MODELLING OF COST OVERRUNS IN BUILDING PROJECTS IN ABUJA

BY

BASHIR MAMMAN

DEPARTMENT OF QUANTITY SURVEYING

AHMADU BELLO UNIVERSITY ZARIA

NIGERIA.

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By

Bashir MAMMAN

B.Sc Quantity Surveying (ABU) 1997

(M.Sc/ENV-DESIGN/4322/2009-2010)

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DECLARATION

I declare that the work in this thesis entitled **MODELLING OF COST OVERRUNS IN BUILDING PROJECTS IN ABUJA** has been carried out by me in the Department of Quantity Surveying. The information derived from the literature have been duly acknowledged in the text and list of references provided. No part of this thesis was previously presented for another degree or diploma at this or any other Institution.

Bashir Mamman	Signature	Date

CERTIFICATION

This thesis titled **MODELLING OF COST OVERRUNS IN BUILDING PROJECTS IN ABUJA** by Bashir Mamman meets the regulations governing the award of the degree of MSc in Quantity Surveying of the Ahmadu Bello University Zaria and is approved for its contribution to knowledge and literary presentation.

Dr. A. D. Ibrahim Chairman Supervisory Committee	Signature	Date
Dr. Y. M. Ibrahim Member Supervisory Committee	Signature	Date
Dr. Y. M. Ibrahim Head of Department	Signature	Date
Prof. A.A. Joshua Dean, School of Post Graduate Studies	Signature	Date

DEDICATION

I dedicate this thesis to my mother who has been a source of comfort and joy for me.

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ABSTRACT

Construction of building projects is an endeavour that involves capital expenditure, which is either borrowed or self-financed by clients. The expected outcome of such expenditure is value for money, which is usually dictated by project objectives of cost, time and quality. Project cost, as a project objective, is a crucial determinant of project success in the prevailing economic challenges being experienced globally. Construction cost overrun has become a reoccurring phenomenon in the delivery of building projects. The major thrust of this study was to identify, analyse and model the factors that contribute to building construction cost overruns in Abuja. The study adopted a Monte-Carlo technique in simulating cost overrun using DiscoverSim® version 1.1 (SigmaXL, 2013) simulation and RiskAmp Microsoft Excel add-in software to analyse data obtained from literature review, review of project documents with contract sum of over Five Million Naira executed within Abuja city in addition to interview sessions with construction professionals. The study revealed that significant cost overruns are mainly due to re-measurement and variation. The simulation result elucidated that less than 10% of building projects are completed below the initial contract sum in Abuja which could be due to the fact that projects tend to be initiated and executed without adequate project information such as client brief, design details and specifications. The study recommends the need for minimizing occurrence of re-measurement in building projects through provision of full design information prior to contract award, development of simulation model for specific project categories and establishment of a project cost overrun band that will enable a scientific measurement of project's value for money benchmarked against initial cost estimate.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Globally, the construction sector is inundated with cost overruns in the delivery of building projects. This experience has brought about loss of clients' confidence in consultants, added investment risks, lack of ability to deliver value to clients, and disinvestment in the construction industry (Mbachu and Nkado, 2004).It is of essence that the objectives of a building contract are met to the contentment of the parties involved. Cost, time and quality are significant, interrelated and interdependent targets for achieving the objectives/goals expected of building contracts (Ashworth, 1999, Gould, 2002). Thus, it is crucial to keep up a proper balance between the three so that project outputs are realised on time, within the financial plan and with the requisite quality (Akinsola and Potts, 1998). However, it is an admitted fact that in Nigeria, the majority of contracts suffer undue time extensions and /or additional cost to the client and /or inadequate quality of work (Oluwole, 2008b).

Project cost overruns can be either avoidable or unavoidable. Overruns due to design plan or project management problems are avoidable because they could have reasonably been foreseen and prevented (Shanmugam *et al.*, 2006). However, there are some unavoidable costs such as those due to unanticipated events which cannot reasonably be prevented. Cost overruns may add value to projects when extra work is done with the intention of producing a better output. Overruns may also add value when they involve work that was omitted from design plans but clearly needed to be done. However, some

overruns may not add value and represent wasted money if they do not result in a better product.

Cost overrun of a project refers to the actual 'cost increase' to the client during construction of a building project (Janaka, 1992). It is merely the difference between the value originally envisaged for the project and the value reflected in the final certificate. Cost overruns occur from overspending the allowances, making changes and encountering unforeseen problems. Proper planning can greatly reduce cost overruns.

Another study from Indonesia revealed the three most frequently occurring causes of cost overruns are materials cost increases due to inflation, inaccuracy of quantity take-off and cost increase due to environmental restrictions (Kaming *et al.*, 1997). But in general it is found that the variation was a main source of cost overrun and the design team believes that the client predominantly creates variations which lead to many problems in building contracts.

The causes for cost overruns differ from country to country. According to a study done in Kuwait by Koushki *et al.* (2005) the three main causes of cost overruns were identified as contractor-related problems, material-related problems and, owners' financial constraints.

However, the design team must examine their activities critically and ensure that they do not mislead the client in an attempt to cover their own inadequacies. A major problem when cost overrun occurs in a project with no adequate provisions to manage is delay in payment and subsequent abandonment of projects. This breeds diversified hardship in project execution (Achuenu and Kolawole, 1998). Thus, an attempt to

simulate cost overrun in construction projects is imperative to understanding the factors that lead to cost overrun in Nigeria construction industry.

1.2 STATEMENT OF RESEARCH PROBLEM

This research work is fashioned after an existing research carried out by Shanmugam *et al*. (2006) which attempted to simulate a model of cost overrun in the Sri Lankan construction industry. The research highlighted some factors that lead to cost overrun in construction projects in Sri Lanka and used Microsoft excel to simulate how the effects of these factors can be identified early in the project to aid decision in decision making. Although there may be some similarities between the construction industry in Nigeria and Sri Lanka; given that both are developing nations. Nonetheless, the research can be replicated in Nigeria because literature has indicated that the causes of cost overrun differ from country to country (Kaming *et al*., 1997; Koushki *et al*., 2005) and insufficient understanding of the causative factors of cost overruns also lead to poor quality proactive decisions aimed at mitigation the negative effects of cost overruns. The focus of this research is to identify, analyse and model factors that contribute to cost overrun in building projects in Abuja using Monte Carlo simulation methods..

1.3 NEED FOR STUDY

The major challenges facing the construction industry in developing countries like Nigeria is the chronic problem of cost overruns. Under normal circumstances a complete set of drawings and specifications should be made available to the Quantity Surveyor; who would prepare fully described and accurate bills of quantities for tendering purposes (Koushki *et al*., 2005). As one arbitrator once observed that, it is

difficult to imagine a building contract, which proceeded to completion without delay or variation whatsoever (Odusami and Onukwube, 2008; Nwachukwu and Emoh, 2010). However, this does not mean that there are no building projects that have been completed within budget. The concern is that such ideal situations are rare (Chan, 2001).

There have been many research works on cost and time overruns (Kaming *et al*., 1997; and Cox *et al*., 1999). Again research has found that there are more building projects that had cost overruns than those which were completed within budget (Chan and Kumaraswamy 1996). The scenario of cost overruns has been blamed on the many factors that influence construction cost overruns (Kaming *et al*., 1997). The recent financial crisis globally brings to the fore the need to adequately manage construction cost at all stages of the project to avoid potential issues such as abandonment of projects and cost escalation.

In general, the results of this research work will aid clients especially the government which is the biggest player in the Nigerian construction Industry as an initiator and financier of construction projects to manage cost overrun. The significant impact of cost overrun cannot be over emphasized as many literatures have highlighted its effect on project execution.

1.4 AIM AND OBJECTIVES

1.4.1 AIM

The aim of the research is to develop a model of cost overrun of building construction projects in Abuja.

1.4.2 OBJECTIVES

To achieve this aim the following three objectives were set. They are to:

a) identify factors influencing tbuilding construction cost overruns;

b) analyse factors leading to cost overruns of building projects in Nigeria; and

c) model the cost overrun factors of building projects in Abuja.

1.5 SCOPE AND LIMITATIONS

1.5.1 SCOPE

The research scope covers cost overrun in building construction project in Nigeria and is limited to projects located within Abuja. Furthermore, the building types studied in this research was office complexes, hospitals, educational, commercial and residential buildings all with a construction cost over 5 million Naira. The decision to limit the data to projects above five million Naira is vested on the idea that such projects within the range of that contract sum cover various project elements. Furthermore, the data obtained from such projects would provide a reliable and realistic data suitable for generalizing cost overruns in building projects in Nigeria as they cut across the major types of projects predominantly undertaken in Nigeria. The data are to be collected from the building projects undertaken by contractors registered not lower than category C registration of the Federal Ministry of Works, which is the regulatory authority of construction in Nigeria. The categories are stipulated by the Federal Ministry of Works who grades Contractors based on the value of the project they can undertake based on their performance.

1.5.2 LIMITATIONS

Data collection techniques and research strategies have limitiations which the researcher was concious of. In tandem with this, the potential limitiations to the conduct of this research as highlighted below were considered prior to commencement of the research.

a) Availability of consultants to be interviewed

b) Accessability of project documents

c) Workload or schedule of employees involved in the case study

d) Reliability of interview and review of project data as data collection technique.

In addressing these limitations, sugestions by letters of request were sent in advance to all employees to be involved in the research informing them about the possible questions to be asked during the interview and documents that will be accessed. This approach allowed for planning and adjustment of interviewees schedule to accommodate the interview sessions to be conducted as well as, facilitating the accessability of relevant data. In addition to this, the provision of potential questions to be asked facilitated the rate of response by the interviewee as it provided the interview with a feel of the scope of the interview questions prior to the interview and also simplified the use of semi-structured interview questions for the research.

To minimize the possibility of obtaining baised responses from the interview, employees of different firms involved in different projects were interviewed. This avoided the dependency on one source for research data. In addition to this, review of project documents was also conducted by correlating data from different project documents that contained information to ascertain the level and extent of cost overrun in the projects.

The numbers of building projects constituting the historical data used for the simulation model in this study are not adequate. A general distribution option is the Normal Distribution, with a minimum sample size of 30; preferably 100 (SigmaXL, 2013). This condition was not met in this study due to time, financial constraints and lack of access to adequate data of Final accounts of completed projects in Abuja.

The categories of building projects were limited to only four, thus the simulation model was developed for all four categories combined. However simulation models developed for specific category are likely to be more reliable and predictive than a combination of diverse building projects, which usually have divergent procurement procedures and components of cost overrun.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 CONSTRUCTION INDUSTRY

The construction industry has a great impact on the economy of all countries (Leibing, 2001). It is one of the sectors that provide crucial ingredients for the development of an economy. According to Chitkara (2004), the construction industry in many countries accounts for 6-9 % of the Gross Domestic Product (GDP); and according to Bhimaraya (2001); it reaches up to 10 % of the GDP of most countries. It is widely acknowledged that the construction industry is a vital element of an economy and therefore has a significant effect on the efficiency and productivity of other industry sectors. One cannot think of widespread investment in manufacturing, agriculture, or service sectors unless the construction results of infrastructure facilities are in place. In some of the developing countries, the growth rate of construction activity outstrips that of population and of GDP (Chitkara, 2004).

The construction industry, in common with most industries, is beset with problems of efficiency and productivity. These problems are perhaps much greater in the construction industry than any other industry due to the complex nature of the industry and the unique characteristics of its end products (Akinsola and Potts, 1997). There has been a number of contributions to our knowledge of the construction industry with regards to its structure, process, products, and the risks and uncertainties of its production systems and the problems of its organizational effectiveness (Arian and Pheng, 2005). Project performance in the construction industry is well researched. A study completed by the International Program in the Management of Engineering and

Construction (IMEC) in 2000 (Miller & Lessard, 2000) revealed that 18% of 60 large engineering and construction projects, with an average capital value of $ 1 billion undertaken between 1980 and 2000, incurred extensive cost overruns. Merrow *et al*. (1988) studied 47 "megaprojects" in the construction environment and found that only four were on budget with an average cost overrun of 88%. Morris & Hough (1987) also provide a comprehensive list of cost overruns on large projects.

According to Flyvbjerg *et al*. (2003), cost overruns are especially evident in infrastructure construction projects. The relatively poor performance of construction projects prompted researchers to investigate and identify the factors that cause cost overrun. Thus, the research intends to contribute to the body of knowledge in the construction industry by simulating a model of cost overrun in public and private sector projects in Nigeria.

2.1.1 NIGERIAN CONSTRUCTION INDUSTRY

The construction industry in Nigeria is an important industry which impacts positively on the national economy contributing 3.12% to the national economic growth as estimated in the rebased nominal GDP of 2013 (NBS, 2014). The growth of the construction industry is rising at a steady rate and is predicted alongside Indian construction industry to enjoy higher growth rate than china between 2009 and 2020 in terms of construction output (GCP, 2009).

Despite the huge capital expenditure and steady growth of the industry, the Nigerian construction industry like other construction industries around the world, is faced with challenges of improvement in terms of product and service delivery necessitated by constant criticism by the industry's customers. The industry is characterized by an

alarming rate of the repeated collapse of buildings (Oke and Abiola-Falemu, 2009) and poor health and safety records (Olatunji *et al*., 2007). Olatunji (2006) reported that the industry is struggling to salvage the economic resources wasted in construction projects as a result of cost and time overrun, poor workmanship and professional incompetence which have left the industry's customers disgruntled with the industry. In addition, Ogunsemi and Saka (2006) stressed that the industry is under siege due to poor performance. Similarly, Dantata (2007) identified lack of skilled manpower, finance and incompetent professionals as contributing factors hindering the performance of the industry.

In an effort to address the prevailing issue of corruption in public procurement, the Nigerian government as a major player in the construction industry as revealed by Dantata (2007), initiated policies aimed at controlling public procurement and contract awards. One of such policy was the introduction of Due Process Policy Model (DPPM) to public procurement contracts (Oluwole, 2008a). The implementation of the policy was supervised by a Budget Monitoring and Price Intelligence Unit (BMPIU) which had a mandate of ensuring a transparent, competitive and fair procurement system in public procurement at the same time ensuring value for money (Oguonu, 2007). The establishment of BMPIU affected the way public construction projects were procured as projects were awarded based on lowest tender which has invariably led to escalation of project cost at completion due to unrealistic tender prices (Oluwole, 2008a). Although over the years review of public procurement framework has been an ungoing concern, enacting of the Public Procurement Act 2007 further cemented the government's willingness in ensuring transparency in public procurements system.

The present state of the construction industry in Nigeria falls short of meeting domestic and international quality standards and the performance demand expected from the sector (Olatunji, 2006). Construction projects have problems with construction techniques and management as wells as limitation of funds and time. The critical problems are liability to complete the projects on schedule, low quality of finished product and significant cost overrun.

