms civil/structural engineering firms are also required by the Engineers Act Cap 530 of the laws of Kenya to register with the Engineer's Board of Kenya (EBK). Hence the population of consulting civil/structural engineering firms for this study was defined by the entire list of registered firms under the category of civil/structural engineering firms with the Engineer's Board of Kenya. A list obtained from the Board in June 2014 revealed that there were 68 registered Civil/Infrastructure Engineering Firms in Kenya.

3.3 Determination of Sample Size

3.3.1 Quantity Surveying Firms

Most Quantity Surveying Firms handle work in the private sector while public jobs are handled by the department of Public Works and the National Housing Corporation operating under the Ministry of Land, Housing and Urban Development. However, quite often the department of Public works and the National Housing Corporation (NHC) usually offload some work to private consulting Quantity Surveying firms when faced with excess workload. The Public Works division of Quantities and contracts at the headquarters in Nairobi is organized into eight public building teams under which Quantity Surveyors work.

These teams advise Government ministries and departments on cost estimates and also prepare bills of quantities for building projects, hence assume the role of consulting firms for the Central Government. Thus, the study excluded the Ministry from the sampling frame because its opinion about public projects could as well be obtained from consulting Quantity Surveying firms to whom the work is offloaded.

The promulgation of the new constitution has since resulted in creation of 47 county governments. Hence while recognizing the fact that the County Government employ Quantity Surveyors under their county planning departments, these Quantity Surveyors work as employees and not agents/consultants as those in the Ministry of Public works, hence they were excluded from the study.

In order to obtain the sample size for the survey, a statistical method was used in deriving the sample size from a list of all registered Quantity Surveying firms. This involved the application of the Kish (1965) formula as stated below;

$$n = \left(\frac{n'}{1 + \frac{n'}{N}} \right)$$

Where:

n = Sample Size

$n' = \frac{S^2}{V^2}$

S = Maximum standard deviation in the population element (total error = 0.5 at a confidence level of 50%)

N = Population Size

V = Standard error of sampling distribution = 0.05

As aforementioned a list of consulting firms obtained from the Board in April 2014 revealed that there were 197 registered Quantity Surveying firms in the country. Therefore the sample size for study was determined as followed;

$$n = \left(\frac{n'}{1 + \frac{n'}{N}} \right)$$

$$n' = \frac{S^2}{V^2}$$

Since N = 197

$$n' = \frac{0.5^2}{0.05^2} = 100$$

$$n = \left(\frac{100}{1 + \frac{100}{197}} \right)$$

$$= 66.3$$

$$= 66$$

3.3.2 Consulting Services and Civil/ Structural Engineering firms

As aforementioned both the Services and Civil/ Structural Engineering consulting firms are normally registered by the Engineers Board of Kenya (EBK) under different disciplines. This means that the entire population of engineers is stratified according to the various engineering disciplines. The researcher also observed that most registered Services Engineering firms offered both Electrical and Mechanical consultancy services. In view of the budgetary and time constraints presented in this study, the researcher opted to consider only registered services engineering firms that offered both electrical and mechanical services.

Services and Civil/Structural Engineering Consulting firms handle work in the private sector while public jobs are handled by the Electrical & Mechanical and Structural divisions in the Public Works department operating under the Ministry of Land, Housing and Urban

Development. These departments, which assume the role of consulting firms for the Central Government, also quite often when faced with excess workload offloads some work to private consulting Services Engineering Firms. As a consequence the study excluded the Ministry from the sampling frame because their opinions about public projects could as well be obtained from consulting firms to whom the work is offloaded.

In addition, the Services and Civil/Structural Engineers working for the County Government were also excluded since they were considered to be employees and not agents/consultants of the county government as those in the Ministry of Public works.

The stratification of Engineers by the Engineers Board of Kenya (EBK) according to their various disciplines of practice was as shown in the table below;

Discipline of Practice	**Number of Registered Firms**
1. Services Engineering Firms	15
2. Civil/Structural Engineering firms	68
Total	**83**

Table 3.3.2: ***Stratification of Consulting Engineering Firms in Kenya***

Source: ***Engineers Board of Kenya***

Since each discipline was considered as a stratum, the sampling technique adopted was stratified random sampling. The sample size was obtained by applying a statistical formula recommended by Mugenda and Mugenda (1999):

$$n = \frac{z^2\, p\, q\, N}{e^2 (N - 1) + z^2\, p\, q}$$

Where:

n = Size of sample

N = Size of population.

p = Sample proportion estimated to have characteristics being measured. Assume a 95% confidence level of target population

q = 1 - p

e = Tolerable error level (assume 0.05 since the estimate should be within 5% of the true curve)

z = The standard normal deviate at the required confidence level i.e. 1.96.

The researcher assumed a 95% confidence level of the target population and that the response achieved would be within $\pm$ 5% of the true state of the population targeted.

$$n = \frac{(1.96^2)\,(0.05)\,(1-0.05)\,(83)}{(0.05)^2 (83-1) + (1.96)^2\,(0.05)\,(1-0.05)} = 39$$

The stratified sample size of 39 was proportionately distributed among the two categories of engineers as follows;

Services Engineering Firms $= \frac{15}{83} \times 39 = 7$

Civil/structural engineering firms $= \frac{68}{83} \times 39 = 32$

3.4 Data Needs Matrix

This section describes the type of information required, sources, methods of collection, analysis and presentation of data for each objective in order to answer the research questions and to test the hypothesis.

3.4.1 Research Objective 1: *Weaknesses of Conventional Methods of Contingency Sum Determination*

3.4.1.1 Type of Data/Information required.

The study needed to first of all identify the various methods used to determine contingency sum for construction projects as observed and documented by several researchers and authors. As had earlier been observed in the problem statement most construction cost experts in Ghana according to Ali (2005) have adopted conventional methods of estimating contingency sum to cover for uncertain events that might occur on a construction project. Thus the study needed information to establish whether the same case of frequent use of conventional methods of contingency sum determination was replicated in Kenya. In view of the chronic problem of cost overruns apparent on construction projects in Kenya as stated in the problem statement notwithstanding the inclusion of contingency sum in the contract price, the study needed information to identify weaknesses of conventional methods in determining the correct contingency sum and to further seek cost expert's opinion on how significant each weakness was.

3.4.1.2 Sources of data

According to Rangit (2005) data can be collected from two sources; secondary sources and primary sources. Data collected from primary sources is known as primary data and data collected from secondary sources is called secondary data. The study therefore considered to obtain data from both secondary and primary sources regarding the weaknesses of conventional methods of contingency sum determination.

Secondary sources provided data that was a fundamental precursor to understand various methods of contingency sum determination as well as their perceived strengths and weaknesses as opined and accentuated by various researchers and authors.

Primary sources enabled the researcher obtain direct opinion and attitude of construction cost experts in Kenya on frequency of use of conventional methods of contingency sum determination in addition to establishing their weaknesses in predicting the correct contingency sum.

3.4.1.3 Data Collection Instruments.

In consideration of the available data collection instruments, nature of information required from respondents, time and budgetary constraints, the questionnaire was considered to be the most appropriate instrument in collecting data regarding the weaknesses of conventional methods of contingency sum determination.

(a) Questionnaire

Since the methods of contingency sum determination were capable of being applied by all cost experts irrespective of their professional background and training, a single questionnaire was prepared and administered to the sampled consulting Quantity Surveying, Services Engineering and Civil/structural Engineering firms.

(b) Personal Interviews

These were conducted hand in hand with the questionnaire where clarity was needed on the issues raised in the questionnaire regarding the weaknesses of conventional methods of contingency sum determination.

3.4.1.4 Data analysis

Data analysis included not only descriptive disposition of variables but also test of hypothesis. To greatly speed up the process of analyzing raw data collected from the field on the weaknesses of conventional methods of contingency sum determination statistical software SPSS version 16.0 for windows was used. In addition, Microsoft excel was also used to derive computations and tables. The basic assumption was that the ranking of weaknesses of conventional methods of contingency sum determination reflected what would be expected from the population distribution.

Descriptive statistic was used to observe some properties of the sample and its strata. These included the mean, frequency, the standard deviation and standard error of the estimate. The mean was used to calculate average score of

the methods contingency sum determination based on their frequency of use by consultants and also to rank weaknesses of conventional methods as identified in order of their significance. Frequency was useful in showing the rate at which weaknesses of conventional methods of contingency sum determination were observed by various cost experts while the standard deviation and standard error of the estimate were used in calculating the critical values.

3.4.1.4.1 Hypothesis testing of significant weaknesses of conventional methods of contingency sum determination using Population Mean

Having identified and ranked the weaknesses of conventional methods of contingency sum determination the next step was to isolate the significant weaknesses. This was done by comparing the mean rating of each weakness with the population mean that provided a basis of making a decision on whether a particular weakness was significant or not. Through literature review the researcher had identified eleven (11) weaknesses of conventional methods of contingency sum determination and further assumed that the rating of significance on each weakness would exhibit a normal probability distribution in the population of cost experts in the Kenyan Construction Industry.

Hence based on the above assumption a horizontal decision scale was generated with five scores. Each of the five possible scores on the decision scale had an equal chance of occurring and therefore, the mean, mode and median were equal. The horizontal scale used in this study had a minimum of 1 and a maximum value of 5. The median (3) in the horizontal numerical scale used in the study was therefore considered to be the population's mean rating of significance for each weakness. This was the point indicating whether the weakness was significant or not on the decision scale and thus forming a decision rule.

3.4.1.4.2 Hypothesis testing of the weaknesses of conventional methods of contingency sum determination using the Z - test.

The results from data analysis on significant weaknesses of conventional methods using the population mean needed further analysis. This was done through hypothesis testing of the identified significant weaknesses using the Z – test. The exercise involved the use of one tail lower limit test to set the lower limit of the sample mean at which a given weakness could be considered as significant. This was because any score above the mean of (3) was already significant.

All the weaknesses of conventional methods found to be significant as per hypothesis testing using Population Mean in 3.4.1.4.1 above had two hypotheses. The null hypothesis (H_0) was that the weaknesses were not significant while the alternative hypothesis (H_A) was that the weaknesses were significant.

The decision rule was evaluated by establishing the probability of committing a Type 1 error i.e. concluding that a weakness is significant when it is not. Harper (1994) argues that Type 1 error can be avoided by setting a lower confidence level at 95 %. In this situation, committing Type 1 error was viewed as less harmful than committing Type II error i.e. concluding that a variable is not significant when it is. Harper (1994) argues further that Type II error can be avoided by setting a higher confidence level. The confidence level of 99% was therefore set. This meant that any variable that scored a sample mean within three standard deviations from the asserted population mean at the lower tail of the distribution was regarded as significant. The upper tail limit was not necessary because a score above the critical value was already significant.

3.4.1.5 Presentation methods

Data under the first objective was presented in form of graphic presentation i.e. charts and tables.

3.4.2 Research Objective 2: *Reasons for continued use of conventional methods of contingency sum determination in spite of the existing scientific methods.*

3.4.2.1 Type of Data/Information required.

To achieve this objective the study needed to identify the possible reasons attributed to the continued use of conventional methods of contingency sum determination in spite of the existing scientific methods as suggested and documented by various scholars and researchers.

Since scientific methods of contingency sum as observed by Oduro et al (2013) were devoid of subjectivity and thus capable of giving more accurate contingency sums, the study needed the opinion of cost experts in Kenya as to why they preferred to continue using conventional methods over the scientific ones.

3.4.2.2 Sources of data

The study considered both secondary and primary sources of data to obtain sufficient information for this objective. Secondary sources provided documented information regarding the possible reasons for continued use of conventional methods of contingency sum determination in spite of the existing scientific methods as reviewed and documented by various scholars and authors.

Primary sources provided first hand opinion and attitude of construction cost experts in the Kenya that attempted to explain why conventional methods were being used in spite of the existing scientific methods which were considered to give more accurate contingency sums.

3.4.2.3 Data Collection Instruments.

Data for the second objective was collected by way of self-administered questionnaire. According to Alreck & Settle (1995:208) respondents may be more willing and open to respond honestly and candidly if they sit down in complete privacy to record their answers and be completely assured of complete anonymity. In addition, since the respondents were to rate their opinions they definitely needed humble time to think and respond appropriately, hence preference for a self-administered questionnaire.

3.4.2.4 Data analysis

Analysis of data for this objective was also performed using a statistical software SPSS version 16.0. Microsoft excel was also used to derive computations and tables. The basic assumption was that the rating of reasons for continued use of conventional methods of contingency sum determination by the sampled respondents represented what would be expected from the parent population.

Descriptive statistic was used to observe some properties of the sample and its strata. These included the mean, frequency, standard deviation and standard error of the estimate. The mean was used to calculate the average rating score of the reasons for continued use of conventional methods of contingency sum determination in spite of the existing scientific methods and was also used to rank the reasons in order of their importance. Frequency was useful in showing the rate at which the reasons were mentioned by various cost experts while the standard deviation and standard error of the estimate were used in calculating the critical values.

3.4.2.4.1 Hypothesis testing of important reasons for continued use of conventional methods in spite the existing scientific methods using population mean

Having identified and ranked the reasons for continued use of conventional methods in spite of the existing scientific methods the next step was to isolate the important reasons. This was done by comparing the mean rating of each reason with the population mean that provided a basis of making a decision on whether a given reason was important or not. Through literature review the study had identified seven reasons for continued use of conventional methods of contingency sum determination and further assumed that the rating of the importance for each reason would exhibit a normal probability distribution in the population of cost experts in the Kenyan Construction Industry.

Hence based on the above assumption, a horizontal decision scale was generated with five scores. Each of the five possible scores on the decision scale had an equal chance of occurring and therefore, the mean, mode and median were equal. The horizontal scale used in this study had a minimum of 1 and a maximum value of 5. The median (3) in the horizontal numerical scale used in the study was therefore considered to be the population’s mean rating of importance for each reason. This was the point indicating whether the reason was important or not on the decision scale and thus forming a decision rule.

3.4.2.4.2 Hypothesis testing of the important reasons for continued use of conventional methods in spite of the existing scientific methods using the Z – test.

To test this hypothesis it was imperative that a decision criterion be established as a benchmark for isolating important reasons from unimportant reasons. This was done through hypothesis testing of the identified reasons using the critical Z – values. The exercise involved the use of one tail lower limit test to set lower limit for isolating important reasons from unimportant reasons based on the sample mean since all reasons with a score above the mean of (3) were already important.

Through literature review the researcher had identified seven reasons for continued use of conventional methods of contingency sum determination in spite the existing scientific methods. These were measured on a five point horizontal scale having a minimum value of 1 and a maximum value of 5. The median 3 in the horizontal numerical scale was therefore considered to be the population's mean rating of importance for each identified reason. All the identified reasons had two hypotheses. The null hypothesis (H_0) was that the reasons were not important while the alternative hypothesis (H_A) was that the reasons were important.

