Assessment of management strategies for residual on-site related risk factors in educational institutional building projects

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Abstract. The magnitude of variance between the projected and actual performance parameters could sometimes be very high, especially in projects which involve huge elements of risk. To avert this unfortunate experience, there is need for the adoption of efficient risk management strategy. This paper therefore presents the report of an investigation conducted on strategies adopted for managing site related risk factors which impact on the educational institutions’ building projects performance. A structured questionnaire was used to collect primary and archival data from 52 building contracting organizations who were involved in the tertiary education building projects in Ekiti State, Southwestern Nigeria. A total of 39 valid questionnaires received were used for the analysis. Data obtained were analyzed using inferential and descriptive statistics. Expected monetary value, risk break-down model and human reliability assessment were identified to have higher efficiency for reducing project completion time overrun. Meanwhile, sensitivity analysis, risk break-down structure and brainstorming were found to provide better degree of effectiveness for curtailing cost overrun.

Key lesson learnt from the study is that practitioners can gain profound insight into onsite related risk management strategies suitable for building projects. The relatively small sample adopted limits the generalization of the findings. Notwithstanding, the study highlights implications for design of formalized risk management strategies specific to site operations in building projects.

Keywords: building projects, risk management, site related risk, tertiary education.

1. Introduction
Some uncertain events could be so disastrous if not properly managed that they may erode a whole fortune in a building project. An example is the power plant explosion which occurred at the start-up phase in a densely populated region (about 43,000 inhabitants) of Connecticut, USA, on 7th February, 2010 during the testing of a gas line; illustrating an on-site related risks [1]. Previous studies in the field of risk management show that the construction industry has suffered poor performance owing to failure in the adoption of appropriate risk management strategies [2]. The merits of risk management practice are enumerated as; conservation of assets, improved profitability, improved quality, improved productivity, reduced costs, improvement of construction project management processes and sustainability, and effective use of resources [3]. Risk management program is therefore a resourceful tool for actualizing the projects’ objectives in relation to cost, time, safety and environmental sustainability and other stakeholders’ parameters.

Project Management Institute [4] considers risk management as the systematic practice of management policies, procedures, and processes related to activities on the risk analysis, evaluation, and control. Thus risk management can be described as the documentation process of the final
decisions, identification and application criteria which are used to reduce risk to an acceptable level. A site related risk management strategy must therefore provide a blueprint for a well-structured and coherent process of effective management, and include an in-built mechanism that allows for regular updating, checking and reviewing of the assessment program as new experiences emerge during the construction work. For purposes of this study, management of residual on-site risk factors refer to strategies, methods, tools, models and procedures used for handling risks that have being accepted or retained after exhausting all other available risk management response options namely; risk avoidance, risk transfer, risk sharing and risk mitigation or reduction during risk management process in construction projects.

This study therefore aims at investigating the modus operandi used for the management of on-site related risk factors that impact building projects with a view to providing information that could enhance the establishment of a valuable framework for managing site related risk factors. This study focuses on exploring various strategies for risk management available in the literature and examining their degree of effectiveness at improving project performance and minimizing cost and time overrun. The study would assist in gaining insight into risk management strategies that are required for the achievement of less vulnerable construction projects.

2. Literature review
Previous studies have identified approaches for managing project risks generally. For instance, Kaur and Singh [5] report that management strategies include conducting site investigation of field survey had been applied to prevent design risk; and installation of CCTV to site location is a means of controlling risk related to insecurity [6]. Use of lump sum contract and preparation of reserves were considered for high inflation rate [7]; and increasing working hour and manpower were means of reducing risk due to shortage of manpower and equipment [7]. Moreover, purchase of insurance cover had been applied to risk due to force majeure [8].

Similar to the above, a study conducted by Chang, Hwang, Deng and Zhao [9] recognized making precise decision, carrying out good negotiations, shaping a good and conducive business environment, completing full preparations, minimizing needless errors and obtaining a logical response as effective for risk factors related to international construction projects. Other previous studies have also identified structured strategies commonly adopted for management of risks among construction industry stakeholders. These include; risk assessment and management practice (RAMP) insurance/bond/warrantee, contingency plans, forms of contracts, contingency drawdown models, special cost schedule allowance, earn value analysis, resource levelling and training [10], [11].