2.1.2 CHALLENGES OF BUILDING PROJECTS

Over the years, the construction industry has been under the search light and has been criticized by reports on the industry's performance. Two notable reports sponsored by the UK government; Latham (1994) and Egan (1998) criticized operations of the construction industry and suggested identified that clients were dissatisfied with the products of the industry and the need for the construction industry needs to re think its approach towards production and delivery of its product and services. The construction industry, in common with most industries, is beset with problems of efficiency and productivity. These problems are perhaps much greater in the construction industry than any other industry due to the complex nature of the industry and the unique characteristics of its end products (Akinsola and Potts, 2003). The productivity and profit level of the industry compared to other industries has been dwindling as a result of inefficiency in the industry. Chapman (2001) reported that the industry is at or near the top in the annual rate of business failures and resulting liabilities compared to other industries. The production and delivery of products and services in the construction industry involves interaction between different parties i.e. (clients, industry professionals, regulators and contractors) within the industry providing a variety of services; all of which directly or indirectly contribute to the overall inefficiency of the

industry. The level of services offered by the professionals in the industry, has contributed to the woes of the construction industry as affirmed by (Egan, 1998) while reporting that in 1997 the British Property Foundation pointed out that more than a third of major clients are dissatisfied with the performance of contractors and consultants inefficiency. The situation in the UK is echoed across different countries around the world and poor performance of the industry is well documented (Amehl *et al*., 2010). According to Daniel and Andrew (2003), poor cost performance of construction projects is continually becoming a reoccurring theme and a norm rather than the exception particularly in most developing countries where the problem is more severe. Kasimu (2012) reported that the construction industry in Nigeria is beset with problems ranging from cost overrun, time overrun and poor risk management etc. all of which has contributed to the woos of the industry in terms of satisfying clients expectations. Ali and Kamaruzzaman (2010) reported that despite the growth of the Malaysian construction industry due to rapid development of the country, poor cost performance of project delivery has been a reoccurring phenomenon. The scenario in Palestine is no different as Mahamid and Dmaidi (2013) reported that poor project performance due to several factors has been the bane of the industry in satisfying clients.

A reoccurring factor highlighted by research on the causes of poor project performance in the construction industry has been cost overrun of projects. The occurrence of cost overrun in the industry has the tendency of increasing the cost of investments in the industry (Morris, 1990). Furthermore, Morris *et al.* (1998) while examining records of more than four thousand construction projects reported that projects were rarely finished on time or within the allocated budget.

Cost is one of the primary measures of a project's success (Atkinson, 1999). This is true, especially for public projects in developing countries like Nigeria, because public construction projects in these countries are executed with scarce financially resources (Daniel and Andrew, 2003). Project success is often measured in terms of success using three parameters namely; cost, time and quality (Mahamid, 2013). These measuring criteria are often referred to as Project 'iron triangle' (Atkinson, 1999). A project may not be regarded as a successful endeavor until it satisfies the cost, time, and quality limitations applied to it (Mahamid, 2013).

Extensive studies of cost overrun in Nigeria have also been conducted over the years. In a study reviewing public sector construction projects in Nigeria, Dlakwa & Culpin (1990) found that the three main reasons for cost overruns are "fluctuations in material, labour and plant costs", "construction delays" and "inadequate pre-planning". In another study, Okpala & Aniekwu (1988) reported that architects, consultants and clients agreed that 'shortage of materials', 'finance and payment of completed works' and 'poor contract management' were the most important causes of cost overruns. Mansfield *et al.*,(1994) studied the performance of transportation infrastructure projects in Nigeria and concluded that 'material price fluctuations', 'inaccurate estimates', 'project delays' and 'additional work' contributed most to cost overruns. In a fourth study on construction projects in Nigeria by Elinwa & Buba (1994), it was found that 'cost of materials', 'fraudulent practices' and 'fluctuations in materials had the most significant impact on project costs.

2.2 COST OVERRUN

Cost overrun as defined by Mahmid and Dmaidi (2013) is the "difference between the final actual cost of a construction project at completion and the contract amount, agreed

by and between the client (the project owner) and the contractor during signing of the contract". The problem of cost overun in the construction industry is a reoccurring phenomenon (Mahmid, 2013) that hinders projects progress, as it has the potentials of decreasing contractor's profit (Kasimu, 2012) and hindering attainment of project objectives. Besides, failure to meet project objectives, cost overrun increases the burden of financial risk to clients (Boukendour, 2005).

2.2.1 CAUSES OF COST OVERRUN

Research on the factors that cause or lead to cost overrun in construction projects are abound in the academic and industry circle. Since the 1980s various studies have investigated the causes for project cost overruns on construction projects. Morris (1990) reported that the occurrence of cost overrun and time overrun has been on the rise since the sixties but gathering this information has been difficult due to lack of information. The causes of cost of overrun vary from project to project (Frimpong et-al, 2003) with most of the factors difficult to predict and mange (Morris and Hough, 1991). Kaming *et al*. (1997) while researching on factors influencing delay and cost overrun in Indonesian high-rise construction projects identified 7 variables of cost overruns. These include materials cost increase due to inflation, inaccurate quantity take-off, labor cost increase due to environment restriction are the first three causes of cost overruns. Chang (2002) while investigating causes of cost and schedule increment in engineering design project grouped the factors into three main headings; project owners factors, consultants factors and external factors i.e. factors beyond the control of either the client or consultant.

Furthermore, in another research, Le-Hoai *et al*. (2008) identified factors influencing delay and cost overrun and grouped them into six main headings; mainly client owner

related factors, consultants related factors, contractors related factors, project related factors, material and labour related factors and finally external related factors.

a. Client Related Factors

   Research has identified that the client pays an important role in ensuring project success (Chang, 2002; Mahmid and Dmaidi, 2013). Nevertheless, the client also influences poor performance of projects (Odeh and Battaineh, 2002). The client's inability to provide needed funds for the project, delay in payment, indecision of client brief, client change of requirement and specifications etc all contribute to the occurrence of cost overrun in construction projects (Warsame, 2006).

b. Consultant Related Factors

   Consultants as project designers, supervisors and monitors advice the client on project parameters needed to ensure success and realization of the client's brief as well as act on behalf of the client to ensure project objectives are successfully achieved. Unfortunately, due to different factors such as consultants incompetence, lack of time, incomplete client brief, poor coordination of consultant team etc the consultant team influences the occurrence of cost overrun in construction projects (Morris, 1990; Frimpong *et al*. 2003; Kasimu, 2012; Mahmid and Dmaidi, 2013). Occurrence of cost overrun impacts negatively on the business aspect of the consultant team as poor cost performance of projects implies inability to provide the project client value for money which in turn may lower client confidence on their capability to deliver project objectives (Mahamid, 2013). Factors under this category include

incomplete designs, poor cost estimation, poor coordination of activities, poor project management and planning, design changes etc.

c. Contractors Related Factors

The contractors play a pivotal rule in the realization of project objectives as they are saddled with the responsibility of transforming designs into physical structures. The competency and technical capability of contractors greatly impacts on their ability to achieve this with minimum difficulty (Odeh and Battaineh, 2002) through proper planning, knowledge of market conditions, adequate pricing strategy etc (Aziz, 2013). Factors that are contractor related include poor project planning, under estimation of projects to gain tender advantage against competitors, lack of technical capability to construct building elements as designed leading to need for design changes etc (Kasimu, 2012; Odeh and Battaineh, 2002; Aziz, 2013). The overall effects of these on the contractor include loss of profit and penalties for non-completion (Akinci, & Fischer, 1998).

d. Project Related Factors

Projects in the construction industry unlike other industries tend to have different characteristics (Al-Najjar, 2008) all of which influences the procurement methods, design, scope and complexity of the projects (Mahmid, 2013). Cost overrun has been found to be influenced by factors specific to the characteristics of the project. These include project size, project location, design features, accessibility to site, etc (Le-Hoai *et al*., 2008).

e. Material and Labour Related Factors

Labour and material are essential resources needed for any construction project to succeed. The provision of these resources for utilization on the project is largely the responsibility of the contractor. However, the contractor is often faced with shortage of these materials due to scarcity of material, increment of price, lack of skilled workmen etc (Le-Hoai *et-al*. 2008) all of which constitute project risks to the contractor. In addition, the unpredictability of the market in terms of fluctuation in material prices and exchange rates have negative effect on a project leading cost overrun. Morris & Hough (1987) as well as Flyvbjerg *et al*. (2003) found that fluctuations in material cost contributed significantly to cost overruns. Furthermore, in Nigeria, shortage of material is further compounded by scarcity of petroleum products such as diesel and fuel needed to transport materials form one region to another. The epileptic supply of electricity is another factor that may give rise to cost overrun of projects in countries like Nigeria.

Taroun *et al*, (2011) argues that with proper risk management, the contractor should be able to minimize the effects of these risk on the overall project objectives. Furthermore, with proper risk management by the consultant team the effects of occurrence of these factors can be minimized through adequate contingency allocation (Boukendour, 2005).

f. External Related Factors

Projects are not conceived and executed in isolation to external factors as these factors often influence determination of project objectives (Morris 1990). External factors such as government policies, weather conditions, site soil

conditions etc have all been identified to influence the final cost of a project (Kaming *et al*. 1997; Al-Najjir, 2006; Kasimu, 2012; Boukendour, 2005; Mahmid and Dmaidi, 2013).

In dealing with occurrence of these factors in a construction project, there are contractual mechanisms in place to adequately manage the overall effect of the factors on the project objectives. There are various contractual forms in use in the construction industry some of which include JCT suite of contracts, NEC suite of contracts, FIDIC suite of contracts etc that are currently being utilized in administering construction projects and managing the effects of these factors on the final project cost. In Nigeria, the most widely used contract form is the JCT suite of contract (Oyediran and Akintola, 2011). Thus, in order to simplify the classification of causes of cost overrun in construction projects, the factors that lead to cost overrun based on contractual mechanism in JCT for dealing with change in contract sum of a project were classified under the following headings

- Fluctuation
- Variation
- Re-measurement
- Adjustment of Prime Cost sums
- Adjustment of Provisional Sums

These headings were utilized in obtaining and analyzing data for this research work.

2.2.2 EFFECTS OF COST OVERRUN

The effect of cost overrun is well documented in literature on cost overrun. Mbachu and Nkado (2004) using a pilot study executed using descriptive survey method involving

qualitative data gathering through semi-structured interviews conducted with a convenience sample made up of (20) twenty principal partners/directors of consulting and contracting firms with a follow up regional questionnaire surveys of 130 identified respondents from various stakeholder groups concluded that effects of occurrence of cost overruns in construction projects on key project stakeholders and the construction industry is glaring. They highlighted that effects of cost overrun on project stakeholders ranges from additional project cost to the client which in turn leads to loss of anticipated revenue to be derived from the project (Mahmid, 2013), inability of project consultants to deliver value for money, contractor's loss of profit. The general effect of these on the construction industry as a whole is potentials of abandonment of project, lower reduction of GDP contribution of the industry and loss of skilled workforce due to poor financial performance of contractors..

CHAPTER THREE

3.0 RESEACH METHODOLOGY

3.1 RESEARCH STRATEGY

There are different strategies to research ranging from case studies, experiments, surveys, histories, and economic and epidemiologic research to mention a few (Biggam, 2008); with each having its advantages and disadvantages (Yin, 2009). The choice of a research strategy is governed by different factors which dictate the suitability of a particular strategy for undertaken a research (Yin, 2009). In making a choice of a suitable research strategy, Yin (2009) outlined three guiding conditions which each strategy must satisfy to validate the choise of an appropriate strategy. The three conditions are

a) The type of research question posed
b) The extent of control an investigator has over actual behavioral events
c) The degree of focus on contemporary as opposed to historical events

Considering the context this research was to be undertaken a case study research strategy was adopted. The choice of case study as a research strategy is underpinned by the real life investigative nature of the research in obtaining reliable data in the context of occurrence of cost overrun in construction projects by modeling this phenomenon. At this point it is imperative to define the term Model in the context of research.

A model as defined by Shanmugam *et al*. (2006) is a logical description of how a system performs. It provides an in-depth understanding of how different variables are connected in a system.

Biggam (2008) argues that for research to have academic credibility, it is important to use a tried and tested research strategy. In agreement with this, it is necessary to state at this point that case study as a research strategy in understanding cost overrun has been previously utilized successfully by Shanmugam *et al*. (2006) in a study which simulated models of cost overrun in construction projects. For the conduct of this research, a multiple case studies approach was designed in order to study and quantify the factors affecting cost overruns. It is believed that data obtained from multiple case studies is sufficient enough to qualify as research findings (Yin, 2009).

3.2 RESEARCH TECHNIQUES

3.2.1 RESEARCH SAMPLE

In selecting a sample size for this research, the author considered many factors which informed the choice of a research sample technique as well as research sample. The factors considered by the author included accessibility, research cost, convenience and time available for preparing the dissertation work. Consequently, projects within Abuja were chosen using convenience sampling technique (Biggam, 2008) as and possibility of easy access to project documents in order to get all necessary data needed. The sample size of projects to be studied is fifteen. These projects range from office building, educational buildings, hospitals and residential buildings. The case study projects are building projects undertaken by contractors registered not lower than category C registration of the Federal Ministry of Works, which is the regulatory authority of construction in Nigeria. In securing access to relevant data needed for the case study, consent of top management of the firms that handled the projects was secured by means of a request letter seeking access to relevant project documents needed for the research.

3.2.2 DATA COLLECTION

Gray (2004) identified four data collection techniques available for conducting reserch. These techniques are questionnaires, interviews, observations and unobstruvtive measures. In conducting reserch, combination of one or more of these reserch techniques might be necessary to better inform a reserch strategy adopted (Robson, 2002) as it allows triangulation of results (Biggam, 2008). Thus, data collection was undertaken using both interviewing professionals associated with the selected projects and by reviewing documents. A preliminary questionnaire was used to select the projects to be used as case studies. Projects selected were projects with a contract sum over 5 (Five) million Naira. Documents of these projects were studied to identify and quantify the cost overrun that occurred in the selected projects. The documents reviewed were the final accounts of the projects. The types of buildings studied include public owned buildings which comprised of office buildings, educational facilities and commercial buildings as well as privately owned and sponsored buildings comprirng shopping complex, hospitals, educational facilities and residential buildings.

Adoption of interview and review of documents as research techniques for the research was informed by the circumstance within which the reserch was conducted in seeking to model cost overrun in building projects by capturing factors and causes of cost overrun in these projects. Furthermore, these techniques provide valuable information about unit of research (Yin, 2009).