The decision rule was evaluated by setting a confidence level of 99% i.e. 1% level of significance in order to reduce chances of committing Type I Error which can be committed by concluding that a given reason is not important when it is.

3.4.2.4.3 One way Analysis of Variance (ANOVA)

The study also sought to establish the degree of agreement between Quantity Surveyors, Services Engineers and Civil/Structural Engineers on the importance of the identified reasons for continued use of conventional methods of contingency sum determination in spite of the existing new scientific methods. This was to ascertain whether the identified reasons were related to professional background of the cost experts.

Analysis of variance also referred to by the acronym (ANOVA) was found suitable for this exercise. According to Alreck & Settle (1995) when the independent variable is categorical i.e. category of cost experts and the dependant variable is continuous i.e. rating of importance of reasons, the appropriate technique to measure the relationship between the two is Analysis of Variance. The objective of the analysis was to determine whether the mean values of rating of the identified reasons differed significantly among the three categories of cost experts. This was to establish whether cost experts differed in opinion based on their specific professional backgrounds on the importance of reasons for continued use of conventional methods of contingency sum determination in spite of the existing new scientific methods.

The null hypothesis (H_0) in the ANOVA test was that there was no difference in the mean rating of importance of reasons for continued use of conventional methods of contingency sum determination in spite of the existing scientific methods among the three categories of cost experts i.e.

H_0 = μ Quantity Surveyors = μ Services Engineers = μ Civil/structural Engineers.

The alternative hypothesis (H_A) was that there was a difference in mean rating among the cost experts on the reasons for continued use of conventional methods of contingency sum determination in spite of the existing scientific methods. i.e.

H_A : μ Quantity Surveyors ≠ μ Services Engineers ≠ μ Civil/structural Engineers.

The testing of hypotheses in ANOVA was done at a Confidence level of 95%. Hence the ANOVA "F" test statistic was expressed as follows;

$$F_{\alpha\,[c-1,\; c(r-1)]}$$

The degrees of freedom V_1 *d f.* & V_2 *d f.* were formulated as follows;

$V_1\, d\,f. = c - 1\, d\,f.$

$= 3 - 1 = 2\ d\ f.$

$V_2\ d\ f. = c(r - 1)$

$= 3\ (7 - 1) = 18\ d\ f.$

Hence the expected F_α statistic was expressed as follows

$F_{\alpha\ 0.05\ (2,\ 18)}$

While the computed F_c statistic was calculated as follows;

$$F_c = \frac{MST}{MSE} = \frac{\sigma_T^2}{\sigma_E^2}$$

Where:

MST = Mean square due to treatment

MSE = Man square due to random error

The decision rule involved comparing the computed Fc with the expected Fα and the null hypothesis H0 would be rejected if the computed Fc was greater than Fα at 0.05 significance level meaning that there is a difference in mean rating of importance of reasons for continued use of conventional methods of contingency sum determination in spite of the existing scientific methods among the three categories of cost experts.

3.4.2.5 Presentation methods

Data under the second objective was presented in form of graphic presentation i.e. charts and mean tables.

3.4.3 Research Objective 3: ***Ascertain whether cost experts had formal policies and management guidelines for estimating, controlling and reviewing the use of contingency sum.***

3.4.3.1 Type of Data/Information required.

To achieve this objective, the study needed to identify the various policies and guidelines for proper management of contingency sum as opined and suggested by various authors and scholars. Since monitoring of project contingency sum during the project's execution was observed as a major guideline for proper management of contingency sum, the study needed information from cost experts in Kenya to establish whether they adequately monitored contingency sum after formulation during the project execution. In addition, the study required information to find out whether cost experts had formulated and documented policies and procedures for proper management of contingency sum.

3.4.3.2 Sources of data

Secondary sources provided information about the various guidelines and policies for proper management of contingency sum as reviewed and documented by various scholars. Subsequently primary sources provided raw data collected from cost experts that indicated whether the identified guidelines and policies were being used by cost experts in Kenya when managing contingency sum.

3.4.3.3 Data Collection Instruments.

In consideration of the available data collection instruments, nature of information required from respondents, time and budgetary constraints, the questionnaire was seen to be the most appropriate instruments to collect data regarding the management guidelines and policies for proper management of contingency sum.

3.4.3.4 Data analysis

Analysis of data for this objective also employed the use of a statistical software SPSS version 16.0 for windows. Microsoft excel was also used to derive computations and tables. Descriptive statistic was used to observe some properties of the sample and its strata such as frequency and sample proportion. Frequency was used to tabulate and sort out raw data in order to show the number of cost experts that monitored the use of contingency sum during construction, the specific monitoring methods used and the documented policies and guideline they had for proper management of contingency sum. The sample proportion was used to ascertain the proportion of cost experts with documented policies for proper management of contingency sum.

3.4.3.4.1 Hypothesis testing on whether cost experts had formal policies and management guidelines for proper management of contingency sum using confidence intervals

All policies and guidelines for proper management of contingency sum had two hypotheses. The null hypothesis (H_0) was that cost experts did not have the identified policies and guidelines for proper management of contingency sum while the alternative hypothesis (H_A) was that cost experts had the identified policies and guidelines for proper management of contingency sum. Since the population mean of cost experts with documented policies and guidelines for proper management of contingency sum was not known Confidence Interval technique (King'oria, 2004) was used to test the above hypotheses.

This technique gives a proportion of an interval under the normal curve and on both sides of the sample proportion that is expected to contain the value of estimated population proportion i.e. probability that the estimated population proportion will lie in the interval formed on both sides of the sample proportion. The technique assumes that the parent population is normally distributed over a proportion upon which a confidence interval is built as a decision criterion.

Hence in this study, the sample proportion of cost experts with documented formal policies and management guidelines for proper management of contingency sum was used to build the interval.

A confidence level of 95% was set in order to build a confidence interval around the sample proportion of cost experts with policies and guidelines for proper management of contingency sum. This was to minimize the risk of committing type II i.e. accepting a false hypothesis as recommended by King'oria (2004). The equation for the interval was built and expressed as follows;

$$\mathbf{CI = P\ (X - Z\alpha.\ \sigma x \leq \pi \leq X + Z\alpha.\ \sigma x)}$$

Where;

CI = Confidence interval.

X = Sample mean (proportion) of cost experts with policies and guidelines for proper Management of contingency sum

$Z\alpha$ = Normal deviate i.e. 1.96

σx = Standard error of sample mean computed as follows i.e. $\sigma x = \sqrt{\frac{\sigma}{n}}$

σ = Standard deviation

n = Sample size

π =Estimated population mean (proportion) of cost experts with policies and guidelines for proper management of contingency sum.

Based on the confidence interval equation formulated above the null hypotheses for each of the policies will be rejected if its sample mean (proportion) lie within the confidence interval of cost experts with identified policies and guidelines for proper management of contingency sum.

3.4.3.5 Presentation methods

Data under the third objective was presented in form of graphic presentation i.e. charts and mean tables.

3.4.4 Research Objective 4: *Strategies for continuously improving skills and methods of cost experts when predicting contingency sum.*

3.4.4.1 Type of Data/Information required.

To achieve this objective, the study needed to identify possible ways of improving methods and skills of cost experts when determining contingency sum as suggested and documented by various scholars and researchers.

As highlighted in the problem statement Adafin et al (2013) observed that most cost experts do not show any sign of improving their approach in contingency sum determination and management as they are stuck to the conventional methods of lump sum and percentage addition to project base estimate. Hence as an attempt to find a solution, the study sought the opinion of cost experts in the Construction Industry to verify the importance of each of the identified ways of improving skills and methods when determining contingency sum.

3.4.4.2 Sources of data

Secondary sources provided information on the possible ways of improving the methods used to determine contingency sum as reviewed and documented by various scholars. Primary sources provided opinion of cost experts in the Construction Industry on important ways of improving their skills and methods when determining contingency sum.

3.4.4.3 Data Collection Instruments.

In consideration of the available data collection instruments, nature of information required from respondents, time and budgetary constraints, the questionnaire was the most appropriate instrument for collecting data regarding important strategies for improving methods and skills of cost experts when determining contingency sum for construction projects.

3.4.4.4 Data analysis

Data analysis for this objective was performed using statistical software SPSS version 16.0 for windows. In addition, Microsoft excel was also used to derive computations and tables. The basic assumption was that ranking of strategies for improving methods and skill of determining contingency sum reflected what would be expected from the population distribution.

Descriptive statistic was used to observe some properties of the sample and its strata. These included mean, frequency, standard deviation and standard error of the estimate. The mean was used to calculate average rating of strategies for improving methods and skills of contingency sum determination in order of their importance. Frequency was useful in showing the rate at which strategies for improvement were mentioned by various cost experts while the standard deviation and standard error of the estimate were used in calculating the critical values.

3.4.4.4.1 Hypotheses testing of the important strategies for continuously improving the methods and skills of determining contingency sum using population mean.

After ranking the strategies of improving methods and skills of contingency sum determination, the next step was to isolate the important strategies. This was done by comparing the mean rating of each strategy with the population mean that provided a basis of making a decision on whether a given strategy was important or not. The basic assumption was that the ranking of the above identified strategies for improvement based on their importance would exhibit a normal probability distribution in the population of cost experts.

These were measured on a five point scale with 5 as the most important strategy. With the assumption that the population was normally distributed, the five possible scores on the scale had an equal chance of occurring and therefore the mean, mode and median were equal. The horizontal scale used in this study had a minimum value of 1 and a maximum value of 5. The median (3.0) was therefore considered to be the population's mean rank of importance of each improvement strategy. This was the point indicating whether a particular improvement strategy was fairly important on the horizontal scale decision scale and thus formed the decision point.

3.4.4.4.2 Hypothesis testing of the important strategies for continuously improving the methods and skills of determining contingency sum using the Z test.

To test this hypothesis it was imperative that a decision criterion be established as a benchmark for isolating important strategies of improvement. This was done through hypothesis testing of the identified reasons using the Z - test. The exercise involved the use of one tail lower limit test to set lower limit for isolating important strategies based on the sample mean since all strategies with a score above the mean of (3) were already important.

Through literature review the study had identified nine strategies through which cost experts could continuously improve their prediction skills and methods when determining contingency sum. These were measured on a five point horizontal scale having a minimum value of 1 and a maximum value of 5. The median 3 in the horizontal numerical scale was therefore considered to be the population's mean rating of importance of each identified strategy.

All the identified strategies had two hypotheses. The null hypothesis (H_0) was that the strategy was not important while the alternative hypothesis (H_A) was that the strategy was important. The decision rule was evaluated by setting a confidence level of 95% i.e. 0.05 level of significance in order to reduce chances of committing Type I Error which can be committed by concluding that a given strategy is not important when it is.

3.4.4.5 Presentation methods

Data for the third objective was presented in form of graphic presentation i.e. charts and mean tables.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION

4.1 Response Profile

A total of 105 questionnaires were generated and disseminated by the researcher to consulting Quantity Surveying, Building Services Engineers and Civil/Structural engineering firms practicing in Kenya. As a consequence of advancement in information technology, majority of the questionnaires were circulated in soft copies via email while the rest were delivered in hardcopies based on the location of the respondent's head office in relation to the researcher's location which was based in Nairobi. The response profile was as follows;

Profession of Respondents	Questionnaires Administered (No)	Questionnaires Returned (%)	Questionnaires Not Returned (%)	Total (%)
1. Building Services	7	100%	0%	**100%**
2. Quantity Surveying Firms	66	65%	35%	**100%**
3. Civil/structural Engineering Firms	32	60%	40%	**100%**

Table 4.1: ***Response Profile***

Source: ***Filed survey, 2014***

As depicted in table 4.1 above all questionnaires administered to Building Services Engineering Firms were returned dully filled by the respondents. This could be attributed to the smaller sample size of Services Engineers selected from an equally smaller population size as per the list obtained from the Engineers Board of Kenya. However, 65% & 60% of the questionnaires administered to Quantity Surveying and Civil/Structural Engineering firms respectively were returned. Consequently an average of 38% of the total questionnaires administered was not returned. Most of these were the ones that had been circulated to

Quantity Surveying and Civil/Structural Engineering Firms. Upon a constant follow up and reminder by the researcher through cell phone calls and emails, some of the non-responsive consulting firms claimed to have lacked time to respond since they were busy in their offices while others simply failed to keep their promise of responding and returning the filled questionnaire to the researcher as had earlier been requested.

The returned questionnaires however amounted to an average response rate of 75% which according to Mugenda and Mugenda (1999) was reasonable and formed a good basis of analyzing data since it was above 60% of the total sample size.

4.2 Involvement of cost experts in formulation of contingency sum.

Due to the fact that the targeted consulting firms had adopted various structures of operation and management in their offices, the researcher aimed at guaranteeing the reliability of raw data from the respondents by ascertaining their direct involvement in formulation of contingency sums for Construction Projects. The results are follows;

Category of Respondents	**Total Number of Returned Questionnaires**	**Involvement in Contingency Sum Formulation**
1. Building Services Engineering Firms	7	100%
2. Quantity Surveying Firms	45	100%
3. Civil/structural Engineering Firms	17	100%
Total	**69**	**100%**

Table 4.2: ***Involvement of cost experts in formulation of contingency sum***

Source: ***Field Survey 2014***

As displayed in table 4.2 above all the responsive respondents had been directly involved in the formulation of contingency sum for Construction Projects. This finding therefore confirmed that the information collected from the respondents was reliable and could be used to generate informed conclusions and recommendations from the foregoing data analysis.

4.3 Duration of Practice

Since the nature of this study required considerable amount of experience and a better understanding of methods of contingency sum determination by cost experts, the study sought to establish the length of time the respondents had been in practice. This was an additional measure of reliability of the information given by respondents. The findings are as shown below.

