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Assessing Risk Impacts on Construction Cost

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Risk in construction is defined as a variable in the process of construction whose occurrence results in uncertainty as to the final cost, duration and quality of the project. Risk is inherent in all human endeavours, including construction activities, and the risk factors involved are diverse and varied. Using a checklist of risk factors, the study conducted a questionnaire survey of the identified risk factors in order to determine their relative importance. The questionnaire survey was self-administered on construction practitioners in contracting organisations, consultancy firms and government organisations involved in construction. Survey responses were analysed using the relative index method. In addition, risk impacts on construction cost were evaluated using multiple regression models to determine the contribution of each risk element to the total construction cost. The survey result showed that the major risk factors inherent in construction are financial, political and physical. On the other hand, the regression model showed that financial risk resulting in fluctuation claims, variation and loss and expense claims are contributory to construction cost overrun, which is an indication of risk impact on construction cost.

Keywords: construction, cost, regression model, risk, Nigeria.

INTRODUCTION

Risk is inherent in all human endeavours, including construction activities, and the risk elements involved are diverse and varied (Odeyinka, 2000). Risk has been defined in many different ways by economists, insurance scholars and construction management researchers among others. In the business and insurance domain, Knight (1971) defines risk as measurable uncertainty or uncertainty of loss. Risk has also been defined as the uncertainty that exists as to the occurrence of some events (Greene, 1973). In the light of these definitions, risk can be viewed as a psychological phenomenon that is meaningful in terms of human reaction and experience. It can also be viewed as an objective phenomenon that may or may not be recognised in terms of human reaction and experience.

In the construction management domain, Perry and Hayes (1985) and Healey (1982) defined risk as an exposure to economic loss or gain arising from involvement in the construction process. Moavenzadeh and Rossow (1976), however, regarded risk as an exposure to loss only. Bufaied (1987) described risk in construction as a variable in the construction process whose variation results in uncertainty as to the final cost, duration and quality of the project. According to Akintoye and MacLeod (1997), risk in construction has been the object of attention because of time and cost overruns associated with construction projects. Many time and cost overruns, according to Perry and Hayes (1985), are attributable to either unforeseen or foreseen events for which uncertainty was not appropriately accommodated. Thompson (1992) also identified an effect of risk on construction projects as failure to achieve the required quality and operational requirements. This is in addition to cost and time overruns which other authors also identified. Some of the major causes of risk in construction at the project level, according to Perry and Hayes (1985) and Healey (1982), include physical risk, environmental risk, logistic risk, legal risk, political risk, financial risk, contractual risk, construction risk and design risk among others. Whilst these risk factors are not unknown to the Nigerian construction practitioners, the relative likelihood of their occurrence and the impact in case of occurrence at the project level is yet to be investigated. In addition, the impact of the identified risk factors on construction cost is yet to be investigated. These are the concerns of this study.

AN OVERVIEW OF RISK IN CONSTRUCTION

The environment within which decision-making takes place can be divided into three parts: certainty, risk and uncertainty (Flanagan and Norman, 1993). According to Flanagan and Norman (1993), 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 the illusion of certainty. They submitted that uncertainty is endemic in construction and needs to be explicitly recognised 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, where the situation 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) stated that while the distinction between risk and uncertainty is recognised, the distinction is unhelpful when it comes to construction projects.

Perry and Hayes (1985), Thompson (1992) and Akintoye and MacLeod (1996) have identified risk sources in construction at the 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 the 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.

Fong (1987) and Odeyinka (2005) asserted that it is generally recognised 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 include timing schedule slippage of the project tasks, technological issues, people-oriented issues, finance, managerial and political issues (Lockyer and Gordon, 1996). Smith (1999) and 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. Lagos was chosen for data collection because 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 nearly completed or recently completed construction projects. Subjects included 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 was 16.25 years, with a standard deviation of 4.75 years. About 23% of the respondents were educated up to HND level, whilst the remaining 77% had at least a 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, view risk as being associated with the probability of cost, schedule or technical performance of a project varying. They argue that risk can 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

I = the consequence or perceived impact on a project

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 the average risk estimate. This method of risk measurement has a well-established place in decision theory domain.