3.2.3 DATA ANALYSIS AND PRESENTATION

The two principal approaches to analysis of research data are qualitative and quantitative methods. Qualitative approach to data analysis uses words as principal data

of analysis while quantitative approach adopts numbers as principal unit of analysis . The principal data obtained from case studies is qualitative data, nevetheless, certain case studies may include substantial amounts of quantitative data as well. As such, both qualitative and quantitative approach to data analysis may be necessary. The data obtained from the case study of this research contained both qualitative and quantitative data. Qualitative data was obtained to get a better insight and understanding of the causes and factors that lead to cost overrun in the projects. While quantitative data was obtained to determine the extent of cost overrun of the projects. Both data types were analyzed using qualitative and quantitative analysis respectively and presented using diagrams, charts and tables as contained in the next chapter.

Furthermore, the qualitative analysis of the research data also adopted a simulation model. A model is a logical description of how a system performs. A simulation model seeks to duplicate the behavior of the system under investigation by studying the interactions among its components. It is a powerful tool for analyzing, designing and operating complex systems.

Simulations involve designing a model of a system and carrying out experiments on it as it progresses along time. However a simulation experiment differs from a regular laboratory experiment in that it can be conducted almost totally on the computer. The relationships in the data are able to be gathered in very much the same way as if the real system was being observed. The nature of the simulation, however, allows us much greater flexibility in representing complex systems that are normally difficult to analyze by standard mathematical models. Simulation can, however, be time-consuming particularly where we try to optimize the model (Ashworth, 1999). But one major benefits of a model is that you can begin with a simple approximation of a process and

gradually refine the model as your understanding of the process improves. This "step-wise refinement" enables you to achieve good approximations of very complex problems surprisingly quickly. As you add refinements, the model becomes more and more accurate.

The term simulation describes a wealth of varied and useful techniques, all connected with the mimicking of the rules of a model of some kind. Simulation techniques are used extensively in different industries. In construction, the use of simulation has many possible applications such as construction planning, construction estimating, life-cycle costing etc. Forecasting of construction cost is a difficult task for estimators as most of the factors involved in pricing are uncertain (Ashworth, 1999). Price prediction is not a precise scientific exercise, but an art which involves both intuition and expert judgment. Despite the undoubted desirability of an unbiased price prediction, there exists no objectives test of the probability that a particular forecast will be achieved. Since a price prediction is the sum of many parts, any such objective evaluation of its precision is possible only by the use of statistical techniques. An estimator can use Monte Carlo simulation to solve this problem. The Monte Carlo technique is a commonly used method and is based upon the general idea of using sampling to estimate the desired result. The sampling process requires describing the problem under study by an appropriate probability distribution from which the samples are drawn. The distributions in a simulation exercise are at the center of the technique, since it is from these that sampling will take place. These distributions can only be determined from data which have been carefully collected over a period of time (Ashworth, 1999).

In this regard this study adopted the Monte Carlo technique which identifies the probability distribution of various factors affecting the cost overruns of the building

projects. Monte Carlo analysis is a form of stochastic simulation. Stochastic or realistic means that the technique concerned is with controlling factors that cannot be estimated with certainty. It is called Monte Carlo because it makes use of random numbers to select outcomes.

SIMULATION MODEL DEVELOPMENT PROCESS USING DISCOVERSIM

DiscoverSim® version 1.1 (SigmaXL, 2013) simulation, a statistical add-in software for Microsoft Excel, was used to perform the Monte Carlo simulation of construction cost overrun model in this study. The simulation model development process is presented in Figure 3.1.

The model function or construction cost overrun equation is calculated as follows:

Cost overrun (CO) = Final contract sum (FCS) – Initial contract sum (ICS) …… (1)

Where FCS = ICS + Factors influencing construction overrun (FCO)

FCO determined include:

i. Variations
ii. Adjustment of PC Sums
iii. Adjustment of Provisional Sums
iv. Re-measurement
v. Fluctuation
vi. Others

The setting up of the model function equation was then followed by the Monte Carlo simulation procedure, which consist of the selection of appropriate probability

distribution fittings for variables and generating distribution plots as model inputs, specify input correlations, indicate model function (CO), run simulation and interpretation of report.

However, the selection of appropriate distribution is influenced by the type of historical data (discrete or continuous) and the result of normality tests performed on each variable.

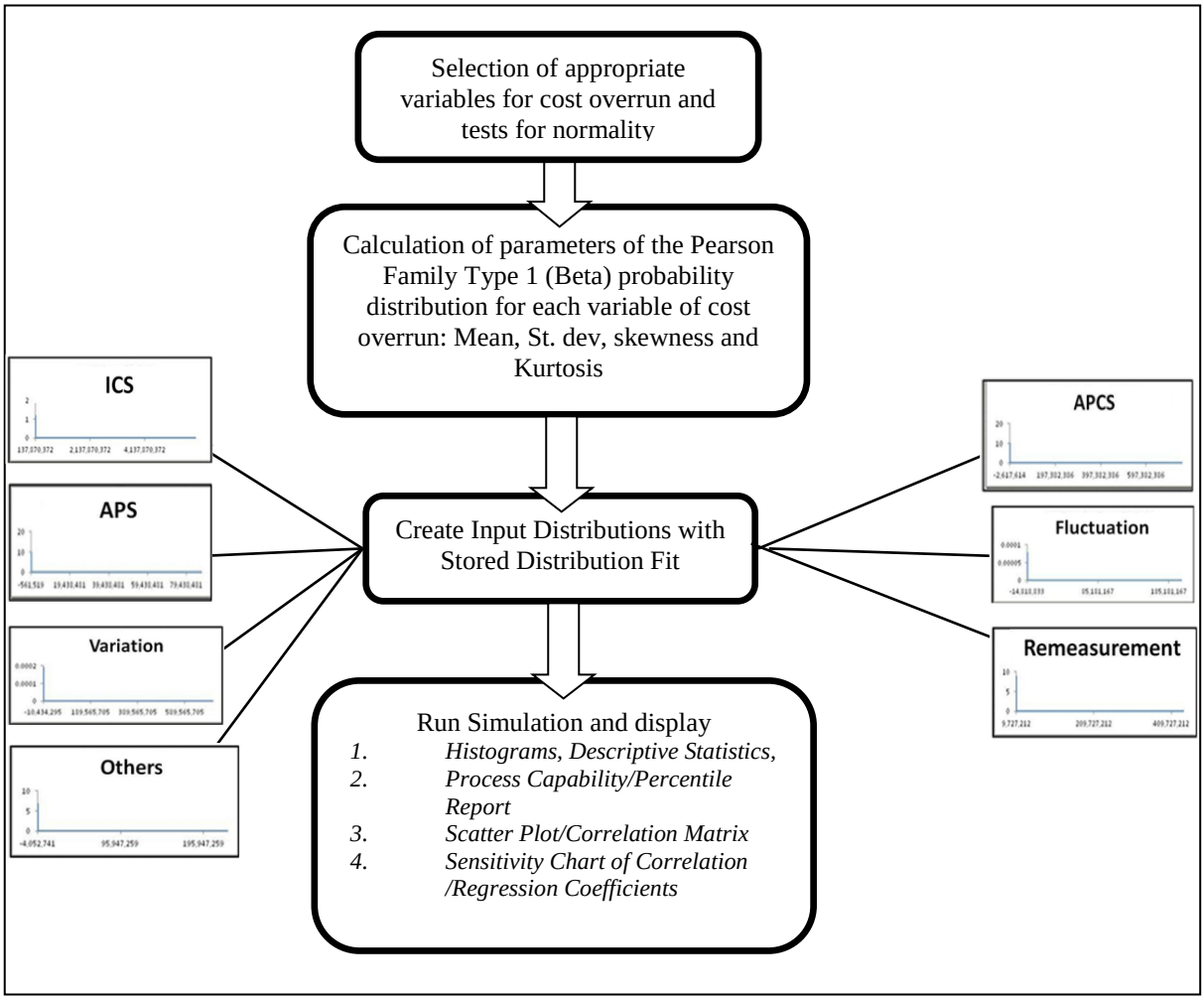


Figure 3. 1: Simulation Model development process using DiscoverSim® (SigmaXL, 2013)

In determining the appropriate variables for cost overrun and tests for normality, The beta distribution probability density function (puff) presented by the equation below was adopted:

f(x;p,q,μ,α=1/σ 1/β(p,q) ((x-μ)/σ)^(p-1) ├ {1-(├ (x-μ)/σ)┤┤ }^(q-1)

For $\mu < x < \mu + \sigma$ ……. (2)

where $-\infty < \mu < \infty$, $\sigma > 0$, $p > 0$, $q > 0$ and $\beta(p, q)$;

μ = mean

σ = SD

p = Skweness

q = Kurtosis

CHAPTER FOUR

4.0 DATA PRESENTATION, ANALYSIS AND DISCUSSION OF RESULTS

4.1 DATA PRESENTATION AND ANALYSIS

The principal data obtained for the research were for projects with a contract sum over twenty million naira carried out within the last ten years. The reason for the choice of data from projects executed within the last ten years is to have an up to date data that will give a level of generalization of cost overrun currently prevailing in the Nigerian construction industry and also provided an opportunity for the researcher to gather relevant information and have a holistic understanding of cost overrun and factors affecting it.

In presenting the case study result, a structured approach was utilized. The data presentation is done in accordance with the sub heading as used for conducting the interview. It should be noted that the research work is not an attempt to assess the execution of projects undertaken by the firms in terms of how they managed the cost overruns in the projects. Rather, the nature of questions asked during the interview sessions were merely to provide the researcher with sufficient information and data on cost overruns and factors that led to these overruns for the purpose of analysis.

In addition to the interviews, the researcher assessed final accounts of the case study projects to identify the level of general cost overruns and those factors that had the most impact on the final cost of the projects under study. Though it was mentioned in Chapter 3 as one of the data collection techniques, assessing the final accounts of these projects provided invaluable information on the occurrence and the impact of these cost overruns on the final costs of the projects studied. This aided the researcher to

understand the reasons behind cost overrun of each project, and to investigate how the actual cost at completion deviates from the contract amount. Collecting these data helped to analyze and draw the relationship between rate of cost overrun and contract amount

4.1.1 GENERAL INFORMATION ABOUT RESPONDENTS

The total respondents interviewed in this research are 24 professionals involved in the 15 number projects assessed in this research. A larger proportion of the respondents are Quantity surveyors by profession, representing 44% followed by architects (26%). Others who participated in the survey are Engineers and Builders accounting for 13% and 17% of the respondents respectively. The high participation of the Quantity surveyors and Architects in the research indicates that the responses gathered are from members of project team who are very knowledgeable and sometimes actors in the area of cost overruns. The Quantity Surveyors for instance deals with the preparation of final accounts which is the primary data for the research.

4.1.2 ANALYSIS OF PROJECT COST OVERRUN

The outcome of the analysis revealed that office complexes accounted for 54% of total projects assessed. Health and educational projects accounted for 20% of the projects assessed while residential and commercial projects each accounted for 13% of total projects investigated as shown in Figure 4.1. The high number of office complex projects is due to the prevailing demand of office complexes by governments, organizations and property developers, another reason is the need for optimal utilization of scarce and expensive land resources by planning buildings on high rise concepts rather than low rise. Categorization of these projects was informed by the

argument in the literature review that type of building projects influences the level of anticipated cost overrun.

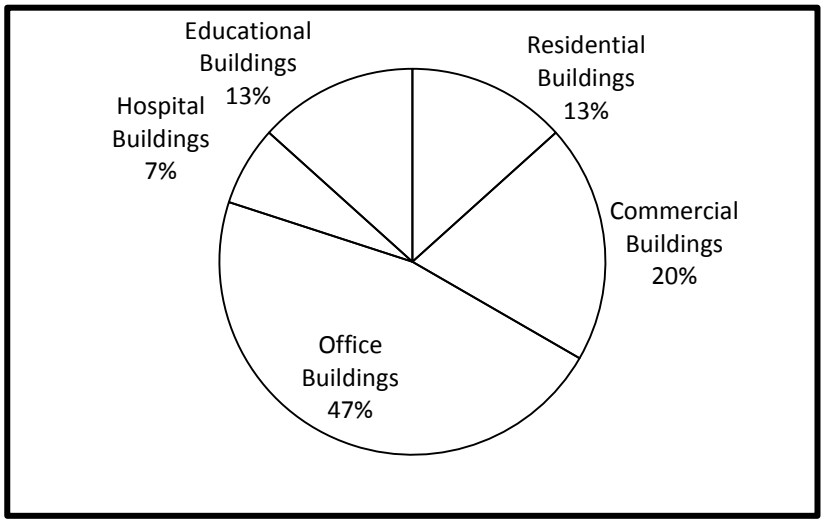


Figure 4.1 Categories of projects

Building projects are capital intensive and require steady cash flow through project duration. Due to the financial requirements of construction projects, the biggest player in the Nigerian construction industry is the Government. This is evident from the projects assessed in Figure 4.2 below where Government sponsored projects accounted for 67% of overall projects.

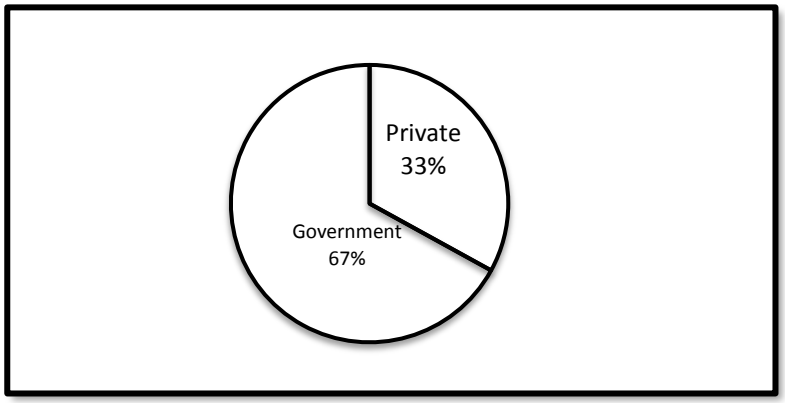


Figure 4. 2: Project Owners

Identifying and classifying projects according to project sponsor enabled the researcher investigate the relationship of project sponsors and cost overrun. The results of analyses show that office complexes which were sponsored by government recorded the highest cost overrun.

From Table 4.1, the summary of project type, cost overrun and cumulative percentage overrun it can be seen that the rate of cost overrun has significant variations for the different types of public building construction projects. The investigation revealed that educational buildings projects have the lowest rate of cost overrun with 8% of the contract amount. Hospital buildings recorded the highest percentage overrun of 86%. Nevertheless, the table revealed an uncommon occurrence of cost overrun in building projects because one of the commercial buildings was completed 8% less than the initial contract sum. Therefore it can safely be assumed that cost overrun can as well be reduction in the final contract sum compared to the initial price.