Duration of Practice	**Frequency**	**%**
0 – 5 Years	15	22%
5 – 10 Years	15	22%
10 – 15 Years	8	12%
15 – 20 Years	1	2%
Above 20 Years	27	42%
Total	**69**	**100**

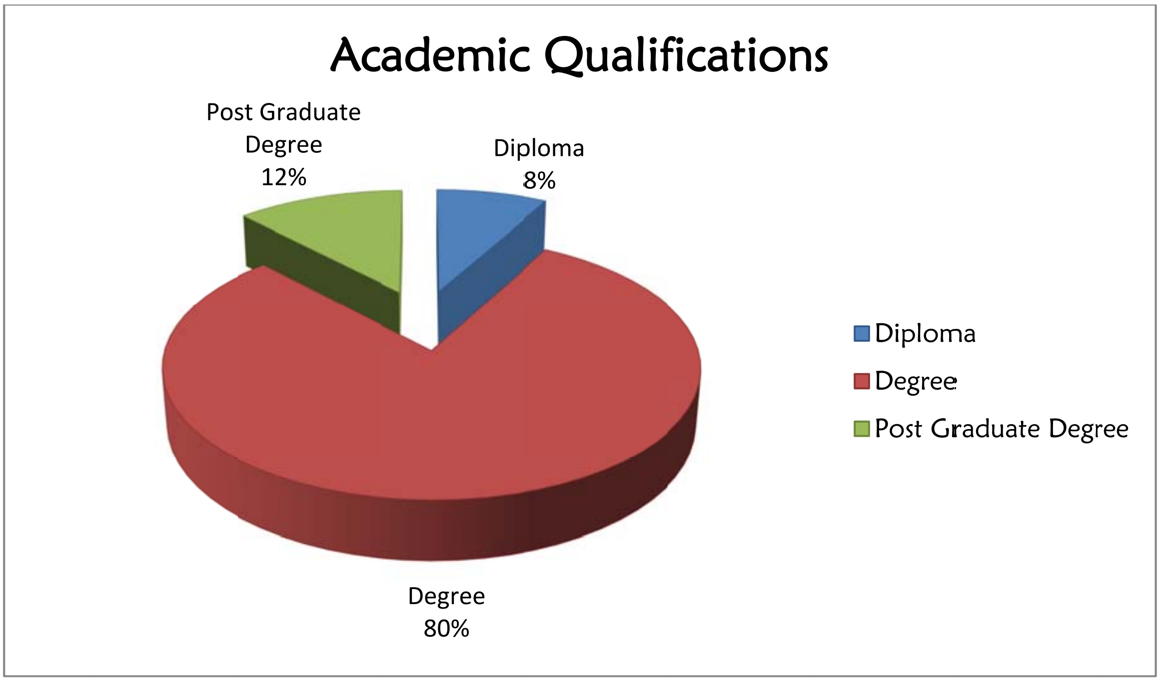
Table 4.3: ***Duration of Practice***

Source: ***Field survey, 2014***

As shown in table 4.3 above majority of the respondents i.e. 42% had been in practiced for over 20 years while 22% had been in practice for 10 years and below. 12% of the respondents had practiced for between 10 – 15 years while 2% of the respondents had practiced for between 15 – 20 years. On average 56% of the respondents had experience spanning for over ten years which was considered adequate for gaining experience and better understanding of the various methods of formulating contingency sum for construction projects.

4.4 Level of Education of the respondents

The respondents were asked to indicate their level of education so as to assess their competence and proficiency in giving technically knowledgeable and reasonably informed responses. The findings are as shown in the chart below.



Pie chart 4.4: ***Level of Education***

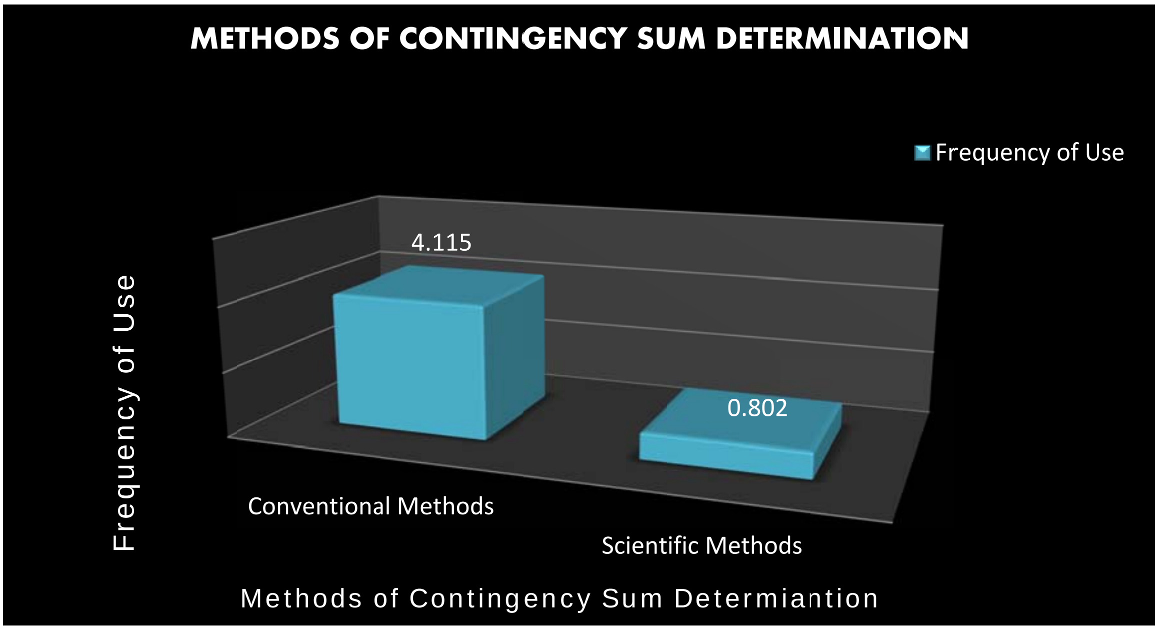
Source: ***Field Survey 2014***

Majority (80%) of the respondents had attained undergraduate degree while 8 % had acquired diplomas. 12% had acquired postgraduate degrees. Cumulatively 92% had a minimum education level of an undergraduate degree. This is attributed to, among others, minimum requirement of undergraduate degree by the relevant professional bodies before an individual is allowed to practice as a consultant Quantity Surveyor or Engineer. Nonetheless, the above findings made certain that all respondents had gone through the elementary level of education and were therefore considered to be technically proficient and competent to give logical and informed responses needed for this study.

4.5 Methods and weaknesses of contingency sum determination

4.5.1 Methods of contingency sum determination

As had earlier been pointed out in the problem statement and further articulated by Ali (2005), most construction cost experts in Ghana had adopted conventional methods of estimating the required contingency sum to cover for uncertain events that might occur on a Construction Project. The study therefore sought to establish whether construction cost experts in Kenya had also adopted conventional methods of determining contingency sum as their counter parts in Ghana. The findings are as shown below.



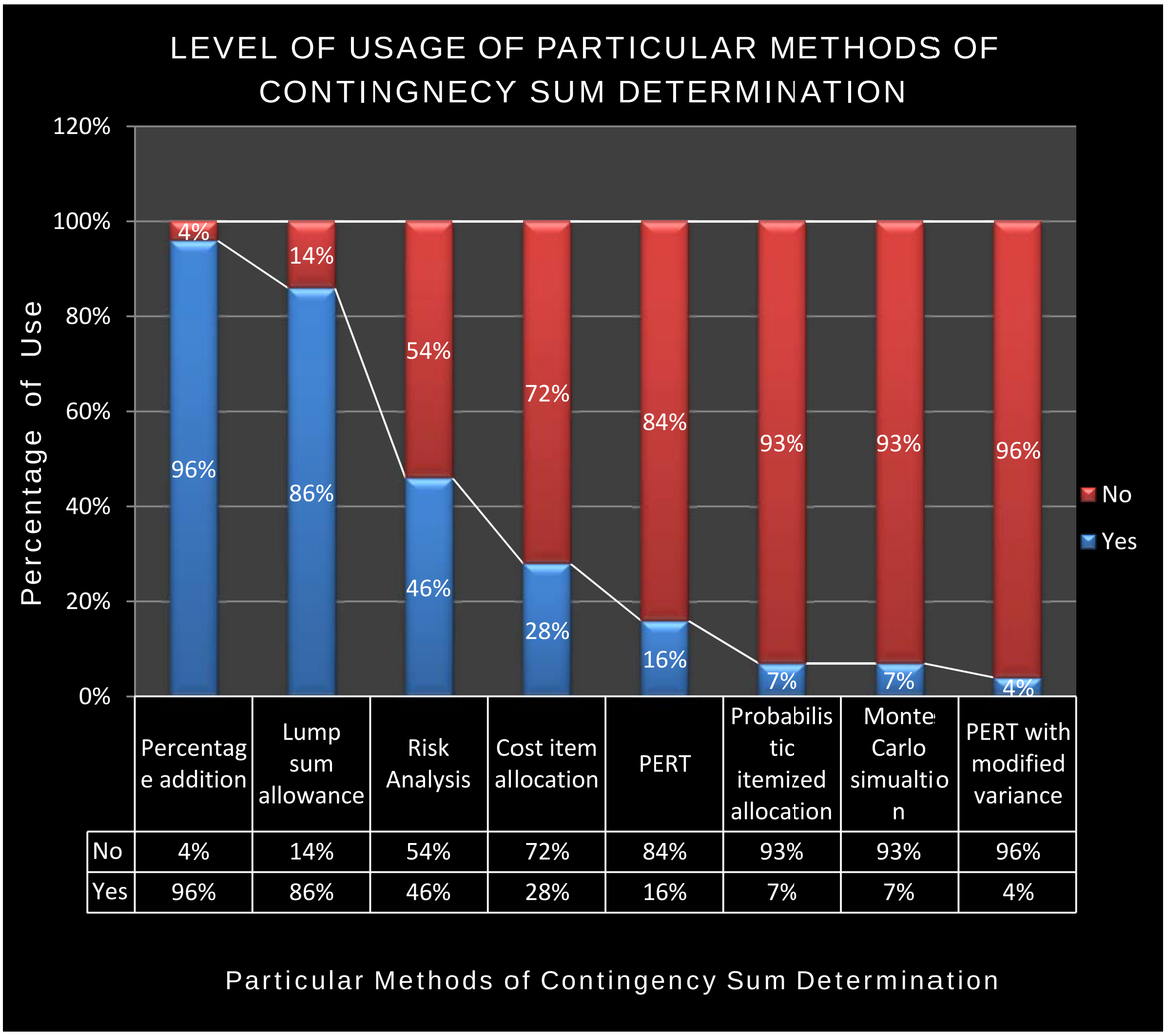
Column chart 4.5.1: ***Mean Rating of Methods of Contingency Sum Determination***

Source: ***Field Study 2014***

Majority of the respondents accorded a high mean rating to conventional methods i.e. 4.115 out of 5 (where 5 represented the most frequently used method of determining contingency sum). This result agrees with a finding by Ali (2005) which had established that most construction cost experts in Ghana had adopted conventional methods of contingency sum determination. This can be attributed to their perceived simplicity in application since, as established in part 2.10.1 of the literature review, cost experts when using conventional methods don't have to identify, describe or value various categories and possible areas of risk and uncertainties on projects. In addition, the high rating might have been caused by limited knowledge on application of scientific methods by cost experts. Consequently scientific methods were accorded a lower mean rating of 0.802 out of 5. This result also agrees with a finding by Bello & Odusami (2008), as articulated in part 2.10.1 of the literature review, which had alluded to the fact that scientific methods were the least used when compared to the conventional methods of contingency sum determination. This can be attributed to their perceived complexity in application which, according to Teye et al (2012), involves application of complex mathematical models that are difficult to comprehend.

4.5.2 Particular Methods of Contingency Sum Determination

There are various methods used by construction cost experts to determine contingency sum as highlighted in part 2.10 of the literature review. The study therefore sought to establish level of usage of these particular methods by cost experts in Kenya. The results are as shown below.



Bar chart 4.5.2: ***Level of usage of particular methods of contingency sum determination by cost experts in Kenya.***

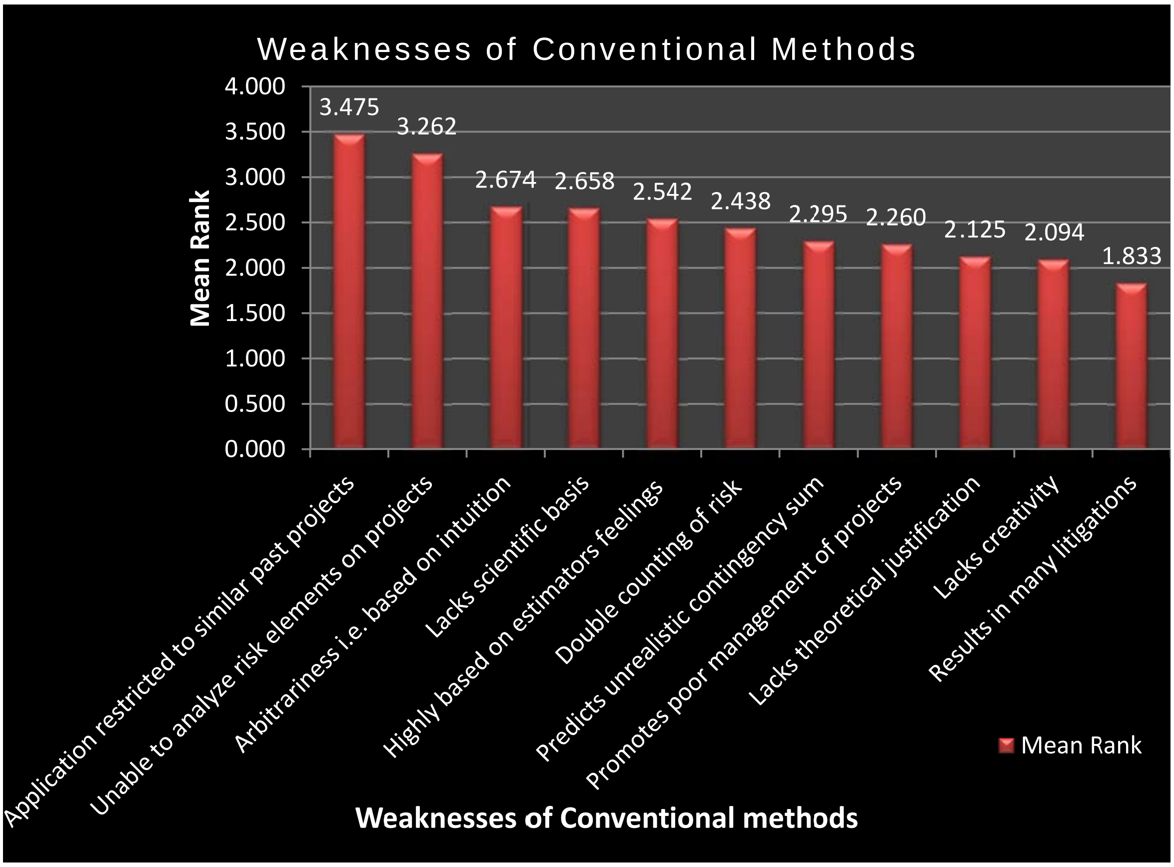
Source: ***Field survey 2014***

As depicted in the above bar chart, at least all methods identified in the literature review of this study had been used by cost experts in Kenya to determine contingency sum. However, the magnitude of use for each method varied considerably. Most of the methods with the highest percentage of use were conventional. This result agrees with the finding in 4.5.1 above which had established that conventional methods were the most frequently used in Kenya. Among the methods percentage addition was the most widely used with 96% of the respondents indicating its usage. This can be attributed to the fact that the method makes reference to historical data especially on similar projects as postulated by Teye et al (2012).