Structured strategies reported in [12] are shown in Table 1. Risk management practices are already in place globally, but evidence of structured strategies that are specific to on-site risk factors for building project is in the Nigerian construction industry remains a gap to be filled in by this study.

| Table 1: Site Related Risk Management Strategies |
|-----------------------------------------------|
| Risk Management Strategies | Authors |
|-----------------------------|---------|
| Brainstorming               | [13], [14], [12] |
| Cause and effect diagram or cause consequence analysis | [13] |
| Change analysis             | [12] |
| Expected monetary value     | [13] |
| Failure mode and effect critical analysis | [15] |
| Human reliability assessment | [16] |
| Interviews                  | [13] |
| Sensitivity analysis        | [13], [14] |
| Lump sum of contingencies as strategy | [17] |

Cagliano [12]
3. Research methodology
In order to identify site related risk factors associated with tertiary education building projects, comprehensive literature review was undertaken. A structured questionnaire was designed based on the review to obtain information from the construction professionals who are presumed to have industry experience and could supply useful information relating to the assessment. The study area is Ekiti State, Southwestern Nigeria. The study population consists of architects, services engineers, project managers, procurement officers and land surveyors. A survey using total census sampling technique was adopted due to the small population size. The study population comprises 52 building contracting organizations that had been awarded building contracts between 2011 and 2016 at; Ekiti State University, Ado-Ekiti; Federal University, Oye-Ekiti; The Federal Polytechnics, Ado-Ekiti, and the College of Education, Ikere-Ekiti.

The questionnaires were self-administered to the construction professionals while others were distributed via e-mail addresses. The questionnaires were meant to furnish the researchers with information on site related risks encountered during the implementation of their present and past projects. The questions focused on probability of occurrence of site related risk, their degrees of impacts on project outcome and the management strategies adopted. However, only the assessment of the management strategies is reported in the present study. Fifty-two copies of questionnaires were administered out of which only 39 were retrieved representing a response rate of 75% which was found suitable for the analysis. The factors were rated using a five-Liker t scale of 1-5, where weighting values of 5, 4, 3, 2 and 1 were attached to; very high, high, moderate, less and none scales, respectively. Data analysis was achieved using percentage, mean item score and standard deviation. The Cronbach alpha values for the frequency of occurrence and degree of impact were significant at 0.985 and 0.988 respectively, while the coefficient for the risk management strategies was 0.985.

4. Results and analysis
This section discusses the profile of the respondents and the results of the analysis

4.1 Profile of the respondents
The results of the analysis of the respondents’ profiles (Table 2) show that the highest academic qualification of 55.3% of the respondents is first degree, 23.7% possess a higher national Diploma (HND) and 21.0 % have a Masters of degree. Analysis of the respondents’ experience in the building industry shows their year of working experience estimated at average 11 years, with 21.1% of the respondents having 11-15 years and 13.2%, 16-20 years. About 23.7% of the respondents were members of the Nigerian Institute of Quantity Surveyors (NIQS), 18.4% were members of the Nigerian Institute of Builders (NIOB) and those that were members of the Nigerian Society of Engineers (NSE) were 12.7%. More than thirteen per cent (13.2%) were affiliated to the Nigerian Institution of Surveyors (NIS) and 10.5% had other professional qualifications. Respondents without professional qualification only accounted for 15.8%.

Like the education levels, the high percentage of respondents with professional affiliations is a good indication of the quality of information obtained on the assessment. Moreover, the respondents that have executed between 6-10 buildings had the highest percentage (36.1%). Respondents that have executed between 1-5 buildings represented 33.3%, and 16.7% of the respondents have executed between 11-15 buildings. Respondents that have executed between 16-20 and 21-25 projects equally accounted for 5.6%. The overall results give an indication that the respondents have considerable measure of experience in construction projects risk management. Moreover, the variety of experiences between each group enriches the research with diverse knowledge and information.
Table 2: Profile of the respondents and their organizations

