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Exploring the Awareness of Advanced Programmatic Risk Analysis and Management Model in Managing Construction Projects in Nigeria

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ABSTRACT

Construction projects can be complicated and involve a number of risks and uncertainties which can lead to project risks and causes of a construction project's failure to achieve predefined objectives. A properly implemented risk management process will enhance the successful completion of building construction projects and thereby making the project more profitable. Risk management is an important part of construction management; various techniques have been developed for use in the management of risks in construction. However, these techniques are limited to addressing risks relating to only cost, schedule or technical performance individual or at best a combination of cost and schedule risks and yet a risk-based decision support tools are not available to adequately address risks relating to cost, schedule and quality together in a coherent framework. This study aimed at assessing the awareness and usefulness of APRAM, as it is a newly developed model/technique for managing construction project; risks relating to time, budget and quality simultaneously, as to enhance better management of construction projects. A quantitative approach was adopted for this study, and further strengthened with a well-structured questionnaire to construction firms in Abuja and Kaduna. The research employed descriptive statistics, tables, pie charts, mean score ranking and percentages in the presentation, analysis and discussion of results. Findings confirmed that there is a significant increase in the level of understanding of risk management. Also, some of the identified risk analysis techniques are very much known and aware of than others, with no awareness of APRAM in the Nigerian Construction Industry. It was recommended that there should be an increment of awareness of risk management knowledge as it will further help in the implementation of risk management practices. Also, there should be an awareness creation of risk analysis techniques as it is a means of managing construction risks effectively and efficiently. This can be done through knowledge-based and expertise training in schools, workshops and seminars.

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1.1 INTRODUCTION

One of the most important sectors of the economy that integrates a wide variety of skilled and unskilled professionals is the Construction Industry (Seeley, 1997). These professionals engage in the provision of goods and services ranging from construction, alteration, refurbishment to repairs of building and civil engineering structures. Each project is unique and has its main objectives outlined by the client and project circumstances. The Construction Industry like many other industries has substantial risk built into its root structure and due to the nature of the different activities involved, construction projects can be complicated and involve a number of risks such as uncertainties about material delivery times and costs, task completion times and costs, and the quality of work completed by subcontractors. Typical construction-related risks are unsafe working practices and failure costs and similar facts as the collapse of structures during or after construction from poor workmanship, construction materials not fulfilling specifications, unexpected poor ground conditions, groundwater leakages in construction pits damaging construction equipment, cracks in buildings adjacent to construction sites or serious annoyance by traffic jams due to delayed construction activities all have their negative impact on project success. According to Sunindijo et al. (2013), The Aspect of risk related to project construction includes; Schedule (time), Budget (cost) and Quality. Risk and uncertainties are unavoidable at every stage of the construction process but can be managed (Ibrahim *et al.,* 2011).

Various techniques have been developed for use in the management of risks in construction. However, these techniques are limited to addressing risks relating to the only cost, schedule or technical performance individual or at best a combination of cost and schedule risks and yet a risk-based decision support tools are not available to adequately address risks relating to cost, schedule and quality together in a coherent framework (Oztas, 2005). Advanced Programmatic Risk Analysis and Management model is the technique used to manage construction risk of cost, time and quality simultaneously and used to determine the cost of failure through optimal allocation of the residual budget. Imbeah (2009) demonstrated the usefulness of APRAM for managing schedule, cost and quality risk in the Construction Industry.

This study aimed at exploring the awareness of Advanced Programmatic Risk Analysis and Management Model in Managing Construction Projects in Nigeria, thus; to identify the Risks analysis techniques/Model tools used for Managing construction projects risks, to determine the level of awareness of the identified analysis techniques/model tools for managing a construction project, to determine the level of awareness of APRAM in Managing Construction project within the Nigerian construction industry and to compare the awareness of APRAM with Other identified risk techniques/model tools.

