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FACTORS AFFECTING COST ESTIMATION IN PLANT INSTALLATION PROJECTS IN KENYA, A CASE OF RICHFIELD ENGINEERING LIMITED

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Abstract

Cost overruns on infrastructure development projects during implementation continue to pose great challenges to developing countries. Research has found that, there are many factors that impede on successful completion of projects on time, budget, and quality. This study seeked to investigate on the factors that significantly contribute to inaccurate cost estimates on plant installation projects implemented by Richfield Engineering Limited and analyse their impact. The four variables were considered as significant in contributing to inaccurate cost estimates, namely; estimator knowledge and experience, scope assumptions, available time and cost models as significant contributors to cost variations.This study reviewed available literature and theories about project cost estimation thus theory of Learning Curve (LC), triple constraint theory, Complexity Theory and S-Curve theory. The descriptive research design was identified as the design of this study. The population of this study was 1000 REL employees and associates working in the area of projects operations and management. The study used a census sampling technique. Primary data was collected using interview and questionnaire and secondary data was collected by reviewing published materials. The data was presented in tables, charts and figures. The study lead to conclusions whether the identified variables and underlying factors contribute to inaccurate cost estimates in plant installation projects in Kenya. The results should enable planners to take stock of past performance and incorporate lessons learned on future projects planning and implementation.

Keywords : Cost estimation, Plant installation , Project, Project Management , Project scope, Project Scope change , Project Scope Management ,Risk, Total estimate cost and Total Project Cost .

Introduction

Brook (1997) defines Estimation as "The technical process of the predicting the cost of construction". In NQF (2007), Estimation is described as "...the process used by the contractor to establish the cost to themselves of carrying out construction works". Estimating is the primary function of the construction industry; the accuracy of cost estimates starting from an early phase of a project through the tender estimate can affect the success or failure of a project. Many failures of construction projects are as a result of cost escalations (Gkritza & Labi, 2008). Cost is one of the primary measures of a project's success. This is true, especially for plant facility construction projects in developing countries, because construction projects in these countries are executed with scarce financial resources. As mentioned by Olawale, this industry contributes to the GDP and employment rate of many nations, and for this reason it is considered vital for the economic development of any nation (Olawale, 2010). Generally, a project is considered successful if the project is completed within a stated cost or budget. The role the plant infrastructure plays in socio-economic development is significant. It provides the basis upon which other sectors can grow by constructing the physical facilities required for the production and distribution of goods and services. The construction industry has a significant multiplier effect on the economy as a whole (Morris, 2006).

Construction and the development of infrastructure are fundamental to economic growth and societal advances. Unfortunately project cost overrun and scope creep are common on infrastructure and construction projects. This applies to both developed countries with highly developed systems in project delivery and developing countries that may have more rudimentary approaches to project delivery. A global survey of the sector spanning twenty countries and five continents found that substantial cost escalation on construction and infrastructure projects is the rule rather than the exception (Flyvbjerg et al. 2003). The survey found average cost escalations of 45% for rail projects, 34% for tunnels and bridges and 20% for roads. Flyberg et al. (2002) found that 90% of construction projects had under-estimated costs and that cost overruns of 50-100% were common. Flyvbjerg (2005) provides a litany of global examples of major project cost overruns. The following are some of these examples. Boston's Central Artery/Tunnel Project went 275% over budget equating to US$11 billion over budget. The Channel tunnel between the UK and France was 80% over budget for construction and 140% over for financing. The Pentagon spy satellite program had a $4 billion cost overrun and the International Space Station had a $5 billion overrun. And the problem is not new. The Suez Canal cost 20 times the original budget and the Sydney Opera House cost 15 times the original estimate.

There is increasing recognition from project clients and financiers that effective project cost management and control requires the use of highly specialised and expert cost management professionals. The problems with project managers, architects, designers, engineers and other professionals undertaking project cost management as simply a subset of their array of activities are becoming increasingly apparent. This presents tremendous opportunities for expert project cost management professionals but also presents many challenges in terms of the global development of the profession, (Arcila, 2012). The construction and infrastructure market is now truly global and major projects are typically undertaken with a range of international participants. This brings together firms and professionals from advanced developed industries and their counterparts from developing industries. This applies equally to project cost management and heightens the importance of the development of global project cost management standards, competencies, education and certification/registration programs, (Arcila, 2012).

In many developing countries, major construction activities account for about 80 percent of the total capital assets, 10 percent of their Gross Domestic Product (GDP), and more than 50 percent of the wealth invested in fixed assets. In addition, the industry provides high employment opportunity, probably next after agriculture (Ofori, 2006). Despite the construction industry's significant contribution to the economy of developing countries and the critical role it plays in those countries development, the performance of the industry still remains generally low (Enshassi, 2008). Studies over the past 20 years reveals a trend of rising cost of construction input resources (Osei-Tutu, 2008) and this trend is expected to continue because the factors responsible for the increased cost trend remain the same. In Africa, the combined prices of labour and materials have increased by 1,229 percent between 1997 and 2010 (Ghana Statistical Services, 2010). According to (Idoko, 2008; & Mwawasi, 2015) many projects in developing countries encounter considerable time and cost overruns, fail to realize their intended benefit or even are totally terminated and abandoned before or after their completion. Moreover, the development of the construction industry in developing countries generally lags far behind from other industries in those countries and their counterparts in developed nations. Generally, the construction industry in developing countries fails to meet expectations of governments, clients and society as a whole (Ofori, 2006; & Jekale, 2004).