| Profile                                | Criteria                           | Frequency | %    | Cumulative Frequency |
|----------------------------------------|------------------------------------|-----------|------|----------------------|
| Educational qualifications             | Master’s degree                    | 8         | 21.0 | 21.0                 |
|                                        | First degree                       | 21        | 55.3 | 76.3                 |
|                                        | Higher national diploma            | 9         | 23.7 | 100                  |
| Professional Designation               | Architect                          | 5         | 12.8 | 12.8                 |
|                                        | Quantity surveyor                  | 10        | 25.6 | 38.5                 |
|                                        | Engineer                           | 9         | 23.1 | 61.5                 |
|                                        | Builder                            | 11        | 28.2 | 89.7                 |
|                                        | Others                             | 4         | 10.3 | 100.0                |
| Professional affiliation               | Nigerian Institute of Quantity Surveyor | 9         | 23.7 | 23.7                 |
|                                        | NIA                                | 5         | 13.2 | 36.8                 |
|                                        | NIOB                               | 7         | 18.4 | 55.3                 |
|                                        | NSE                                | 7         | 18.4 | 73.7                 |
|                                        | Others                             | 4         | 10.5 | 84.2                 |
|                                        | None                               | 6         | 15.8 | 100.0                |
| Years of working Experience            | 1-5 years                          | 9         | 23.7 | 23.7                 |
|                                        | 6-10                               | 13        | 34.2 | 57.9                 |
|                                        | 11-15                              | 8         | 21.1 | 78.9                 |
|                                        | 16-20                              | 5         | 13.2 | 92.1                 |
|                                        | 21-25                              | 1         | 2.6  | 94.7                 |
|                                        | Over 26                            | 2         | 5.3  | 100.0                |
| Number of projects executed till date  | 1-5                                | 12        | 33.3 | 33.3                 |
|                                        | 6-10                               | 13        | 36.1 | 69.4                 |
|                                        | 11-15                              | 6         | 16.7 | 86.1                 |
|                                        | 16-20                              | 2         | 5.6  | 91.7                 |
|                                        | 21-25                              | 2         | 5.6  | 97.2                 |
|                                        | Over 26                            | 1         | 2.8  | 100.0                |
| Company Worth                          | <10,000,000                        | 6         | 16.7 | 16.7                 |
|                                        | 10,000,000 - 100,000,000           | 12        | 33.3 | 50.0                 |
|                                        | >100,000,000                       | 18        | 50.0 | 100.0                |
| **Total**                              |                                    | **36**    | **100.0** |               |

4.2 Risk management techniques adopted for site related risk factors
The risk management strategies (RMS) adopted by the contracting firms for site related risk factors were evaluated in Table 3. The Cronbach alpha coefficient for the variables as presented in Table 3 was satisfactory at 0.985. Out of the 34 management techniques identified from literature review, only 14 strategies were identified to be used in by the firms. These include; brainstorming, specification of ISO31000, strict adherence to occupational safety and health, contingency sum, interviews with specialists in the organization, human reliability assessment, delphi method, change analysis, event and causal factor charting. Others strategies were strengths weaknesses opportunities and threats, sensitivity analysis, expected monetary value, hazard and operализация and swift analysis.
Table 3: Risk management strategies for site related risk factors