2.1 LITERATURE REVIEW

Wang et al. (2004) state that within the context of the Construction Industry, Risk has been defined as the likelihood of the occurrence of a definite event/factor during the construction process which will have a detriment on the project. Risk is inherent in all human endeavours, including construction activities, and the risk elements involved are diverse and varied (Odeyinka, 2016). Both in the Construction Industry and other industry, the success or failure of any venture strongly depend on how to deal with these risks. Oyewobi et al (2012) stated that the common consequences of the project a risk includes among others are; the cost overruns, time overrun, poor quality, and disputes among the partings to construction contracts. Hillson (2002) criticised the many definitions of risk which emphasize risk in terms of negative events which does not capture the potential positive events that could occur as opportunities to the project objectives. He classified risk as an umbrella term of threats and opportunities which, should it occur has a negative and positive effect on the project objectives respectively. Ward and Chapman (2003) strongly buttressed the criticism of Hillson (2002) that risk has been mostly associated with adversity while negating other opportunities that could have "potential welcome effect on project performance". The key objectives of risk management are to increase the likelihood and impact of the positive outcomes and decrease the probability and impact of negative outcomes Project Managers Body of Knowledge (2006).

Risk management process (RMP) is the basic principle of understanding and managing risks in a project, and consists of the main segments: identification, assessment and analysis, and response (Smith *et al.*2006). All steps in RMP should be included when dealing with risks, in order to efficiently implement the process in the project. There are many variations of RMP available in the literature, but most commonly described frameworks consist of those mentioned steps. In some models, there is one more step added, and the majority of sources identify it as risk monitoring or review.

Construction risk, which is inherent in the process, arises from such diverse issues as unforeseen conditions, weather, business climate, and resource availability. Construction risks are major elements that can significantly affect, the final cost of any project. Specifically, how these risks are allocated has a direct bearing on the final total cost. The Quantity Surveyor is at the risk of ensuring that estimated cost not exceeding the final cost and ensure the client receives its value for money. The contractor is at risk to ensure the construction is completed on time, within budget and with the quality specified and also there is risk related with Designers, Sub-contractors, Government Bodies, and External Issues. However, mitigation measures are the most recommended management method. To maximize the efficiency of risk management, the RMP should be continuously developed during the entire project. In this way, risks will be discovered and managed throughout all the phases (Smith et al. 2006). The benefits from RM are not only reserved for the project itself, but also the actors involved. The main incentives are clear understanding and awareness of potential risks in the project. In other words, risk management contributes to a better view of possible consequences resulting from unmanaged risks and how to avoid them. Different attitudes towards risk can be explained as cultural differences between organisations, where the approach depends on the company's policy and their internal procedures (Webb, 2003).

Hence, the most common strategies for risk response are avoidance, reduction, transfer and retention (Potts, 2008).

APRAM is one of the techniques that can be used as an efficient decision- support tool for the risk management of construction project failures (Imbeah and Guikema 2009). The model was developed to address the need to balance different types of project risks concurrently. APRAM permits explicitly quantified optimization of budget reserves allocation through trade-offs between technical and managerial failure risks based on the preferences of the decision-maker(s). It also allows for checking whether technical and managerial risks meet the thresholds of acceptability (Dillon et al. 2003).APRAM involves eight main steps as shown in Fig. 1. The first step in APRAM is to identify the possible alternatives for the design of the system. For example, for a building construction project, one could consider a building based on a number of different structural materials such as precast concrete, steel, or wood.

The second step in APRAM, as shown in Figure 1, involves specifying the possible components for the major portions ("subsystems") of the building such as the roof, the cladding, the foundation, etc. This step also involves conducting the preliminary cost estimate for each of the possible components for each of the subsystems of the building. The third step consists of identifying the minimum cost set of alternatives for each design configuration. For example, the minimum cost precast concrete building design would be identified, where minimum cost is based on the set of components that would just meet the minimum technical specifications for the facility. The difference between the minimum cost design for each system configuration (identified in Step 1) and the total budget is the available budget reserve for each of the system configurations. Each configuration may have a different budget reserve.

