Project variables influencing contingency on construction contract in Nigeria

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Abstract:

In most construction contracts, risk is either ignored or dealt with in an arbitrary way by adding a percentage allowance in form of contingency sum for changes that experience shows will likely be required without considering the project variables. Contingency is used to cater for events that are unforeseen which threaten the achievement of objective within the defined project scope. The aim of the study is to assess the influence of project variables in determining the contingency sum applied to the construction cost estimate in Nigeria construction industry. The study identifies correlation between contingency and project characteristics and variables. In order to achieve the objectives, information of past projects were collected from 21 organisations and included project variables of ninety-nine projects of varying sizes and contract types. Correlation analysis was used to establish the strength and direction of linear relationship between the project variables with special attention on variation to determining future contingency. Analysis of variance (ANOVA) was also used for the analyses of data in exploring relationships among variables and compare groups respectively. There was a strong, positive correlation between variation and five of the variables: consultant estimate, contingency sum, planned duration, gross floor area, and lowest bid and also there was a strong positive correlation between contingency and five of the variables including consultant estimate, planned duration, total variation, the lowest bid and gross floor area with high value of the variables associated with high value of contingency. The result of the ANOVA indicated that there is no statistical significant difference in the contingency applied on project based on nature of project, type of project and type of client. Therefore, contingency by cost expert is not really dependent on these three variables.

Keywords: Contingency, variation, budget, correlation, factors, estimation.

1 Introduction

The aspiration and expectation of building clients and consultants is to keep the final construction cost within the initial budget estimate or approved expenditure that include a justified additional amount that caters for uncertainties and risk events which amounts to variation. In construction and engineering projects plans and cost estimates are usually drawn to ensure that the work is carried out to the desired quality, within allowed time, and within budget. The construction industry is inherently uncertain according to the nature of the industry itself- the competitive tendering process, the company's turnover, site production rates and the weather are all features that are characterised by variability and a degree of uncertainty (Harris and McCaffer, 2001). Invariably unforeseen items and events in the execution of any building project are inevitable. Most times the successful completion of any project is assessed on the basis of three parameters, which constitute risks namely; time, money and performance which according to Smith (1999) are the three types of contingencies. The relative magnitude of these three types will be related to project objectives. In a construction project and from the owner's point of view, contingency is the budget that is set aside to cope with uncertainties during construction. Touran (2003) posited that it is common to assign contingency value to both cost and schedule because project uncertainties can affect project schedule as well as cost. Contingency allocation has been the subject of various research and various methods of contingency calculation and allocation have been described in several sources. One of the more common methods of budgeting for contingency is to consider a percent of estimated cost, based on previous experience with similar projects.

According to Thomson and Perry (1992), all too often risk is either ignored or dealt with in an arbitrary way; simply adding a ten percent contingency onto the estimated cost of construction project is typical and unscientific. Argenti (1969) cautiously predicted that model building will become a key technique for future generation managers. This has manifest itself in the number of research reports in which models are developed to serve as basis for construction cost estimate in order to achieve better level of accuracy and reliability of cost estimate. Touran (2003) identified project size, type of construction, difference between low bid and owner's estimate among factors that affect project cost overrun. Andi (2004) identified cost-risks factors influencing project cost elements.

Therefore, the objectives of the study is to assess the relationship between contingency and project variables (consultant estimate, planned duration, total approved variation, fluctuation, gross floor area and the lowest bid). Also to find out if there is correlation between total variation and these project variables in order to predict contingency for future projects. The effect of different types of clients, the nature of projects and types of projects on the contingency applied to the construction contracts by cost experts was also examined.

Assurance of a reliable construction contingency is sine qua non to client's satisfaction on the estimated final construction cost. Specifically, it will assist consultant quantity surveyors in their estimating practice to know project variables that could affect their decision on the contingency sum which is applicable to construction projects.

2 Literature Review

Virtually all authors and researchers acknowledge the fact that construction contract delivery is a complex undertaking, which is characterised with uncertainties and risk. According to Odeyinka (1987) risk is inherent in any construction project right from inception through its completion. Ashworth (1999) posited that risk can be mathematically predicted, whereas uncertainty cannot. Different authors and researchers including Odeyinka (1987); Yeo (1990); Ramus and Birchall (1998); Mak, Wong and Picken (1998); Ashworth (1999); Smith (1999); Harris and McCaffer (2001); Picken and Stephen (2001) and Andi (2004) have written on construction risks and its management. Thus, changes and risks are inevitable in construction contract and these are the major cause of disruption, delay and dispute on construction contracts. Nworuh and Nwachukwu (2004) asserted that experience on many projects indicate poor performance in terms of achieving time and cost targets, thus many cost and time overruns are attributable to unforeseen events for which uncertainties was not