| Risk Management Strategies                                      | Mean  | Standard deviation | Rank | Risk Management Strategies                                      | Mean  | Standard deviation | Rank |
|----------------------------------------------------------------|-------|--------------------|------|----------------------------------------------------------------|-------|--------------------|------|
| Brainstorming                                                   | 4.26  | 0.64               | 1    | Risk Register                                                   | 3.24  | 1.20               | 15   |
| Specification of ISO31000                                      | 3.95  | 0.77               | 2    | Event Tree Analysis                                            | 3.22  | 0.92               | 16   |
| Strict adherence to occupational safety and health              | 3.92  | 0.82               | 3    | Hazard Review                                                   | 3.21  | 0.78               | 17   |
| Contingency sum                                                 | 3.82  | 0.93               | 4    | Preliminary Hazard Analysis                                    | 3.21  | 0.96               | 17   |
| Interviews with Specialists in the Organization                 | 3.66  | 0.81               | 5    | Risk Probability and Impact Assessment                          | 3.16  | 1.08               | 18   |
| Human reliability assessment                                    | 3.65  | 0.86               | 6    | Pareto Analysis                                                 | 3.13  | 1.19               | 19   |
| Delphi method                                                   | 3.61  | 1.15               | 7    | Failure Mode and Effect Analysis                                | 3.11  | 1.13               | 20   |
| Change analysis                                                 | 3.55  | 1.06               | 8    | What-if Analysis                                                | 3.11  | 1.23               | 20   |
| Event and Causal Factor Charting                                | 3.53  | 1.13               | 9    | Cause and Effect Diagram Analysis                               | 3.11  | 1.05               | 20   |
| Strengths Weaknesses Opportunities and Threats                  | 3.50  | 1.16               | 10   | Fuzzy Logic                                                     | 3.05  | 1.21               | 21   |
| Sensitivity analysis                                            | 3.50  | 1.13               | 10   | Fault Tree Analysis                                             | 3.03  | 1.22               | 22   |
| Expected monetary value                                         | 3.45  | 0.89               | 11   | Monte Carlos Simulation                                         | 3.00  | 1.09               | 23   |
| Hazard and Operalization                                        | 3.45  | 1.25               | 11   | 5 Why’s Technique                                               | 3.34  | 1.12               | 24   |
| Swift analysis                                                  | 3.43  | 1.09               | 12   | Risk Breakdown Structure                                        | 3.33  | 1.20               | 25   |
| Incident Reporting                                              | 3.32  | 0.96               | 13   | Expert Judgement                                                | 3.27  | 1.19               | 26   |
| Probability and Impact Matrix                                   | 3.32  | 1.12               | 13   | Decision Tree Analysis                                          | 3.26  | 1.08               | 27   |
| Risk Breakdown Matrix                                           | 3.29  | 1.06               | 14   | Failure Mode and Effect Critical Analysis                       | 3.26  | 1.16               | 27   |

Aggregate mean 3.39
The above strategies had mean score which is greater than the aggregate mean (3.39) computed for each management strategies.

Brainstorming, specification of ISO 31000, strict adherence to occupational safety and health, contingency sum as well as interviews with specialists were highly rated. These variables have mean score of 4.26, 3.95, 3.92, 3.82 and 3.66 and thus ranked 1st, 2nd, 3rd, 4th and 5th respectively. The result of the survey showing these RMS as highly significant strategies is logical in the sense that they assist in eradicating high impact risks such as occupational accidents and quality assurance issues as construction job sites are naturally precarious due to large exposure to fire risk, theft and water damage. It is also evident from the results that two of the significant risk management strategies can be categorized as financial risks management strategies. These risk factors were contingency sum and expected monetary value ranking 4th, and 11th respectively, in overall mean score. Meanwhile, the financial RMS is adjudged to be highly significant since contractor’s cash-flow is a major determinant of project success. Their respective mean scores were 3.82 and 3.45 measured on a 5-point likert scale. The results confirm the findings of [18] that factors such as finance and site accidents are critical on construction site and thus must be managed with greater effort to reduce their effects.

The study revealed that; brainstorming, delphi method, change analysis, event and causal factor charting, strengths weaknesses opportunities and threats, sensitivity analysis and swift analysis as ranked 1st, 7th-10th and 14th respectively in the overall mean score. Their respective mean scores ranged between 3.43 and 4.26. These risk variables fall under mitigation risk management strategies which are generally used to nip the risk in the bud before it occurs. They are thus adequate for managing preventive risks [18]. The risk management strategies comprising interviews with specialists in the organization and human reliability assessment are termed assumption risk management strategies. Their respective mean score were 3.66 and 3.65 and were ranked 5th and 6th in the overall mean score. The fact that brainstorming is a top ranking strategy as revealed in the analysis portends the fact that fantastic ideas can be exhaustively and all inclusively generated when experts from all parties come together to cross fertilize ideas to build risk catalogue and response strategies.