Lump sum allowance method was ranked second at 86% while cost item allocation method was ranked fourth at 28%. The rest of the remaining methods were scientific whose usage was minimal when compared to conventional methods. This result agrees with a finding by Bello & Odusami (2008) which, as indicated in part 2.10.2 of the literature review, had established that most cost experts were yet to fully explore the benefits of scientific methods when determining contingency sums. Among these, risk analysis was ranked third overall with 46% of the respondents indicating its use while Programme Evaluation Review Technique (PERT) ranked fifth with 16% of the respondents indicating its use. Probabilistic itemized allocation and Monte Carlo Simulation were both ranked sixth with 7% of the respondents indicating their use while Programme Evaluation Review Technique (PERT) with modified variance was ranked lowest with 4% of the respondents indicating its use.

4.5.3 Significant weaknesses of Conventional Methods

As had been alleged in the problem statement the frequent occurrence of cost overruns on construction projects in Kenya implied a potential weakness in the conventional methods frequently used by cost experts in determining the required contingency sum. The study had, through literature review, conceptualized and perceived eleven (11) weaknesses of conventional methods. The respondents were then asked to rank these weaknesses in order of their significance on a 5 point horizontal numerical scale (where 5 represented the extremely significant weakness of conventional methods). The mean ratings were computed and result summarized in the bar chart below-overleaf.



Bar chart 4.5.3: ***Weaknesses of conventional methods of Contingency sum determination***

Source: ***Field survey, 2014***

The results in the bar chart above shows application of conventional methods being restricted to similar past project as an extremely significant weakness with the highest mean rating of 3.475 out of 5. This implies that most cost experts experience difficulties in determining accurate contingency sums for new projects whose scope and specifications are different from that of a previous project. Inability of the conventional methods to analyze risk elements on projects was ranked second with a mean rating of 3.262 out of 5. This result indicates a possible analytical failure of conventional methods in assessing risk factors and uncertain events inherent on a construction project. Arbitrariness and lack of scientific basis ware ranked third and fourth with a mean rating of 2.674 and 2.658 out of 5 respectively. Conventional methods being highly based on estimator's feelings was ranked fifth by the respondents with a mean rating of 2.542. Double counting of risk was ranked sixth with a mean rating of 2.438. This may be due to fact that most cost experts allow contingency sum for their respective scope of work notwithstanding the overall allowance of contingency sum to the entire construction project. Prediction of unrealistic contingency sum was ranked seventh with a mean rating of 2.295 out of 5 while poor management of projects was ranked eighth by respondents with a mean rating of 2.26 out of 5. Lack of theoretical justification was ranked ninth with a mean rating of 2.125 out of 5. Lack of creativity was ranked second lowest with a mean rating of 2.094 out of 5 while conventional methods resulting in many litigations was ranked lowest with a mean rating of 1.833 out of 5 which implied that there were other more important causes of litigations in construction projects other than the use of conventional methods of contingency sum determination.

Having identified and ranked the weaknesses of conventional methods of contingency determination the next step was to isolate the significant weaknesses as objectively as possible. This was done using the population mean score and the Z test.

4.5.4 Hypotheses testing of the significant weaknesses of conventional methods of contingency determination using Population Mean score

In view of the ranked weaknesses of conventional methods of contingency sum determination it became necessary to set the decision point to reject or fail to reject the null hypotheses based on the population mean score. The study assumed that the ranking of the eleven (11) weaknesses based on their significance would exhibit a normal probability distribution in the population of cost experts. Hence a horizontal five point scale was generated with the assumption that each score on the point scale had an equal chance of occurring since the population had been assumed to be normally distributed. This therefore meant that the mean, mode and median were equal. The horizontal scale used in this study had a minimum value of 1 and a maximum value of 5. The median (3.0) in the horizontal numerical scale used in the study was therefore considered to be the population's mean rating of significance for each weakness. This was the point indicating whether a particular weakness was fairly significant and thus formed the decision point.

All the variables had two hypotheses. The null hypotheses (H_0) stated that the weakness was not significant while the alternative hypothesis (H_A) stated that the weakness was significant. The results for one tail test of null hypothesis (H_0: $\mu < 3.0$) are as follows;

Weaknesses of Conventional Methods	**Mean Ranking of Significance (On a 5 point scale)**	**Decision**	**Status**
(i) Application restricted to similar past projects	3.475	Reject $\mathbf{H_0}$	Significant
(ii) Unable to analyze risk elements on projects	3.262	Reject $\mathbf{H_0}$	Significant
(iii) Arbitrariness i.e. based on intuition	2.674	Fail to Reject $\mathbf{H_0}$	Insignificant
(iv) Lacks scientific basis	2.658	Fail to Reject $\mathbf{H_0}$	Insignificant
(v) Highly based on the estimators feelings	2.542	Fail to Reject $\mathbf{H_0}$	Insignificant
(vi) Double counting of risk	2.438	Fail to Reject $\mathbf{H_0}$	Insignificant
(vii) Predicts unrealistic contingency sum	2.295	Fail to Reject $\mathbf{H_0}$	Insignificant
(viii) Promotes poor management of projects	2.260	Fail to Reject $\mathbf{H_0}$	Insignificant
(ix) Lacks theoretical justification	2.125	Fail to Reject $\mathbf{H_0}$	Insignificant
(x) Lack creativity	2.094	Fail to Reject $\mathbf{H_0}$	Insignificant
(xi) Results in many litigations	1.833	Fail to Reject $\mathbf{H_0}$	Insignificant

Table 4.5.4*: Results for test of significant weaknesses of conventional methods using population mean*

Source: ***Field survey, 2014***

The results in the above table indicate that only two weaknesses of conventional methods had their means greater than the population mean of (3.0) and thus had their null hypotheses rejected meaning that they were significant. These weaknesses included restriction of application of conventional methods to similar past projects and inability to analyze risk elements on projects. To conclusively isolate the significant weakness from the two, the Z – test was carried out as shown below.

4.5.5 Hypotheses testing of the significant weaknesses of conventional methods using the Critical Z - test

The two weaknesses established through hypothesis testing using the population mean were subjected to further analysis so as to conclusively ascertain whether they were still significant when tested by other statistical tool. This entailed the application of critical Z values to test the hypotheses. This involved the use of the one tail lower limit test to set the lower limit of sample mean at which the weakness could be significant. This was because any score above the mean of (3) was already significant.

Each of the two weaknesses of conventional methods of contingency sum determination identified in 4.5.4 above had two hypotheses. The null hypothesis (**H_0**) stated that the weaknesses were not significant while the alternative hypothesis **(H_A)** stated that the weaknesses were significant. The decision rule was evaluated by establishing the probability of committing type 1 error that is concluding that a factor is significant when it is not. Harper (1994) argues that Type 1 error can be avoided by setting a lower confidence level at 95 %. In this situation committing Type 1 error was viewed as less harmful than committing Type II error i.e. concluding that a variable is not significant when it is. Harper (1994) argues further that Type II error can be avoided by setting a higher confidence level. The confidence level of 99% was therefore set. This meant that any variable that scored a sample mean within three standard deviations from the asserted population mean at the lower tail of the distribution was regarded as significant. The upper tail limit was not necessary because any score above the critical value was already significant. The results are as shown in the table below.

Weaknesses of Conventional Methods	**Mean Ranking of significant weaknesses**	**Critical Z Values**	**Normal Deviate**	**Decision**
(i) Application restricted to similar past projects	3.475	2.33	3.345	Reject $\mathbf{H_0}$
(ii) Unable to analyze risk elements on projects	3.262	2.33	1.844	Fail to Reject $\mathbf{H_0}$

Table 4.5.5: ***Results for hypothesis testing of significant weaknesses of conventional methods using the Z test***

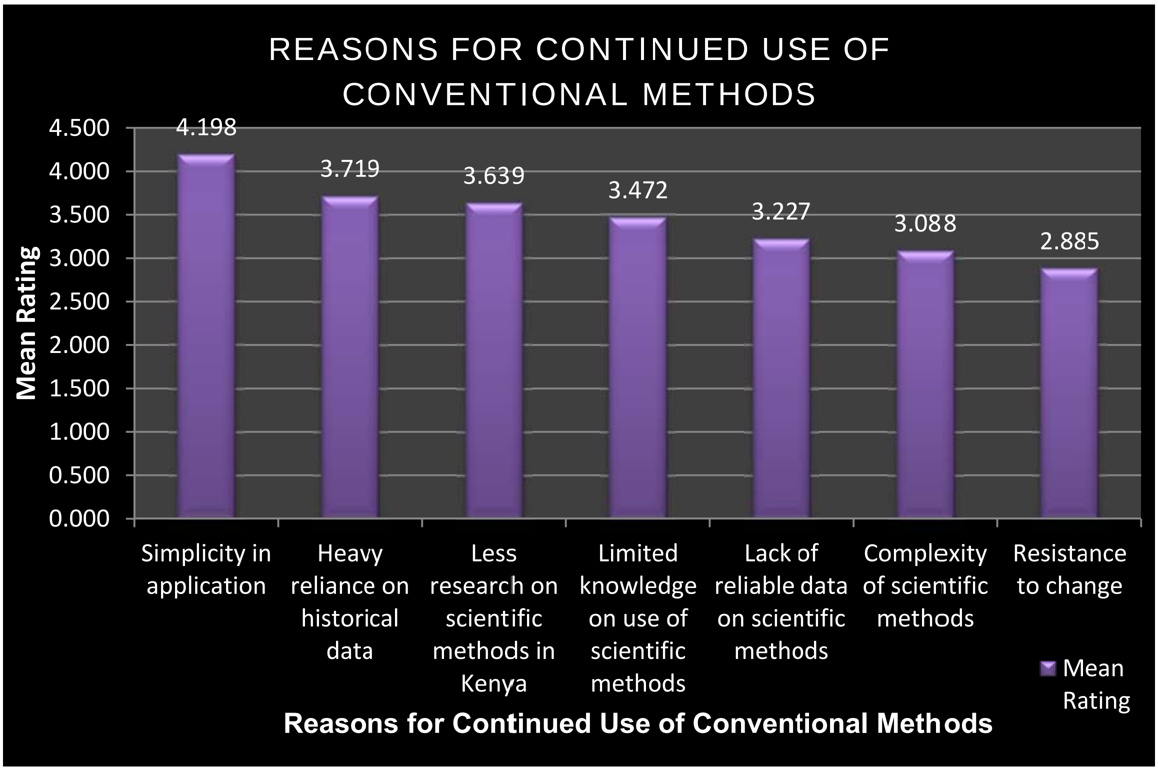
Source: ***Filed study 2014***

Analysis of data in table 4.5.5 above indicates that the normal deviate value of 3.345 for application of conventional methods being restricted to similar past project was greater than the critical Z value of 2.33. Hence the null hypothesis for this weakness was rejected meaning that it a significant weakness. Consequently since the normal deviate value of 1.844 for inability of conventional methods to analyze risk elements on projects was less than the critical Z value of 2.33. Hence the null hypothesis for this weakness was not rejected meaning that it was not significant.

The above analysis therefore confirms only one out of the eleven weaknesses i.e. application of conventional methods being restricted to similar past projects to be significant. This result supports the affirmation by Baccarini (2004) which mentioned conventional methods as being subjective and arbitral since they based on intuition and past experience.

4.6 Reasons for continued use of conventional methods of contingency sum determination in spite of the existing scientific methods.

As stated in the problem statement and further substantiated by Bello and Odusami (2008) construction cost experts continue to use conventional methods of contingency sum determination in spite of the existing scientific and statistical methods which are said to predict more accurate contingency sums. The study therefore sought to find out why cost experts continued to use conventional methods of contingency sum determination in spite of the development of new scientific methods. The respondents were therefore asked to rank the identified seven (7) reasons that were perceived to encourage the continued use of conventional methods. The results are as shown below.



Bar Chart 4.6: R***easons for continued use of conventional methods***

Source: ***Field survey 2014***

As depicted in the bar chart 4.6 above simplicity in application of conventional methods was accorded the highest mean rating of 4.198 out of 5, meaning that it is the most important reason for continued use of conventional method of contingency sum determination in spite the existing scientific methods. This can be attributed to the fact that conventional methods are easy to understand unlike the scientific methods which, according to Teye et al (2012), involves the application of complex mathematical models that are difficult to comprehend. Heavy reliance on historical data was ranked second with a mean rating of (3.719) which is attributed to the fact that cost experts value and consider experiences and lessons learned from previous projects when formulating budgets for new projects. Less research on scientific methods in Kenya was ranked third with a mean rating of 3.639 out of 5, implying a possible lack of confidence by cost experts in Kenya on scientific models based on research done abroad. In addition, this observation also suggests that minimal research on formulation of contingency sum has been done in the Kenyan Construction Industry. Limited knowledge on use of scientific methods was ranked fourth with a mean rating of 3.472 out of 5, implying a possible deficiency in understanding comprehensive risk modeling tools and techniques such as statistical and probabilistic models. Lack of reliable data and complexity of scientific methods were ranked fifth and sixth with a mean rating of 3.227 and 3.088 out of 5 respectively. The lowest important reason for continued use of conventional methods was resistance to change with a mean rating of 2.885 out of 5. The lowest rank on resistance to change implies a possible willingness of cost experts to embrace new scientific methods of contingency sum determination.

Having identified and ranked the reasons for continued use of conventional methods in spite of the existing scientific methods the next step was to isolate the important reasons as objectively as possible. This was done using the population mean score and the Z - test.

4.6.1 Hypotheses testing of the reasons for continued use of conventional methods of contingency sum determination using Population Mean score

In consideration of the ranked reasons for continued use of conventional methods it became necessary to set the decision point for either rejecting or not rejecting the null hypothesis based on the population mean score. The assumption made in the study was that the ranking would exhibit a normal probability distribution in the population of cost experts. Hence a five point scale was generated and since the population was assumed to be normally distributed each point had an equal chance of occurring and thus the mean, mode and median were equal. The horizontal scale used in this study had a minimum value of 1 and a maximum value of 5. The median (3.0) in the horizontal numerical scale used in the study was therefore considered to be the population's mean rating of importance for each reason. This is a point indicating whether that the reason was fairly important on the horizontal scale and thus forms the decision point.