In Kenya, major plant facility construction projects have a history of problems; cost overruns, delays, failed procurement, or unavailability of private financing is common, yet most overruns are foreseeable and avoidable with the right legal and institutional frameworks. Researches on construction projects in some developing countries indicate that by the time a project is completed, the actual cost exceeds the original contract price by about 30 percent (Bruland & Mahamid, 2011). Risk is also under-managed in the later stages of plant infrastructure projects, destroying a significant share of their value. Apart from causing budget overruns, it also results in uncertain cost-benefit for decision-making (Jenpanitsub, 2011).

A cost overrun of plant installation projects is one of the most important problems in plant facility construction. Past empirical findings confirm that cost overrun problem is a global phenomenon. Inaccurate project cost estimates can raise the capital-output ratio in the construction sector and elsewhere, bringing down the efficacy of investments (Morris, 2008). In a nutshell, accurate cost estimates are considered the most important element of successful projects, which help to decrease problems for all parties and give new chances to construct other related projects. It also helps to increase the profit margins and development growth of the manufacturing sectors in Kenya. Although, risk in construction has been the object of attention because of time and cost overruns associated with construction projects, few studies have focused on factors leading to inaccurate cost estimates of plant installation projects in Kenya, hence this study.

Statement of the Problem

The aftermath of the global financial crisis (GFC) has introduced stiff competition for jobs in the construction industry (Cong J., Mbachu J. and Domingo N., 2014). Tendering risks are at now at all-time highs, with the popular saying these days that "projects are awarded to the bidders who make the biggest mistakes" (O'Brien *et al*., 2014). This is mainly because of several risks which might not have been accounted for and these risks are compounded by the frequent use of fixed price lump sum contracts; with clients being eager to contest contractors' claims for the variations they ordered (Mbachu, 2011). Inaccurate estimation of the contract price has resulted in the insolvency and liquidations of many contracting firms of all sizes. This is important because it could make or mar the ability of the tenderer to achieve expected profit margin and maintain credibility with the client, which is a condition for future invitations to tender (Cong and Domingo, 2014). Establishing and prioritizing the factors that may influence the final contract price when responding to a call for tenders is therefore crucial for proper risk analysis and reliable construction cost forecasting. In Kenyan plant installation projects, these factors have not been researched; hence contractors rely only on judgement to 'guess-estimate' in their price forecasting (Mbachu, 2011; O'Brien *et al*., 2014).

Richfield Engineering Limited, a multifaceted projects execution & management company operating in Kenya and other East African countries, provides plant installation services in the engineering, infrastructure & process industries. Inaccurate cost estimates have been a major challenge and considered to be the biggest problem which hinders project's progress since it decreases the contractors' profit margin, hence leading to huge losses, leaving the project in a big trouble or the contractor loses on the bid for not offering a competitive price. It is therefore important to contribute to filling the knowledge gap by examining the key influencing factors and their relative levels of influence from the contractor's points of view.

Objective of the Study

The purpose of this study was to analyse the essential factors affecting cost estimation in plant installation projects in Kenya. The study was guide by the following objective

i. To evaluate the effect of contractor knowledge and experience on cost estimation in plant installation projects in Kenya.
ii. To analyze the effect of scope assumptions on cost estimation in plant installation projects in Kenya.
iii. To determine the effect of available time on cost estimation in plant installation projects in Kenya.
iv. To find out the influence of cost models on cost estimation in plant installation projects in Kenya.

Theoretical Review

This study was informed by the following theories; Theory of Learning Curve (TLC), Triple Constraint Theory (TCT), Complexity Theory (CT) and S-Curve Theory. Each of these theories was discussed here below with respect to cost estimation.

Theory of Learning Curve (TLC)

The theory of Learning Curve (LC), sometimes also called 'experience curve' or 'dynamic curve' was first developed by T.P. Wright in 1936, while studying time required to make airplane parts. He observed that, as the workers gained more experience, less time was required to manufacture these parts. This effect was not linear, but seemed to have a constant decrease. To be more precise, he observed that the labor required for producing doubled quantities, decreased by a constant factor in relation to the original quantity.The rate of improvement is referred to as the learning rate and is expressed in terms of the slope of a curve. Contractors can apply it in productivity studies and productivity improvement and for future bidding of similar activities. Owners may utilize this theory in evaluating bids or change orders and subsequently for negotiating prices (Sundaram, 2015).

Cost estimation requires that a project team comes up with a good cost estimation approach taking into consideration the fact that processes may change in due course thus calling for review of the cost budget. One of the cost element that estimators should take into consideration is the additional incremental costs arising from project review.The adjusted amortization model (McNeill, 2003) serves as a good measure of estimating the Marginal Capacity Cost of developer charges when estimating developer charges in plant installation projects. From an economic point of view marginal cost of capital serves as a good measure of evaluating the existing plant infrastructure projects while looking into the prospects of future investments in such facilities. This 'experience curve' theory supports the variable 'contractor experience and knowledge' effect on cost estimation by stating that experience makes repetitive tasks easier to perform and when a particular task or sequence of work is repeated without interruption, subsequent operations require reduced time and effort.

