MODELING THE RELATIONSHIP BETWEEN THE INITIAL TENDER SUM, DURATION AND FINAL CONSTRUCTION COST OF BUILDING PROJECTS IN NIGERIA: A PROPOSED STUDY

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Abstract
Cost and time overruns have instituted a high level of discredit and stigmatization on the construction industry professionals. This is an issue that should task built environment practitioners. While accepting the challenges of project overruns as emerging negative trend in construction industries, the aim here is to propose solutions to the problems by investigating the variability, with a view of relating all the variables together in a single equation. The derived relationship is intended for use in constructing final cost predictive models or charts for building constructions. The objectives include; studying 420 completed buildings and extracting the variables, plotting graphs of costs against times, to establish a relationship. In addition, 1050 project officers shall be interviewed across Nigeria's six geo-political zones and Abuja the federal capital territory to source for other data to complement those from files. Artificial Neural Network system shall be used for analysis leading to the models/charts design. The derived models/charts would serve as formulae/graphs for predicting future cost of building projects. The research outcome shall be a solution to the growing negative trend of wide variability between the targeted and those achieved. The models/charts shall be tools for construction planning and cash flow projections. This invariably shall be instruments for reducing building project abandonments which major reason has been sudden upsurge in construction funds requirement.

Keywords: Cost, Modeling, Predictive, Relationship, Variability

1 Introduction

Tender sum is the estimated cost of building project at the conclusion of tender meetings and award. In all systems of contract, the as-built cost (final cost) is always determined at completion stage (Hammad *et al.*, 2008). The only exception is fixed or firm price contract for which the initial tender sums cannot be altered; i.e., the final construction cost remain same althrough the project stages. Construction cost overrun is a major problem faced by the industry globally and it needs serious attention to alleviate (Rahman *et al.*, 2013). Otunola (2008) and Rowland (1981) in Vidalis and Najafi (2002) explain cost and time overruns as the excess amount of money/time over the original contract sum/time. They negate the projected budgets, and account for numerous abandoned projects that litter parts of the world (Hachney, 1997 in Otunola, 2008: and Amusan *et al.*, 2013b). Variables like material price inflation, work additions and subtractions, changes in policy and fiscal measures, corruption (kickbacks), etc. usually come to play during project execution. Otunola (2008) grouped these variables into ten and ranked them in order of severity in Nigeria construction industry, inflation ranked highest while underpricing the bills of quantities is least. Rahman *et al.*, (2013) ranked contractor's poor site management highest among the factors in Malaysia. Ugulu & Ikwuogu (2011) affirmed that as the project takes longer to complete, effects of fluctuation are more pronounced especially in an unpredictable and inflationary economy like Nigeria's. They also affirmed that bigger and more complex building projects attract more variations. Managing these variables so as not to have wide deviations from the planned, becomes a major activity of the contractual parties. Inability to manage the project to equate tender sum with final cost voids a major objective of cost control. Since changes in the initial and final figures are not limited to one project, or to one nation, relationship seems to exist between the variables which are: final cost of construction, extensions, resources' price galloping, work changes, daywork, provisional and prime cost sums inadequacies, corruption; etc.

1.1 The Research Gap

Gonzalex (2007) investigated the possibility of using fuzzy mathematical models for construction project scheduling; the results are relevant practically to the construction industry. Analysis of Amusan *et al.,* (2013b) presents preliminary validation of prospect of obtaining a model that would predict building construction cost with minimum error, this also demonstrates the applicability of neural network in forecasting the cost of building work. The NIOB (2002) attributed among others the causes of time and cost overruns in Nigeria to the consequence of not engaging the services of professional builders at the design stages or not early enough even when engaged. The professional institution advocates the engagement of Builders who use Building Production Management Document (Construction Methodology Statement/Construction Plan) to nip in the bud the current trend of time and cost variability. NIOB (2002) document went further to stress that construction programmes hitherto used on Nigerian sites are either too long or short for the projects. This is also the view of Aiyetan *et al* (2012) in South African construction industry, the authors described the targeted completion times as always inaccurate. The conclusion of the NIOB is that they are inaccurate because they are not always prepared by professional builders. Could it be said, all over the world, that construction programmes are prepared by quacks, since the Institute says non-professional builders who prepare programmes are into quackery? Solutions hitherto proffered for solving the variability issue and cost control had not provided cost predictive formulae or charts for construction project as envisaged in this work. The gap of unavailable mathematical formulae or charts for cost prediction at commencement stage is yet to be filled in the building construction industry i.e., cost variability seems **not** to have been reasonably dealt with from several research findings across the globe such as (Azis, *et al.* 2013; Bamile, 2004; Edwards, 2009; Gandu, 2014; Idoro, 2012 and Odeyinka, *et al.* 2012). A number of scholars had worked on issues of time and cost overruns including Odediran and Windapo (2014), the focuses were on the causes. Moreover, time and cost variability are studied separately. This work intends to fill this gap in the construction industries particularly in Nigeria.