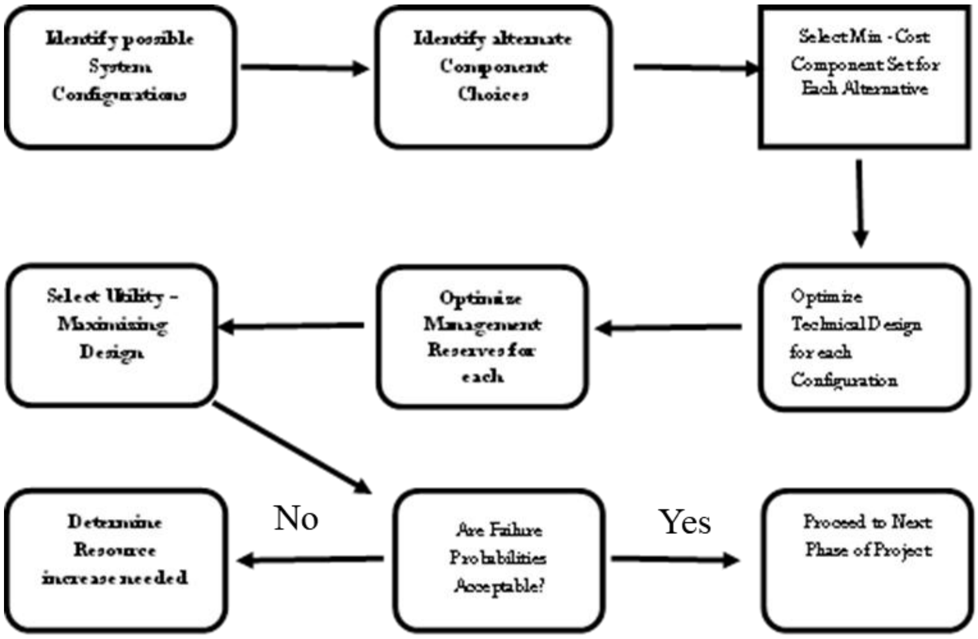

Figure: *1: APRAM process*

The fourth through sixth steps of APRAM, shown in Fig. 1, involve optimizing the allocation of the budget reserve for each system configuration and then choosing the optimal overall configuration and design. The process starts in the fourth step by analysing the possibility of improving the technical aspect of the facility by spending money from the reserves. First, this is done for technical reinforcement independently of managerial reserves (Step 4). A nonlinear optimization problem is solved for a given fraction (e.g., 75%) of the reserves that is to be spent on technical reinforcement. This optimization returns the optimal set of upgrades to components of the building given the assumed allocation from reserves. For example, the optimization may suggest that the roofing material be upgraded for increased durability but that the cladding be left at the minimum-cost level. The optimization problem is repeated for all possible allocations from the reserves from 0 up to 100%, typically discretized into 5 or 10% increments. The fifth step is similar, except that the optimization is solved for allocating money to avoid schedule and budget problems. Again, the optimization problem is solved for managerial allocations of 0 up to 100% of the total reserves. Then, in the sixth step, the technical and managerial optimizations are combined to choose the overall allocation of reserves that achieves the maximum value for each of the system configurations. Each configuration may have a different portion of the overall reserves being allocated to avoiding technical problems. With a choice of design and budget allocation made, project managers have to determine whether the level of risk for the selected alternative and budget is acceptable and if it is not acceptable, how much the budget needs to be increased to reduce the risk to an acceptable level.

The Advanced Programmatic Risk Analysis and Management Model (APRAM) is an example of a decision support framework that can be useful for the management of the risk of project failures (Dillon and Paté-Cornell 2001; Dillon et al. 2003) Examples of Risk Analysis Techniques for Construction Management.

Table 1: *Some risk analysis techniques and risks addressed*

Risk analysis technique	Addresses Schedule risk	Addresses budget risk	Addresses technical risks (quality)
Computer Aided Simulation for Project Appraisal and Review	Yes	Yes	No
Schedule Risk System	Yes	No	No
Judgmental Risk Analysis Process	Yes	No	No
Estimating Project and Activity Duration Using Network Analysis	Yes	No	No
Data Driven Analysis of Corporate Risk Using Historical Cost – Control data	No	Yes	No
Estimating Using Risk Analysis – ER	No	Yes	No
Failure Modes and Effects Analysis	Yes	Yes	Yes
Utility – Functions in Engineering Performance Assessment	No	No	Yes
Programme Evaluation and Review Technique	Yes	No	No

As summarised in Table 1, various techniques have been developed for use in the management of risks in construction. However, these techniques are limited to addressing risks relating to only cost, schedule, or technical performance individually or at best a combination of cost and schedule risks. The exceptions to this general conclusion are approaches based on Failure Modes and Effects Analysis (FMEA). FMEA addresses budget, schedule, and technical risk together, but it does so basely on ordinal, rather than cardinal, scales. That is, the different possible failure events are ranked, but the differences between the rankings for any two possible failure events are not proportional to their risk. However, FMEA does not provide a sound basis for allocating resources to manage risk. For example, if there are sufficient funds to address either a potential failure event given a score of 10 or two potential failure events each with a score of 5, which should be addressed? FMEA cannot answer this question because ordinal scales do not provide a sound basis for optimizing the use of scarce resources to best manage project risk. Next, an overview of selected construction risk management techniques is provided, focusing on approaches that do provide cardinal scales and a basis for resource allocation decisions for at least one of schedule, budget, and technical risk.