Triple Constraint Theory (TCT)

The triple constraint theory or project management triangle (pmt) involves Scope, Time and Cost. Time refers to the actual time required to produce a deliverable, which in this case, would be the end result of the project. Naturally, the amount of time required to produce the deliverable will be directly related to the amount of requirements that are part of the end result (scope) along with the amount of resources allocated to the project (cost).Cost is the estimation of the amount of money that will be required to complete the project. Cost, in itself encompasses various things, such as: resources, labor rates for contractors, risk estimates, bills of materials, et cetera. All aspects of the project that have a monetary component are made part of the overall cost structure. Scope is the functional elements that, when completed, make up the end deliverable for the project. The scope itself is generally identified up front so as to give the project the best chance of success. Although scope can potentially change during the project life-cycle, a concept known as 'scope creep', the common success measure for the scope aspect of a project is its inherent quality upon delivery.

The Triple Constraint, being a triangle, one cannot adjust or alter one side of it without in effect, altering the other sides. So for example, if there is a request for a scope change midway through the execution of the project, the other two attributes (cost and time) will be affected in some manner. How much or how little is dictated by the nature and complexity of the scope change. The limited information available at the early stages of a plant installation project may mean the cost estimator must make assumptions about the scope of the project, which may not eventuate as project design, planning and construction evolve. This theory supports the variable 'scope assumptions' effect on cost estimation by stating that naturally, the amount of time required to produce the deliverable will be directly related to the amount of requirements that are part of the end result (scope) along with the amount of resources allocated to the project (cost), hance an assumption on the scope directly affects the cost estimate incase of scope change.

The Complexity Theory (CT)

The complexity theory where a prominent author in the field of complexity Terry Williams, shares the view of other scholars on complexity, but extends it by one additional dimension of cost estimates. In addition to the two components of complexity, vis-àvis the number of factors and the interdependency of these factors, he introduces the third factor which is uncertainty. Since uncertainty adds to the complexity of a project, cost estimates therefore can be viewed as a constituent dimension of project complexity that can be as a result of various factors (Williams, 2008). Projects occasionally demand for more additional funds as there is an increasing desire to reduce time to market thus affecting the cost estimates of the project (Williams, 2008). Kahane on the other hand puts a lot of emphasis on talking and listening to each other when solving tough problems when developing estimate costs. His approach to complexity is deeply rooted in a social environment. He distinguishes complexity in three ways. One of ways is Dynamic Complexity which means that the cause and effect are far apart and it is hard to grasp from firsthand experience. They usually unfold in unpredictable and unfamiliar ways emanating especially from cost related issues such as design variations (Kahane, 2004). Companies undertaking plant infrastructure projects where complexities revolving around cost estimates arise, seek to explore transformation programs aimed at identifying a cost-benefit model that integrates unit costs in the cumulative costs. This theory supports the variable 'available time' on cost estimation by stating that cost estimates can be viewed as a constituent dimension of project complexity that can be as a result of various factors hance adequate costing time is required.

S - Curve Theory

An S-Curve is a sigmoid function, that is a mathematical process or function that results in a S shaped curve also called a Sigmoid Curve. The S-Curve is used in project management as a means of representing the various expenditures of resources over the projected time of the project or as a means of charting the real-time expenditure of resources. This is important to project management in that it can be used to monitor the project as is progresses and compare it to the projected S-Curve to determine whether or the project is being completed within the time and budget limitations. These resources might be the cumulative cost of the project, the number of man hours required at any given stage in the project, the expenditure of raw materials for construction or assembly, etc. The term S-Curve can also be used to indicate an S shaped chart resulting from a cumulative likelihood distribution. In this function, an S-Curve is a tool of quantitative risk analysis which project management would use to determine the possible dangers of any given course of action.

S-curve modelling in early phases of construction projects, where the methodological procedure for forecasting cost distribution over time is given for the project realization phase using cost S-curves for three different types of structures: building, tunnel, and motorway. Three different approaches are used, and their results are correlated and presented in form of mathematical regression expressions and appropriate diagrams. The proposed methodology can be used for cost estimation in plant installation projects, specially in the earliest phase in which detailed information about the project is scarce. This theory supports the variable 'cost model' effect on cost estimation by stating how the S-Curve cost model is used as a means of representing the various expenditures of resources over the projected time of the project.

Conceptual framework

This study seeked to analyse the essential factors affecting cost estimation in plant installation projects in Kenya. Bogdan & Biklen (2003) elucidates conceptual framework as a basic structure that represents the observational and analytical aspects of a system, laying out the conceived interconnection of variables. Informed by the relevant fields of enquiry, broad ideas and principles are used to structure a visual representation showing the expected relationship between variables where the dependent variable responds to the independent variable. The independent variables were contractor experience and knowledge, scope assumptions, time & cost model and the dependent variable was cost estimation.