Table 1: Types of organisations surveyed.

Type of organisation	Frequency	Percent	Cumulative percent
Construction company	22	33.85	33.85
Consulting firm	28	43.08	76.93
Government establishment	10	15.38	92.31
Others	5	7.69	100.00
Total	65	100.00	

Table 2: Respondents' designation.

Respondent's designation	Frequency	Percent	Cumulative percent
Quantity surveyors	29	44.62	44.62
Architects	15	23.08	67.70
Engineers	7	10.77	78.47
Builders	8	12.30	90.77
Others	6	9.23	100.00
Total	65	100.00	

Table 3: Educational qualification of respondents.

Qualification	Frequency	Percent	Cumulative percent
HND	15	23.08	23.08
B.Sc.	38	58.46	81.54
B.Sc. + M.Sc/MBA	12	18.46	100.00
Total	65	100.00	

William (1996), however, contended that rather than decreasing the two-dimensional nature of risk measure, it should be extended. Charette (1989) used 3-dimensional graphs (see Figure 1) with independent axes labelled 'severity' (i.e. impacts), 'frequency' (i.e. likelihood) and 'predictability' (in technical terms, the extent to which the risk is aleatoric rather than epistemic). William (1996) demonstrated that calculating 'expected' risk as probability multiplied by impact has limitations and that ranking risks according to this figure is misleading. William (1996) concluded that both probability and impact must be considered at all times. Taking the cue from Williams (1996) and Charette (1989) underpins the approach adopted in this study in measuring respondents' perception of risk. In this study, two-dimensional approaches to measurement of risk have been adopted, in which case the likelihood or probability of risk occurring and the impact in case of occurrence have been considered.

Out of the 100 questionnaires administered, 65 responses fit for analysis were received, representing a response rate of 65%. The questionnaire identified from literature and through discussion with industry practitioners, various risk factors encountered at the project level. Using a two-dimensional scaling, respondents were requested to score on a Likert–type scale of 0-4, the likelihood of the identified risk factors occurring and their perceived impacts in case of occurrence. The measuring scale of 0 represents a situation where there was no likelihood of occurrence or impact, while 4 represents a very high likelihood of occurrence or impact. This then gives the measuring scale the property of an interval scale, which enables the collected data to be subjected to various statistical analyses.

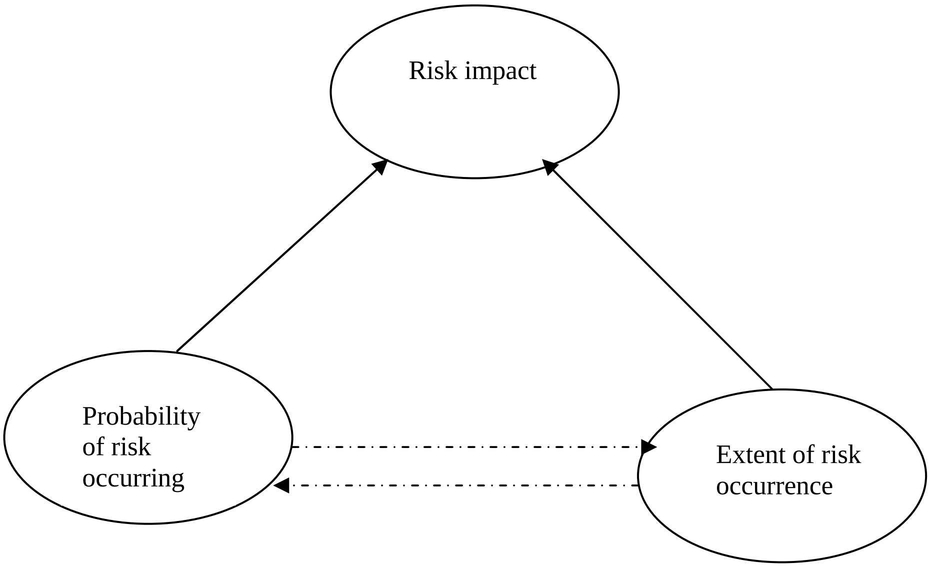

Fig 1: A three-dimensional model of risk (Adapted from Charette, 1989).