JRAP is considered a pessimistic risk analysis approach because it assumes that the actual duration of construction activity is greater than the most likely duration more than 50% of the time (Öztas and Ökmen 2005). An activity-risk factor matrix can then be established using the constraint that the total influence of all risk factors on any activity in the schedule network should be 100%. According to Öztas and Ökmen (2005), the activity-risk factor matrix quantifies the varying effect of each risk over each activity. An ERA is a methodology that can be used to determine the amount of contingency required for a project by identifying uncertainties and determining the effects of the uncertainties on the project budget (Mak and Picken 2000). To use ERA, a risk-free base estimate has to be prepared. Project risks need to be identified and these are classified as either fixed or variable. Fixed risk events are those that either fully occurs, or do not occur, whereas variable risk events are events that will definitely occur but whose extent of occurrence cannot be ascertained. An average risk allowance and a maximum risk allowance are then calculated for each risk event. With all-risk events identified and the average and maximum risk allowances calculated, the average risk allowances for all events can be summed to obtain the required contingency. Except for FMEA, none of the above-discussed approaches address schedule, budget, and technical risks simultaneously. However, these three key aspects of risk are all interrelated in construction projects.

2.1.1 APRAM Compared with other Risk management approaches

FMEA is the only other risk analysis approach among the techniques mentioned in the literature that can simultaneously handle the cost, schedule, and quality risk in construction projects. However, FMEA provides ordinal rankings of risk, not cardinal rankings. That is, FMEA can help a construction manager rank-order risks according to their likelihood and severity, assuming FMEA is implemented well and the score levels for severity and likelihood are clearly and logically defined. However, FMEA does not provide information about how much worse one risk is than another. That is, it does not provide cardinal rankings. Having cardinal rankings of risk is critical if the allocation of scarce resources is to be optimized. If a project manager does not know how much worse one risk is than another, he or she does not have a sound basis for deciding how many resources to allocate to reducing each of the risks. FMEA is appropriate for helping to identify risks and ranking risks ordinal but it does not provide a sound basis for allocating resources to optimally manage risk because it does not provide cardinal rankings.

The other risk analysis techniques discussed in the literature either address only cost or schedule risks or a combination of the two. Also, available construction risk analysis techniques such as JRAP, PERT, and SRS only provide probabilities for project parameters but do not offer any means to reduce the probabilities. APRAM thus provides a basis for a more comprehensive decision support tool that construction industry professionals can use to allocate limited resources for managing risk for construction projects when simultaneously accounting for schedule, cost, and technical risk.

3.1 RESEARCH METHODOLOGY

A quantitative research approach was adopted for this study. The quantitative research approach is explaining phenomena by collecting numerical data that were analyzed using mathematically based methods (in particular statistics). The objective of quantitative research is to develop and employ mathematical models, theories and/or hypotheses about phenomena. Descriptive research involves either identifying the characteristics of an observed phenomenon or exploring possible correlations among two or more phenomena. For this research, a well-structured questionnaire was adopted to collect data, views and opinions about the subject matter. The questionnaire that was adopted was a close-ended questionnaire which had different sections to be answered by the respondent. The first section of the questionnaire comprised of personal information of the respondent.

The second section of the questionnaire comprised of basic information on risk management practices of respondents. Two sources of data were also used to obtain data for the study; primary and secondary data. In this research, the population includes 1312 construction companies handling and managing construction projects in Nigeria. Typically, the population is very large; making a census or a complete enumeration of all the values in population is impractical or impossible, so only a subset or sample of the population will be used.

From (businesslists.com.ng), a total of 1312 Construction firms in Abuja and Kaduna State were chosen as the target population for this study, construction firm was chosen on the basis that; Majority of project risks are usually borne by contractors (Andi, 2006); this is because contractors are usually visible for almost the entire project life- cycle, hence contractors are exposed to risks and are constantly saddled with the responsibility of managing risks and uncertainties inherent in the project life-cycle.