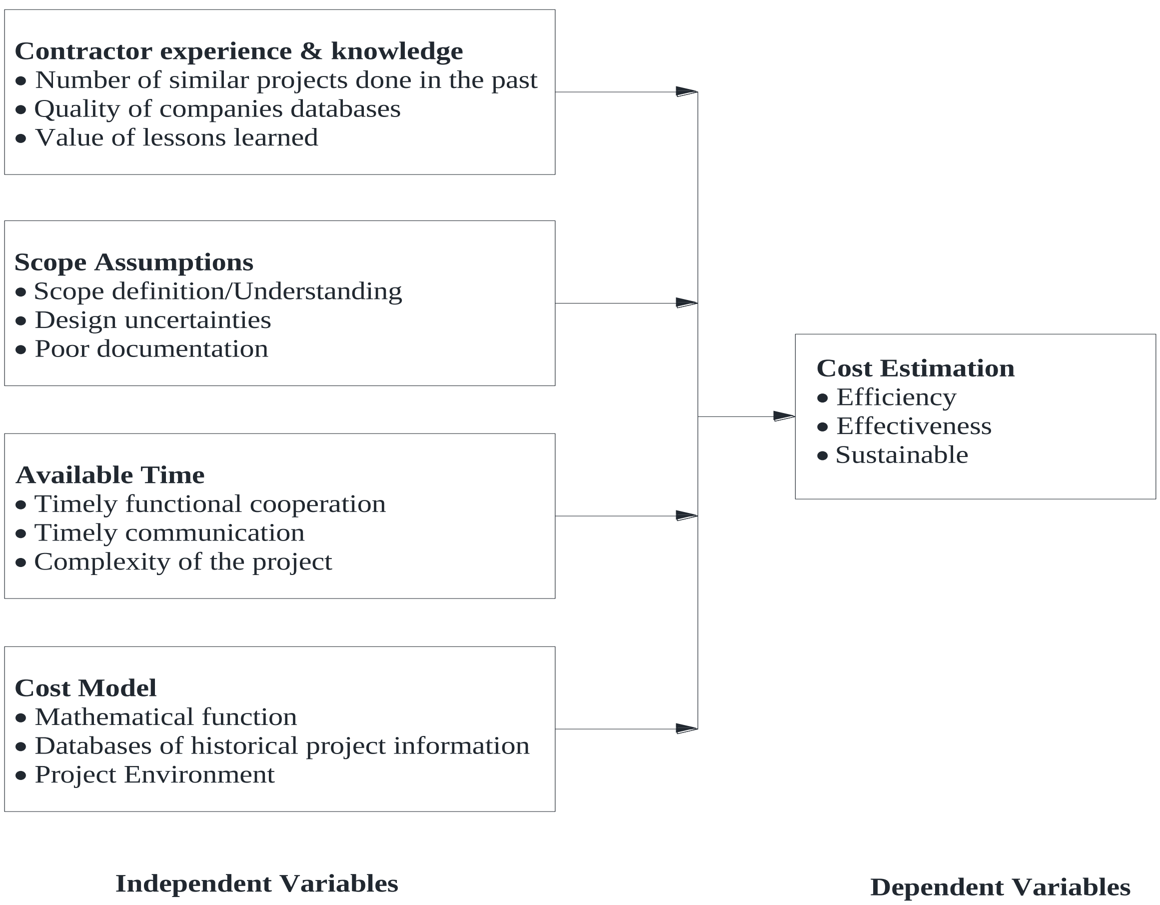

Figure 1: **Conceptual framework**

Summary of literature

In the construction industry worldwide, failure to achieve accurate cost estimates is prevalent especially during the implementation of the construction projects. Although there have been improvements in the management of construction projects over the years, the problem of cost escalation is still a critical issue in the construction industry. Inaccurate cost estimates is a phenomenon that if given attention can play a key role in reducing the occurrence of cost escalation. However, past research has established that accurate cost estimates has never been achieved in most construction projects especially in plant infrastructures, hence leading to a negative impact on the cost estimates of the relevant projects.

The study seeked to objectively solve the problem of inaccurate cost estimates in plant infrastructure projects undertaken by REL and suggest how such occurrences can be reduced through the employment of identified factors that determine the success. The objective of the study was to examine the factors that affect cost estimation in the implementation of plant infrastructure construction projects by REL. By considering these factors and the implementing the recommendations that were raised by this study, the stakeholders will be enabled to stick to the pre-determined cost estimates thus easing the burden that would have been placed on the stakeholders. This research carried out a literature review which helped in establishing factors affecting cost estimation in plant infrastructure projects. The methodology used was a census survey of the REL employees, surveyors, consultants, and sub contactors who were actively working for/with and on behalf of the REL. The study seeked the significant relationship between contractor experience and knowledge, scope assumptions, available time and cost models to cost estimation in plant installation projects in Kenya.

Research Gaps

The study only focused on four principal factors considered affecting the accuracy of cost estimation in plant infrastructure construction projects in Kenya thus contractor knowledge and experience, scope assumptions, available time and cost models. The theoretical and the empirical literature gave a comparative and a theoretical review of the major activities that have been undertaken to analyse the factors considered affecting the accuracy of cost estimation in construction projects. However, the explored past studies and the theoretical issues have not addressed the major factors affecting cost estimation in plant installation projects in Kenya and this indicates that both the empirical and the theoretical literature were of little assistance towards providing an effective solution to embracing accurate cost estimation in the plant infra-structure construction projects in Kenya. Application of effective cost estimation practices that increase performances of contractors remain core critical issue that should be dealt with, this study provided appropriate recommendations on challenges facing cost estimation in plant installation projects in kenya. While the present assessment has contributed to the understanding of these factors, further analysis in some areas is required to ensure the cost estimation performance is addressed adequately.