All the reasons had two hypotheses. The null hypotheses (**H_0**) were that the reasons were not important while the alternative hypothesis (**H_A**) were that the reasons were important. A one tail test of null hypothesis (H_0: $\mu < 3.0$) for each reason was carried out. The results are as shown below.

Reasons for Continued Use of Conventional Methods	**Mean rating (on a 5 point scale)**	**Decision**	**Status**
(i) Simplicity in application	4.198	Reject **H_0**	Important
(ii) Heavy reliance on historical data	3.719	Reject **H_0**	Important
(iii) Less research on scientific methods in Kenya	3.639	Reject **H_0**	Important
(iv) Limited knowledge on use of scientific methods	3.472	Reject **H_0**	Important
(v) Lack of reliable data on scientific methods	3.227	Reject **H_0**	Important

(vi) Complexity of scientific methods	3.088	Reject $\mathbf{H_0}$	Important
(vii) Resistance to change	2.885	Fail to Reject $\mathbf{H_0}$	Unimportant

Table 4.6.1: ***Results for hypothesis testing of important reasons for continued use of conventional methods using population mean***
Source: ***Field Study 2014***

The results in table 4.6.1 above shows that six reasons had their means greater than the population mean (3.0) and hence their null hypotheses were rejected, meaning that they were important. These included simplicity in application, heavy reliance on historical data, less research on scientific methods in Kenya, limited knowledge on use of scientific methods, lack of reliable data on scientific methods and complexity of scientific methods. Consequently only one reason i.e. resistance to change had its mean being less than the population mean and hence its null hypothesis was not rejected meaning that the reason was not important. To conclusively isolate important reasons the Z test t was carried out.

4.6.2 Hypotheses testing of the reasons for continued use of conventional methods using the Z test.

The six weaknesses isolated as important using the population mean were subjected to further analysis in order to find out whether they were still important when subjected to other statistical test. This was done through hypothesis testing of the six reasons using the Z - test. The exercise involved the use of one tail lower limit test to set the lower limit of sample mean at which a given reason could be considered as important. This was the decision point since any score above the mean of (3) was already important. Each of the six important reasons had two hypotheses. The null hypotheses ($\mathbf{H_0}$) were that the reasons were not important while the alternative hypotheses ($\mathbf{H_A}$) were that the reasons were important. These hypotheses were measured on a five point horizontal scale having a minimum value of 1 and a maximum value of 5. The median 3 in the horizontal numerical scale was therefore considered to be the population's mean rating of importance for each identified reason. The decision rule was evaluated by setting a confidence level of 99% i.e. 1% level of significance in order to reduce chances of committing Type II Error which can be committed by concluding that a given reason is not important when it is. The results are as shown in the table below.

Reasons for Continued Use of Conventional Methods	**Mean Ranking of Important Reasons**	**Critical Z Values**	**Normal Deviate**	**Decision**
(i)Simplicity in application	4.198	2.33	7.748	Reject $\mathbf{H_0}$
(ii) Heavy reliance on historical data	3.719	2.33	4.650	Reject $\mathbf{H_0}$
(iii) Less research on scientific methods in Kenya	3.639	2.33	4.133	Reject $\mathbf{H_0}$
(iv) Limited knowledge on use of scientific methods	3.472	2.33	3.055	Reject $\mathbf{H_0}$
(v) Lack of reliable data on scientific methods	3.227	2.33	1.470	Fail to Reject $\mathbf{H_0}$
(vi)Complexity of scientific methods	3.088	2.33	0.571	Fail to Reject $\mathbf{H_0}$

Table 4.6.2: ***Results for hypothesis testing of important reasons for continued use of conventional methods using the Z - test***

Source: ***Field Study 2014***

Analysis of data in the above table shows that the normal deviate values for four reasons i.e. simplicity in application, heavy reliance on historical data, less research on scientific methods in Kenya and limited knowledge on use of scientific methods were greater than the expected critical Z value of 2.33. As a consequence the null hypotheses for each of these weaknesses were rejected which meant that the reasons were important. This result attempts to explain the ironical finding by Bello & Odusami (2008), as highlighted in the problem statement, where cost experts continued to use conventional methods in spite of the development of scientific and statistical methods which are perceived to predict accurate contingency sums. Consequently since the normal deviate values for two reasons i.e. lack of reliable data on scientific methods and complexity of scientific methods were less than the expected critical Z value of 2.33, their null hypotheses for each of them were not rejected, meaning that these weaknesses were not important.

4.6.3 Hypothesis testing of the agreement among cost experts on the reasons for continued used of conventional methods using One way Analysis of Variance (ANOVA)

The study also sought to establish the degree of agreement among Quantity Surveyors, Services Engineers and Civil/Structural Engineers on the importance of the identified reasons for continued use of conventional methods of contingency sum determination in spite the existing scientific methods. This was to ascertain whether there was any difference in means among the various categories of cost experts on how important the reasons were in influencing the continued use of conventional methods. This was done using one way Analysis of Variance (ANOVA) which was found suitable for this exercise.

According to Alreck & Settle (1995) when the independent variable is categorical i.e. category of cost experts and the dependant variable is continuous i.e. rating of importance of reasons, the appropriate technique to measure the relationship between the two is Analysis of Variance. The objective of the analysis was to determine whether the mean values of rating of the identified reasons differed significantly among the three categories of cost experts on the basis of their specific professional disciplines. The process started with the tabulation of means per category of cost experts as shown below.

Reasons for Continued Use of Conventional Methods	Mean Rating of Importance by Cost Experts		
	Quantity Surveyors	Building Services Engineers	Civil/Structural Engineers
(i) Simplicity in application	4.167	4100	4.318
(ii) Heavy reliance on historical data	4.135	3.167	3.214
(iii)Less research on scientific methods in Kenya	3.792	3.500	3.300
(iv) Limited knowledge on use of scientific methods	3.577	2.900	3.375
(v)Lack of reliable data on scientific methods	2.893	2.500	3.917

(vi)Complexity of scientific methods	3.136	2.500	3.300
(vii)Resistance to change	2.357	2.625	3.938

Table 4.6.3: ***Tabulation of means for reasons according to professional background***

Source: ***Field Study 2014***

The hypotheses were as follows;

$\mathbf{H_0}$**:** There is no difference in mean rating among the cost experts on the importance of reasons for continued use of conventional methods of contingency sum determination in spite of the existing scientific methods. i.e.

$\mathbf{H_0}$ = μ Quantity Surveyors = μ Services Engineers = μ Civil/structural Engineers.

$\mathbf{H_A}$**:** There is a difference in mean rating among the cost experts on the importance of reasons for continued use of conventional methods of contingency sum determination in spite of the existing scientific methods. i.e.

$\mathbf{H_A}$: μ Quantity Surveyors ≠ μ Services Engineers ≠ μ Civil/structural Engineers.

The testing of hypotheses in ANOVA was done at a Confidence level of 95%. This implied that:

C = 1 - 0.95

α = 0.05

The degrees of freedom were as follows;

$\boldsymbol{V_1\ d\,f.} = c - 1\ d\,f.$

$= 3 - 1 = 2\ d\,f.$

$\boldsymbol{V_2\ d\,f.} = c(r - 1)$

$= 3\,(7 - 1) = 18\ \mathrm{d}\,f.$

Hence the expected F_α statistic is expressed as follows

$$F_{\alpha\ 0.05\ (2,\ 18)} = 3.5546$$

The sum of squares due to random error (SSE) = **5.949**

The sum of squares due to treatment (SST) = **1.234**

Mean of squares due to treatment $MST = \frac{SST}{V_1\ df.}$

$$= \frac{1.234}{2}$$

$$= \mathbf{0.617}$$

Mean of squares due to random error $MSE = \frac{SSE}{V_2\ df}$

$$= \frac{5.949}{18}$$

$$= 0.330$$

$$F_c = \frac{MST}{MSE}$$

$$= \frac{0.617}{0.330}$$

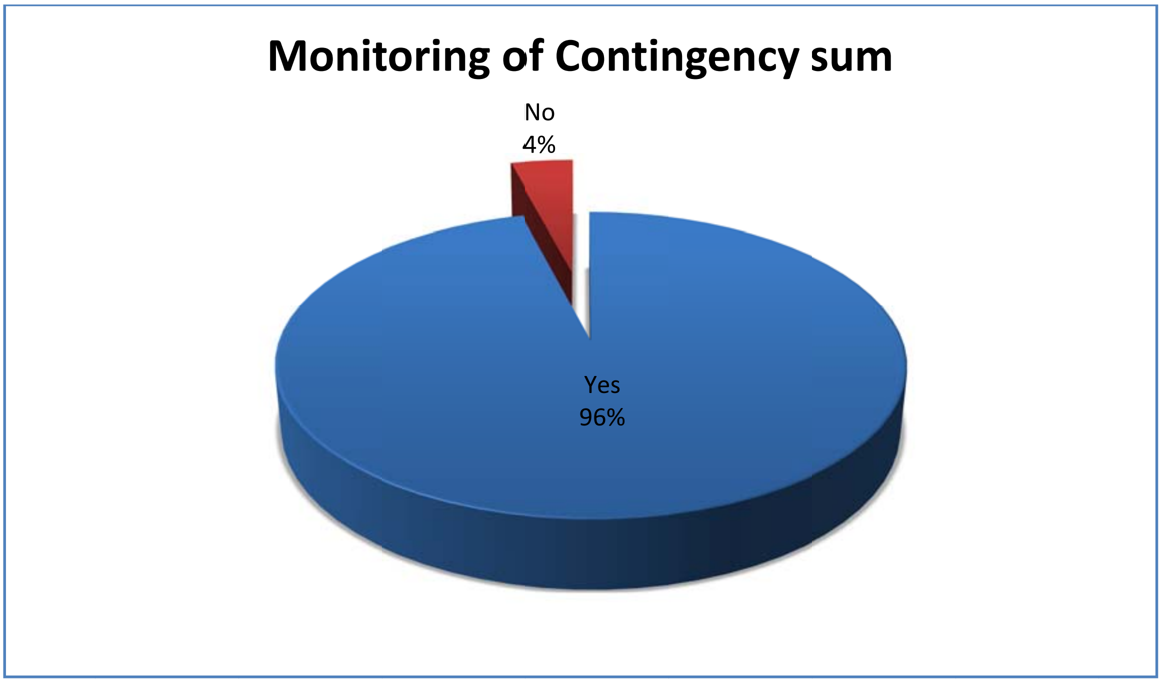
$$= 1.87$$

Therefore, since the computed F_c statistic (1.87) is less than the expected F_α statistic (3.5546) the null hypothesis which stated that there was no difference in mean rating of the importance of reasons among the cost experts is therefore not rejected. This means all cost experts irrespective of their professional backgrounds were in agreement on the importance of the identified reasons for continued use of conventional methods of contingency sum determination in spite the existing scientific methods.

4.7 Formal policies and management guidelines for estimating, controlling and reviewing the use of contingency sum.

4.7.1 Monitoring of Contingency Sum

Monitoring the use of contingency sum as recommended by CIRIA (1996) and Lorance (1992) is one of the best practices for proper management of contingency sum. The study therefore sought to establish whether construction cost experts in Kenya monitored the use of contingency sum during the project execution. The findings are as shown in the chart below.



Pie Chart 4.7.1: ***Percentage of cost experts who monitored use of contingency sum***

Source: ***Field study***

Majority of the respondents (96%) indicated that they monitored the use of contingency sum on construction projects. This result implies that most cost experts in Kenya appreciates the good practice, as established by Lorance (1992) and CIRIA (1996), of monitoring, controlling, reassessing and scrutinizing the use of contingency sums on construction projects. Few respondents (4%) indicated that they did not monitor the use of contingency sum on construction projects. The researcher observed that most of the respondents who did not monitor the use of contingency sum had practiced for only five years and below. This implies that most cost experts who had practiced for a longer time appreciated the exercise of monitoring contingency sum on construction projects.

4.7.2 Methods of monitoring of Contingency Sum

According to Oduro (2008) there are various methods used to monitor the use of contingency sum on Construction Projects. The study therefore sought to establish particular methods cost experts in Kenya use to monitor use of contingency sum. The findings are as shown in the following table;

Methods of monitoring use of Contingency Sum	Yes %	No %	Total %
1. Project Manager	83%	17%	100%
2. Sensitivity analysis software	0	100%	100%
3. Risk management & communication	28%	72%	100%
4. No method	0	100%	100%

Table 4.7.2: ***Methods of monitoring use of contingency sum***

Source: ***Field study 2014***

Most of the respondents (83%) affirmed the engagement of Project Manager as their preferred method of monitoring use contingency sum. Since Project Management is a developing practice in Kenya's Construction Industry when compared to Quantity Surveying, Engineering and Architecture this observation suggests a possible appreciation of Project Management services in cost management by clients in Kenya. None of the respondents had used sensitivity analysis software in monitoring use of contingency sum on Construction Projects which implies a low uptake and acknowledgement of information technology in cost management by cost experts in Kenya. This observation further compliments the finding by Bello and Odusami (2008) as highlighted in the problem statement which indicated that cost experts in the Construction Industry continue to use the conventional methods of contingency sum determination in spite of the existing scientific methods. In addition, this finding might be the cause for occurrence of cost overruns on projects in spite of the monitoring of contingency sum use by other non-scientific methods. A few respondents (28%) indicated that they used risk management communication to monitor contingency sum. This might have been caused by low understanding of the process of risk assessment and management by some of the cost experts.

4.7.3 Policies for proper management of contingency sum

As a strategy for proper management of contingency sum Hamburger (1994) observes that it is prudent for the cost experts to have formal policies and management guidelines for estimating, defining and controlling the scope of contingency sums. Through literature review the study had identified seven (7) policies for proper management of contingency sum. The respondents were asked to indicate whether they had used any of them in management of contingency sum. The results are as follows.

Policies for proper management of contingency sum	Yes	No
(i) Assessing potential risks inherent on a project	59%	41%
(ii) Measures for accountability on the usage of contingency sum	58%	42%
(iii) Filling and signing contingency sum forms by Client & Project Manager	41%	59%
(iv) Allocation of contingency sum to specific risk elements	41%	59%
(v) Standard templates for plan on contingency sum	33%	67%
(vi) Continuous training on proper management of contingency sum	30%	70%
(vii) Procedures for reviewing and updating contingency plan templates	26%	74%

Table 4.7.3: ***Percentage of cost experts with policies for proper management of contingency sum***

Source: ***Field study 2014***

Results from table 4.7.3 above shows that policies for assessing potential risks inherent on construction projects were the most used since 59% of the respondents had indicated their use. This implies that a fairly above average number of cost experts understand the process of assessing potential risks inherent on a construction project. 58% of the respondents indicated that they had policies that stipulated the measures for accountability on the usage of contingency sum. A fairly below average percentage of respondents (41%) indicated that they had policies outlining the procedures for filling and signing contingency sum forms by the client or Project Manager and for allocation of contingency sum to specific risk elements on projects. A moderately smaller percentage (33%) of the respondents indicated that they had policies outlining standard templates for plan on usage contingency sum. 30% of the respondents indicated that they had policies for continuous training on proper management of contingency sum while 26% of the respondents indicated that they had procedures for reviewing and updating contingency plan templates.