Secondary data were also collected from recently completed residential projects. Data collected include in the main, estimated contract sum, final account sum, fluctuation cost, variation cost and loss and expense claim. A research pro forma was given to construction companies and consulting firms of quantity surveyors in order to generate the needed data.

DATA ANALYSIS AND RESULTS

Data analysis was carried out by evaluating the relative importance of the identified risk factors at the project level. The numerical scores assigned by respondents were transformed to a relative importance index (RII) using the following formula:

$$\text{RII} = \sum_{i=0}^{i=4} E_i P_i \qquad \text{(Equation 2)}$$

Where:

E_i = the i^{th} likelihood of occurrence of risk factor or impact

P_i = the percentage of respondents to the i^{th} likelihood of occurrence or impact

Further analysis was carried out using multi-linear regression analysis in order to determine the impacts of the identified risk factors on total construction cost.

RISK FACTORS ASSOCIATED WITH CONSTRUCTION AT PROJECT LEVEL

An analysis was carried out to evaluate the relative importance of the identified risk factors at the project level. Table 4 summarises the result of the analysis, from which it is evident that the highest-ranking risk factor at the project level is financial risk. This is not surprising due to the fact that many construction contracts in the Nigerian construction industry are awarded without a clear indication of where the funds for the project would be made available. As a result of this, many projects are abandoned midway due to lack of funds. It is therefore not a surprise that financial risk ranks highest. Following financial risk on relative importance scale are political risk and physical risk. Political risk was a major consideration, especially during the military regimes. An on-going construction project could be stopped just because a new military government was in power. It is therefore not a surprise that this risk factor ranks next to financial risk and should therefore engage the attention of the construction contractor. Physical risk, which comes in the form of loss or damage by fire, flood, accident or soil subsidence ranks next to political risk. This is not a surprise because construction activities, being carried out in the open, are prone to a lot of vagaries in the surroundings. It is therefore another risk factor that should greatly engage the attention of the construction contractor at the project level. It is also noteworthy that for financial, political, physical and environmental risk, the ranking of the likelihood of these risk factors occurring also follows the ranking of the risk impact. However, this is not the case for other risk factors. This suggests that for these other risk factors, the order of impact does not follow the order of risk occurrence. This observation needs to be borne in mind by the construction contractor so that adequate provision is made in responding to such risk factors.

RISK IMPACTS ON CONSTRUCTION COST

A further analysis was carried out in order to determine the impact of risk on construction cost. The basic assumption of this analysis is that cost overrun is an expression of impacts of risk. Data collected for the purpose of this analysis include in the main, estimated contract sum, final account sum, fluctuation cost, variation cost and loss and expense claim (see Table 5).

Table 4: Likelihood and impact of risk factors at project level.

Risk factor	Likelihood of risk occurrence index	Rank	Risk impact index	Rank
Financial risk	2.69	1	2.86	1
Political risk	2.23	2	2.75	2
Physical risk	2.14	3	2.68	3
Contractual risk	1.74	4	2.55	5
Construction risk	1.69	5	1.45	7
Logistic risk	1.55	6	1.35	8
Design risk	1.45	7	2.63	4
Legal risk	1.40	8	1.48	6
Environmental risk	1.08	9	1.02	9

Table 5: Secondary data collected on executed residential projects.