Research Methodology

The study adopted a descriptive survey design as it aims at collecting information from respondents on factors affecting cost estimation in plant infrastructure construction projects at REL. In this study target population was 1000 REL employees and associates, the population targeted comprised of REL employees, Surveyors, Consultants and Sub Contractors in Kenya. REL was considered as the case study due to proximity to the study, time available for research and budgetary constraints. They advise that a researcher sample size of 10% to be appropriate as long as the sample size is more than 30, (n > 30). Therefore our sample size will be 100.

Table 1: Sampling frame

Category	Total number	Number in samples
REL Employees	300	30
Surveyors	240	24
Sub Contractors	320	32
Consultants	140	14
Total	1000	100

Primary data was collected using structured questionnaires, used in varius previous research projects (Lumpikin & Dess, 2001), which was self-administered to the target population. The instrument was used because it covers a large number of respondents at a relatively shorter period of time. In addition, it gave the respondents the privacy to give free and independent opinions because of absence of the researcher. The study used both primary and secondary data. Structured questionnaires were used to collect primary data from respondents. Self-administered questionnaires were administered to the respondents. The purpose of pilot testing aims to establish the validity and reliability of the research instruments and hence enhance face validity (Cooper & Schindler, 2006). Data analysis pertains to examining, categorizing, tabulating, testing or otherwise recombining both quantitative and qualitative evidence to address the research question(s). The data collected was analyzed using qualitative and quantitative techniques. The qualitative data was analyzed by describing, structuring, categorizing, and combining into relevant themes. The data was then be presented using tables and various figures (bar graphs, pie charts, curves etc) generated through a computer's Microsoft spreadsheet for easy understanding and interpretation of the readers and other consumers of this research. Quantitative data collected was analyzed by descriptive statistics, whereby percentages, tables, pie charts and descriptive statistics were conducted through a survey whose aim was only to describe the main variables on the factors that affect cost estimation in plant installation project. Inferentially using Correlation to show the relationship between independent and dependent variables and ranges from -1 to +1, multiple regression model on SPSS Version 22 to determine the (R^2) magnitude of the relationship that exist between independent variables and dependent variable thus percentage change in the dependent variable can be accounted for by unit change in the independent variable and ANOVA to determine the comparable groups for the experimental and control sections. Tables were used to summarize responses for further analysis and facilitate comparison. The findings were presented using tables and charts.

Results And Discussion

Out of 100 questionnaires (30 for REL employees, 24 for Surveyors, 32 for sub contractors and 14 for consultants), 86 questionnaires (22 from REL employees, 18 from Surveyors, 32 from sub contractors and 14 from consultants), were filled and returned .This constitutes an overwhelming (86 %) response rate which is considered adequate for this study. In fact, most of the researcher and scholars consider (70%) response rate as adequate for descriptive research. This was in agreement with Graham (2012) that a response rate above 30 to 50% of the total sample size contributes towards gathering of sufficient data that could be generalized to represent the opinions of respondents in the target population on the sought study problem. The recorded high response rate can be attributed to the data collection procedures.

A pilot test was conducted on a sample of ten respondents drawn from Richfield Engineering Limited that was not included in the final study sample. The objective of the pilot study was to test the validity, and reliability of the data collection instruments. Cooper & Schindler (2011) explain that pilot test is conducted to detect weaknesses in design, instrumentation and to provide proxy data for selection of probability sample, that is, reliability and validity. The results of the test was also used to refine the questionnaire to ensure respondents didn't have problems in answering the questionnaire and that there were no problems in recording the responses**.** Reliability analysis was used to assess the internal consistency of the questionnaire for purposes of identifying those items in the questionnaire with low correlations in order to exclude them from further analysis. Through a pilot study on 10 respondents from Richfield Engineering Limited, the study established the reliability of the instruments. In general, a Cronbach's alpha value of 0.70 or higher is considered to be acceptable (Sekaran, 2009). Cooper and Schindler (2006) accept an alpha of 0.8 while Mugenda and Mugenda (2008) noted that an alpha of 0.6 to be poor. A commonly accepted rule of thumb for describing internal consistency using Cronbach's alpha is as follows.

However, a greater number of items in the test can artificially inflate the value of alpha and a sample with a narrow range can deflate it, so this rule of thumb should be used with caution. The reliability of the questionnaire was tested using the Cronbach's Alpha correlation coefficient with the aid of SPSS software. Reliability analysis for the constructs of the variables yielded a Cronbach alpha statistics of more than 0.7 implying that the data collection instruments were reliable. As shown in Table 3 Cronbach alpha values for all the variables; Contractor Knowledge and Experience, Scope Assumptions , Available Time, Time Model and Cost Estimation were all greater than 0.7. From these findings it can be concluded that the constructs measured have the adequate reliability for the subsequent stages of analysis since all the Cronbach Alpha values were greater than 0.7.