Table 4. 1**:** Summary of project type, client, cost overrun and cumulative percentage overrun

Project Type	Client	Initial Contract Sum (₦)	Final Contract Sum (₦)	Cost Overrun (₦)
Office	Government	4,203,790,000.05	4,631,010,380.05	**427,220,380.00**
Office	Government	328,800,014.20	1,173,449,982.07	**844,649,967.87**
Office	Government	983,127,500.00	1,547,303,089.35	**564,175,589.35**
Office	Government	328,800,014.20	1,804,353,535.06	**1,475,553,520.86**
Office	Government	576,441,447.69	1,103,253,726.82	**526,812,279.13**
Office	Government	821,692,220.38	1,162,904,890.73	**341,212,670.35**
Office	Government	328,800,014.20	1,163,853,276.82	**835,053,262.62**
Office Building Cumulative		**7,571,451,210.72**	**12,586,128,880.89**	**5,014,677,670.17**
Hospital	Private	3,364,284,903.00	6,258,838,975.31	**2,894,554,072.31**
Hospital Cumulative		**3,364,284,903.00**	**6,258,838,975.31**	**2,894,554,072.31**
Education Facility	Government	35,693,083.18	64,761,625.84	**29,068,542.66**
Education Facility	Private	1,490,004,589.00	1,587,800,034.00	**97,795,445.00**
Educational Building Cumulative		**1,525,697,672.18**	**1,652,561,659.84**	**126,863,987.66**
Commercial Building	Government	144,337,697.80	241,765,238.95	**97,427,541.15**
Commercial Building	Government	34,962,648.80	32,219,674.63	**-2,742,974.17**
Commercial Building	Private	7,867,200.00	13,628,024.33	**5,760,824.33**
Commercial Cumulative		**187,167,546.60**	**287,612,937.90**	**100,445,391.30**
Residential Building	Private	95,975,217.00	171,742,774.84	**75,767,557.84**
Residential Building	Private	794,443,000.33	808,430,590.33	**13,987,590.00**
Residential Cumulative		**890,418,217.33**	**980,173,365.17**	**89,755,147.84**

The detailed calculations of the cumulative percentage cost escalation of the overrun factors comprising variations, re-measurement, adjustment of PC sums, adjustment of provisional sums, fluctuation and others of the project costs analysed are shown in appendix 1.

4.1.3 FACTORS INFLUENCING BUILDING COST OVERRUNS

Further to the above analysis, it was imperative that factors causing cost overrun as evident in the final accounts are assessed. The data is analysed under the classification of contractors registration categorization of the Federal Ministry of works of Nigeria, category A, B, C and D as follows category A (₦0m – ₦50m), category B (₦50 – ₦250m), category C (₦250 – ₦500m) and category D (₦500 and above). However, the cost structure of the final accounts analysed in this project largely falls under projects categorization B, C. and D of the Federal Ministry of works categorization. Therefore for ease of analysis, the cost data are categorized and analysed in the bands of ₦5m-N50m, ₦50m-₦100m, ₦100m- ₦150m and ₦150m and above. The results reveal projects in the range of ₦5 million – ₦50 million have fluctuation as the most prevailing factor accounting for 48% of total cost overrun, followed by variation 22%, adjustment of provisional sums 20% re-measurement 10% as shown in Figure 4.3.

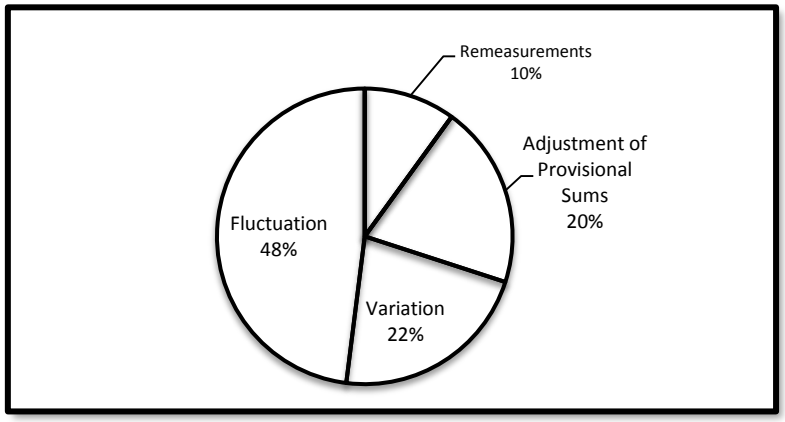


Figure 4.3: Distribution of Cost Overrun for projects with ₦5 million – ₦50 million Contract Sums

It was interesting to note that Adjustment of PC sums was a factor that did not reflect in the final accounts of project within this band. However, a brief interview with research interviewees associated with these projects indicated that PC sums were not included in these

projects due to relative simplicity of design and scope of works not requiring the involvement of any specialist works.

For projects in range of (₦50m-₦100m), variation accounted for 67% of total cost overrun, re-measurement 19%, while both adjustment of provisional sums and PC sums accounted for 5% each of total cost overrun while fluctuation and other factors is 2% as shown in Figure 4.4.

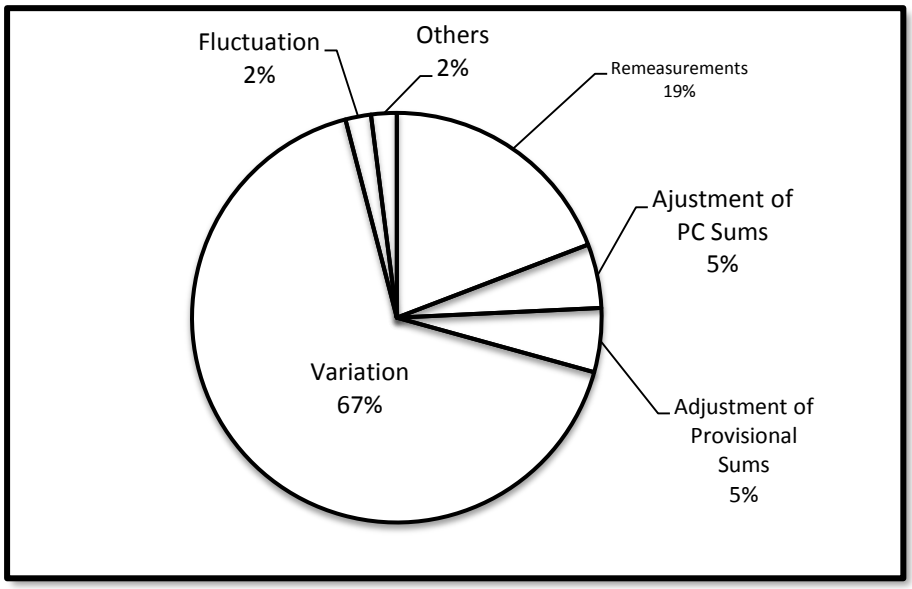


Figure 4.4: Distribution of Cost Overrun for projects with ₦50 million – ₦100 million Contract Sums

Subsequently, for projects in range of (₦100m- ₦150m), variation accounted for 36% of total cost overrun, re-measurement 25%, fluctuation 19%, adjustment of PC sum 17% and adjustment of provisional sum 10% as shown in Figure 4.5. Fluctuation and other factors accounted for 5% and 8% respectively.

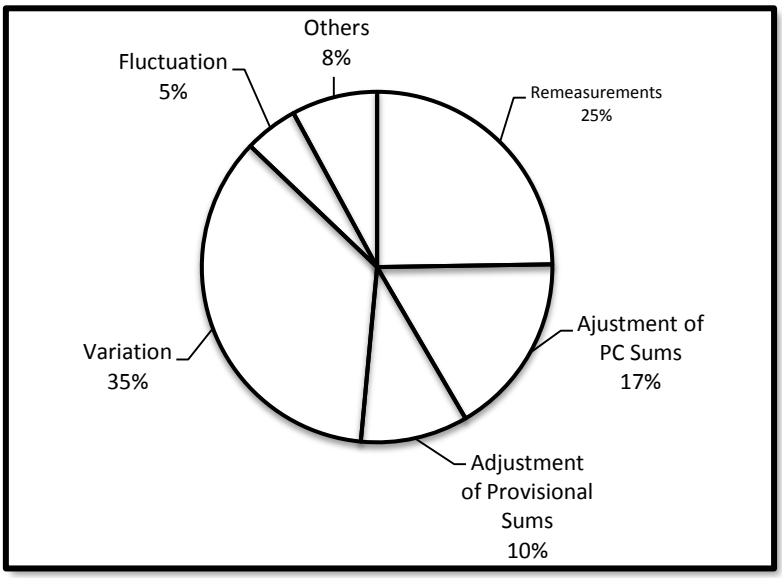


Figure 4.5: Distribution of Cost Overrun for projects with ₦100 million – ₦150 million Contract Sums

However, for projects in range of (₦150m and above), variation accounted for 37% of total cost overrun, re-measurement 26%, adjustment of PC sums 20%, fluctuation 10%, adjustment of provisional sums 3% while others accounted for 4% as shown in Figure 4.6.

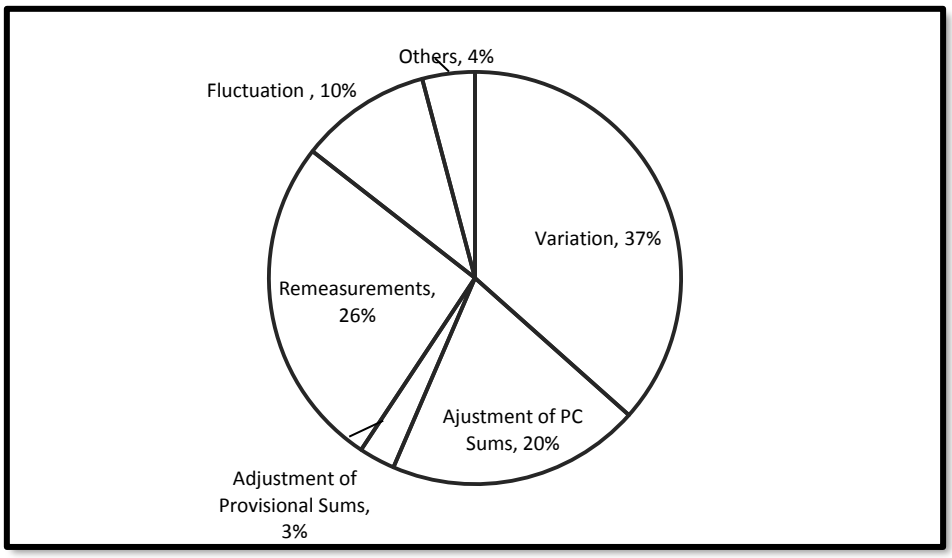


Figure 4. 6: Distribution of Cost Overrun for projects with Contract Sums of ₦150 million and above

Average cost overruns identified in each factor were computed as a percentage of total average cost overruns. Figure 4.7 shows the breakdown of the total cost overruns where average value of each factor can be seen.

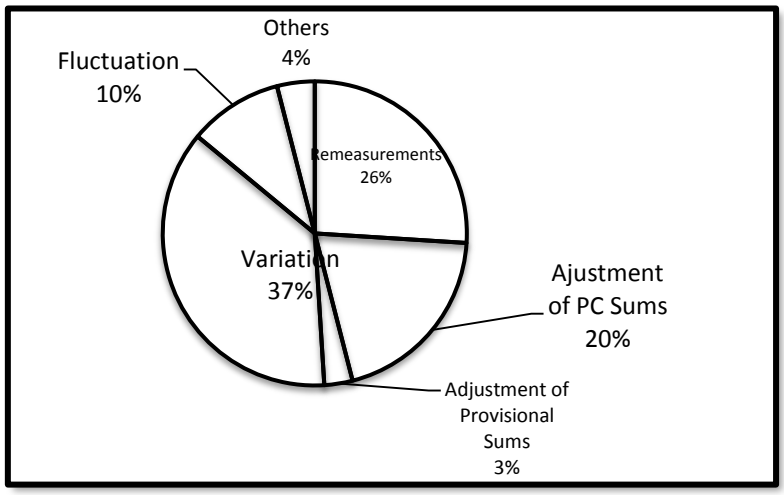


Figure 4.7: Distribution of Average Cost Overrun for Building projects

It is clearly seen from the analysis that the highest cost overruns are mainly due to Variation and re-measurement. Thus, the average cost overruns identified in variation and re-measurement were of 37% and 26% respectively of the total cost overrun. 20% of the total cost overrun is due to adjustment of PC Sums. Fluctuation account for 10%., adjustment of provisional sum 3% while other factors 4%.

4.1.3.1 NORMALITY TESTS FOR VARIABLES OF HISTORICAL DATA

Table 4.2 shows that all the variables from historical data collected are not normally distributed as the Anderson-Darling (AD) tests p-values are <.05. Detailed descriptive statistics of each variable of the historical data are presented on Appendix 2.

Table 4.2*:* Normality test results of historical data of cost overrun (₦)

Variables	Anderson-Darling (AD) Normality Test	p-value (AD Test)
Initial Contract Sum	1.7794	0.0001
Variation	1.4069	0.0008
Adjustment of PC Sums	3.1830	0.0000
Adjustment of Provisional Sums	2.3046	0.0000
Re-measurements	1.6559	0.0002
Fluctuation	2.8030	0.0000
Others	3.0716	0.0000
Final Contract Sum	1.5225	0.0004
Cost Overrun	1.4471	0.0006

4.1.3.2 SELECTION OF DISTRIBUTION FITTING

Considering the small numbers of historical data and non-normality, the Pearson Type 1 family distribution, also known as the beta probability distribution, is a simplistic and suitable distribution for this form dataset. It allows simply specifying the mean, standard deviation (Selvin, 2004), Scenes and Kurtosis (Johnson *et al.,* 1995, Wang, 2005, SigmaXL, 2013).

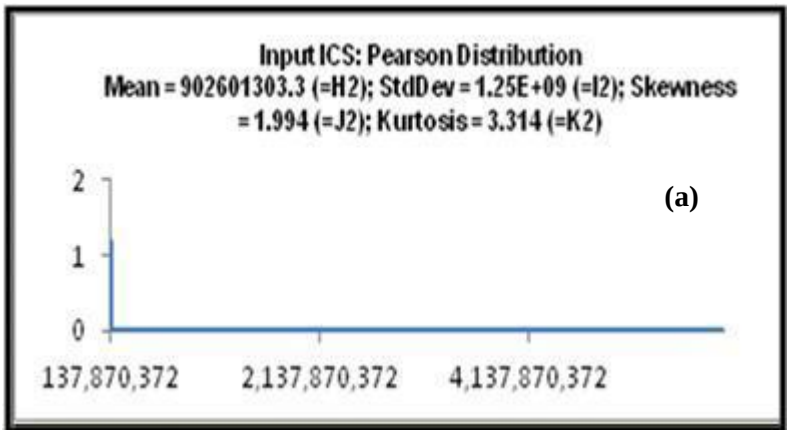
Table 4.3 shows the values of each variable using the beta distribution probability density function (puff) stated in the previous Chapter calculated from the historical data used to develop the beta probability distribution for simulating the cost overrun.