4.7.4 Hypothesis testing on whether cost experts had policies for formulation and management of contingency sum.

All policies and guidelines for proper management of contingency sum had two hypotheses. The Null hypothesis (H_0) was that cost experts did not have policies and guidelines for proper management of contingency sum while the alternative hypothesis (H_A) was that cost experts had policies and guidelines for proper management of contingency sum. Since the population's percentage of cost experts with documented policies and guidelines for proper management of contingency sum was not known Confidence Interval for population proportion technique (King'oria, 2004) was used to test the above hypotheses.

This technique gives a proportion of an interval under the normal curve and on both sides of the sample proportion that is expected to contain the value of estimated population proportion i.e. probability that the estimated population proportion will lie in the interval formed on both sides of the sample proportion. The technique assumes that the parent population is normally distributed over a proportion upon which a confidence interval is built as a decision criterion. Hence in this study, the sample proportion of cost experts with documented formal policies and management guidelines for proper management of contingency sum was used to build the interval.

A confidence level of 95% was set in order to build a confidence interval that was expected to have a population's percentage of cost experts with policies and guidelines for proper management of contingency sum. The equation for the interval was built and expressed as follows;

$$CI = P(X - Z\alpha .\ \sigma x \leq \pi \leq X + Z\alpha .\ \sigma x)$$

Where;

CI = Confidence interval.

X = Sample mean (proportion) of cost experts with policies and guidelines for proper Management of contingency sum i.e. 41%

$Z\alpha$ = Normal deviate i.e. 1.96

σx = Standard error of sample mean computed as follows i.e. $\sigma x = \sqrt{\frac{\sigma}{n}}$

σ = Standard deviation

n = Sample size

π =Estimated population mean (proportion) of cost experts with policies and guidelines for proper management of contingency sum.

Hence

$CI = P(41\% - 1.96 \times 4.565 \leq \pi \leq 41\% + 1.96 \times 4.565)$

$CI = P(32\% \leq \pi \leq 49\%)$

This interval was then used to examine the percentage of each policy so as to find out whether it belonged to the population's interval. The results are as shown in the table below.

Policies for proper management of contingency sum	Percentage of Cost experts with policies (X)	Confidence Intervals	Decision
(i) Assessing potential risks inherent on a project	59%	$32\% \leq \pi \leq 49\%$	Fail to Reject H_o
(ii) Measures for accountability on the usage of contingency sum	58%	$32\% \leq \pi \leq 49\%$	Fail to Reject H_o
(iii) Filling and signing contingency sum forms by Client & Project Manager	41%	$32\% \leq \pi \leq 49\%$	Reject H_o
(iv) Allocation of contingency sum to specific risk elements	41%	$32\% \leq \pi \leq 49\%$	Reject H_o
(v) Standard templates for plan on contingency sum	33%	$32\% \leq \pi \leq 49\%$	Reject H_o
(vi) Continuous training on proper management of contingency sum	30%	$32\% \leq \pi \leq 49\%$	Fail to Reject H_o
(vii) Procedures for reviewing and updating contingency plan templates	26%	$32\% \leq \pi \leq 49\%$	Fail to Reject H_o

Table 4.7.4: ***Results for hypotheses testing on whether cost experts had policies for proper management of contingency sum using confidence interval.***

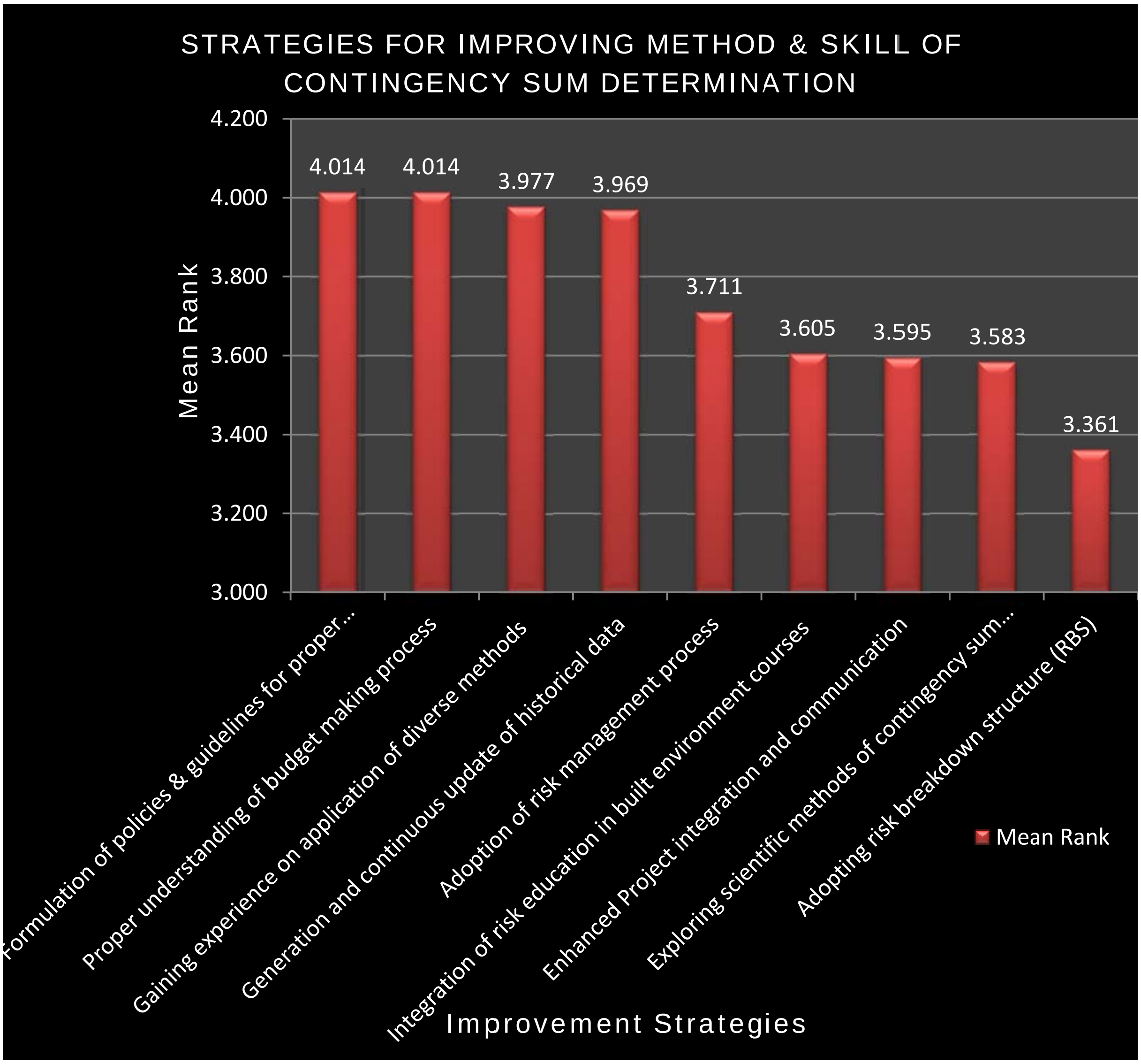
Source: ***Field Study 2014***

Analysis of data in the table above indicates that the percentage of cost experts with policies for assessing potential risks inherent on a project, measures for accountability on the usage of contingency sum, continuous training on proper management of contingency sum and procedures for reviewing and updating contingency plan templates fell outside the confidence interval of between 32% and 49%. Hence, the null hypotheses for these policies were not rejected meaning that most cost experts did not have them. Consequently the percentage of cost experts with policies for filling and signing contingency sum forms by Client & Project Manager, allocation of contingency sum to specific risk elements and standard templates for plan on contingency sum fell within the confidence interval of between 32% and 49%. Thus, their null hypotheses were rejected meaning that most cost experts did have these policies.

The above analysis therefore confirms that out of the seven policies only three were in use by cost experts i.e. filling and signing contingency sum forms by Client & Project Manager, allocation of contingency sum to specific risk elements and standard templates for plan on contingency sum. This result shows a fairly below average use of policies and guidelines for proper management of contingency sum as opposed to their full usability recommended by Baccarini, (2005). Hence this might be the cause of prediction of inadequate contingency sums for construction projects in Kenya.

4.8 Strategies for continuously improving methods and skills of cost experts when predicting contingency sum.

In view of the frequent occurrences of cost overruns on construction projects as highlighted in the problem statement the study sought to establish strategies for continuously improving methods and skills of cost experts when determining contingency sum for construction projects. The respondents were therefore asked to rank the following strategies of improvement order of their importance. The findings are shown below.



Bar Chart 4.8: ***Improvement strategies of methods and skills of cost experts when determining contingency sum***

Source: ***Filed study 2014***

Majority of the respondents accorded a high mean rating of 4.014 out of 5 (where 5 represented the most important strategy of improvement) to formulation of policies and guidelines for proper management of contingency sum. Since hypotheses testing at 4.7.4 above had revealed a fairly below average usability of policies and guidelines for proper management of contingency sums by cost experts, this finding affirms the prime importance of policies and guidelines for proper management of contingency sum in averting cost overruns on construction projects. Proper understanding of the process of budget making was also accorded a similar high rating of 4.014 out of 5, this implies that contingency sum decisions are very crucial since they have an impact on level of accuracy of predicted contingency sum. Gaining experience on application of diverse methods of contingency sum determination was ranked third with a mean rating of 3.97 out of 5. This finding might be as a result of frequent use of conventional methods of contingency sum determination by cost experts. Generation and continuous update of historical data was ranked fourth with a mean rating of 3.96 out of 5, indicating the need for cost experts to have data base of key information from previous projects which will be useful for future reference and use. Adoption of risk management process was ranked fifth with a mean rating of 3.71 out of 5. Integration of risk education in built environment courses was ranked sixth with a mean rating of 3.605 out of 5 while enhanced project integration and communication ranked seventh with a mean rating of 3.595 out of 5. Exploration of scientific methods, at 3.583 out of 5, and adoption of risk breakdown structure, at 3.361 out of 5, were ranked eighth and ninth respectively.

4.8.1 Hypothesis testing of the strategies for continuously improving methods and skills of cost experts when predicting contingency sum using Population Mean Score

After ranking the strategies of improving methods and skills of contingency sum determination, it became necessary to set the decision point. This was the point to either reject or fail to reject the null hypotheses based on the population mean score. The basic assumption was that the ranking of the above identified strategies for improvement based on their importance would exhibit a normal probability distribution in the population of cost experts.

These were measured on a five point scale with 5 as the most important strategy. With the assumption that the population was normally distributed the five possible scores on the scale had an equal chance of occurring and therefore the mean, mode and median were equal. The horizontal scale used in this study had a minimum value of 1 and a maximum value of 5. The median (3.0) was therefore considered to be the population's mean rank of importance of each improvement strategy. This was the point indicating whether a particular improvement strategy was fairly important on the horizontal scale and thus formed the decision point. All the strategies had two hypotheses. The null hypotheses (H_0) was that the strategy was not important while the alternative hypothesis (H_A) was that the strategy was important. The results are as follows;

Strategies of improving methods and skills of cost experts when determining contingency Sum	**Mean ranking (on a 5 point scale)**	**Decision**
(i) Formulation of policies and guidelines for proper management of contingency sum	4.014	**Reject H0**
(ii) Proper understanding of the process of making budget	4.014	**Reject H0**
(iiii) Gaining experience on application of diverse methods	3.977	**Reject H0**
(iv) Generation and continuous update of historical data	3.969	**Reject H0**
(v) Adoption of risk management process	3.711	**Reject H0**
(vi) Integration of risk education in built environment courses	3.605	**Reject H0**
(vii) Enhanced Project integration and communication	3.595	**Reject H0**
(viii) Exploring scientific methods of contingency sum determination	3.583	**Reject H0**
(ix) Adopting risk breakdown structure (RBS)	3.361	**Reject H0**

Table 4.8.1: ***Results for hypothesis testing of important improvement strategies using Population Mean***

Source: ***Field Study 2014***

A one tail test of null hypothesis (H_0: $\mu < 3.0$) shows that all improvement strategies had their means greater than the population mean (3.0) and hence all the null hypotheses were rejected. This meant that all the improvement strategies as identified in the literature review were important. In spite the above findings the researcher sought to conclusively isolate important strategies of improving the methods and skill of determining contingency sum. Hence the Z-test was applied.

4.8.2 Hypotheses testing of ways in which cost experts can continuously improve their prediction skills and methods when determining contingency sum using critical Z - test.

The results from data analysis at 4.8.1 above on the important strategies of improving methods and skill of contingency sum determination using the population mean needed further analysis to conclusively isolate the important strategies. This was done through hypothesis testing of the nine strategies for improvement using the Z - test. All the strategies as tested through population mean had been found to be most and averagely important since their means were above 3.0. Hence a one tail lower limit test was applied to test the lower limit of the sample mean of the strategies in order to find out whether they were still important. This was because any score above the mean of (3.0) was already important. The median 3.0 in the horizontal numerical scale was therefore considered to be the population's mean rating of importance for each identified strategy. All the strategies had two hypotheses. The null hypothesis (H_0) was that the strategy was not important while the alternative hypothesis (H_A) was that the strategy was important. The decision rule was evaluated by setting a confidence level of 95% i.e. 0.05 level of significance in order to reduce chances of committing Type II Error which can be committed by concluding that a given strategy is not important when it is. The results are as shown below.