1.2 Aim and Objectives

The research seeks to assess the relationship between the tender sum, initial contract duration, extensions and final construction duration/cost of building projects in Nigeria with a specific objective of generating final cost predictive models or charts. The objectives therefore shall be to;

- **(i)** Investigate the average percentage time and cost variability for building projects.
- **(ii)** Survey a sample of completed building projects and extract the contract durations, tender, additional costs/times in course of construction and final construction time and

cost, plot graphs of the cost against duration and hence, the angles of inclination to the horizontals.

(iii) Establish the mean of all the angles of inclination to the horizontals (α), test for any relationship between the variables by the use of regression analysis.

(iv) Build final cost predictive model(s) or chart(s) from the relationship.

(v) Test the models for reliability.

1.3 The Research Questions

Questions to be answered in this work are:

(i) What is currently the average percentage time and cost variability for building projects in Nigeria? Analysis of variance (ANOVA) is most suitable among the available statistical tools for answering this question.

(ii) What is the relationship between the tender sum, the intervening variables of time and cost; with respect to final construction duration and cost of building projects i.e. is there a trend? This can be answered with the use of Regression Analysis.

(iii) What mathematical formulae (models)could be developed from the trend for use in predicting final construction cost of projects with respect to the initial tender sum, the intervening costs and time extensions, project initial completion target date and final durations? Artificial Neural Network (ANN) is a most suitable tool for exploring the possibility.

(iv) What charts could be developed from the trend that would serve as tools for predicting final cost of building projects from the tender sums and other variables? Artificial Neural Network (ANN) is also most suitable tool for exploring the possibility.

According to Morenikeji (2006) model specification as a process of identifying and operationalising suspected variables that best explain the phenomenon being modeled. Keeling and Rohani (2008) numerous scientific computer packages permit quite sophisticated modeling, such as Mathematica, Maple R, MathCAD, and Matlab. Given (t tan α) as the *mean* from a number (n) of past projects a relationship is therefore established (see equation 5), cost predictive model which this research is proposing could be derived by operating on equation 6.

$$FCC_{tn} = ICS_{t0} + \sum(ADC_{t1} + ADC_{t2} + ADC_{t3}) \quad \text{……………………e q (1)}$$

Where; FCC_{tn} = final construction cost at time t_n.

ICS_{t0} = initial tender sum.

$\sum(ADC_{t1} + ADC_{t2} + ADC_{t3})$ = additional costs arising at project execution stage at differing points of time……………………………………e q (2)

Similarly;

$$FCD_{tn} = ICD_{t0} + \sum(ADT_{t1} + ADT_{t2} + ADT_{t3}) \quad \text{……………….......e q (3)}$$

Where; FCD_{tn} = final construction duration at time t_n

ICD_{t0} = initial construction duration set at award stage

$\sum(ADT_{t1} + ADT_{t2} + ADT_{t3})$ = secured construction time extensions on work items…e q (4)

Combined variables (additional works and time extensions) that influence the initial tender sum.

$$\left.\sum(ADC_{t1} + ADC_{t2} + ADC_{t3})\right\} = t \tan\alpha \quad \text{..e q (5)}$$

$\sum (ADT_{t1} + ADT_{t2} + ADT_{t3})$

Equation (5) establishes the value of all variables that shoot tender sums to a certain final cost.

The **desired model** tentatively put **as equation 6** can be operated upon mathematically for standardizations; $FCC_{tn} = ICS_{t0} + ICD_{t0} + t \tan \alpha$ ……………....................................e q (6)

Analysis of field data hopefully shall focus on the predictive model.

1.4 The Research Hypotheses

Null $\mathbf{H_o}$ – There is no relationship between the initial tender sum, targeted duration, extensions and final construction cost of building projects.

Alternate $\mathbf{H_1}$ – There is a relationship between the initial tender sum, targeted duration, extensions and final construction cost of building projects.