Table 4. 3*:* Beta probability distribution data for cost overrun (₦)

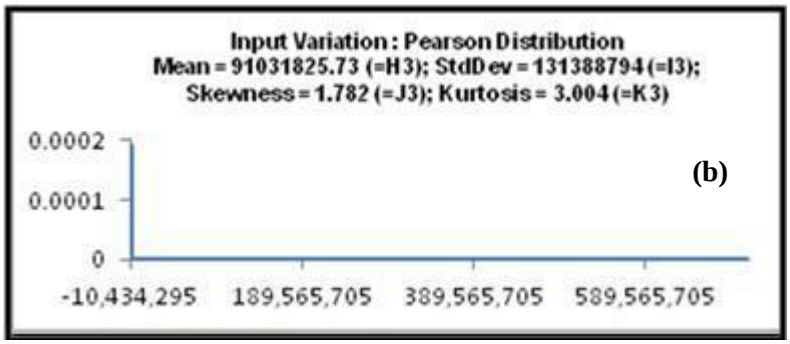
Variable	**Mean** (μ)	**Stdev** (σ)	**Skewness** (p)	**Kurtosis** (q)
ICS	902,601,303.32	1,252,201,310.37	1.99	3.31
Variation	91,031,825.73	131,388,794.04	1.78	3.00
APCS	50,639,047.22	120,044,932.16	3.06	9.82
APS	10,479,452.65	18,587,080.66	2.06	3.61
Re-measurements	141,710,469.33	176,427,622.86	0.83	1.11
Fluctuation	32,437,409.16	52,195,885.81	1.21	0.56
Others	23,167,599.19	47,496,156.34	2.16	4.07
Final Contract Sum	1,451,021,054.61	1,757,764,778.54		
Cost Overrun	548,419,751.29	773,472,337.22		

The Pearson family (Beta) probability distribution curves for each of the input variables, excluding FCO and CO, because these are output variables in the model function, are presented in Figures 4.8 (a-g).

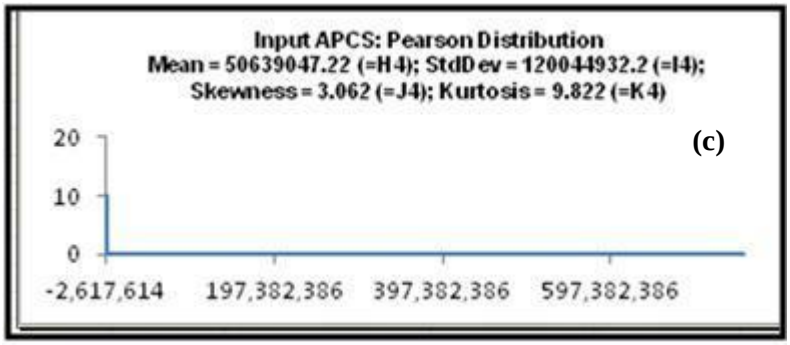
The distribution curves, for instance in Figure 4.8(a) for ICS, the term “Input” appears next to the variable, indicating a specified input variable. Values of mean, stdev, skewness and kurtosis also appear on the curve indicating the elements of the Pearson (Beta) distribution, as shown on Table 4.2. The cell address of each respective element as located on the Excel spread sheet appears next the element on the curve. A screen shot detail is shown on Appendix 3.


Input ICS: Pearson Distribution
Mean = 902601303.3 (=H2); StdDev = 1.25E+09 (=I2); Skewness = 1.994 (=J2); Kurtosis = 3.314 (=K2)
2
1
0
137,870,372
2,137,870,372
4,137,870,372

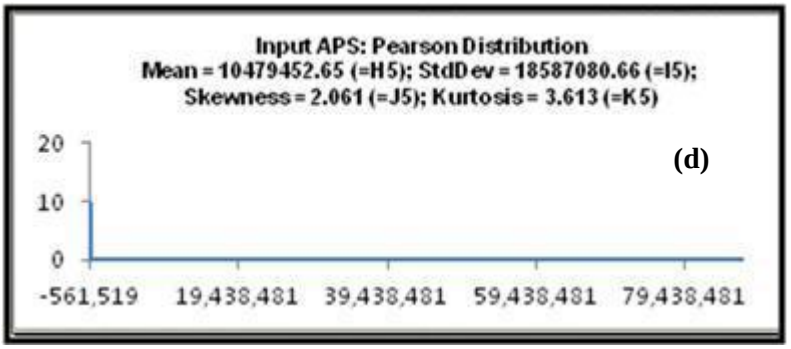
(a)


Input Variation : Pearson Distribution
Mean = 91031825.73 (=H3); StdDev = 131388794 (=I3); Skewness = 1.782 (=J3); Kurtosis = 3.004 (=K3)
0.0002
0.0001
0
-10,434,295
189,565,705
389,565,705
589,565,705

(b)


Input APCS: Pearson Distribution
Mean = 50639047.22 (=H4); StdDev = 120044932.2 (=I4); Skewness = 3.062 (=J4); Kurtosis = 9.822 (=K4)
20
10
0
-2,617,614
197,382,386
397,382,386
597,382,386

(c)


Input APS: Pearson Distribution
Mean = 10479452.65 (=H5); StdDev = 18587080.66 (=I5); Skewness = 2.061 (=J5); Kurtosis = 3.613 (=K5)
20
10
0
-561,519
19,438,481
39,438,481
59,438,481
79,438,481

(d)

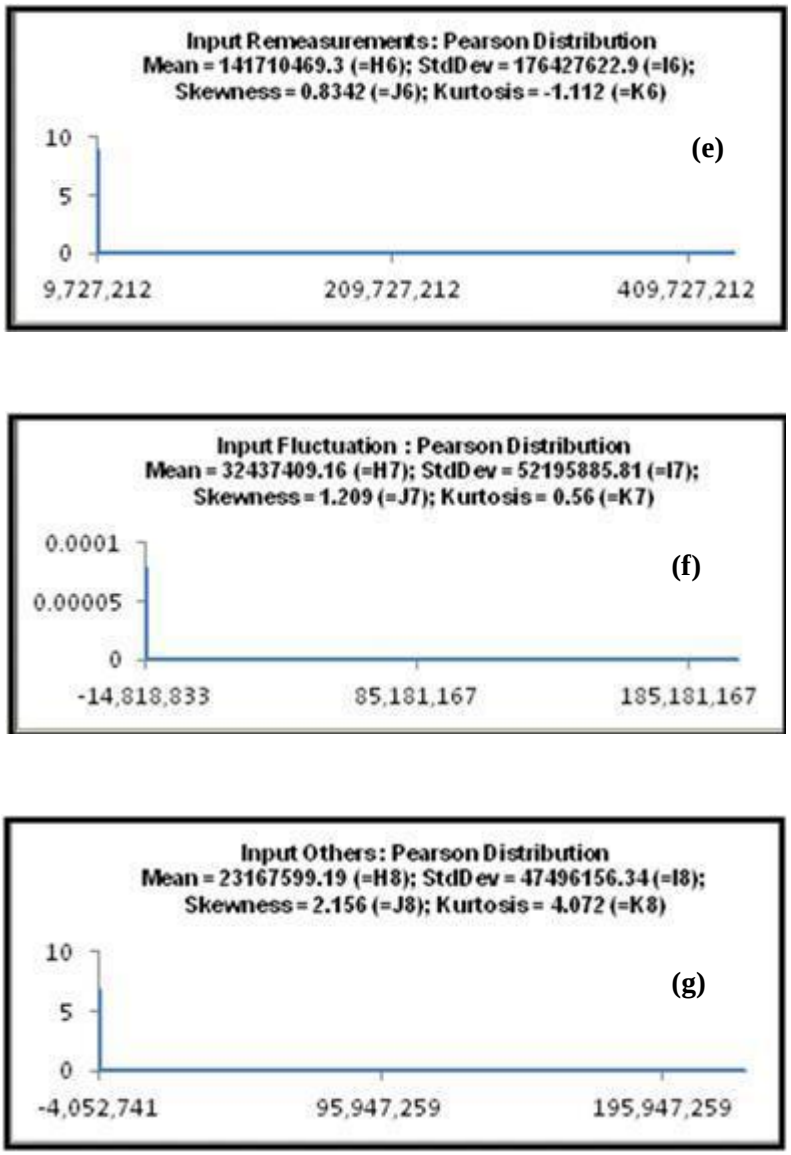


Figure 4.8: Beta probability distribution curves for (a) ICS, (b) variation, (c) APCS, (d) APS, (e) Re-measurement, (f) fluctuation; (g) others

4.1.3.3 CORRELATION ANALYSIS OF INPUTS VARIABLES

Table 4.4 shows the Spearman rank correlation matrix with p-values of inputs variables for the cost overrun simulation model. The result indicated no strong correlation coefficient (r > .7) between the variables; they were generally no relationships between the input variables. It is essential to indicate strong correlation values prior to running the simulation as it will be included in determining the nature of sensitivities as described in the results of correlations /regression sensitivity below.

Table 4. 4*:* Spearman Rank Correlations Coefficients of Inputs Variables

Spearman Rank Correlations Coefficients	**ICS**	**Variation**	**APCS**	**APS**	**Re-measurements**	**Others**	**Fluctuation**
ICS	**1.00**	0.01	-0.01	-0.01	0.02	0.01	-0.01
Variation		**1.00**	-0.01	0.00	-0.02	0.00	0.02
APCS			**1.00**	0.00	0.01	0.02	0.01
APS				**1.00**	0.02	0.01	0.00
Re-measurements					**1.00**	0.00	0.00
Others						**1.00**	-0.01
Fluctuation							**1.00**

Spearman Rank p-values	**ICS**	**Variation**	**APCS**	**APS**	**Re-measurements**	**Others**	**Fluctuation**
ICS		0.31	0.23	0.60	**0.01**	0.38	0.52
Variation			0.31	0.70	0.05	0.99	0.09
APCS				0.72	0.30	0.07	0.56
APS					0.07	0.61	0.65
Re-measurements						0.87	0.96
Others							0.48
Fluctuation							

4.1.3.4 MONTE CARLO SIMULATION

The simulation model was generated from 10000 iterations. The probabilities of cost overrun generation process are presented on Figure 4.9.

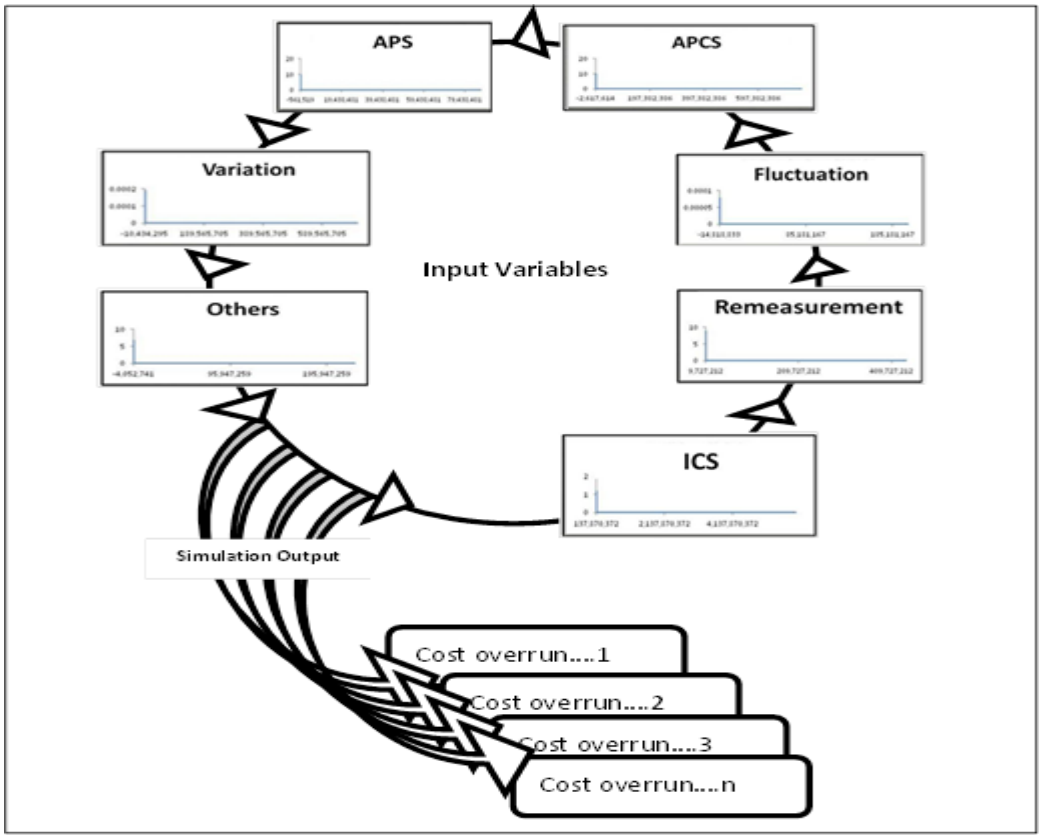


Figure 4. 9: Process of cost overrun simulation and data generation process

Figure 4.10 shows the distribution histogram of building construction cost overrun and summary statistical result of the distribution is presented on Table 4.5.