appropriately estimated. An amount of money used to provide for uncertainties associated with a construction project is referred to as contingency allowance (Mak and Picken, 2000).
Contingencies are crucial to achieving project objectives. Contingency funds are included in development budgets to provide managers with flexibility required to address uncertainties and deviations that threaten achieving objectives (Diekmann, Sewester and Taker 1988). It is used to cater for events that are unforeseen within the defined project scope. It is added to indicate likely total cost of the project, which means that the estimate represents the total financial commitment for a project. Contingency is used as a financial treatment in risk treatment strategies thus; it caters for risk associated with a project.
According to Yeo (1990) the objectives of the contingency allocation are to ensure that the budget set aside for the project is realistic and sufficient enough to contain the risk of unforeseen cost increases. Therefore, any realistic contingency must serve as a basis for decision making concerning financial viability of the variations, and a baseline for their control (Akinsola, 1996).

2.1 Construction contingency

2.1.1 Types of construction contingency

In engineering projects, two types of contingencies are used to compensate for different types of uncertainties. These are Project contingency and Process contingency (Parsons, 1999).

Project contingency is based on the degree of project definition available at the time of making the estimate. It covers expected omissions and unforeseen costs caused by lack of complete engineering. According to HM Treasury (1993) two major categories of contingency can be identified for construction projects and these are Design and Construction contingencies. Design contingency is for changes during the design process for such factors as incomplete scope definition and inaccuracy of estimating methods and data (Clark and Lorenzoni, 1985). Construction contingency is for changes during the construction process.

Process contingency is based on the degree of uncertainty caused by use of new technology. It is an effort to quantify the uncertainty in performance because of limited technical data. It is important to note that project contingency is broader and could be a determinant of process contingency, which could be a variable of construction contingency in a construction project.
Traditionally, a contract is signed between a client and the contractor which according to Staugas (1995) typically contains variation clauses to allow for changes and provide a mechanism for determining and valuing them. Construction contingency exists to cater for these variations Akinsola (1996), Mak et al. (1998), Mak and Picken (2000) and Baccarini (2005).

2.1.2 Contingency estimating

According to Bello and Odusami (2008) factors considered most important in making provision for construction contingency are: size and complexity of project, assessed risk on the project and adequacy of information. Andi (2004) identified cost-risks factors influencing project cost elements, relationship among the risks themselves and proposes risk analysis methodology for allocation of contingency. Touran (2003) identified project size, type of construction, difference between low bid and owner's estimate among factors that affect project cost overrun. Project size, type of construction, type of client, method of procurement, percentage of design completed before tender, adequacy of information, and number of subcontractors used were identified by Akinsola, Potts, Ndekugri and Harris (1997). In estimating for contingency, major project factor or variables considered are project cost data and duration with their variabilities (Ahmad 1992; Ranasinghe, 1994; Moselhi, 1997; Chen and Hartman, 2000; Nassar, 2002; Touran 2003; Baccarini 2005 and Rowe 2006). And significant risk factors (Mak et al. 1998; Mak and Picken 2000; Chen and Hartman, 2000; Bajaj 2001 and Sonmez, Ergin and Birgonul, 2007). It becomes more difficult to determine overall estimate reliability because some sections of a project may be completely defined at the time of estimate, and others only sketchily defined.

2.1.3 Correlation of project variables in contingency estimation

In estimating for contingency, major project factors or variables considered are project cost data and duration with their variabilities (Ahmad 1992; Ranasinghe, 1994; Moselhi 1997; Chen and Hartman, 2000; Nassar, 2002; Touran, 2003; Baccarini, 2004; Rowe, 2006; Sonmez, et al. 2007 and; Bello and Odusami, 2008) and significant risk factors (Mak et al. 1998; Mak and Picken, 2000; Chen and Hartman, 2000; Bajaj, 2000 and; Andi 2004). Different methods and techniques have been proposed for contingency estimation in literature. The methods are primarily traditional algorithmic methods (Moselhi, 1997). Some of the methods are deterministic and others are probabilistic accomplished by either expert opinion or statistical methods. They range from a simple crystal-ball-type estimate to elaborate Monte Carlo simulations (Moselhi, 1997). Statistical technique used to analyse contingency can range from Monte Carlo simulations to regression and variance analysis (Philip, 2001) but most cost experts and practitioners in the construction industry are yet to explore the benefits of these scientific methods as they are still glued to the conventional method of lumpsum and percentage addition (Bello and Odusami, 2008).