1.5 Need for the Research

Actual or final project costs need not be too wide in deviations from the planned and uncertain to clients and project consultants, otherwise projects get revised when resources needed to complete them overshoot the budget. Moreover the result could be abandonment, where were no provisions for supplementary. In the case of capital projects, which costs at inception, are most likely to change with work progress, and because forces beyond the control of the contractual parties definitely come to play, formulae/models are needed as a guide (indicator) to what the initial cost will change to, with respect to time. This is vital for healthy, effective and efficient budgeting for an agency like the Nigeria Budget Monitoring and Price Intelligence Unit (BMPIU) now Bureau of Public Procurement (BPP). One of the policy objectives of BPP is funding the projects that were duly certified in annual appropriations by the National Assembly (State House, 2005). This implies that estimates for goods and services are pegged at periods prior to tendering and contract award stages. If the policy must be sustained, and if projects are to be completed within budgets (a major project success criteria), the use of a predictive tool like that envisaged from this study shall be relevant to BPP, other corporate clients and even private individuals in capital project financial planning.

2 Project Success Criteria

The achievement of the targeted cost, time and quality in a construction project has remained the success rating tools among construction professionals and clients, Atkinson (1999) label these criteria as the "iron triangle". Baccarini and Collins (1999) notes that the traditional project management success criteria still hold strong within the project management community in Australia. According to Duggal (2015) project managers are expected to manage the triple constraints and often compelled to live in this triangle of time, cost and quality. Although it is a way to track and monitor projects, many scholars like Atkinson (1999) now view the triple criteria as not sufficient, insisting that there is more to project success than meeting time, cost and quality. According to Atkinson (1999) other success criteria include; the information system, organizational benefits and stakeholder community benefits. Together with the iron triangle they are tagged the "square route". Notwithstanding, the iron triangle seems to continue to be the preferred success criteria.

2.1 Construction Project Cost Analysis and Control Procedure

Seeley (1976) define cost analysis (cost to the client), as the systematic breakdown of the cost according to the sources from which they arise. This means the tender sum of a project can be broken into elemental costs. Cost control, embarked upon at execution stage aims at ensuring that resources are used to the best advantage. Cost analysis is the basis of cost control.

Cost control process ideally is continued from tender stage through to the construction period by the Quantity Surveyor to ensure that the cost of the building is kept within the agreed cost limit. When work on site commenced, cost analysis is used for controlling variation. Priced bills of quantities, schedules of basic, insurances and other relevant documents are scrutinized, suitable arrangements for dealing with daywork vouchers and claims for increased costs are agreed with the contractor. Accurate record of drawings is maintained with revisions noted and costed, variation orders costed and filed. On site visits for measurements and interim valuations, matters such as labour strength, plant in use, weather conditions and causes of delay, which may subsequently have a bearing on claims, are noted. Throughout the contract period the Quantity Surveyor maintains effective cost control arrangements to keep a constant check on the costs and supplies advice to the project Architect for action to be taken without adverse effects on the project cost.

The foregoing professional duty of the Quantity Surveyor at controlling building construction cost notwithstanding, construction project still terminate at figures above the target. In most cases, plans are hardly made for such uncertain extra fund to complete the project. What industrial damages this inflicts, together with the solution is the concern of this study. Hitherto, researchers are yet to proffer quantitative mechanism(s) for relating the terminal cost to that in the bills of quantities at pre-contract stage. The results of this study hopefully shall be relevant to Quantity Surveyors and Clients for predicting the final construction cost at for use in cash flow planning.

2.2 Combine Effects of Time and Cost Overruns on Final Construction Cost

Hasan *et al.* (2014) submit that cost and time overruns are two most frequent effects of project delay. Completion time the authors posit is very essential in construction; because “time is money”. To the contractor, delay causes higher overhead costs because of longer construction period, material costs may increase due to inflation. To the client especially the investor, delay means losing profits. Delays translate always into expenses for the period lost, while materials may not be lost in the period of work hold-ups except when stolen. Delays are funded and this adds to the initially set contract sum. Where additional jobs were duly approved for executions, automatically extra times are required for the extra works. Effects of cost of variated works and delays are interwoven, they both cause increase to the construction cost, or a decrease which in most cases is rear. Studies on time and cost overruns conducted separately would not have much practical relevance to the industry, as it is currently.