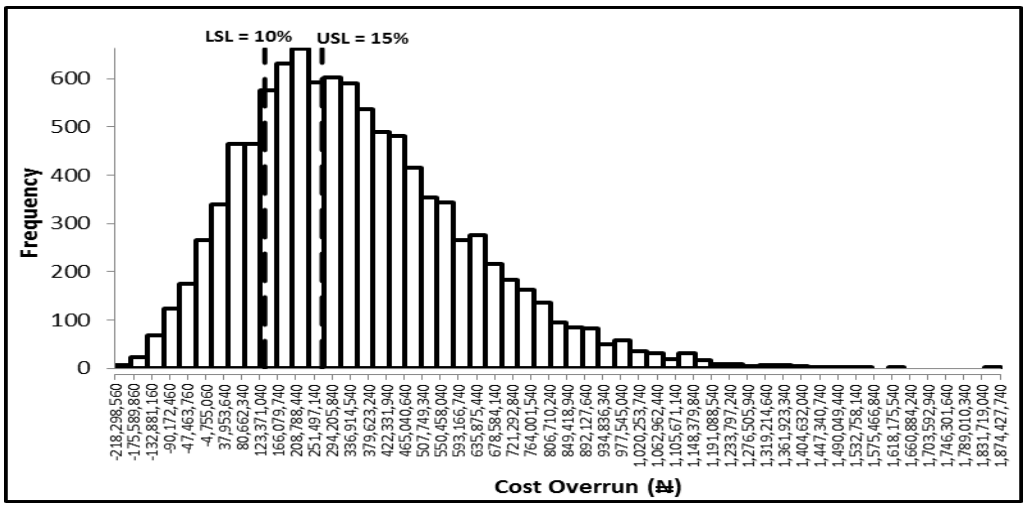


Figure 4. 10: Distribution histogram of construction cost overrun indicating assumption band of performance within specifications (LSL = Lower specification limit, 10%; USL = Upper Specification Limit, 15%)

It revealed an average cost overrun of ₦ 350,987,772.8, between a minimum of ₦ -218,298,554.1 and a maximum of ₦ 1,874,427,836.8 in the simulated cost overrun. Normality test for the distribution failed as was the case with all the input variables. While the model was set up on a premise of historical data that had an average initial contract sum of = ₦ 902,601,303.32, final contract sum = ₦ 1,252,067,106.60 and cost overrun of ₦ 349,465,803.28 (% Cost overrun = 27.9), the result of simulation model represent closely the actual premise as expected and indicated a possibility of a contract cost overrun of as high as ₦ 1,874,427,836.8. This is about 50% above the average initial contract sum of the historical data.

Table 4. 5*:* Statistical results of probability distribution of cost overrun

Descriptive Statistics	
Count	10,000.0
Mean	350,987,772.8
StDev	261,138,596.3
Range	2,092,726,390.9
Minimum	-218,298,554.1
25th Percentile (Q1)	161,612,475.6
50th Percentile (Median)	315,093,150.9
75th Percentile (Q3)	504,497,220.6
Maximum	1,874,427,836.8
95.0% CI Mean	3.46E+08 to 3.56E+08
95.0% CI Median	3.09E+08 to 3.21E+08
95.0% CI StDev	2.58E+08 to 2.65E+08
Normality Tests	
Anderson-Darling Normality Test	73.911317
p-value (A-D Test)	**0.0000**
Skewness	0.772213
p-value (Skewness)	**0.0000**
Kurtosis	0.763627
p-value (Kurtosis)	**0.0000**
Actual Performance (Empirical)	
% > USL	56.98
% < LSL	21.08
% Total (out of spec.)	78.06
% Total (within spec.)	21.94

4.1.3.5 CONTRACT PERFORMANCE IN TERMS OF COST OVERRUN

The simulation model was performed to indicate an assumption band of performance within specifications (LSL = Lower specification limit, 10% (₦ 135,390,195.50) USL = Upper Specification Limit, 15% (₦ 270,780,391.00)), as shown on Figure 4.9. The result of this indicated that only 21.94% of building constructions fit within this specification in Nigeria.

The cumulative probability distribution of cost overrun (Figure 4.11) indicates that less than 10% of building contracts will be completed at costs below the initial contract sum. It also revealed a 1.2 billion Naira threshold beyond which the cost overruns show no significant cumulative probability difference.

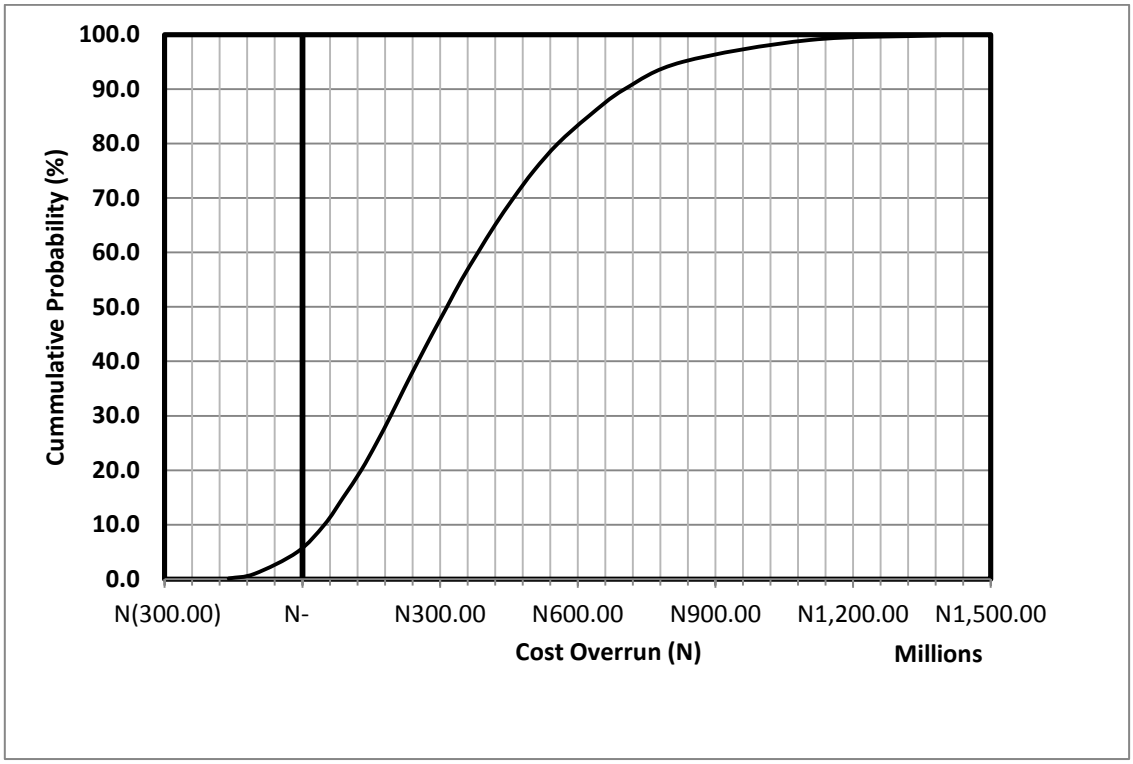


Figure 4. 11: Cumulative probability distribution of cost overrun simulation model

4.1.3.6 SENSITIVITY ANALYSIS

Figure 4.12 show the sensitivity regression chart of factors responsible for cost overrun. It revealed that re-measurement accounts for about 45% of differences between the initial contract sum and the final cost. In other words, 45% of building construction overrun is caused by re-measurement. The least is APS accounting for <1% of construction cost overrun.

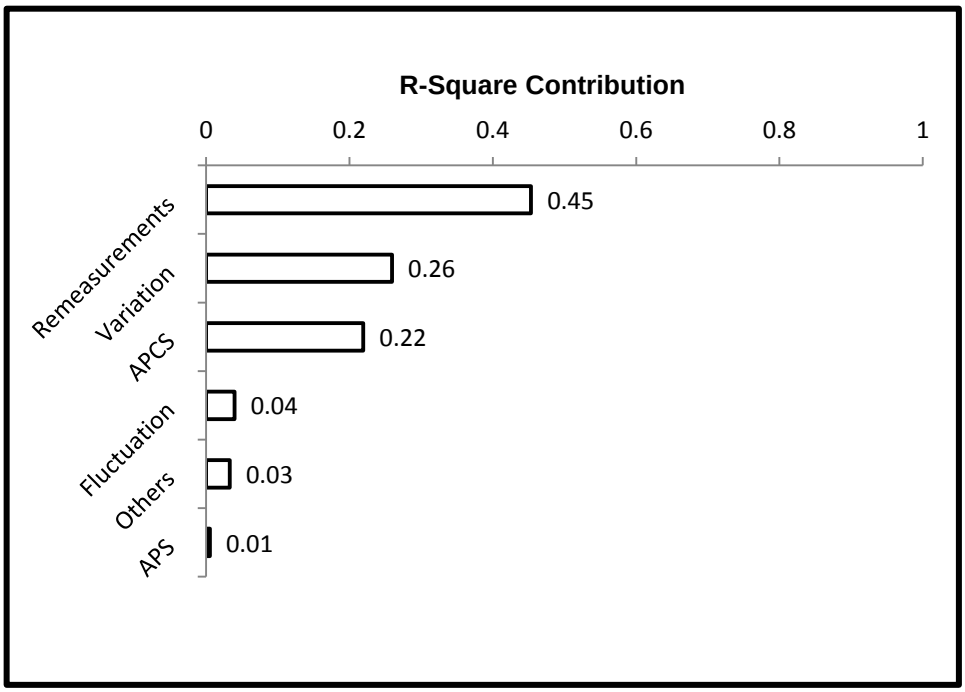


Figure 4. 12: Sensitivity regression chart of factors of cost overrun

4.2 DISCUSSION OF RESULTS

All the projects studied exceeded their initial contract sum with exception of a commercial building project which was completed with less than the initial contract sum. This is similar to the data collected in earlier study conducted in Sri-Lanka (Shanmugam, *et al*., 2002). However, interview with a respondents involved in the project indicated that this was achieved due to value engineering exercise undertaken during the construction phase of the project. This brings forth the argument that cost overrun could be avoided in projects.

In literatures, it has been established that government sponsored projects often experience cost overrun compared to non-government sponsored projects (Achuenu & Kolawole 1998, Al Najir, 2008; Nega, 2008,). The final accounts of these projects reveal a staggering difference in completion cost largely influenced by variation and adjustment of PC sums.

Re-measurement and variation accounting for the bulk of cost overrun in projects with initial contract sums in range of ₦150m and above as shown in Fig 4.6 may be attributed to the complexity of designs of projects within that range where details are not usually finalized at the early stages of the project when cost estimates and BOQs are prepared based on measurements undertaken from existing information at time of production. As argued in the literature, incomplete design is major factor leading to cost overrun which is influenced by factors such as indecision of clients, inadequate planning, and inadequate time available to the design team.

The low cost overrun identified in educational projects as shown in Table 4.1 is found to be as a result of the simplified designs for these projects which did not require many changes during execution of the project thereby reducing the possibility of cost increases due to cost overrun factors like re-measurement, variations, adjustment of provisional sums, etc. Furthermore, the wide disparity between the initial and the final contract sums of the only two projects examined for educational buildings as shown in Table 4.1 are a result of the wide difference in these project costs and the number of the projects analysed. One of the projects has a very huge cost initial and final cost whereas the other project used has a smaller initial and final cost. There is therefore the tendency of the results to tend towards one of the projects cost pattern of either high or low cost overrun, in this case it has indicated low overrun in these building type. The two samples used for these projects type was what is available during this research and should serve as one of the limitations of the project.

The sources of variations can be classified into client initiated variations, consultant initiated variations and unforeseeable variations. The main reasons behind the higher percentages in variation and adjustment of PC sums as shown in Fig 4.7 are identified as design changes during the construction stage, improper management, ineffective communication and incorrect assessment of brief. Lack of information about the actual design during the tendering stage and inaccurate quantities of tender Bill of Quantities also contribute to these factors. There are instance where the actual quantities of work included in the bills of quantities, may change probably due to errors in the Bill of Quantities and/or in adequacy of the provisional sum and prime cost sums. The provisional sum inserted in the bill of quantities will only be confirmed when the work is carried out actually. Similarly a prime cost sum which is a sum provided for work or services to be executed by a nominated sub-contractor, a statuary authority will be known only at the time of executing the works. Therefore the amount allocated in the bill of quantities will not always be equal to the final value thus will lead to cost overruns. The cost overruns can occur even due to fluctuations which includes both prices of materials and labour and currency fluctuations. Other factors which cause cost overruns include claims, interest on delay in payment, termination of contract, compensation etc.

The few numbers of historical data and diverse categories utilized for the cost simulations as shown in Table 4.1 are the likely cause of failure to pass normality tests. Usually dataset obtained from similar observation or processes are very likely to present a normal distribution (Johnson *et al.,* 1995).

There was no correlation between the factors influencing building cost overrun, this may be due to the fact that external factors such as client type, project type procurement methods, etc, influenced the occurrence of these factors.

Simulation result from Fig 4.11 elucidated that less than 10% of building projects are completed below the initial contract sum in Nigeria. This may generally not represent optimisation process fitted to project execution but indicates an ineffective cost management process in the projects studied which is likely due to factors such as incomplete brief, incomplete designs, change in client needs, etc, that inevitably lead to increase in project cost as revealed in the literature.

For process optimisation in building cost overrun, re-measurement is the principal factor to be considered as it was the factor that had the most impact overall in all the projects studied as shown in Appendix 1. Re-measurement which entails determining of actual quantities of work items where the work has been substantially designed, but final detail was not completed at the time of going to tender or the under estimation of quantity of work involved at the time of preparing tender documents. This could arise due to the need for an early start on site as designs are being firmed up, incomplete client brief, uncertainty of ground conditions etc.

It is certainly not spectacular as only about 20% of building construction cost overruns will be within the 10-15% specification limits of cost overrun as revealed by the results of the simulation using the upper and lower limits of overrun as shown in Fig 4.10. This is due to the fact that projects are being initiated and subsequently commenced without ensuring all necessary design details and client needs are clearly identified and firmed up before going to tender.

CHAPTER FIVE

5.0 SUMMARY CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

The major thrust of this study was to identify, analyse and model the factors that contribute to building construction cost overruns in Abuja. The study adopted a Monte-Carlo technique in simulating cost overrun using DiscoverSim® version 1.1 (SigmaXL, 2013) simulation and RiskAmp Microsoft Excel add-in software to analyse data obtained from literature review, review of project documents with contract sum of over Five Million Naira executed within Abuja city in addition to interview sessions with construction professionals. Significant data was obtained from the research which could aid in understanding cost overrun in building projects. The conclusions and recommendations drawn from this study are presented in this section of the project.

5.2 CONCLUSION

Generally, the results of this study reveals and confirm the established facts that cost overrun occurs in all types of building projects.

- Financial resources are so scarce in developing countries like Nigeria, hence, cost related issues in the Nigerian construction industry are sensitive issues. Therefore, carrying out a research in this area will have a paramount importance in understanding cost overrun which is a prerequisite to minimizing or to avoid cost it occurrence in the construction industry.
- In the domain of construction, cost overruns from tender Bill of Quantities (BOQ) to final account are common in Nigeria in almost every project. Main reason for this is tendering with very limited or inadequate information. In the requirement of design the

scope and complexity of the project should be clearly defined, no matter how much changes are subsequently made in the design. However, it should be noted that change is not always a threat, but can be an opportunity to save cost and make the client's money more valuable when it is managed effectively.