Most research on contingency always treat cost data and duration as important factor in contingency but not much is reported about the relationship between these variables. Baccarini (2004) researched into correlation between project variables including project size, project duration, location, bid variability and concluded that there was no significant correlation between project variables and cost contingency. Andi (2004) posited that relationships among risks could be identified in his risk analysis methodology for allocation of contingency. Sonmez, et al. (2007) used correlation and regression analysis to identify factors impacting cost contingency and present a robust and practical statistical approach for determination of contingency.

This study found that there was a strong positive correlation between contingency and five of the variables considered in the study; consultant estimate, planned duration, total approved variation, gross floor area and the lowest bid. Conversely, there was no statistical significant correlation between contingency and fluctuation; there was a very weak negative correlation. The research also revealed a positive correlation between variation and some project variables which include consultant estimate, contingency sum; planned duration; gross floor area and lowest bid.

3 Research methodology

The data for this study were obtained from records of past projects in government, institutional and consulting organisations to get cost data variables required for research analysis. Most of these organisations have projects across the country hence, are representative of the entire population of the study area.

A data collection schedule was used for the generation of cost data of past projects from the organisations. The schedule contains 14 variables extracted from the records of completed projects or projects at completion. Computer based statistical tools such as Frequency distribution of respondents; Mean Score, Descriptive statistics, Correlation, Regression, and Analysis of Variance ANOVA were used for processing the research data in order to achieve precision.

The analysis of the data was done using the statistical package for social sciences (SPSS). SPSS is an enormously powerful data analysis package that can handle very complex statistical procedures (Pallant, 2005). The information collected were summarized and presented in form of frequency distribution tables for a total of 99 project cost data which were generated from 21 organisations.

RESEARCH HYPOTHESES

H1: There is no statistically significant relationship between the project variables (Consultant estimate, Contingency sum, Planned duration, Location of the project, Nature of project, Type of project, Type of client, Gross floor area and the Lowest bids) and Total variation.

H2: There is no statistical significant difference in the contingency applied on project based on nature of project, type of project and type of client

4 Findings and Discussion

A total of 70 questionnaires were administered to quantity surveyors and or cost experts in three different organisations; government, institutions and quantity surveying consultancy firms in the construction sector. Fifty-three of the administered questionnaires were returned, representing 76 percent response rates. Ten representing 18% of the sample were from government establishment such as Ministry and Housing or Property Corporations, 8 representing 16% were from institutional such as educational and banking institution while 35 are from consulting firms. Important observation is that consulting firms represent 66% of the sample. The sample also sought for the age of the organisations in which 11 representing 21% of the respondents were less than 10 years old, 19 or 36% were between 11 and 20 years old while about 19% were above 40 years in age. It is important to note that the age bracket of between 5 years and 20 years represent the vibrant and modern quantity surveying firms in Nigeria and this is represented by 57% of the sample.

In order to assess the relationship that exists between the construction contingency and project variables for any proposed project, correlation analysis was used to establish the strength and direction of linear relationship between the project variables with special attention on variation and the other variables. Any variables that are found to have relationship with the variation might be used to develop a model within the acceptable statistical limit to predict a more reliable project cost contingency. The first correlation analysis carried out was to confirm the strength and the direction of relationship between contingency and six variables from the project data. The variables include; consultant estimate, planned duration, total approved variation, fluctuation, gross floor area and the lowest bid. Table 1 summarises the result of the correlation analysis. Thus, the relationship between contingency and consultant estimate, planned duration, and total approved variation, fluctuation, gross floor area and the lowest bid was investigated using Pearson product moment correlation coefficient. Preliminary analysis was performed to ensure no violation of the assumption of normality, linearity, and homoscedasticity.

There was a strong positive correlation between contingency and five of the variables including Consultant estimate[r=0.837, N=99, p<.01], Planned duration[r=.64, N=99, p<.01], Total variation[r=0.591, N=99, p<.01], the Lowest bid[r=0.839, N=99, p<.01] and Gross floor area [r=0.526, N=75, p<.01]with high value of the variables associated with high value of contingency. However, there was a very weak negetive correlation between contingency and Fluctuation[r=-0.113, N=21, p<.01] that is not significant at the traditional p<0.05 level of significance. Table 1 shows the details.

Table 1: Correlation between contingency and selected project variables
Dependent Variable: Contingency

Project Variables	R	Sig. (2-tailed)	Result, Reject Ho?	p-value
Consultant's estimate	0.837	0.000	Yes	Significant, <0.01
Planned duration	0.674	0.000	Yes	Significant, <0.01
Total variation	0.591	0.000	Yes	Significant, <0.01
Fluctuation	-0.113	0.626	No	Not Significant, <0.05
Lowest bid	0.839	0.000	Yes	Significant,<0.01
Gross floor area	0.526	0.000	Yes	Significant,<0.01

r = Pearson Product -Moment Correlation Coefficient; Ho = null hypothesis; *p*= probability that rejects the null hypothesis wrongly, significant at the 0.01 level (2-tailed).