2.3 Cost of Delivery Public Infrastructures in Nigeria

Nnorom (1998) discovered cost differences in completed building projects in the study of the effects of variations on project final costs. One of the most highlighted of the findings is that, in the Nigerian Construction Industry, almost all projects are being completed at sums much higher than their initial contract sums. For instance, the Amenity Hospital Kaduna originally awarded at ₦1.25 Million had a projected final account of ₦2.00 Million, an increase of about 63%. Also, the Specialist hospital in Minna, Niger State originally awarded at initial contract sum of ₦17 Million was rewarded to the same contractor at ₦40.50 Million, an increase of 138%. Furthermore, the Presidential Lodge Abuja originally awarded at about ₦20 Million was revised to ₦35 Million, an increase of 75%. More so in Zaria, the contract for the new office complex for the Nigeria Institute of Transport and Technology (NITT) was awarded at a cost of ₦14.50 Million in 1983. However it was reviewed to a cost of ₦31 Million in 1986 and again to ₦100 Million in 1989. Giwa (1988) in Nnorom (1998) noted an overall increase on initial contract sum of 36.02% on ninety (90) completed projects. Analysis of the various final account statements of some of these projects attributed the increases to: fluctuation

10.20%, variation 8.43%, PC sums 5.98%, re-measurement 0.50%, provisional sums 1.37% and others 2.28 % (Nnorom, 1998, p. 2).

3 Research Methodology

Primary data shall be collected through the examination of files of completed projects in the offices of registered Quantity Surveyors across Nigeria's six geo-political zones together with the federal capital territory, Abuja. Corporate and organized private sector clients shall also be visited for collection of data pertaining to the variables. Cluster sampling is a technique suitable for surveys involving natural groupings in a statistical population. The advantage of cluster sampling method is economizing on traveling expense for data sourcing for researches involving geographical area. Six (6) state capitals shall be visited in each of the six (6) geo-political zones and Abuja to study ten (10) projects files in each state. This means sixty (60) completed projects per zone making a total number of 420 completed projects. Also 1050 respondents across the zones i.e. 150 in each geo-political zone including Abuja shall be interviewed to source data that will not be possible to extract from project files. Designed templates for recording data shall be used for the files studies. Interview guide designed with considerations for confidentiality of data involved shall be used, so as not to scare respondents from giving full supports in the provision of relevant data. Space for sourcing the biographical data of respondents shall be created on the guide to enhance the assessment of respondents' professional background, experience and reliability of the data sourced. The interviews with project officers shall focus on sourcing data on type and number of professionals that were involved in the design as well as the contract documents (production information) used in executing the projects. Collected data shall be presented in Tables, Figures and Charts with respect to the research aim and objectives.

3.1 Analysis of Variance (ANOVA) and Artificial Neural Network (Expert System)

According to Agbola *et al.* (2013) and Kirk (2008) the method for testing the difference among k *means (n)* where k>2, is Analysis of Variance (ANOVA). This technique shall be used for testing the hypothesis that the *means (n)* for time and cost overruns of the seven zones are equal at 5% confidence level. If differences exist among the *means (n),* ANOVA also shows the zone and the zonal difference.

Series of modeling framework had been adopted in the past which are regression based (Amusan, *et al.* 2013a). Efforts in research Amusan *et al. (*2013a) maintained are now directed towards validating the applicability of the developed models. Mawdesley *et al.* (1999) and Asworth (1994) in Amusan *et al.* (2013a) present approaches in modeling; elemental, regression, heuristics and expert system (artificial neural network). Molenaar *et al.* (2000) in Rahman *et al.* (2013) regard Structural Equation Modeling (SEM) as an extension of standardized regression modeling used in dealing with poorly measured independent variables and is ideally suited for many research issues in the field of construction engineering and management. Yang and Ou (2008) and Ng *et al.* (2010) in Rahman *et al.* (2013) state that the SEM method is suitable for exploring relationships among key variables and is highly applicable for resolving the complicated problems in the construction domain as the functionality of SEM is better than other multivariate techniques including multiple regression path and factor analysis. In the context of engineering and management SEM is still new (Henseler *et al.* in Rahman *et al.*, 2013). Therefore this study will not explore further the use of PLS-SEM in data analysis because of its relative newness to construction and engineering fields, the advantages notwithstanding. Regression based models are also found to be limited in application as a result of non-flexibility and margin of error between input and output. The system also relies on historic cost and has its short comings which include; inability to capture intervening variables that impact project, such as price change, inflation change among others (Moore *et al.*, 1999 in Amusan, *et al.*, 2013a).