- The aim of this study is to identify and analyze cost overruns in building projects in the Nigerian construction industry. The factors affecting the cost overruns were identified and quantified. Probability distribution was established for each factor identified. The simulation model was developed to quantify the cost overruns.
- As highlighted in the literature, cost overrun is a phenomenon that occurs due to many factors influenced by different reasons. The results indicated that occurrence of cost overrun may be influenced by design changes during construction stage, improper management and ineffective communication, lack of information about the actual design during the tendering stage and inaccurate quantities of tender BOQ.

The findings of this research revealed that although all factors may occur in a single project, the influence of each factor on the overall project cost overrun of the projects surveyed in this study differs as highlighted below

- Variation accounts for 37% of the total cost overrun
- Re-measurement accounts for 26% of overall cost overrun of all projects surveyed.
- Adjustment of PC sum stood at 20% of the total cost overrun
- Fluctuation accounts for 10% of the total cost overrun
- Other factors accounts for less than 10% of the total cost overrun
- Factors leading to cost overrun of buildings does not follow a common pattern in relation to their effect on the total cost of a particular kind of building

In addition the simulation model provided insight on the occurrence of cost overrun in Nigeria as highlighted below

- Simulation result indicated that less than 10% of building projects are completed below the initial contract sum in Abuja.
- For process optimization in building cost overrun, re-measurement is the principal factor to be considered.
- Only about 20% of building construction cost overruns will be within the 10-15% specification limits of cost overrun as revealed by the results of the simulation using the upper and lower limits of overrun.

5.3 RECOMMENDATIONS

The following recommendations are proffered in attempts to minimize the occurrence of cost overrun as revelled from the interview results

a) Clarification of client needs in terms of specification and designated use of the proposed building project.
b) Proper briefing prior to award of contract
c) Notwithstanding early project planning and consideration of all possible design solutions, value engineering during project execution will go a long way in minimising cost overrun in projects.

Further study of cost overrun in construction projects will go a long way in understanding the phenomenon and improve project delivery in terms of client's expectations and attainment of project objectives. Thus, the following recommendations are highlighted below

a) Further studies in building projects cost overrun with more categories and larger dataset to validate the findings of this research
b) Simulation models developed for specific project categories which may be considered more pragmatic
c) Further investigation of re-measurement as identified as a key risk factor and contributor to project cost overruns which needs to be managed during planning

phase and project execution phase in a project delivery which will aid the project team in avoiding or minimizing it's occurrence of factors that instigate the occurrence of re-measurement.

d) Formulation of an acceptable cost overrun band to be used as a benchmark by policy makers in project certification and determination of performance in terms of value for money expended on a building project.

In general, the results of this research work will aid clients especially the government which is the biggest player in the Nigerian construction Industry as an initiator and financier of construction projects to manage cost overrun. The significant impact of cost overrun cannot be over emphasised as many literature have highlighted its effect on project execution.

5.4 CONTRIBUTION TO KNOWLEDGE

This research work has contributed to the knowledge and understanding of cost overrun in building projects by

- Indicating that not all projects experience cost overrun. Cost savings can be achieved through effective management of the project as eluded by results of the interview sessions.
- Highlighting that factors leading to cost overrun do not necessarily have a determined pattern of influence on the overall project cost. The result brings out the divergence of impact of factors leading to cost overrun on the final cost of the building projects studied.
- Modelling cost overrun in building projects using more recent modelling software DiscoverSim (SigmaXL, 2013). Although this research work was modelled after a similar research conducted by Shanmagum *et. al* (2002), the use of a more recent and

robust software in modelling the cost overruns provides additional resources to the study of cost overrun in building projects.

REFERENCES

Achuenu, E., and Kolawole, J. O. (1998). Assessment and Modeling of Cost Overrun of Public Building Projects in Nigeria. *Nigerian Journal of Construction Technology and Management, 1*

Akinci, B. & Fischer, M. (1998). Factors Affecting Contractors' Risk of Cost Overburden. *Journal of Management in Engineering, 14,*(1)

Akinsola, A. & Potts, K.F. (1998). A methodology for evaluation of the variation clause in the standard forms of contract, *Proceeding of COBRA 98, RICS*

Al-Najjar, J. (2008). *Factors influencing time and cost overruns on construction projects in the Gaza Strip.* Master Thesis, Islamic University, Gaza

Ali, A.S & Kamaruzzaman, S.N. (2010). Cost Performance For Building Construction Projects In Klang Valley. *Journal of Building Performance, 1*(1)

Amehl, O. Soyingbe, A. & Odusami, K. (2010) Significant factors causing cost overruns in telecommunication projects in Nigeria. *Journal of Construction in Developing Countries,* 15

Arain, F. M., & Pheng, L. S. (2005). The potential effects of variation orders on institutional building projects. *Facilities*, 23(11/12), 496-510

Ashworth, A. (1999). *Cost Studies of Buildings,* 3rd ed., Wesley Longman Ltd., London

Atkinson, R. (1999). Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria. *International Journal of Project Management*, 17(6), 337-342.

Aziz, R. F (2012). Factors causing cost variation for constructing wastewater projects in Egypt; *Alexandria Engineering Journal*,I, (1), 51–66

Bhimaraya, A. M. (2001) Development of Benchmarking Tool for Construction Industry. *Foundations of Control and Management Sciences*, 5.

Biggam, J. (2008). *Succeeding with Your Master's Dissertation*. Berkshire: Open University Press.

Boukendour, S (2005). A New Approach of Project Cost Overrun and Contingency Management; *OCRI Partnership Conferences Series Process and Project Management*

Chan Albert P.C., (2001). Time cost relationship of public sector projects in Malaysia. *International Journal of project Management*, *19*, (4),223-229.

Chan Daniel and Kumaraswamy M. M., (1996). An Evaluation of Construction Time Performance in The Building Industry. *Journal of Building and Environmental*, *31*, (6),569-578

Chang, A. S. T. (2002). Reasons for cost and schedule increase for engineering design projects. *Journal of Management in Engineering*, 18(1), 29-36.Chapman, R. J (2001). The controlling influences on effective risk identification and assessment for construction design management; *International Journal of Project Management* Volume 19, Issue 3, April 2001, Pages 147–160

Chitkara, K. (2004). *Construction Project Management, Planning, Scheduling, and Controlling*. Tata McGraw Hill, 4th edition, India.

Cox, I D, Morris, J P, Rogerson, J H & Jared, G E (1999). A Quantitative Study of Post Contract Award Design in Construction, *Construction Management and Economics, 17,* 427 – 439

Daniel, B. & Andrew, D. (2003) Modeling global risk factors affecting construction cost performance. *International Journal of Project Management,* 21, pp. 261–269

Dantata, S. (2007). General Overview of the Nigerian Construction Industry. *Unpublished Master's Thesis Massachusetts Institute of Technology,* Massachusetts

Dlakwa, M. M. & Culpin, M. F. (1990). Reasons for overrun in public sector construction projects in Nigeria. *International Journal of Project Management*, 8(4), 237–240.

Egan, J. (1998) *Rethinking Construction, The Report of the Construction Industry Task Force,* DETR, London.

Elinwa, A. U., & Buba, S. A. (1993). Construction cost factors in Nigeria. *Journal of Construction Engineering and Management*, 119(4), 698-713.

Flyvbjerg B., Holm, M., & Buhl, S. (2003). How common and how large are cost overruns in transport infrastructure projects? *Transport Reviews,* 23 (1), 71-88

Frimpong, Y., Oluwoye, J., & Crawford, L. (2003). Causes of delay and cost overruns in construction of groundwater projects in a developing country: Ghana as a case study, *International Journal of Project Management,* 21 (5), 321-326.

GCP. (2009). *Global Construction Perspective 2020: A global forecast for the construction industry over the next decade to 2020.* London: Global Construction Perspectives and Oxford Economics.

Gould, F. E. (2002). *Managing The Construction Process: Estimating, Scheduling, And Project Control*. Upper Saddle River, NJ: Prentice Hall

Gray, D. E. (2009). *Doing research in the real world*. Sage.

Janaka, Y.R.A (1992). A Study of Cost and Time Overruns in Sri Lankan Building Contract, *Unpublished B.Sc. in Quantity Surveying Dissertation, University of Moratuwa*, Sri Lanka

Johnson, N.L., S. Kotz, & N. Balakrishnan (1995). *Continuous Univariate Distributions*, 2, Wiley-Interscience.

Kaming, P., Olomolaiye, P., Holt, G., & Harris, F. (1997). Factors Influencing Construction Time and Cost Overruns on High-Rise Projects in Indonesia. *Construction Management and Economics*, 15 (1), 83-94

Kasimu, M. A. (2012). Significant Factors That Causes Cost Overruns in Building Construction Project in Nigeria. *Interdisciplinary Journal of Contemporary Research in Business*, *3*(11)

Koushki, P.A, AL-Rashid, K & Kartam, N.,(2005). Delays and Cost Increases in The Construction of Private Residential Projects in Kuwait, *Journal of Construction Management and Economics*. *23*, (3), 285-294.

Latham, M. (1994) *Constructing the Team, Final Report on Joint Review of Procurement and Contractual Agreements in the UK Construction Industry*, HMSO, London

Leibing, R. (2001). *The Construction Industry*: Process Players. Upper Saddle River, NJ: Prentice Hall.

Le-Hoai L., Dai Lee, Y& Lee, J. Y (2008). Delay and Cost Overruns in Vietnam Large Construction Projects: A Comparison with Other Selected Countries; *KSCE Journal of Civil Engineering*

Mahamid, I. (2013). Effects of project's physical characteristics on cost deviation in road construction: *Journal of King Saud University - Engineering Sciences,* 25, (1), 81–88

Mahamid I.& Dmaidi N. (2013). Risks Leading to Cost Overrun in Building Construction from Consultants' Perspective. *Organization, Technology & Management in Construction – An International Journal* 5 (2) 2013

Mansfield, N.R., Ugwu, O.O., & Doran, T., (1994). Causes of delay and cost overruns in Nigeria Construction Projects, *International Journal of Project Management*.12 (4) 254–60.

Mbachu, J. I. C., & Nkado, R. N. (2004). Reducing Building Construction Cost: The Views of Consultants and Contractors. *Proceedings of the COBRA 2004*.

Merrow, E,. McDonnell, L & Arguden, R. (1988). 'Understanding The Outcome of Mega-Projects. A quantitative analyse of very large civilian projects'. *Rand Reports*.

Miller, L. & Lessard, D. (eds.) (2000). *"Introduction", Strategic Management of Large Engineering Projects: Shaping Institutions, Risks, and Governance*, Harvard: MIT-Press, 1 – 18.

Morris, P.W.G., & Hough, G.H. (1987). *The Anatomy of Major Projects*. John Wiley and Sons, New York

Morris, P. W. G (1990). The Strategic Management of Projects. *Technology in Society*, 12(2), 197-215.

Morris, P. W. G., Caupin, G., Knöpfel, H., Motzel, E., & Pannenbäcker, O. (1998). ICB IPMA Competence Baseline, International Project Management Association, Zurich.

National Bureau of Statistics (2013). http://nigerianstat.gov.ng/

Odeh, A.M. and Battaineh, H.T. (2002) Causes of construction delay: traditional contracts, *International Journal of Project Management*, 20, 67-73

Odusami, K. T., & Onukwube, H. N. (2008). Factors Affecting the Accuracy of a Pre-Tender Cost Estimate in Nigeria. *Cost Engineering* 50(9) 32-35.

Ogunsemi, D. R., & Saka, N. (2006). The Nepad Initiative and The Challenge of Efficient Cost Management of Infastructure Development in Nigeria. *NIQS 22nd Bienniel Conference*, 67-86

Oguonu, C. N. (2007, October 10). Hollerafrica Politics. Hollerafrica http://www.hollerafrica.com/author.php?authorNm=Dr_Chika_N._Oguonu&artId=248 [Last accessed 29 April 2012]

Oke, A., & Abiola-Falemu, J. (2009). Relationship Between Building Collapse and Poor Quality of Materials and Workmanship in Nigeria. *RICS COBRA Research Conference*, 873-884. Cape Town.

Okpala, D. C., & Aniekwu, A. N. (1988). Causes of high costs of construction in Nigeria. *Journal of Construction Engineering and Management*, 114(2), 233-244.

Olatunji, O. A. (2006). Assessing Client's Confidence and Satisfaction in Construction Professionals in Nigeria. *NLCIB* , 436-445.

Olatunji, O. A., Aje, O. I., & Odugboye, F. (2007). Evaluating Health and Safety Performance of Nigerian Construction Site. *CIB World Congress*, 1176-1190 Cape Town. http://www.irbnet.de/daten/iconda/CIB4786.pdf [Last accessed 7 April 2012]

Oluwole, A. O. (2008a). Due Process and Contractor Selection for Public Works in Nigeria. In G. Lizarralde, C. Davidson, A. Pukteris and M. de Blois (Eds): *Building Abroad: Procurement of construction and reconstruction projects in the international context*. Groupe de recherche if - grif, Université de Montréal, Montreal, pp. 385-396 http://www.grif.umontreal.ca/pages/conferencegrif08/34-Oluwole.pdf. [Last accessed 11 April 2012]

Oluwole, A. O. (2008b). A comparative analysis of tender sums and final costs of public construction and supply projects in Nigeria. *Journal of Financial Management of Property and Construction 13* (1), 60-79.

Oyediran O. S & Akintola A.A (2011). A Survey of The State of The Art of E-Tendering In Nigeria; *Journal of Information Technology in Construction*

Robson, C. (2002). Real Life Research: A Resource for Social Scientists and Practitioner Researchers.

Selvin, S. (2004). *Statistical analysis of epidemiologic data* (No. Ed. 3). Oxford University Press.

SigmaXL (2013). *Discovery through simulation, DiscoverSim® version 1.1 workbork*, SigmaXL Inc. 803, Toronto, Ontario, M4W-3C7, Canada. www.sigmaxl.com

Shanmugam, M., Zainudee, M.N., & Amaratunga, R.D.G. (2002). Simulation Modeling of Cost Overruns In Building Projects, 103-114

Taroun, A., Yang, J.B. and Lowe, D. (2011). Construction Risk Modelling and Assessment: Insights from a Literature Review. *The Built & Human Environment Review*, *4*,

Wang, J.Z. (2005). A note on Estimation in the Four Paramter Beta Distribution, *Comm in Stats Simulation and computation*, (34) 495-501.

