MODELLING RISK IMPACTS ON THE BUDGETED COST OF TRADITIONALLY PROCURED BUILDING PROJECTS

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Risk is inherent in construction from the inception to the completion stages of a project's life. The less information is available at the inception of a construction project, the higher the level of risks and uncertainties. Whilst it is a known fact that the risk factors inherent in a construction project are responsible for the deviation between the budgeted and actual project costs, how these risk factors combine to impact the project cost has not been investigated. This then is the concern of this study. The study identified the risk factors impacting the budgeted cost of traditionally procured building projects through a structured questionnaire survey. Using the mean ranking analysis, the significant risk factors were determined which were used in developing a risk/impact assessment model for evaluating the impacts of risk on the budgeted cost of traditionally procured building projects. The developed model shows a very good predictive ability; indicating that the model could assist in pro-actively determining the likely impacts of identified risks on the budgeted cost of traditionally procured building projects.

Keywords: model, mean ranking, risk, traditional procurement.

INTRODUCTION

According to Flanagan and Tate (1997), the budgeted cost determined at the pre-contract stage of any construction project forms the basis of the contract sum and it is the amount established for the project, which is not expected to be exceeded. According to Flanagan and Tate (1997), the budgeted cost should incorporate both foreseen and unforeseen costs needed for the achievement of project's objectives. Ashworth and Hogg (2002) submitted that all the planning and decision-making by both the client and the contractor for the success of the project centre on the budgeted cost. Therefore the budgeted cost is expected to be accurate to avoid cost overruns. Ramus *et al.* (2005) asserted that contingency sums are often allowed in cost estimates to ensure that the estimated project cost is realistic and sufficient to accommodate any surprises. Perry and Hayes (1985); Flanagan and Tate (1997) were of the opinion that construction projects are expected to be completed at budgeted costs. This is because of the expected inclusion of contingency sums to cover all the foreseen and unforeseen occurrences.

On the contrary, evidences abound in construction management literature that it is very difficult to find a project in which the initial contract sum is not exceeded at completion (Winch, 2002; Walker, 2002). This according to Perry and Hayes (1985) and Odeyinka (2000) could be traceable to risk factors inherent in construction.

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According to Winch (2002), risk is inherent in construction from the inception to the completion stages of a project's life. According to him, less information is available at the inception of a construction project, the higher the level of risks and uncertainties. Whilst it is a known fact that the risk factors inherent in a construction project are responsible for the observable deviation between the budgeted and actual project costs, how these risk factors combine to impact the project cost is the concern of this study. The overall aim of the study is to assess risk impacts on the budgeted cost of traditionally procured construction projects with a view to modelling the observed significant risk impacts.

TRADITIONAL PROCUREMENT AND ITS INHERENT RISK

Procurement refers to the choice of contractual arrangements available for selecting a contractor to construct a building (Ramus *et al.* 2005; and Kelly *et al.* 2002). One of the procurement options available which is relevant to this study is traditional procurement. According to Ramus *et al.* (2005), in traditional procurement arrangement, a client appoints a design team to produce the production information needed for the project, then to select the contractor and supervise the works until completion. Tendering involves selected contractors offering a price for which they will carry out the work described, in accordance with the conditions of the contract. A tender is chosen which represents the best overall value for money and a contractor is appointed to proceed with the building project. Kelly *et al.(* 2002) highlighted the advantages of this procurement options as high degree of certainty on cost and time before commitment to build; clear accountability and control; competitive pricing; combination of best consultant and contracting skills; flexibility in design development. However, it is disadvantageous in that greater coordination and control is required; it gives little opportunity for contractor to contribute to design stage and the system is relatively slow.

The environment within which decision-making takes place can be divided into three parts: certainty, risk and uncertainty (Flanagan and Norman, 1993). According to them, certainty exists only when one can specify exactly what will happen during the period of time covered by the decision. This, they concluded, of course does not happen very often in the construction industry. Bennett and Ormerod (1984) also concluded that an important source of bad decisions is illusions of certainty. They submitted that uncertainty is endemic in construction and needs to be explicitly recognized by construction managers.