For the purpose of this research, construction companies firms in Abuja and Kaduna State were chosen. The choice of Abuja and Kaduna State was based on the premise that they have a large concentration of Firm. To ensure that adequate representation of information was collected, the sample frame used in this study was drawn primarily from businesslists.com.ng. A total of 87 construction companies were obtained in Kaduna State and Abuja.

Making use of Kish (1965)'s formula for calculating sample size i.e;

$$n = \frac{n^1}{1 + \frac{n^1}{N}} \quad \text{..................} \quad (1)$$

Where; n = sample size

$$n^1 = \frac{S^2}{V^2}$$

N = total population
(from the list of professional).
S = maximum standard deviation in population element i.e S = (1-P)
P = proportion to the defined category, i.e p = 0.5 considering (95%).
V = standard error of the sample distribution i.e V = 0.05

The analysis of the data involved descriptive statistical operations available in the SPSS software. The quantitative data were analyzed and results of descriptive statistics obtained include frequency distributions (represented in tables and charts), measures of central tendency (means) and standard deviation.

4.1 RESULT AND DISCUSSIONS

This section is designed to analyse the responses given by the respondents via questionnaires. The research employed descriptive statistics, tables, pie charts, mean score ranking and percentages in the presentation, analysis and discussion of results.

4.1.1 Demographic Profile of Respondents

The survey elicited data from Construction firms through a structured questionnaire. A total of 87 questionnaires were self-administered in Abuja (FCT) and Kaduna state. A total of 73 questionnaires were subsequently retrieved, 5 were badly completed and were therefore considered invalid for use in the survey. Only 68 were considered and subsequently used for data analysis, signifying a 78.16% response rate. Idrus & Newman (2002) both cited in Oladapo (2007), a response rate of 30% is good enough in construction–based studies. The table below presents the response from this questionnaire survey.

4.1.2 Awareness of some risk analysis techniques/approaches

To demonstrate the validity of the responses elicited above, respondents were asked to indicate their knowledge of the level of some selected risk analysis techniques identified from the literature.

Table 2: *Analysis of responses*

Description	Number	Per centage
Number of questionnaires distributed	87	100
Number of questionnaires retrieved	73	83.90
Invalid questionnaires	5	5.74
Total valid response rate	**68**	**78.16**

Source: *Field survey (2017).*

Table 3: *Awareness of Advanced Programmatic Risk Analysis and Management model (APRAM)*

Description	Number	Per centage
Not Aware	23	39.0
Partially Aware	19	32.2
Aware	14	23.7
Very much Aware	3	5.1
Total valid response rate	**59**	**100**

Source: *Field survey (2017).*

Key: -1 = "Not Aware", 2 = "Partially Aware", 3 = "Aware", 4 = "Very much Aware",

Table 4.3 shows the responses gotten from the various respondents as to the ranking of knowledge of the level of awareness of some selected risk analysis techniques as identified from the literature, based on a Likert scale of 1 to 4 as obtained from the responses to the questionnaires. The mean gotten for the awareness of each of the identified technique, a group ranking was achieved for the awareness.

As shown from table 4.3, starting with the first technique which is Programme Evaluation and Review Technique (PERT), it was ranked first with a mean score of 2.92 and standard deviation of 1.071, followed by Estimating using Risk Analysis (ERA) with a mean of 2.69 and standard deviation of 0.915. Schedule Risk System (SRS) ranked 3rd with a mean score and standard deviation of 2.59 and (1.092), Estimating Project and Activity Duration Using Network Analysis ranked 4th with a mean score and standard deviation of2.58 and 1.102, Computer-Aided Simulation for Project Appraisal and Review ranked 5th with a mean score and standard deviation of 2.49 and 1.073, Judgement Risk Analysis Process (JRAP) ranked 6th with a mean score and standard deviation of 2.36 and 1.095, Utility Functions in Engineering Performance Assessment ranked 7th with a mean score and standard deviation of 2.15 and 0.906, Data-Driven analysis of Corporate Risk Using Historical Cost Control Data ranked 8th with a mean score and standard deviation of 2.05 and 0.753, Failure Modes and Effects Analysis (FMEA) ranked 9th with a mean score and standard deviation of 2.03 and 0.809 and Advanced Programmatic Risk Analysis and Management model (APRAM) ranked the 10th with a mean score of 1.95 and standard deviation of 0.918 respectively.