Strategies for improving methods & skills of determining contingency sum	**Normal Deviate**	**Critical Z Values**	**Decision**
(i) Formulation of policies and guidelines for proper management of contingency sum	13.346	1.65	Reject $\mathbf{H_0}$
(ii) Proper understanding of the process of making budget	13.346	1.65	Reject $\mathbf{H_0}$
(iii) Gaining experience on application of diverse methods	12.859	1.65	Reject $\mathbf{H_0}$

(iv) Generation and continuous update of historical data	12.747	1.65	Reject $\mathbf{H_0}$
(v) Adoption of risk management process	9.349	1.65	Reject $\mathbf{H_0}$
(vi) Integration of risk education in built environment courses	7.964	1.65	Reject $\mathbf{H_0}$
(vii) Enhanced Project integration and communication	7.832	1.65	Reject $\mathbf{H_0}$
(viii) Exploring scientific methods of contingency sum determination	7.675	1.65	Reject $\mathbf{H_0}$
(ix) Adopting risk breakdown structure (RBS)	4.751	1.65	Reject $\mathbf{H_0}$

Table 4.8.2: ***Results for hypothesis testing of important strategies for improving method and skill of determining contingency sum using Z test***

Source: ***Field Study 2014***

From the above analysis all the normal deviate values for each improvement strategy were greater than the critical Z value which was 1.65. As a consequence the null hypotheses for all the improvement strategies were rejected. This means that all the strategies for improving methods and skills of determining contingency sum are important. Hence the adoption and subsequent implementation of these strategies would resolve the rigidity of cost experts in improving their approach in contingency sum determination and management which had been observed by Adafin et al (2013).

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter retrospects the objectives, unfolds the findings and presents conclusions and recommendations based on the validated assessment of the findings.

5.2 Objectives of the study

The objectives of this study were as follows;

(v) To establish significant weaknesses of conventional methods of contingency sum determination.

(vi) To find out why construction cost experts continue to use the conventional methods of contingency sum determination in spite of the existing new scientific methods

(vii) To ascertain whether construction cost experts have formal policies and management guidelines for estimating, controlling and reviewing the use of contingency sum

(viii) To find out ways in which construction cost experts can continuously improve on their prediction methods and skills when determining contingency sum?

5.2.1 Objective 1 : Significant weaknesses of conventional methods of contingency sum determination.

This objective was achieved through testing of hypothesis using the Z- test. Out of the eleven (11) perceived weaknesses of conventional methods that had been identified in literature review only one weakness i.e. application of conventional methods being restricted to similar projects was found to be significant.

The following weaknesses though significant when tested using Population Mean, were found not to be significant when tested using Z test;

(i) Inability to analyze risk elements on projects.

(ii) Arbitrariness.

(iii) Lack of scientific basis.

(iv) Highly based on estimators feelings.

(v) Double counting of risk.

(vi) Prediction of unrealistic contingency sum.

(vii) Promotes poor management of projects.

(viii) Lack of theoretical justification.

(ix) Lack of creativity.

(x) Results in many litigations.

It is imperative to note that in as much as the above weaknesses of conventional methods were found not to be significant in this study they were however capable of causing inaccurate prediction of contingency sum on construction projects that could result in cost overruns.

5.2.2 Objective 2 : Reasons for continued use of conventional methods of contingency determination in spite the existing scientific methods

In order to achieve this objective the Population Mean test and Z - test were used to ascertain the important reasons. Out of the seven (7) perceived reasons that had been identified in literature review, four were found to be important and thus contributed to the continued use of conventional methods in spite the existing scientific methods. These are as follows;

(i) Simplicity in application.

(ii) Heavy reliance on historical data.

(iii) Less research on scientific methods in Kenya.

(iv) Limited knowledge on use of scientific methods.

In as much as the following reasons were observed to be important when tested using Population Mean, they were however found not to be significant when tested using the Z - test;

(i) Lack of reliable data on scientific methods.

(ii) Complexity of scientific methods.

(iii) Resistance to change.

Other reasons for continued use of conventional methods though not tested statistically but mentioned by the respondents included;

(i) Limited time in preparation of budgets for construction projects.

(ii) Corruption among the cost experts.

(iii) Inadequate training in tertiary institution on diverse methods of contingency sum determination.

(iv) Simplicity in scope and specifications of projects which does not warrant the use of scientific methods.

In addition to identifying the important reasons, the study also sought to establish the degree of agreement among the cost experts on the importance of the reasons for continued use of conventional methods of contingency determination in spite the existing scientific methods. This was to ascertain whether certain reasons were related to or influenced by the professional background of the cost experts. This entailed the use of One Way Analysis of Variance to test the variance of means of various cost experts. The findings established a unanimous agreement among the cost experts on the important reasons encouraging the continued use of conventional methods.

5.2.3 Objective 3: Whether most cost experts had documented formal policies and management guidelines for estimating, controlling and reviewing use of contingency sum.

This objective was achieved through testing of the null hypothesis which stated that most cost experts did not have documented formal policies and management guidelines for estimating, controlling and reviewing the use of contingency sum. This was done using the confidence interval for proportion method. Out of the seven (7) policies that had been identified in literature review three were found to be in use by most of the cost experts. These were:

(i) Policies for filling and signing contingency sum forms by Client & Project Manager.

(ii) Policies for allocation of contingency sum to specific risk elements.

(iii) Policies outlining standard templates for plan on contingency sum.

Consequently the study also established that most cost experts did not have the following policies and guidelines for proper management of contingency sum:

(i) Policies for assessing potential risks inherent on a project.

(ii) Policies for measures for accountability on the usage of contingency sum.

(iii) Policies for continuous training on proper management of contingency sum.

(iv) Policies for procedures for reviewing and updating contingency plan templates.

5.2.4 Objective 4: Strategies for improving methods and skills of cost experts when determining contingency sum.

This was the fourth objective and was achieved through testing of hypothesis using the Population Mean and Z - test. All the nine strategies of improving methods and skills of cost experts when determining sum were found to be important. These include;

(i) Formulation of policies and guidelines for proper management of contingency sum.

(ii) Proper understanding of the process of budget making.

(iii) Gaining experience on application of diverse methods of contingency sum determination.

(iv) Generation and continuous update of historical data.

(v) Adoption of risk management process.

(vi) Integration of risk education in built environment courses.

(vii) Enhanced project integration and communication.

(viii) Exploration of scientific methods of contingency sum determination.

(ix) Adoption of risk breakdown structure.

Other strategies for improvement though not tested statistically but mentioned by the respondents included;

(i) Training of cost experts during Continuous Professional Development seminars organized by professional bodies on diverse methods of contingency sum determination.

(ii) More time allowed for preparation of budgets for construction projects.

(iii) Sharing of cost information among the cost experts.

These above findings indicate the achievement of the forth objective.

5.3 Limitations of the study

This study was primarily limited by its unique sample that majorly targeted cost experts working in private consulting firms. The sample size could have been expanded to include cost experts working in the public sector such as Public Works Department, County Governments and Parastatals among other public agencies. Hence to generalize the results for all cost experts in the Kenyan Construction Industry, the opinions and attitudes of cost experts working in the public sector would have to be sought. The result validity is affected by this limitation. There is need for a study to consider the other cost experts so as to give a complete industry wide perspective.

5.4 Recommendations

The study has established the main significant weakness of conventional methods of contingency sum determination as being restricted application to similar projects. Hence cost experts should learn, adopt and use different methods of determining contingency sum that are capable of taking into consideration the various peculiar factors and variables associated with different specifications and scope of projects. This will help to minimize cost overruns on construction projects and also to effectively manage and control expenditure on contingency sum.

In view of the continued use of conventional methods of contingency sum determination in spite the existing scientific methods, researchers in the Construction Industry must endeavor to simplify the scientific methods in order to make them less complex in application by cost experts. In addition, historical data on previous projects must be well documented in simple form that is easy to retrieve, process and understand. More research should be done on the application of scientific methods in Kenya in order to generate relevant data appropriate for use by statistical and probabilistic models of contingency sum determination. More awareness on scientific methods in terms of their application and benefits must done in order to enable cost experts embrace them.

The study has also established that the usage of policies for proper management of contingency sum was fairly below average and this might have contributed to occurrence of cost overruns on projects. The study therefore recommends the formulation of policies and guidelines for proper management of contingency sum as a measure of reducing cost overruns on projects.

In order to continuously improve the methods and skills of determining contingency sum, construction cost experts ought to formulate and document formal policies and guidelines for estimating and controlling the use of contingency sum. In addition, they should endeavor to fully understanding the process of budget making, gain experience on application of diverse methods of contingency sum determination, generate and continuously update historical data from previous projects, adopt risk management processes in assessing construction related risks and enhance project integration and communication so as to uncover risks and improve on project coordination. In addition, tertiary institutions should integrate risk education in the built environment courses so as to make future cost experts graduating from these institutions aware of the tools and techniques of managing risks and uncertainties which if not properly managed can result in cost overruns.

5.4 Areas of further research

A research should be done and model generated for predicting contingency sum based on data from construction projects in Kenya.

APPENDIX 1: Bibliography

Abwunza A.A (2006), *The relationship between actual and perceived risk in Building contracts in Kenya,* A research report submitted in partial fulfilment of the requirement for Degree of Master of Arts in Construction Management at the University of Nairobi.

ACQS – Association of Consultant Quantity Surveyors (2012), *Practice Notes for Quantity Surveyors – Cost Control & Financial Statements*, The Hong Kong Institute of Surveyors

Adafin J. K, *Suzanne W. Rotimi James (2013), Risk-contingency fund in the design stage elemental cost planning function: A theoretical exploration,* Department of Civil & Environmental Engineering, The University of Auckland, New Zealand

Ahmad I (1992), *Contingency Allocation: A Computer-Aided Approach,* 1992 AACE Transaction F.5,F.5.1- F.5.5.

Akinsola A.O, Potts K.F, Ndekugri I and Harris F.C. (1997), *Identification and evaluation of factors influencing variations on building projects* International Journal of Project Management 15(4), 263 - 267

Ali Rashed (2005), The Application of risk management in infrastructural construction projects, Journal of Cost Engineering Vo. 47/No. 8 pp 20—27

Alreck P.M. & Settle R.B. (1995), *The Survey Research Handbook,* 2nd Edition. Richard D. Irwin, Inc

Architect's Handbook of Professional Practice (2008), 14th edition, Published by John Wiley & Sons, Inc, Hoboken, New Jersey

Baccarini David (1998a), *Project Risk Management – Cost Contingency,* Australian Project Manager, 18, 7-8

Baccarini D (1998b), *Cost Contingency-A Review,* Australian Institute of Quantity Surveyors, Refereed Journal, 2, 8-15.

Baccarini David (2004), *Accuracy in estimating project cost construction contingency – A statistical analysis,* Cobra 2004: RICS International Construction Conference, responding to Change, 7-8 September, 2004.Headingley Stadium, U.K.

Baccarini David (2005). *Understanding Project Cost Contingency- A Survey*. In: Sidwell A.C (ed.), Proceedings of the Queensland University of Technology Research Week International Conference, 4-8 July 2005, Brisbane, Australia.

Baccarini David (2006). *The maturing concept of estimating project cost contingency,* Department of Construction Management, Curtin University of Technology, Western Australia, Australia.

Banaitiene Nerija & Banaitis Audrius (2012), *Risk Management in Construction Projects*, Department Construction Economics and Property Management, Faculty of Civil Engineering, Vilnius Gediminas Technical University, Vilnius, Lithuania

Beardsall D (2005), *Value, Risk and Uncertainty*, The Quantity Surveyor, 51(2), 1-40.

Bello A & Odusami K (2008), *The practice of contingency allocation in construction projects in Nigeria,* Cobra 2008: The construction and building research conference of the Royal Institution of Chartered Surveyors, Held at Dublin Institute of Technology, 4-5 September 2008

Bello A & Odusami K (2009), *Project variables influencing contingency on construction contract in Nigeria*, Cobra 2009: The construction and building research conference of the Royal Institution of Chartered Surveyors, Held at the University of Cape Town, 10-11 September 2009

Bello A & Odusami K (2012), *The effectiveness of construction contingency in contract delivery in Nigeria,* Cobra 2012: RICS International Construction Conference, 11th – 13th September, 2012. Las vegas, Nevada USA, Arizona State University

Boukendour S. (2005), *A New Approach to Project Cost Overrun and Contingency Management*. OCRI Partnership Conferences Series Process and Project Management,22 March 2005,Ottawa.

Burroughs S. E & Juntima G (2004), *Exploring Techniques for Contingency Setting,* 2004 AACE International Transactions, Morgantown, WV

Chau K. (1995), *Monte Carlo simulation of construction costs using subjective data,* Construction Management and Economics, 369 - 383.

Chen D & Hartman F.T (2000), *A Neural Network Approach to Risk Assessment and Contingency Allocation*, AACE International Transactions, Risk.07.01- Risk.07.06

Clark D. E (2001), *Monte Carlo Analysis: ten years of experience*, Cost Engineering, 43 (6), 40 – 45.

Clark F D & Lorenzoni A B (1985). *Applied cost engineering*. New York: M. Dekker

Construction Industry Research and Information Association (CIRIA), (1996), *Control of risk: a guide to the systematic management of risk from construction.* London: CIRIA

Curran M W (1989), *Range estimating: Contingencies with confidence,* Cost Engineering 31(3), 18 – 26

Demkin A. Joseph (2007), *The Architect's Handbook of Professional Practice*, (2007), Fourteenth Edition, Published by John Wiley & Sons, Inc

Dey P, Tabucanon M T, and Ogunlana S O (1994) *Planning for project control through risk analysis, a petroleum pipelaying project.* International Journal of Project Management, 12(1), 23-33.

Ergin A. A (2005), *Determination of Contingency International Construction Projects During Bidding Stage*, MSc. Thesis Middle East Technical University, Turkey.

European Commission(1997),*Understanding and Monitoring the Cost-Determining Factors of Infrastructure Projects A User's Guide,* Published by European Commission Directorate-General for Regional Policy and Cohesion

Gary Jackson (2012), *Contingency for cost control in project management: a case study* School of Construction Management and Property, Queensland University of Technology, Australia

Gunhan S. & Arditi D. (2007), *Budgeting Owner's Construction Contingency*. Journal of Construction Engineering and Management, 429-497.

Hamburger D (1994), *Upper management's leadership role in the Contingency planning and control process*, PMI Annual Seminars & Symposium, Vancouver, 17-19 October

Harper W.M (1994), *Statistics,* Sixth Edition, M & E handbook Series, Pitman Publishing, London

Hart H. David (2007), *Managing the Contingency Allowance,* AIA Best Practices

Hartman F T (2000), *Don't park your brains outside,* Upper Darby PA: PMI

Hogg K. (2003). *The Role of Quantity Surveying Profession in Accommodating Client Risk,* Journal of Financial Management of Property and Construction 8(1), 49-56.

Investopedia Dictionary (2014), *Contingency,* [Online].
Available from: http://www.investopedia.com/terms/c/contingency.asp
[Accessed 12th June, 2014]

Jackson. J (1999), *Facility construction cost overruns: Analysis for Navy construction contracts.* A Report for CE675-civil Engineering Department, North Carolina state university, Raleigh, N.C.