4.3 Examination of the effectiveness of the risk management strategies

In order to examine the level of effectiveness of the RMS, secondary data collected were analyzed and the results are summarized in Table 4. From the result of the analysis in Table 4, the average percentage of time overrun was observed to be highest where training was used as a RMS (T=91.8%). This suggests that training has the least potential for reducing time overrun on projects, ceteris paribus. The results also show that the degree of the potential of other RMS to influence time overrun on building projects is in the following descending order; expected monetary value (T= 8.82%), risk break-down model (T = 12.44%), human reliability assessment (T = 15.79%), use of safety precautions (T = 20.00%), contingency sum (T = 20.38%), hazard operability (T = 21.67%), change analysis (T = 23.03%), sensitivity analysis (T = 26.92%), brainstorming (T = 32.54%), risk impact analysis (T = 51.92%), interactions among experts on issues (T = 76.92%) and risk break-down structure (T = 83.18%). These results suggest that expected monetary value, risk break-down model and human reliability assessment ranked 1st, 2nd and 3rd respectively in the degree of effectiveness at minimizing time overrun on projects while training ranked 13th.
Table 4: Degree of effectiveness of risk management techniques

| RMS                        | N   | T (%) | C (%) | R_t | R_c |
|---------------------------|-----|-------|-------|-----|-----|
| Brainstorming             | 4   | 32.54 | 0.00  | 9   | 3   |
| Contingency Sum           | 2   | 20.38 | 0.00  | 5   | 4   |
| Human Reliability Assessment | 1   | 15.79 | 0.00  | 3   | 5   |
| Change Analysis           | 3   | 23.03 | 0.00  | 7   | 6   |
| Sensitivity Analysis      | 1   | 26.92 | -57.58| 9   | 1   |
| Hazard Operability        | 4   | 21.67 | 0.93  | 6   | 9   |
| Expected Monetary Value   | 22  | 8.82  | 4.65  | 1   | 10  |
| Risk Break-down Structure | 13  | 83.18 | -4.43 | 12  | 2   |
| Risk Break-down Model     | 12  | 12.44 | 6.92  | 2   | 12  |
| Training                  | 1   | 91.80 | 16.67 | 13  | 13  |
| Use of safety Precautions | 1   | 20.00 | 6.8   | 4   | 11  |
| Risk Impact Analysis      | 1   | 51.92 | 0.2   | 10  | 8   |
| Interactions Among experts on Issues | 1 | 76.92 | 0.00  | 11  | 7   |

RMS = Risk Management Strategies; N = average number of projects where used; T = average percentage of time overrun on projects; C = average percentage of cost overrun on projects; R_t = Rank of effectiveness in reducing time overrun on projects; R_c = Rank of effectiveness in reducing cost overrun on projects where used.

On the other hand, the results further showed that the highest percentage of cost overrun was obtained where training was adopted as RMS (C=16.67%). This again, implies that training is the least effective strategy used for controlling cost overrun. Table 4 reveals that the potential of other strategies to minimize cost overrun are in descending order of; sensitivity analysis (C = -57.58%), risk break-down structure (C = -4.43%), brainstorming (0.00%), contingency sum (0.00%), human reliability assessment (0.00%), change analysis (0.00%), interactions among experts on issues (C = 0.00%), risk impact analysis (C = 0.2%), hazard operability (C = 0.93%), expected monetary value (C = 4.65%), use of safety precautions (C = 6.8%), risk break-down model (C = 6.92%), training (C = 16.67%). These results show that sensitivity analysis was found to be the most effective site related risk management strategy at curtailing cost overrun and was ranked 1st. These findings seem to support its wide adoption and application in mitigating risk in building project according to [19]. Risk break-down structure was the next most effective strategy and was ranked 2nd while brainstorming was the 3rd most effective and training was the least effective. These results again confirm the validity of brainstorming as a very high effective risk management strategy.

5. Conclusion and recommendations

The study investigated site related risk management strategies used in building projects. Findings from the study highlighted that brainstorming, specification of ISO 31000, strict adherence to occupational safety and health, contingency sum as well as interviews with specialists, had received some applications and were considered more suitable. Findings also showed that strategies such as; sensitivity analysis, expected monetary value, risk-break-down structure and brainstorming offer better efficacy for reducing project completion time and cost overrun. It was however revealed that staff training has negligible effect on project performance. A key lesson learnt from the study is that practitioners can gain useful insights into onsite related risk management strategies suitable for educational institutional projects based on criteria of contribution to cost and time performances. Recommendation of choice of appropriate management strategies is also suggested based on this criterion. Notwithstanding possible limited generalizability of the study, it highlights implications for design of formalized risk management strategies specific to site operations in institutional building projects. The study may be extended to evaluation of severity indices of the risk variables to further guide the choice of appropriate strategies and thus improve overall project performance.

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