Paradigm need to be shifted in the direction of conventional method that complements the regression method's shortcomings as cased base reasoning and expert system. Expert system are patterned after the neural biological neurons with the ability to map input to output and deduct a meaningful inference, it possess capability of studying data trend even if the series is inconsistent. Once the pattern is mastered, the network can generalize the trend to predict a consistent series having mastered the previous trend. Expert system's attributes include; capacity to accommodate large data input, consistent output, output and input mapping, low variation error between input and output. Expert-based system generates less error between input and expected output, it tends to have variation error within the range of 2% to 4% while regression model often have variation error greater than 7%, (David and Seer 2004; Dissanayaka and Kumaraswamy 2007 and Moore *et al.*, 1999 in Amusan *et al.*, 2013a). A robust expert-based model (ANN) incorporates economic and environmental parameters capable of generating accurate project cost. According to Aigbomian and Momoh (1996); Egbule and Okobia (1998) in Idogho (2001) research is act of consciously organizing oneself to solve a given problem with the specific aim of improving on the existing standard, for greater comfort and convenience resulting in contribution to knowledge. Halmatadlefs (1970) in Iredia (2003) defined research as an activity of solving problems which leads to new knowledge using methods of inquiry which are currently accepted as adequate by scholars in the field. The weakness of correlation/regression analysis to capture intervening variables such as, works delay due to inclement weather, daywork, material and labour price rise which are peculiar to construction activities coupled with these definitions of research, shift the anticipated analytical technique to ANN. The relationship between the variables shall therefore be investigated with regression analysis and expert-based system (Artificial Neural Network ANN) explored for predictive cost model construction.

4 Expected Research Findings and Usefulness

The study results are expected to address the following issues:

- **(i)** Establish the percentage deviations between targeted project construction duration and actual contract duration.
- **(ii)** Establish the percentage deviations between targeted project construction cost and final completion cost.
- **(iii)**Establish the relationship between the project variables; initial contract sum, duration, extended times, additional costs, final construction completion time and cost.
- **(iv)** Build final cost predictive models/charts upon the relationship in (iii).

The anticipated results are going to be disseminated widely through seminars, conferences, workshops, technical journals, internet etc.

4.1 Discussion of Related and Earlier Studies

Azis *et al.* (2013) investigated the contributors to cost overrun and proposed fifteen (15) mitigating measures classified into pro-active strategy, organizational and fluid. Idoro (2012) concludes that the level of use of project plans can be a strategy for reducing the high time and cost overruns recorded in design-build projects given room for stakeholders to increase the level of use of project plans in design-build projects. The study suggested that stakeholders should ensure that the required project plans are prepared when projects are procured through design-build system. Bamisile (2004) argued that it is the construction methodology that determines the programme of works, and hence the duration. The construction methodology dictates the details of project quality management plan, which is used to achieve the specified quality standards from effective site management. Odeyinka *et al.* (2012) presents a different perspective for investigating the solutions to cost overrun. The study modeled the impacts of risks on the variability between contract sum and final account. The focus was on creating awareness on issues capable of raising the signed contract price in the construction stage. An artificial neural network (ANN) for predicting project final cost was recommended. Edwards (2009) in proffering solutions to the negative impacts of cost overrun in United States of America recommended a fundamental reform which is, to terminate and privatize as many federal activities as possible, and move funding for state activities, such as highways, back to the states. That way, federal policymakers could focus on ensuring that the few needed areas of federal spending, such as defense, are carried out as efficiently as possible". This seems a management and executive strategy for dealing with the issue of cost overrun. Gandu (2014) proposed a mathematical proactive cost management model for building projects in Nigeria. The model seems **not** to have considered all the variables that influence cost growth. While project durations seem to address material and labour price galloping others, like contractor's managerial powers, gratifications etc. are part of the variables upon which the mathematical model should have been built. Aiyetan *et al.* (2012) investigated the relationship between initial and final contract time with the aim of developing an equation for reasonably estimating project completion period and derived the following: $Y = 13.1159 + 1.1341X$, where Y is final construction time and X targeted contract duration set at tender stage. That study only focused on contract duration.

5 Conclusion

This paper addresses the conference sub-theme "Emerging trends in construction project delivery" and specifically, trends in international construction issue of cost variability. It is a preliminary part of an ongoing Ph.D. thesis in the department of Construction Economics & Management, Faculty of Engineering and Built Environment, University of Cape Town. Models/Charts derived from this study shall serve as solutions to the current trend of cost variability particularly in the Nigeria construction industry. The findings shall also serve as tools for future project planning to enhance smooth cash flow projections. Project abandonments, which major cause is sudden upsurge in fund requirements, leading to loss of investment interest, shall be reduced when the expected models/charts become operational.

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