JaneCameron Architects (2012), Contingency Sum, Bespoke residential architecture and interiors [Online Blog].
Available from http://janecameronarchitects.com/what-is-a-contingency-sum-3/
[Accessed 13th June, 2014]

Hanlon J.H (1997), *Detector Contingency Working Meeting* Germantown, MD

Hobbs Jeremy (2010), *A Methodology for Setting Contingency Reserves Using Probabilistic Cost Risk Analysis in Small to Medium Construction Projects*, Research paper

Isidore L.J, Back W. E & Fry G. T (2001), *Integrated probabilistic schedules and estimates from project simulated data,* Construction Management and Economics, 19, 417 – 426

Iqbal & Robert Tichacek (2004), *Contingency Misuse and other Risk*

Joint Building Council Kenya (JBC) (1999), *Agreement and Conditions of Contract for Building Works,* Published by JBCK

Joint Contracts Tribunal (JCT) (2011), *Standard forms of building contract,* Published by JCT England and Wales.

Jomah M.A (2008), *Factors Influencing Time and Cost Overruns on Construction Projects in the Gaza Strip,* A Thesis submitted in partial fulfilment of the requirement for Degree of Master of Science in Civil Engineering – Construction Management The Islamic University of Gaza

Kamalesh P, Ahmed S.M, & Ogunlana S O (2009), *Contingency Estimation for Construction Projects Through Risk Analysis,* International Journal of Construction Education and Research 5 (2), 79 - 94.

Karlsen J.T & Lereim J (2005), *Management of Project Contingency and Allowance,* Cost Engineering, 47(9),24- 29.

Kasimu M.A (2012), *Significant factors that causes cost overruns in building construction project in Nigeria,* Interdisciplinary Journal of Contemporary Research in Business. Vol,3 No 11

Kish L (1965), *Survey Sampling,* John Wiley and Sons Inc. New York

Kothari C.R (2004), Research Methodology: Methods and techniques 2nd Edition, New Delhi, New Age International Publishers.

Krosch A (1995), *Total Project Cost Control Guidelines,* Queensland Dept. of Transport, Infrastructure Development Division, Brisbane.

Kwakye A. A. (1997), *Construction project Administration in Practice,* Longman Publishers

Laws of Kenya (2010), *Architects and Quantity Surveyors Act, Cap 525,* Revised Edition, National Council for Law Reporting.

Laws of Kenya (2009), *Engineers Registration Act, Cap 530, Revised* Edition, National Council for Law Reporting.

Levine H (1995), *Risk management for dummies: managing schedule cost and technical risks and contingency*. PM Network, October, 30-32.

Lorance (1992), *Contingency Draw-Down Using Risk Analysis* American Association of Cost Engineers Transactions. 28 June - 1 July. Orlando. Pp.F.6.1-6

Mak S, Wong J & Picken D (1998). *The effect on contingency allowances of using risk analysis in capital cost estimating:* A Hong Kong Case Study. Construction Management and Economics. 16, 615-619.

Mak S. & Picken D, (2000), Using risk analysis to determine construction project contingencies Journal of Construction Engineering and Management, 126(2), 130-136

Mak S. & Picken D (2001), *Risk Analysis In cost planning and its Effect on efficiency in capital cost budgeting.* Logistic Information management Volume 14 number 5/6, pp318-329.

Masu S. M (2006), *An investigation into the causes and impact of resource mix practices in the Performance of construction firms in Kenya,* Unpublished PHD Thesis submitted at the University of Nairobi

Matt Stelzman (2014), Business Valuation Insight, Chattanooga, Tennessee [Online]. Available from http://chattanoogabusinessvaluation.com/2014/02/04/the-ins-and-outs-of-business-contingencies [Accessed 12th June, 2014]

Merrow E W and Schroeder B R (1991), *Understanding the costs and schedule of hydroelectric projects,* AACE Transactions, 23-26 June, Seattle, I.3.1-7.

Moselhi O (1997), *Risk assessment and contingency estimating*, AACE Transactions, 13-16th July, Dallas. DandRM/A.06.1-6.

Mugenda, O. M. & Mugenda, A. G. (1999).*Research Methods: Quantitative and Qualitative Approaches*. Nairobi: Acts Press

Nyamoki E. Nyabwari (2012), An *investigation on the causes and effects of cost overrun on civil works Projects in Mombasa County,* Unpublished MBA theses submitted at Kenyatta University

Newell Ken (2011), *Fire stations: the Construction Contingency Allowance,* Article published in Fire Rescue EMS Journal

Oduro Asamoah Richard (2008), *Determining and monitoring of project contingency sum for building development in Ghana,* Project Report presented in fulfillment of requirement for degree of MSC in Construction Management

Oduro, Danku & Amissah (2013), Estimating Contingency Sum for Building Works in Ghana, Research Scientist, Building and Road Research Institute, Council for Scientific and Industrial Research, Kumasi, Ghana, Department of Building Technology, Kwame Nkrumah University of Science and Technology, Ghana.

Owusu Tawiah (1999), *Factors Affecting the Performance of Ghanaian Owned Construction Firms*, Unpublished Msc. Thesis, Department of Building Technology, K.N.U.S.T- Kumasi.

Oxford English Dictionary, *Language matters* [Online]. Available from: http://www.oxforddictionaries.com/definition/english/contingency [Accessed 12th June, 2014]

Patrascu A (1988), *Construction cost engineering handbook,* New York: M. Dekker.

PMI (Project management Institute) (2000), *A guide to the project management body of knowledge,* Upper Darby PA:PMI.

Rangit Kumar (2005), Research Methodology, Sage Publications Republic of Kenya (2006), *Standard Tender Documents for Procurement of Works – Building and Associated Civil Engineering Works*, PPOA.

Rao Battu Hanumantha et al (2013), *A Brief View of Project Scheduling Techniques,* International Journal of Engineering Research & Technology (IJERT), Vol. 2 Issue 12, December - 2013

Risner R (2010), *Auditing Construction Contingency*, Construction Auditing, pp. 37-38

Selltitz, Clare (1962), Research methods in social sciences

Smith G. R & Bohn C.M (1999), *Small to medium contractor contingency and assumption of risk*, Journal of Construction Engineering and Management March/April 1999, 101-108

Smith N. J, Merna T & Jobling P (2006), *Managing Risk in Construction Projects*, Malden: Blackwell Publishing.

Sonmez R (2004), *Conceptual Cost Estimation of Building Projects with Regression Analysis and Neural Networks*, Canadian Journal of Civil Engineering 31, 677-683

Sonmez R, Ergin A and Birgonul M.T (2007), *Quantitative methodology for determination of cost contingency in international projects.* Journal of Management in Engineering, 23(1), 35-39.

Teye Buertey et al (2012), *Project Cost Contingency Estimation in Ghana: An Integrated Approach,* Science Journal of Civil Engineering and Architecture, Published By Science Journal Publication

Thompson P A and Perry J G (1992), *Engineering construction risks*. London: Thomas Telford.

Touran A. (2003), *Calculation of contingency in construction projects*, IEEE Transactions on Engineering Management, 50(2), 135-140

Touran A & Wiser E P (1992), *Monte Carlo Technique with Correlated Random Variables*, Journal of Engineering and Management 188, no.2 (1992):258-272

Treasury HM (1993), *Managing Risk and Contingency for Works Projects,* Guidance Note No. 41, Central Unit on procurement, Her Majesty's Treasury, U.K.

Wall D. M (1997), *Distributions and Correlations in Monte Carlo Simulation*, Construction Management and Economics, 15, 241-258.

Woollett J (1998), *Project Cost and Risk Management,* Queensland University of Technology, Brisbane

Yeo K.T. (1990), *Risks, Classification of Estimates and Contingency Management*, Journal of Management in Engineering, 6(4), 458-470.

Zhu K. & Lin L (2004), *A stage by stage factor control frame work for cost estimation of construction projects,* Owners Driving Innovation International Conference.

APPENDIX 2: Questionnaire

An investigation into the preferred use of Conventional Methods of Contingency Sum determination over scientific methods on Construction Projects in Kenya

Simiyu Erick Wanjala
(BQS, RQS, CIQSK)
Dept. of Real Estate & Construction Management
University of Nairobi

QUESTIONNAIRE

PART A: PARTICULARS OF THE RESPONDENT

1. Which profession do you belong to in the Construction Industry?

    (a) Quantity Surveying ☐

    (b) Building Services Engineers ☐

    (c) Civil / Structural Engineers ☐

2. Are you personally involved in the formulation of contingency sum for construction projects?

    (a) Yes ☐

    (b) No ☐

    *If **Yes** proceed to answer the remaining questions, if **No** please forward the questionnaire to the person involved in formulating contingency sum for construction projects in your firm.*

3. How long has your firm been operating in the Construction Industry?

    (a) 0 – 5 Years ☐

    (b) 5 – 10 Years ☐

    (c) 10 – 15 Years ☐

    (d) 15 – 20 Years ☐

    (e) Above 20 Years ☐

4. Please indicate the academic credentials that you hold.

   (a) Diploma ☐

   (b) Degree ☐

   (c) Post graduate degree ☐

   (d) Other (specify) ☐

PART B: METHODS OF CONTINGNECY SUM DETERMINATION AND THEIR WEAKNESSES

5. (a) How often do you use the following methods of contingency sum determination in your firm?

	Less Frequently			Most Frequently	
Method	**1**	**2**	**3**	**4**	**5**
(i).Conventional methods –based on intuition, past experience and historical data					
(ii).Scientific methods – based on statistical and probability models					

(b) State whether you have used any of the following particular methods when determining contingency sum for projects in your firm?

Methods of Contingency Sum Determination	**Yes**	**No**
(i) Lump Sum Amount – Single figure allowance for contingency sum based on intuitive perception and superficial assessment.		
(ii) Percentage Addition – Considers a percentage of the base estimate as contingency sum basically derived from intuition, gut feeling, past experience and historical data.		
(iii) Cost Item Allocation – Creates a Work Breakdown Structure (WBS), allocates contingency percentage to each item in the WBS and estimating project contingency sum as the weighted average.		

(iv) Probabilistic Itemized Allocation – Creates a Work Breakdown Structure (WBS) and allocates a risk probability value to each item depending on significance of risk. Using the Pareto's law i.e. 80/20 rule 80% of contingency is allocated to 20% of significant risky items and 20% percent allocated to 80% insignificant risky items.		
(v) Programme Evaluation Review & Technique (PERT) - Estimates contingency sum by manipulating the probability density function for each cost item with the three cost estimates i.e. lowest cost (optimistic); highest cost (pessimistic); & the most likely cost (modal value).		
(vi) PERT with modified variance – Estimates contingency sum by manipulating probability density function using three cost estimates i.e. optimistic, pessimistic and most likely cost while modeling any existing correlation among the project cost items.		
(vii) Monte Carlo Simulation – Uses computer programmes such as spreadsheets and definitive scenarios to create a simulation model which is basically a cost breakdown structure or work package where each cost item in the structure is a single point estimate for contingency sum.		
(viii) Risk Analysis – Systematically identifies significant risk factors, assesses probability of risk factors and allocating contingency sum to risk factors.		

(c) Please rank the following weaknesses of conventional methods of contingency sum determination in order of their significance.

Weaknesses of Conventional Methods	**Not Significant**				**Extremely Significant**
	1	**2**	**3**	**4**	**5**
(i) Predicts unrealistic contingency sum					
(ii) Arbitrariness i.e. based on intuition					
(iii) Lacks scientific basis					
(iv) Lacks theoretical justification					
(v) Application restricted to similar past projects					

(vi) Highly based on the estimators feelings					
(vii) Unable to analyze risk elements on projects					
(viii) Double counting of risk					
(ix) Promotes poor management of projects					
(x) Lack creativity					
(xi) Results in many litigations					

PART C: REASONS FOR CONTINUED USE OF CONVENTIONAL METHODS OVER SCIENTIFIC METHODS

6. (a) Please rate the following reasons in order of their importance for continued use of conventional methods of contingency sum determination in spite of the existing new scientific methods.

Reasons for Continued Use of Conventional Methods	**Least Important**				**Most Important**
	1	**2**	**3**	**4**	**5**
(i) Simplicity in application					
(ii) Limited knowledge on use of scientific methods					
(iii)Less research on scientific methods in Kenya					
(iv)Complexity of scientific methods					
(v) Heavy reliance on historical data					
(vi)Resistance to change					
(vii)Lack of reliable data on scientific methods					

(b) Please indicate any other reasons for (a) above.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

PART D: CONTINGENCY SUM POLICY & MANAGEMENT GUIDELINES

7. (a) Do you monitor the use of contingency sum during the project execution?

Yes ☐

No ☐

(b) If yes, which of the following methods do you normally use to monitor contingency sum?

Methods of Monitoring Contingency Sum	
1.Project Manager – Contingency sum under the control of Project Manager who with the consent of the Client approves its allocation upon request by subsystem managers i.e. Quantity Surveyor, Architect, Civil Engineer and other related professionals.	
2. Sensitivity Analysis Model- Utilizes simulation software with sensitivity features to determine and rank significant risk factors based on regression or correlation techniques and there after assign contingency sum on the basis of the rank.	
3. Risk Management Communication - Risks are continuously assessed and prioritized and continuously communicated to the project team.	
4. No method	

(c) Please state whether your firm has the following documented policies and procedures on proper management of contingency sum?

Policies for proper management of contingency sum	Yes	No
(i) Standard templates for plan on contingency sum		
(ii) Procedures for reviewing and updating contingency plan templates		
(iii) Filling and signing contingency sum forms by Client & Project Manager		
(iv) Assessing potential risks inherent on a project		
(v) Allocation of contingency sum to specific risk elements		
(vi) Measures for accountability on the usage of contingency sum		
(vii) Continuous training on proper management of contingency sum		

PART E: CONTINUOUS IMPROVEMENT ON METHODS AND SKILLS OF DETERMINING CONTINGNECY SUM

8. (a) Please rank the following strategies on how cost experts can continuously improve their skills and methods of determining contingency sum in order of their importance.

Improvement on Methods & Skills of Determining Contingency Sum	Least Important				Most Important
	1	2	3	4	5
(i) Gaining experience on application of diverse methods					
(ii) Formulation of policies and guidelines for proper management of contingency sum					
(iii) Exploring scientific methods of contingency sum determination					
(iv) Proper understanding of the process of making budget					
(v) Adoption of risk management process					
(vi) Generation and continuous update of historical data					
(vii) Integration of risk education in built environment courses					
(viii) Enhanced Project integration and communication					
(ix) Adopting risk breakdown structure (RBS)					

(b) Make other suggestions on how construction cost experts can continuously improve their skills and methods of determining contingency sum.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………