Table 2: Cronbach Alpha for Reliability Assessments

Variables	Cronbach's Alpha Values	Comments
Contractor Knowledge and Experience	0.710	Accepted
Scope assumptions	0.833	Accepted
Available time	0.701	Accepted
Cost model	0.854	Accepted
Cost Estimation	0.823	Accepted

Validity tests involve ascertaining the accuracy of the instrument by establishing whether the instrument focuses on the information they are intended to collect (Zakimund, 2010). Face validity refers to what the instruments superficially appears to measure, it assesses whether the test "looks valid" to the examinees who take it, the administrative personnel who decide on its use, and other technically untrained observers (Bryman & Bell, 2007). In order to ascertain face validity, the instruments were constructed and passed over to senior scholars for constructive criticism. Thereafter they were revised according to their comments. Content validity was achieved by subjecting the data collection instruments to an evaluation by a group of five Engineering experts who provided their comments on the relevance of each item on the instruments. The experts were required to indicate whether the item was relevant or not. The results of their responses were analyzed to establish the percentage representation using the content validity index. From Table 4 the validity of test yielded an average validity index score of 84%. This implied that the instrument was valid as emphasized by Amin (2005).

Correlations

Pearson correlation analysis was used to measure the linear relationship between two or more study variables. The value of Pearson correlation ranges between -1 and +1, with -1 indicating negative correlation, 0 indicating no correlation and +1 indicating positive correlation between the variables. Besides, the closer the value is to +1, the stronger the relationship between the variables (Berthold et al., 2010).

Contractor knowledge and experience

According to table 3, Contractor knowledge and experience and cost estimation have a significant positive correlation of 0.895 at the 0.01 significant level in plant installation projects. The results are in agreement with (Choge & Muturi, 2014) who 's study revealed that experience is a significant factor to adherence to cost estimates. At pre-qualification stage, the study established that contractors past experience in similar assignments and environment coupled with the entire team is among the parameters used in qualifying the contractors invited to bid for works.

Scope assumptions

Table 3 shows that scope assumption and cost estimation have a significant negative correlation of - 0.933 at the 0.01 significant level in plant installation projects. Increased scope assumptions negatively affects cost estimation in plant installation projects. Scope assumptions leads to under estimating or over estimating the cost. The results are in agreement with Fageha & Aibinu (2013) who indicated that adequate front-end project planning with clear project scope definition can alleviate the potential for cost overrun; inadequate project planning and poor scope definition can lead to expensive changes, delays, rework, cost overruns, schedule overruns, and project failure.

Available time

Table 3, depicts that available time and cost estimation have a significant positive correlation of 0.963 at 0.01 significant level in plant installation projects. These findings concurred with the findings Bryan (1991) who explains that entire process of estimating a project is always time consuming and often tedious. The Estimator is main character of the whole estimation process. The Estimator receives the contract drawings, specification and appropriate bill of quantities and starts work in the given limited time frame.

Cost model

According to Table 3, cost model and cost estimation have a significant positive correlation of 0.941 at 0.01 significant level in plant installation projects. The results are in agreement with Bubshait and Al-Juwairah (2002) who stated that cost models are a major determinant of project cost estimation and may cause a project to stall if not appropriately put in place.

Table 3: Correlation Analysis

		CE	CK&E	SA	AT	CM
CE	Pearson Correlation	1	.895**	-0.933**	.963**	.941**
	Sig.(2-tailed)	0.000	0.000	0.000	.000	0.000
	N	100	100	100	100	100
CK&E	Pearson Correlation	0.895**	1	0.909**	0.862**	0.819**
	Sig.(2-tailed)	0.000		0.000	0.000	0.000
	N	100	100	100	100	100
SA	Pearson Correlation	-0.933**	0.909**	1	0.893**	0.894**
	Sig.(2-tailed)	0.000	0.000		0.000	0.000
	N	100	100	100	100	100
AT	Pearson Correlation	0.963**	0.862**	0.893**	1	0.934**
	Sig.(2-tailed)	0.000	0.000	0.000		0.000
	N	100	100	100	100	100
CM	Pearson Correlation	0.941**	0.819**	0.894**	0.934**	1
	Sig.(2-tailed)	0.000	0.000	0.000	0.000	
	N	100	100	100	100	100
CE	Pearson Correlation	1	0.895**	-0.933**	.963**	0.941**

**. Correlation is significant at the 0.01 level (2-tailed).

Regression Analysis

The study further carried out regression analysis to establish the statistical significance relationship between the independent variables notably, (X1) Contractor's knowledge and experience, (X2) scope assumptions, (X3) available time and (X4) cost models as the major factors influencing cost estimation and dependent variables (Y) cost estimation in plant installation in Kenya.

For this model, cost estimation in plant installation projects in Kenya was used as the dependent variable (Y) and independent variables included (X_1) Contrator knowledge and experience, (X_2) scope assumptions (X_3) available time and (X_4) cost models The relationships between the dependent variable and independent variables, and the results of testing significance of the model were also respectively interpreted. In interpreting the results of multiple regression analysis, the three major elements considered were: the coefficient of multiple determinations, the standard error of estimate and the regression coefficients. R squared was used to check how well the model fitted the data. R squared is the proportion of variation in the dependent variable explained by the regression model. These elements and the results of multiple regression analysis were presented and interpreted accordingly in Tables 4, 5 and 6.