Proj. No.	Final Account	Estimated Contract Sum	Cost Overrun	Fluctuation Cost	Variation Cost	Loss and Expense Claim
	(₦ mill.)	(₦ mill.)	(₦ mill.)	(₦ mill.)	(₦ mill.)	(₦ mill.)*
1	83	78	5	3.5	1	0
2	45	33	12	7.5	3	0
3	52	47.5	4.5	1.58	0.2	0.25
4	15.85	11.6	4.25	1.39	2	0.5
5	43	38	5	3.5	1.2	0
6	89	73	16	9.5	4.5	0.5
7	58.9	43	15.9	9.2	4.3	0.4
8	83.75	75.52	8.23	5.25	1.5	0.5
9	92.51	78	14.51	9.85	*3.5*	0
10	33	28	5	4.08	4.25	0.2
11	120	95	25	16	509	0.5
12	78	62	16	8	5.5	1.5
13	56	39	17	9	6	0.5
14	83	58	25	17	6.5	0
15	95.7	78.5	17.2	27.59	9.56	0
16	78.95	62.45	16.5	7.85	5.69	0.36
17	73	67	6	3.5	0.6	0.05
18	85	78	7	4.2	1.35	0.08
19	38	25.36	12.64	7.86	3.5	1
20	47	39.39	7.61	5.39	2	0.19
21	93	79	14	7	5	0.5
22	61.58	58.01	3.57	1.58	1.2	0.007

* Figures in millions of Nigerian Naira (₦). £1.00 = ₦ 250.00 June 2006

The proposition being tested by this data set is that the observed cost overrun (an expression of risk impact) is dependent on fluctuation cost, variation cost and loss and expense claim. The cost overrun data set was obtained by subtracting the estimated contract sum from the final account sum.

From the data set in Table 5, a multi-linear regression model was developed, taking the form:

Cost Overrun = *f* (fluctuation cost, variation cost, loss and expense claim)

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.

Table 6: Multiple linear regression coefficients.

Variables	Coefficients
(Constant)	4.26873
Fluctuation Cost (X_1)	0.76122
Variation Cost (X_2)	0.01299
Loss and Expense Claim (X_3)	3.96822
Dependent Variable: Cost Overrun (Y)	

From the coefficients, a regression equation can be derived as follows:

$$Y = 4.26873 + 0.76122X_1 + 0.01299X_2 + 3.96822X_3 \quad \text{(Equation 3)}$$

Where:

Y = the cost overrun

X_1 = the fluctuation cost

X_2 = the variation cost

X_3 = the loss and expense claim

The coefficient of multiple correlation 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 the 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 71.29% is also quite promising. This implies that 71.29% of the risk impact on construction cost, resulting in cost overrun is explained by fluctuation cost, variation cost and loss and expense claim, whilst the remaining 28.71% is explained by some other risk factors. This corroborates the findings of the questionnaire survey, which placed the highest likelihood of risk occurring and impact in case of occurrence at project level on financial risk

Table 7: Accuracy measurement of regression model.

Measure	Value
R Square	0.712901038
Adjusted R Square	0.679774235
Coefficient of multiple correlation R	0.844334672

CONCLUSION

This study has attempted to examine the impact of risk on construction cost. 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 at the project level and their impact in case of occurrence. The second stage was the use of empirical data from the archives of construction companies and consulting firms to develop multi-linear regression model so as to examine statistical relationships.

From the questionnaire survey, it was found that financial risk ranked highest in the respondents' scoring of both the likelihood of risk occurring and impact in case of occurrence. This is not surprising because in the Nigerian construction sector, there is a high instability in the prices of building materials, as most of them are still dependent on foreign components. This leads to a high degree of fluctuation in prices of building materials and components. Moreover, as most design decisions are left till construction stage, this also leads to a high level of variation and completion delays. All these factors combine together to impact on the total construction cost. A multi-linear regression model that was developed in the study corroborated the impact of the financial risk. About 71% of the risk impact on construction cost, resulting in cost overrun was explained in the model by fluctuation cost, variation cost and loss and expense claim, with the remaining 29% due to some other risk factors. The model will serve as a very good predictor of risk impacts resulting in cost overrun once data are available on fluctuation costs, variation costs, and loss and expense claims.

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