According to Flanagan and Norman (1993), uncertainty, in contrast to risk, might be defined as a situation in which there are no historic data or previous history relating to the situation being considered by the decision-maker. In other words according to them, it is 'one of a kind'. A company has to operate in an environment where there are many uncertainties. The aim is to identify, analyse, evaluate and operate on risks. Accordingly, the company is converting uncertainty to risk. The more one thinks about risk and uncertainty, the more one is inclined to the view that risk is the more relevant term in the building industry (Flanagan and Norman, 1993). Perry and Hayes (1985) submitted that while the distinction between risk and uncertainty is recognized, the distinction is unhelpful when it comes to construction projects.

Various researchers have adopted different approaches in identifying risks inherent in construction. Perry and Hayes (1985) and Ashworth and Hogg (2002) using risk register have identified risk sources in construction at pre contract stage to include design risk, competitive tendering risk, tender evaluation risk and estimating risk among others. In addition, they also identified risk factors at post contract stage to include physical risk, site condition, inclement weather, legal risk, environmental risk, logistic risk, political risk, financial risk and contractual risk among others. Edward and Bowen (1998) have employed risk categorization in identifying risk sources. Starting with the top-level categories of natural and human risks, they subdivided these into lower levels. In a similar approach, Tar and Carr (1999) employed the hierarchical risk breakdown structure. In this approach, they started with the highest hierarchies of internal and external risks and proceeded to break these down into lower hierarchies.

Fong (1987) and Odeyinka *et al.* (2006) asserted that it is generally recognized that those within the construction industry are continually faced with a variety of situations involving many unknowns, unexpected, frequently undesirable and often unpredictable factors. These factors according to Fong (1987) include timing schedule slippage of the project tasks, technological issues, people-oriented issues, finance, managerial and political issues. Chapman and Ward (1997) submitted that generally, risk is viewed within the context of the probability of different outcomes and that the general attitude towards risk is its identification, evaluation, control and management.

DATA AND METHODOLOGY

Data were collected from Lagos, which is the commercial capital of Nigeria. The choice of Lagos was made for data collection, as it is a major hub of construction activities in Nigeria. Data collection was done through a questionnaire survey self-administered on 100 randomly selected construction practitioners involved in a nearly completed or recently completed traditionally procured construction projects. Subjects include practising quantity surveyors, architects, engineers and builders. These professionals were in the employment of construction companies, consulting firms, government establishment and institutions. About two-thirds of the respondents were Architects and Quantity Surveyors, whilst the majority of the respondents were employed in construction companies or consulting firms (see Tables 1 and 2). The computed mean experience of the respondents is 15.25 years with a standard deviation of 3.75 years. About half of the respondents were educated up to OND and HND level whilst the remaining half had at least first degree in construction related fields (Table 3). This background information regarding the respondents indicates that responses provided by them could be relied upon for this study.

Many risk management researchers as stated earlier viewed risk as the probability that cost, schedule or technical performance of a system goes wrong combined with the consequences of these aspects going wrong. With this view, they argued that risk could be measured through the following formula:

$$R = P * I \qquad \text{(Equation 1)}$$

where: R = the degree of risk, P = probability of occurrence of a risk factor

I = the consequence or perceived impact on a project

Table 1: Type of Organization

Organization	Frequency	Percent	Cumulative percent
Contracting	28	50.9	50.9
Consulting	21	38.2	89.1
Employer's Representative	6	10.9	100.0
Total		100.0	

Table 2: Designation of Respondents

Respondent	Frequency	Percent	Cumulative percent
Quantity Surveyor	27	49.1	49.1
Architect	6	10.9	60.0
Engineer	14	25.5	85.5
Builder	8	14.5	100.0
Total	55	100.0	

Table 3: Academic Qualification of Respondents

Qualification	Frequency	Percent	Cumulative percent
M. Sc	10	18.2	18.2
B. Sc	16	29.1	47.3
HND	23	41.8	89.1
OND	5	9.1	98.2
B.Sc + MBA	1	1.8	100.0
Total	55	100.0	

Akintoye *et al.* (2001) and Carter *et al.* (1994) referred to this as the risk exposure or expected value (EV) while Tweeds (1996) referred to it as average risk estimate. This method of risk measurement has a well-established place in decision theory domain and has been employed in this study.