4.2 DISCUSSION

As shown earlier (table 4.2), 39.0% of the respondents indicated lack of awareness of APRAM, 32.2% were partially aware, 23.7% were aware and only 5.1% indicated very much aware of the Model. However, their level of involvement with the technique could not be assessed, considered as one of the limitations of questionnaire surveys with limited probing. Lou & Ashalwi (2009) in Oyediran & Akintola (2011) considered lack of awareness as one of the major barriers specifically acknowledged as the principal impediment to the adoption of collaborative technology environments, which is in line this study. Thus determining the level of awareness about the use of new technology in construction is of utmost necessity as a prelude to assessing the challenges and benefits encountered in its implementation.

Table 4: *Group ranking of the respondent level of awareness of some of the identified risk analysis techniques used in the construction industry showing per centages.*

Technique		Level of Awareness in Per centage						
	N	1	2	3	4	Mean	Std. Deviation	Rank
Programme Evaluation and Review technique (PERT)	59	15.3%	15.3%	32.2%	37.3%	2.92	1.071	1
Estimating using Risk Analysis (ERA)	59	11.9%	25.4%	44.1%	18.6%	2.69	0.915	2
Schedule Risk System (SRS)	59	18.6%	27.1%	23.7%	25.4%	2.59	1.092	3
Estimating Project and Activity Duration Using Network Analysis	59	18.6%	33.9%	18.6%	28.8%	2.58	1.102	4
Computer Aided Simulation for Project Appraisal and Review	59	18.6%	39.0%	16.9%	25.4%	2.49	1.073	5
Judgement Risk Analysis Process (JRAP)	59	30.5%	20.3%	32.2%	16.9%	2.36	1.095	6
Utility Functions in Engineering Performance Assessment	59	22.0%	52.5%	13.6%	11.9%	2.15	0.906	7
Data Driven analysis of Corporate Risk Using Historical Cost Control Data	59	25.4%	44.1%	30.5%	0%	2.05	0.753	8
Failure Modes and Effects Analysis (FMEA)	59	30.5%	35.6%	33.9%	0%	2.03	0.809	9
Advanced Programmatic Risk Analysis and Management model (APRAM)	59	39.0%	32.2%	23.7%	5.1%	1.95	0.918	10

Key: - 1 = "Not Aware", 2 = "Partially Aware", 3 = "Aware", 4 = "Very much Aware",

From the result presented in the previous section *(Table 4.3)*, it can be seen that Programme Evaluation and Review technique PERT ranked 1st with 37.3% of the respondents been very much aware, Estimating using Risk Analysis ERA ranked 2nd, Schedule Risk System SRS ranked 3rd and Advanced Programmatic Risk Analysis and Management model (APRAM) ranked 10th which was the last of the identified techniques and/or model. Findings confirmed that some of the identified techniques are very much known and aware of than others, but also the literature showed various techniques had been developed for use in the management of risks in construction, but these techniques are limited to addressing risks relating to only cost, schedule, or technical performance individually or at best a combination of cost and schedule risks. APRAM thus provides a basis for a more comprehensive decision support tool that construction industry professionals can use to allocate limited resources for managing risk for construction projects when simultaneously accounting for schedule, cost, and technical risk.

5.1 CONCLUSION

In view of the above findings, Construction firms partly utilise formal risk management approach in handling construction projects due to increase in the level of understanding of the formal risk management practice with departmental personnel mostly tasked with the job, and thereby concludes that Contractors handling construction projects in the Nigerian construction industry utilise both formal and informal risk management approach with the informal approach been the most dominant. The results also indicate that there is no awareness of APRAM within the Nigerian construction industry. Also, the research work concludes that the new risk analysis technique APRAM is not been aware of as some other identified analysis technique such as PERT was very much aware of within the industry.

6.1 RECOMMENDATION

In the light of the aim and objectives of the research and the above findings, this study makes the following recommendations.

i. Contracting organisations should as a matter of significance, train their project and risk management officers in the various techniques of managing project risks. This will educate and breed confidence for the utilisation of both formal and informal approaches in PRM.
ii. Contractors should have prioritized formal risk assessment in their approach in order to assess the riskier projects, plan for the potential sources of risk in each project and manage each source during construction.

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