From the findings of the study it shows that the regression model coefficient of determination (R2) is 0.971 and R is 0.943 at 0.05 significance level. This is an indication that the four independent variables notably; Contractor knowledge and experience, scope assumptions, available time and cost models were significant in contributing to cost estimation in plant installation projects in Kenya. This indicates that 94.3% of the variation on cost estimation in plant installation in Kenya is influenced by independent variables (X_1) Contractor knowledge and experience, (X_2) scope assumptions (X_3) available time and (X_4) cost models. This implies that there exists a strong positive relationship between independent variables and cost estimation in plant installation projects in Kenya. The remaining 6.1% of the variation on cost estimation in plant installation projects in Kenya can be explained by other variables not included in the model. This shows that the model has a good fit since the value is above 75%. This concurred with Graham (2002) that (R2) is always between 0 and 100%: 0% indicates that the model explains none of the variability of the response data around its mean and100% indicates that the model explains all the variability of the response data around its mean. In general, the higher the (R2) the better the model fits the data.

Table 4: Regression Model Summary

Model	R	R Square	Adjusted R squared	Std error of the Estimate
1	.971	.943	0.943	6.17566

Predictors: (Constant), X1, X2, X3, X4

The study further used one way Analysis of Variance (ANOVA) in order to test the significance of the overall regression model. Green & Salkind (2003) posits that one way Analysis of Variance helps in determining the significant relationship between the research variables. Table 4.20 hence shows the regression and residual (or error) sums of squares. The variance of the residuals (or errors) is the value of the mean square which is 2.280. The predictors X1, X2, X3 and X4 represent the independent variables notably; (X_1) Contractor knowledge and experience, (X_2) scope assumptions (X_3) available time and (X_4) cost models as the major factors influencing success of cost estimation in plant installation projects in Kenya.

Table 6presents the results of ANOVA test which reveal that all the independent variables notably; (X_1) Contractor knowledge and experience, (X_2) scope assumptions (X_3) available time and (X_4) cost models have a significance influence on cost estimation in plant installation projects in Kenya.. Since the P value is actual 0.00 which is less than 5% level of significance. Table 4.20 also indicates that the high value of F (84.353) with significant level of 0.00 is large enough to conclude that all the independent variables significantly cost estimation in plant installation projects in Kenya.

Table 5: Analysis of Variance (ANOVA)

Model		Sum of Squares	Df	Mean Square	F	P-Value.
1	Regression	9.119	4	2.280	84.351	.000
	Residual	1.000	51	.027		
	Total	10.119	55			

Table 7 presents the results of the test of beta coefficients which indicates that the significant relationship between independent variables notably; (X_1) Contractors knowledge and experience. Coefficient of 0.898 was found to be positive at significant level of 0.001 and this indicates that contractor's knowledge and experience has a positive influence on cost estimation. (X_2) scope assumptions coefficient of 0.544 was found to be positive at significant level of 0.004 and this indicates that scope assumptions has a positive influence on project cost estimation. (X_3) available time coefficient of 0.644 was found to be positive at significant level of 0.003 and this indicates that available time has a positive influence on cost estimation. (X_4) cost model coefficient of 0.787 was found to be positive at significant level of 0.002 and this indicates that contractor cost model has a positive influence on project cost estimation. This clearly demonstrates that all the independent variables significantly influenced cost estimation in plant installation projects in Kenya although the relative importance of each independent variable was different. However, since the significance values were less than 0.005, all the coefficients were significant and thus the regression equation was;

$$Y= 217 + 898X_1 +787X_2 + 644X_3 +544X_4 + \varepsilon$$

Table 6: Coefficients

	B- Coefficients	Std. Error	Sig F
(Constant)	0.217	.211	.005
Scope Assumption	0.898	.184	.001
Cost Model	0.787	.184	.002
Available Time	0.644	.170	.003
Contractor Knowledge and Experience	0.544	.168	.004

Dependent Variable Y

The regression model above has established that taking all the independent variables into account notably; (X_1) scope assumptions, (X_2) cost model (X_3) available time and (X_4) Contractor knowledge and experience constant at Zero influences project cost estimation (0.217). The results presented also shows that taking all other independent variables at zero, a unit decrease in scope assumption leads to a 0.898 increase in success of cost estimation; a unit increase in cost model leads to 0.544 increase in success of cost estimation ; a unit increase in available time leads to 0.644 increase in success of cost estimation and a unit increase in Contractor knowledge and experience leads to 0.787 increase in success of cost estimation Inferences can therefore be made that scope assumption followed by contractor knowledge and experience, available time and cost model influences success of cost estimation in plant installation projects in Kenya.

Conclusion

The study found that contractor's knowledge and experience has a direct and positive influence on cost estimation in plant installation projects in Kenya. The greater the levels of contractor's knowledge and experience increases the confidence levels of estimators, consequently impacting positively on their ability to give a precise cost estimate. The number of similar projects done in the past was found to give the estimator an edge when carrying out cost estimation on current plant infrastructure projects based on past experience. High quality of past similar projects databases was observed to enhance the accurancy of the cost estimate given the data can easily be accessed and references made on costing.

The lessons learnt in previous plant infrastructure projects was observed to greatly enhance the accuracy of the cost estimate since it facilitates continous improvement in the process by avoiding a repeat of the same mistakes done in the past on similar projects. Akintoye and Fitzgerald (2000) in their study about UK current cost estimation practices reported that the standard estimation procedure is a widely used method in construction companies, followed by comparison of similar project completed by the company and with the help of personnel experience on similar projects.

This is same as traditional method of estimating, where the cost of construction items prepared based on (labour, plant, material, subcontractor, and preliminary) on top of it overhead and profit added. Even though, Contractor always follows a systematic process for cost estimating for construction project, but the ratio of research for the cost estimating practice is very less within specialized Contractors (Al-Hasan *et al,* 2005).