Two methods of data collection were adopted in this study. The first is a two-stage questionnaire survey and the second is secondary data generation from the archives of the organizations studied. In the fist stage of the questionnaire survey, 100 questionnaires were self-administered to the respondents. Out of these, 55 responses fit for analysis were received, representing a response rate of 55%. The questionnaire identified from literature and based on discussion with industry practitioners, 28 risk factors encountered at the project level in traditionally procured building projects. Using a two-dimensional scaling, respondents were requested to score on a Likert –type scale of 0-5, the extent of the identified risk factors occurring and their perceived impacts in case of occurrence. The Likert-type scale used for the two-dimensional scaling questionnaire was defined as follows: 0 – no likelihood of occurrence and no impact, 1 – very low occurrence and very low impact, 2 – low occurrence and fairly critical impact, 3 – medium level of occurrence and critical impact, 4 – high level of occurrence and very high impact, 5 – very high level of occurrence and extremely critical impact. This then gives the measuring scale the property of an interval scale, which makes the collected data suitable for various statistical analyses.

Responses from the first stage of the questionnaire survey were analysed in order to determine significant risk factors to concentrate on for modelling purposes. In all, 8 significant risk factors were determined using the criticality scale earlier defined in the data gathering questionnaire. In addition, secondary data were generated from recently completed projects regarding budgeted and actual construction cost of recently completed traditionally procured building projects. Using the 8 significant risk factors, the Contractors' Quantity Surveyors who worked on the projects were asked to provide opinions on a Likert-type scale, regarding the extent of occurrence of the identified significant risks. The data obtained together with the secondary data generated were used in modelling risk impacts on the budgeted construction cost using multi linear regression analysis.

DATA ANALYSIS AND RESULTS

Data analysis was carried out in two stages. The first stage employed the mean ranking analysis of responses to the questionnaire survey using the Statistical Package for Social Scientists (SPSS). Responses to the two-dimensional scaled questionnaire were analysed using the mean ranking analysis. The summary of the analysis result regarding construction professionals' perception of the likelihood of the identified risk factors occurring is shown in Table 4. From column 2 of the Table, it is evident that only one risk factor, i.e. 'completion delays' was scored by all the respondents as having a medium level of occurrence with a rank of 1. The majority of the risk factors were scored by all the respondents as having a low likelihood of occurrence whilst few were scored as having a very low likelihood of occurrence.

Responses regarding respondents' perception of the impacts of the identified risk factors in case of occurrence were also analysed using the mean response analysis.

The summary of the overall response is shown in columns 4 and 5 of Table 4. From this Table, it is evident that 8 out of the 28 identified risk factors were scored as critical on the Likert-type criticality scale of 0-5. These factors include, 'under-estimation', 'completion delays', 'inadequacy of cash flow', 'poor site investigations', 'changes in scope of work', 'defective construction works, 'non-availability of fund' and 'under-valuation'. The risk-impact scores from the mean ranking analyses were used to determine the significant risk factors to focus on for modelling purpose. This is because some risk factors may have a higher likelihood of occurrence but little or no impact.

Using the 'Degree of Risk', defined as $R = P * I$ in equation 1, column 6 in Table 4 shows the product of likelihood of risk occurrence and perceived impact in case of occurrence. This was then rank ordered so as to determine the significant risk factors to focus attention on. The original intention was to have a cut off point of significant risk factors as factors scoring 3.0 and over on the criticality scale earlier defined. However, with the low scores recorded on the likelihood of risk occurring, the cut off point was brought a little lower as the combined degree of 8.0 and over. With this, cut off point, 8 risk factors were identified as the significant risk factors to focus on for modelling purpose.