Warsame, Abukar (2006). Supplier Structure and Housing Construction Costs. *Report 5:73 Division of Building and Real Estate Economics Royal Institute of Technology Stockholm.*

Yin, R.K. (2009). *Case Study Research: Design and Methods*. Sage publications, London

APPENDICES

Appendix 1: Project data collected and utilized for simulation modelling of cost overrun

Project Type	Initial Contract Sum (₦)	Final Contract Sum (₦)	Factors	Cost Overrun (₦)	% Overrun
Office	4,203,790,000.05	4,631,010,380.05		**427,220,380.00**	10%
			Variation	67,135,000.00	16%
			Adjustment of PC Sums		0%
			Adjustment of Provisional Sums		0%
			Remeasurements	360,085,380.00	84%
			Fluctuation		0%
			Others		
Office	328,800,014.20	1,173,449,982.07		**844,649,967.87**	257%
			Variation	49,243,976.08	6%
			Adjustment of PC Sums	176,995,439.58	21%
			Adjustment of Provisional Sums	4,304,845.02	1%
			Re-measurements	327,727,955.94	39%
			Fluctuation	128,365,810.00	15%
			Others	158,011,941.25	19%
Office	983,127,500.00	1,547,303,089.35		**564,175,589.35**	57%
			Variation	113,809,700.00	20%
			Adjustment of PC Sums		0%
			Adjustment of Provisional Sums		0%
			Re-measurements	350,360,800.00	62%

Project Type	Initial Contract Sum (₦)	Final Contract Sum (₦)	Factors	Cost Overrun (₦)	% Overrun
			Fluctuation	100,005,089.35	18%
			Others		0%
Office	328,800,014.20	1,804,353,535.06		**1,475,553,520.86**	449%
			Variation	282,077,384.00	19%
			Adjustment of PC Sums	449,714,264.60	30%
			Adjustment of Provisional Sums	61,453,833.35	4%
			Re-measurements	480,208,991.78	33%
			Fluctuation	116,881,320.83	8%
			Others	85,217,726.30	6%
Office	576,441,447.69	1,103,253,726.82		**526,812,279.13**	91%
			Variation	449,185,064.69	85%
			Adjustment of PC Sums		0%
			Adjustment of Provisional Sums		0%
			Re-measurements	73,518,714.44	14%
			Fluctuation	4,108,500.00	1%
			Others		0%
Office	821,692,220.38	1,162,904,890.73		**341,212,670.35**	42%
			Variation	187,988,130.87	55%
			Adjustment of PC Sums	49,700,324.50	15%
			Adjustment of Provisional Sums	25,354,985.00	7%
			Re-measurements	73,518,714.44	22%
			Fluctuation	4,108,500.00	1%
			Others	542,015.54	0%

Project Type	Initial Contract Sum (₦)	Final Contract Sum (₦)	Factors	Cost Overrun (₦)	% Overrun
Office	328,800,014.20	1,163,853,276.82		**835,053,262.62**	254%
			Variation	167,516,174.54	20%
			Adjustment of PC Sums	62,373,345.55	7%
			Adjustment of Provisional Sums	43,012,185.34	5%
			Re-measurements	360,052,510.00	43%
			Fluctuation	116,881,320.89	14%
			Others	85,217,726.30	10%
Office Buildings Cumulative	**7,571,451,210.72**	**12,586,128,880.89**		**5,014,677,670.17**	**66%**
Hospital	3,364,284,903.00	6,258,838,975.31		**2,894,554,072.31**	86%
			Variation	1,599,961,709.97	55%
			Adjustment of PC Sums	850,000,000.00	29%
			Adjustment of Provisional Sums	91,424,737.51	3%
			Re-measurements	542,520.22	0%
			Fluctuation	352,625,104.60	12%
			Others		0%
Hospital Cumulative	**3,364,284,903.00**	**6,258,838,975.31**		**2,894,554,072.31**	86%
Education Facility	35,693,083.18	64,761,625.84		**29,068,542.66**	81%
			Variation	3,152,520.00	11%
			Adjustment of PC Sums		0%
			Adjustment of Provisional Sums	9,600,000.00	33%
			Re-measurements	800,000.00	3%
			Fluctuation	6,448,866.37	22%
			Others	9,067,156.29	31%

Project Type	Initial Contract Sum (₦)	Final Contract Sum (₦)	Factors	Cost Overrun (₦)	% Overrun
Education Facility	1,490,004,589.00	1,587,800,034.00		**97,795,445.00**	7%
			Variation	10,523,520.00	11%
			Adjustment of PC Sums	4,550,252.00	5%
			Adjustment of Provisional Sums	1,025,362.00	1%
			Re-measurements	74,409,055.00	76%
			Fluctuation	5,235,210.00	5%
			Others	2,052,046.00	2%
Education Facilities Cumulative	**1,525,697,672.18**	**1,652,561,659.84**		**126,863,987.66**	**8%**
Commercial Building	144,337,697.80	241,765,238.95		**97,427,541.15**	67%
			Variation	35,052,350.00	36%
			Adjustment of PC Sums	16,252,082.00	17%
			Adjustment of Provisional Sums	9,782,158.00	10%
			Re-measurements	24,409,055.00	25%
			Fluctuation	4,526,520.00	5%
			Others	7,405,376.14	8%
Commercial Building	34,962,648.80	32,219,674.63		**-2,742,974.17**	-8%
			Variation	-2,742,974.17	100%
			Adjustment of PC Sums		0%
			Adjustment of Provisional Sums		0%
			Re-measurements		0%
			Fluctuation		0%
			Others		0%
Commercial Building	7,867,200.00	13,628,024.33		**5,760,824.33**	73%
			Variation	2,536,540.00	44%

Project Type	Initial Contract Sum (₦)	Final Contract Sum (₦)	Factors	Cost Overrun (₦)	% Overrun
			Adjustment of PC Sums		0%
			Adjustment of Provisional Sums	2,658,421.00	46%
			Re-measurements	565,863.33	10%
			Fluctuation		0%
			Others		0%
Commercial Buildings Cumulative	**187,167,546.60**	**287,612,937.90**		**100,445,391.30**	**54%**
Residential Building	95,975,217.00	171,742,774.84		**75,767,557.84**	79%
			Variation	50,130,317.30	66%
			Adjustment of PC Sums	4,025,251.00	5%
			Adjustment of Provisional Sums	3,526,250.00	5%
			Re-measurements	14,526,250.00	19%
			Fluctuation	1,852,500.00	2%
			Others	1,706,989.54	2%
Residential Building	794,443,000.33	808,430,590.33		**13,987,590.00**	2%
			Variation	6,526,851.00	47%
			Adjustment of PC Sums	2,525,620.00	18%
			Adjustment of Provisional Sums	1,413,109.00	10%
			Re-measurements	3,522,010.00	25%
			Fluctuation		0%
			Others		0%
Residential Buildings Cumulative	**890,418,217.33**	**980,173,365.17**		**89,755,147.84**	**10%**

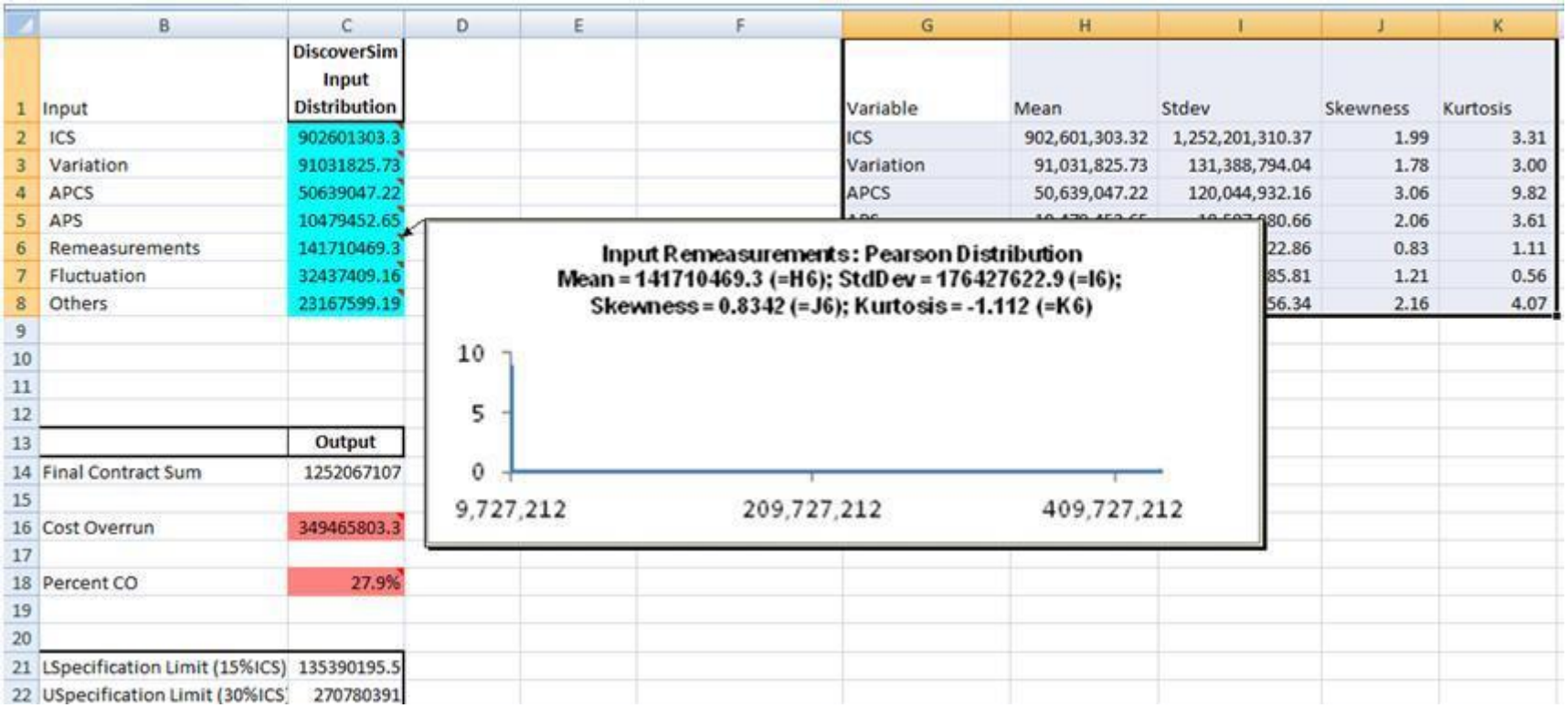
Appendix 2: Descriptive statistics of variables used for simulation modelling of cost overrun

Parametric	Count	Mean	Stdev	95.0% CI Mean	95.0% CI Sigma
Initial Contract Sum	15	902601303.3	1252201310	2.0916E+008 to 1.596E+009	9.1677E+008 to 1.9748E+009
Variation	15	91031825.73	131388794	1.8271E+007 to 1.6379E+008	9.6193E+007 to 2.0721E+008
Ajustment of PC Sums	15	50639047.22	120044932.2	-1.584E+007 to 1.1712E+008	8.7888E+007 to 1.8932E+008
Adjustment of Provisional Sums	15	10479452.65	18587080.66	1.8627E+005 to 2.0773E+007	1.3608E+007 to 2.9314E+007
Remeasurements	15	141710469.3	176427622.9	4.4008E+007 to 2.3941E+008	1.2917E+008 to 2.7824E+008
Fluctuation	15	32437409.16	52195885.81	3.5323E+006 to 6.1343E+007	3.8214E+007 to 8.2318E+007
Others	15	23167599.19	47496156.34	-3.1349E+006 to 4.947E+007	3.4773E+007 to 7.4906E+007
Final Contract Sum	15	1451021055	1757764779	4.776E+008 to 2.4244E+009	1.2869E+009 to 2.7722E+009
Cost Overrun	15	548419751.3	773472337.2	1.2009E+008 to 9.7675E+008	5.6628E+008 to 1.2198E+009

Normality Tests	Anderson-Darling Normality Test	p-value (A-D Test)	Skewness	p-value (Skewness)	Kurtosis	p-value (Kurtosis)
Initial Contract Sum	1.779376449	**0.0001**	1.994328872	**0.0021**	3.3135191	**0.0307**
Variation	1.406888489	**0.0008**	1.782018501	**0.0048**	3.00411044	**0.0410**
Ajustment of PC Sums	3.182993434	**0.0000**	3.061887216	**0.0000**	9.821649619	**0.0003**
Adjustment of Provisional Sums	2.30461526	**0.0000**	2.060730605	**0.0016**	3.613195749	**0.0234**
Remeasurements	1.655949704	**0.0002**	0.834179216	0.1435	-1.112274192	0.2274
Fluctuation	2.80301664	**0.0000**	1.208914437	**0.0410**	-0.560039321	0.6961
Others	3.071566657	**0.0000**	2.155702023	**0.0011**	4.072188835	**0.0156**
Final Contract Sum	1.522473257	**0.0004**	1.982044421	**0.0022**	3.754621638	**0.0206**
Cost Overrun	1.447069585	**0.0006**	2.287087976	**0.0007**	5.908033386	**0.0035**

Non-Parametric	Range	Minimum	25th Percentile (Q1)	50th Percentile (Median)	75th Percentile (Q3)	Maximum
Initial Contract Sum	4195922800	7867200	95975217	328800014.2	983127500	4203790000
Variation	451928038.9	-2742974.17	0	35052350	167516174.5	449185064.7
Ajustment of PC Sums	449714264.6	0	0	0	49700324.5	449714264.6
Adjustment of Provisional Sums	61453833.35	0	0	1025362	9782158	61453833.35
Remeasurements	480208991.8	0	0	73518714.44	350360800	480208991.8
Fluctuation	128365810	0	0	4108500	100005089.4	128365810
Others	158011941.3	0	0	0	9067156.29	158011941.3
Final Contract Sum	6245210951	13628024.33	171742774.8	1162904891	1587800034	6258838975
Cost Overrun	2897297046	-2742974.17	29068542.66	341212670.4	835053262.6	2894554072

Appendix 3: Screen shot of Pearson Distribution curve generated on Excel spread sheet



Appendix 3: Research Interview Questions

The following questions are part of a research which attempts to contribute to knowledge under the M.Sc. research in Quantity Surveying titled **"SIMULATE A MODEL OF COST OVERRUNS IN BUILDING PROJECTS IN NIGERIA"**. This questionnaire is strictly for academic purpose and will be treated with utmost confidentiality. The respondent will be provided with a copy of the research findings if he/she so desires.

1. What is your profession?
2. Have you been involved in construction projects within the last 15 years?
3. Who was the sponsor of these projects? Government or Private?
4. What type of buildings were they?
5. Where there detail designs for these projects?
6. How many of these projects were completed within budget?
7. How many were completed with cost savings?
8. What was the initial project cost?
9. What was the final cost of the project?
10. What were the factors that led to the cost overrun?
11. What measures did you take to avoid these cost overruns?
12. What were the factors that led to cost savings?
13. In your opinion what influenced the occurrence of these factors mentioned above?
14. As a professional in the field, in your view how do you think cost overrun can be minimized or avoided in construction projects in Nigeria?
15. In your opinion, do you think that having a project performance band can be useful in project planning and execution?