The Study also established that scope assumptions negatively impacts cost estimation in plant infrastructure projects in kenya. The pressure to submit the offer to clients by the contractor the soonest time possible makes the contractor to make assumptions in the course of the cost estimation thus risking under estimating or over estimating. Scope definition directs impacts the cost estimation process since a well defined and understood plant infrastructure project scope eliminates assumptions therefore a more precise estimate can be obtained. Design uncertainities in the projects directly influences the cost estimation since the contractor could settle for a design option which is not acceptable by the client bringing in cost implications to the parties involved later in the project. Design change always has an adverse effect on the cost of the project therefore a clear design instruction from the client in Bill of materials or technical drawings avoids assumptions in cost estimation. The quality of tender documents has an impact on cost estimation given misleading or conflicting information in the documents results in inaccurate cost estimates.

The study further established that available time for costing positively impacts cost estimation in plant infrastructure projects. Timely functional cooperation adversely affects cost estimations since one function may run ahead and make its decisions locking in cost estimates before a comprehensive assessment of the project could be completed leaving out critical elements of the project. Timely communication between contractor and supplier or client has a direct influence on the cost estimates since the contractor relys on the client to give all the requirements in time and the supplier to give their offers for the required materials/equipment and delivery schedule in good time for them to work on their cost estimates and give their offer to the client. The complexity of the project affects cost estimation since more complex projects require more time to carry out the costing. Fitzgerald (2000) found out, not providing enough estimating time will cause estimators to miss out on critical cost components. For instance, details of site drawings and specifications could be easily ignored, which can cause errors in estimating.

The study found that cost model impacts cost estimation in plant infrastructure projects since every project is unique with a varying project environment. The cost models are designed based on proven mathematical functions and data from previous similar projects. The quality of databases of previous projects and proven mathematical functions based on project environment directly affects the cost estimations. On development of cost models, generally the infrastructure projects do not present dramatically different issues in cost estimations (Barger, 2014).

Recommendation of the study

The following recommendations were made based on the findings and conclusions of the study: Since the result showed that contractor's knowledge and experience, available time, scope assumption and cost model played a critical role on cost estimation in plant installation projects in Kenya.

Contractor knowledge and experience was found to have an adverse effect on cost estimations in plant infra-structure projects thus the number of similar projects done in the past, quality of past projects databases and value of lessons learned. Therefore the contractor should specialize in plant infrastructure projects to have an edge in terms of experience on those types of projects, hance enhance the experience and knowledge in plant installation projects. Having a good number of similar projects done in the past hance an area of specialization, the contractor should have a quality past projects database to make maximum use of data from past similar projects when carrying out cost estimations for current jobs.

The value of lessons learned from previous plant infrastructure projects is very cruisal in cost estimations. Mistakes done on cost estimations in previous plant infrastructure projects should be well documented and lessons learnt drawn not to be repeated. The contractor should put in place the kaizen policy thus continous improvement thus making use of lessons learnt for improvement in cost estimation. Project managers and other stakeholders in the construction industry should consider the knowledge and experience an estimator has on the industry . Estimators' past work experience should also be considered during the hiring process.

Scope assumptions are a great risk to project cost estimations and as such should be avoided to avoid major project risks. The project scope should be very clear and understood by the contractor before working on the costing. The Contractor should request for a clear scope of works from the client or prepare a scope check list to be approved by the client before working on the cost estimations to give a more precise cost estimate. For cases of design uncertainities the contractor should get clear design instructions from the client or propose the various design alternatives to the client for them to settle on one of the options before embarking on cost estimates. This will avoid over estimating thus losing the job or under estimating thus suffering losses.

The contractor should ensure that they have proper documentation from the client to be in a position to give a more precise cost estimate. The contractor should assist the client where necessary to come up with proper documents to facilitate cost estimation such as Bill of Materials (BOQ), technical site drawings, Scope of works etc. The scope control policy already in place should be made more effective. Adequate time should be well considered when committing to the client on timelines to submit the costings to give the estimator enough time to do a proper cost estimate but not rushed into locking the cost estimate before a comprehensive assessment of the project could be completed, thus missing critical elements of scope. Currently there is no policy or Policy statement on adequate costing time, it should be put in place. There is need to put up such a structure in place so as to ensure success of cost estimation.

The contractor should ensure timely functional cooperation of the various functions involved in cost estimation to avoid one function running ahead and making its decisions locking in cost estimates before a comprehensive assessment of the project could be completed thus assumptions are made, negatively affecting the cost estimates. Timely communication between the contractor & client and between contractor & materials/equipment suppliers is a very important element to be considered when carrying out cost estimation, this will give the estimator adequate time to carry out a more precise cost estimation based on the right information and not assumptions or guessing. The contractor should allocate more time for costing more complex plant infrastructure projects to avoid assumptions and missing out of critical elements of scope. Cost models should not be underestimated. A contractor should choose the best suited model for each and every project as each project is unique and hence different model requirements. The project environment should be considered when modeling the cost of the plant infrastructure project since different project environment have different cost implications. The contractor should ensure that the models are designed based on proved mathematical functions and high quality previous projects databases to attain more efficient cost model. The cost models should be contiously be measured to ensure they give accurate cost estimate.

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