RISK-IMPACT MODELLING

Using the 8 risk factors determined from the analysis of the first set of questionnaires, a second set of questionnaires were administered on Quantity Surveyors who worked on some recently completed traditionally procured building projects. They were requested to provide information on the initial budget cost as well as the actual construction cost. From this data set, the cost overrun was determined. In addition, they were requested to provide opinions on a Likert-type scale on the extent of risk occurrence on each of the identified 8 significant risk factors. Data were obtained from 22 Quantity Surveyors and this is presented in part in Table 6.

Table 4: Perception of Risk Occurrence and Impact on Construction Cost

Risk Factors	Risk occurrence mean score (P)	Rank	Risk impact mean score (I)	Rank	Degree of Risk (P*I)	Rank
Under-estimation	2.84	5	4.05	1	11.50	1
Completion delays	3.20	1	3.16	2	10.11	2
Inadequacy of cash flow	2.95	2	3.13	3	9.23	3
Default of contractors	2.91	3	2.96	9	8.61	4
Poor site investigations	2.78	8	3.09	4	8.59	5
Change in scope of work	2.78	7	3.02	5	8.40	6
Defective construction works	2.76	9	3.02	6	8.34	7
Delay in payment	2.85	4	2.84	11	8.09	8
Default of sub-contractors	2.82	6	2.67	15	7.53	9
Fluctuation in market demand	2.76	10	2.65	17	7.31	10
Defective design	2.55	14	2.84	10	7.24	11
Delay in material supply	2.71	11	2.67	16	7.24	12
Inadequate specification	2.56	12	2.80	12	7.17	13
Under-valuation	2.38	16	3.00	8	7.14	14
Non-availability of fund	2.36	17	3.00	7	7.08	15
Foreign exchange fluctuation	2.55	13	2.49	20	6.35	16
Labour strikes	2.15	21	2.78	13	5.98	17
Labour shortage	2.42	15	2.44	22	5.90	18
Use of inappropriate plant	2.22	18	2.44	23	5.42	19
Civil disorder	2.05	24	2.56	19	5.25	20
Delay in resolving disputes	2.11	23	2.44	21	5.15	21
Loss or damage in material transportation	2.15	19	2.35	24	5.05	22
Loss or damage by fire	1.8	27	2.78	14	5.00	23
Loss or damage by flood	1.78	28	2.65	18	4.72	24
Feasibility of construction methods	2.13	22	2.16	26	4.60	25
Third party delays	2.15	20	2.09	28	4.49	26
Revolutionary changes in law	1.93	25	2.25	25	4.34	27
Legal impossibilities	1.82	26	2.09	27	3.80	28

Out of the 22 data set obtained from the questionnaire survey, 17 were used to develop a multi linear regression risk impact assessment model. The remaining 5 virgin data set were used for testing and validating the model.

Using the cost overrun as a measure of risk impact as well as the dependent variable (Y_i) and the extent of occurrence of the identified significant risk factors as the independent variables (X_{ij}), a multiple linear regression model was developed which maps the relationship between the extent of risk occurrence on the budgeted cost of traditionally procured building projects. Using the simultaneous multiple regression procedure of the Statistical Package for Social Sciences (SPSS), the multi-linear regression model was developed. The coefficient of the model is presented in Table 6. From the coefficients, a regression equation can be derived as follows:

$$Y = 0.113 - 0.381X_1 - 0.205X_2 + 1.154X_3 + 0.239X_4 - 0.186X_5 - 0.847X_6 - 0.223X_7 + 0.978X_8 \quad \text{(Equation 2)}$$