The second analysis was to obtain the correlation between variation and nine project variables. The variables selected for analysis include: consultant estimate, contingency sum, total variation, planned duration, location of the project, nature of project, type of project, type of client, gross floor area and the lowest bid. all the variables were part of data collected for each of the 99 projects. the relationship was investigated using

Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure no violation of the assumption of normality, linearity, and homoscedasticity. It was revealed that five of the nine variables have significant correlation with total variation at $p < 0.01$ level. Table 2 summarizes the result of the correlations.

Table 2: Correlation between total variation and selected project variables
Dependent Variable: Total Variation

Project Variables	R	Sig. (2-tailed)	Result Reject Ho?	*p*-value
Consultant's Estimate	0.635	0.000	Yes	Significant, <0.01
Contingency Sum	0.591	0.000	Yes	Significant<0.01
Planned Duration	0.549	0.000	Yes	Significant<0.01
Location of the Project	-0.065	0.525	No	Not Significant<0.05
Type of Client	-0.003	0.980	No	Not Significant<0.05
Gross Floor Area	0.566	0.000	Yes	Significant<0.01
Lowest bid	0.613	0.000	Yes	Significant<0.01
Nature of project	-0.182	0.072	No	Not Significant<0.05
Type of Project	0.129	0.202	No	Not Significant<0.05

r = Pearson Product -Moment Correlation Coefficient; Ho = null hypothesis; p= probability that rejects the null hypothesis wrongly, significant at the 0.01 level (2-tailed).

There was a strong, positive correlation between variation and five of the nine variables: Consultant estimate [r=0.64, N=99, $p<0.01$]; Contingency sum [r=0.59, N=99, $p<0.01$]; Planned duration [r=0.67, N=98, $p<0.01$]; Gross floor area[r=0.53, N=75, $p<0.01$] and Lowest bid [r=0.61, N=99, $p<0.01$].

Impact of nature of project, types of project and types of client on contingency

The study further assessed the impact of the different types of clients, the nature and types of projects on the contingency applied to the construction contracts perhaps this could have significant effect on the result of findings.

Therefore, a one-way between-groups analysis of variance was conducted to explore the impact of the three variable groups; (1) types of clients, (2) the nature and (3) types of projects on contingency. There was no statistically significant difference at the $p < 0.05$ level for the three groups. Table 3 shows the results.

Table 3: Test of Agreement on Contingency by three project groups variables: types of clients; the nature and types of projects.

Project Variables	F	Sig.	Remark
Nature of project	1.483	0.084	Not significant $p < 0.05$
Type of project	1.019	0.469	Not significant $p < 0.05$
Type of client	1.141	0.319	Not significant $p < 0.05$

The result of the ANOVA indicated that there is no significant difference in the contingency applied on project based on nature of project, type of project and type of client. Therefore, contingency by cost expert is not really dependent on these three variables. It would have been expected that the consideration of these three project attributes in contingency allocation by quantity surveyors is significant. Despite not reaching statistical significant the Sig. value of 0.08 for nature of project is considerable which indicated that the consideration given to the nature of project (new or refurbishment) is relatively important.

5 Conclusion and further research

Changes and risks are inevitable in construction contract thus, many cost and time overruns are attributable to either unforeseen events for which uncertainties was not appropriately estimated. The study revealed statistical relationship between some project variables which could be used to develop models for contingency. The effectiveness of contingency management can strongly influence project success. The study revealed that there was a strong, positive correlation between variation and five of the variables: consultant estimate, contingency sum, planned duration, gross floor area, and lowest bid and also there was a strong positive correlation between contingency and five of the variables including consultant estimate, planned duration, total variation, the lowest bid and gross floor area with high value of the variables associated with high value of contingency. The result of the ANOVA indicated that there is no statistical significant difference in the contingency applied on project based on nature of project, type of project and type of client. Therefore, contingency by cost expert is not really dependent on these three variables.
Contingency is proportional to the risk present in a project, and this risk diminishes as the design advances, construction contracts are awarded, and construction is completed. Total project contingency decreases over the life cycle of a project.

The importance of forecasting an accurate and effective construction contingency is essential to client's satisfaction on the estimated final construction cost and hence, the construction contract delivery. Developing estimating models should be encouraged in organisations where quantity surveying (or cost engineering) is being practiced having established relationship between contingency and some project variables, and similarly between variation and project variables as found in this study. The established relationship could be scientifically analysed to develop a more confident forecast for construction contingency.

6 References

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