Table 5: Data collected on traditionally procured building projects

Proj. No.	**Cost Overrun Y**	**Under-estimation X1**	**Inadequacy of cash flow X2**	**Completion delay X3**	**Poor site investigation X4**	**Changes in scope of work X5**	**Completion delays X6**
	(₦ mill.)*						
1	5	3	2	3	2	2	1
2	12	4	3	4	3	3	3
3	4.5	3	3	3	2	2	2
4	4.25	4	3	2	2	2	3
5	5	3	4	3	2	3	2
6	16	3	4	4	3	4	4
7	15.9	5	3	4	3	4	4
8	8.23	4	2	3	2	3	3
9	14.51	5	4	4	4	4	3
10	5	3	2	3	3	2	3
11	25	5	5	4	4	4	4
12	16	4	3	4	4	4	3
13	17	4	3	4	4	4	4
14	25	5	4	5	5	5	4
15	17.2	4	3	4	4	4	5
16	16.5	4	4	4	3	4	4
17	6	3	3	3	3	3	2
18	7	3	3	3	2	4	2
19	12.64	4	4	4	3	3	4
20	7.61	3	3	3	3	3	3
21	14	4	4	4	4	4	4
22	3.57	2	2	3	2	2	1

Figures in millions of Nigerian Naira (₦). £1.00 = ₦ 250.00 June 2007

The coefficient of multiple correlations R, which shows the correlation between the predicted and actual values of the dependent variables, gives a very good result as shown in Table 7. According to Dometrius (1992), one touchstone of a good model is its predictive power. The R square and adjusted R square of multiple regression models are means of assessing their predictive power. According to Dometrius (1992), they pre-measure the proportion of variance explained or error reduced by the model. The R square and adjusted R square values shown in Table 7 are mostly above average. The proportion of variance explained of about 74.6% is also quite promising. This implies that 74.6% of the risk impact on the budgeted cost, resulting in cost overrun is explained by the identified significant risk variables, i.e. ‘under-estimation’, ‘inadequacy of cash flow’, ‘completion delay’, ‘poor site investigation’, ‘changes in scope of work’, ‘default of contractors’, ‘defective construction works’ and ‘delay in payment’. The remaining 25.4% unexplained variance would therefore be due to some other risk factors. The validation of the model using virgin data could not be reported in this paper due to space limitation but this will be reported in future work.

Table 6: Multiple linear regression coefficients

Risk Variables	Coefficients
(Constant)	0.113
Under-estimation	-0.381
Inadequacy of cash flow	-0.205
Completion delay	1.154
Poor site investigation	0.239
Change in scope of work	-0.186
Default of contractors	-0.847
Defective construction work	-0.223
Delay in payment	0.978

Dependent Variable: Cost Overrun (Y)

Table 7: Accuracy measurement of regression model

Measure	Value
Coefficient of multiple correlation R	0.864
R.Square	0.746
Adjusted R Squared	0.545

CONCLUSIONS

This study has attempted to examine the impact of risk on the budgeted cost of traditionally procured building projects. A two-stage approach was employed in carrying out the investigation. The first was a perceptive questionnaire survey of respondents' opinions of the likelihood of the identified risk factors occurring in traditionally procured building projects and their impact in case of occurrence. Analysis of the first stage questionnaire survey enabled the determination of significant risk factors. The second stage was the use of empirical data from the archives of Contractors' Quantity Surveyors. Data requested was regarding budgeted and actual cost of recently completed traditionally procured building projects in order to determine cost overrun. Contractors' Quantity Surveyors were then requested to score on a Likert-type scale, their perception of extent of occurrence of the identified significant risk factors. The two data sets were used to model risk impacts on the budgeted cost of traditionally procured building projects.

From the first stage questionnaire survey, it could be concluded that the identified significant risk factors in terms of likelihood of occurrence as well impact in case of occurrence could be grouped under two generic headings of financial risk as well as construction risk. Financial risk would include 'under-estimation', 'inadequacy of cash flow' and 'delay in payment'. Construction risk on the other hand would include 'poor site investigation', 'completion delay', 'changes in scope of work', 'default of contractors' and 'defective construction works'. These entire factors combine together to impact the budgeted construction cost. A multi-linear regression model that was developed in the study corroborated the impact of the risk factors. About 75% of the risk impact on construction cost, resulting in cost overrun was explained in the model by the identified significant risk factors, whilst the remaining 25% of the unexplained variance would be due to some other risk factors. The predictive ability of the model indicates that it could assist in pro-actively determining the likely impacts of identified risks on the budgeted cost of traditionally procured building projects.

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