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PRACTICAL APPLICATION OF RISK MANAGEMENT TECHNIQUES IN INFRASTRUCTURAL DELIVERY: A CASE STUDY OF GHANAIAN CONSTRUCTION INDUSTRY

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Abstract

Risk is seen as the chance of something happening that will have an impact on the achievement of the objectives of an organization or a project. Risk management is a key project management knowledge area and a tool applicable in management of project uncertainties. Project professional acquire knowledge through education or experience through practice. In their daily decision making process, practitioners rely on their expert judgment, past experience, intuition, acquired and accumulated knowledge and gut feelings to make decisions, the absence of risk management which possess a great level of uncertainty. The paper discusses some theories related to risk management, the risk management process and unveils the extent of application of risk management techniques by professionals in the infrastructural and development industry to achieve project success. The research is based on the mixed method: qualitative and quantitative approach. Analysis of structured questionnaire distributed to professionals in the built environment indicates that some 71% of built environment professionals have no knowledge about risk management theories and techniques with only 6.2% of respondents have applied a risk management tool before in their professional practice. The paper concludes by recommending that some key project management knowledge areas be included in curricula of built environment programmes to enhance professional responsibility through rather than relying on experience alone. Thus if the deficit in infrastructural development is to be closed, the key agents of infrastructural development must be abreast with effective technological knowhow through varying risk techniques.

Keywords: Risk Management, Uncertainties, Deterministic Methods, Expert Judgment, Knowledge Areas.

INTRODUCTION

According to the Royal society (1991): "At the most general level, the process of risk management can be understood in terms of the three basic elements of organizational control theory…..: setting of goals, whether explicitly or implicitly; the gathering and interpretation of information; and action to influence human behaviour…." Risk is described as the systematic application of risk management policies, procedures and practices to the task of analyzing, evaluating and controlling risk (AS/NZS 3931 1995). According to Schieg (2006) by adopting risk management, potential saving can be realized in construction projects. Although at the start of a project, the introduction of risk management can result in an increased cost of the project; this is compensated for through the advantage of risk management. The above context broadly includes setting goals and objective, identification and analysis of risk, influence risk decision making, monitoring and review of risk.

Risk management is crucial to project planning since planning without taking into account risk is meaningless. The aim of risk management is to manage the exposure by taking action to keep exposure to an acceptable level in a cost effective way. Risk management at the project level focuses on keeping unwanted risk to an acceptable minimum. Schieg (2006) postulated that the purpose of risk management cannot be over emphasized since it is needed to minimize the crises by management, minimize surprises and problems, increase probability of success of projects and better handle true cost and schedule through estimating contingencies.

AN OVERVIEW OF SOME RISK MANAGEMENT THEORIES

Various risk management theories have been postulated over the years. These theories have been used to assist in determination of risk either qualitatively or quantitatively. Prominent amongst which are the probability and set theory, fuzzy set theory, the decision theory and the Dempster Shaffer Theory. The discussions below would expose the strength and weaknesses of each theory, and their appropriate application, relating them to the larger, ongoing dialogue and theoretical debates.

Probability theory

The central objects of the probability theory are random variables, stochastic process and event: mathematical abstractions of non-deterministic events or measured quantities that may either be single occurrence or evolve over time in an apparently random fashion. It builds on some ideas of the theory of semi sets, but also introduces more radical change: for example all sets are formally infinite. The alternative set theory is an alternative mathematical approach to the concept of set. This differs significantly from the Zermelo-Frankel set theory. Some researchers have combined probability using simulation to determine the degree of uncertainty. In the construction field however, the above has been prominent using sensitivity analysis, expected monetary value and decision tree analysis during the quantitative risk assessment process. Ali (2005) holds that most cost estimates prepared for construction projects lacks any rigorous risk analysis and hence proposed the application of risk analysis method in the estimation of the expected cost of a project, hence the predominant challenge of cost overruns and abandonment of most project.

Decision theory

Closely related to the probability theory is the decision theory; relating to decision making. It is concerned with identifying the values, uncertainties and other issues relevant in a given decision, its rationality and the resulting optimal decision. Thus the decision theory focuses on some aspects of human activity and how to use freedom; it is focused on goal-directed bahaviour in the presence of options. Mendoza (2002) states that descriptive decision making offers an account of the way people actually make decision and a discussion on the mechanism underlying this bahaviour. Normative decision theory is concerned with principles underlying rational decision making. It is concerned with identifying the best decision to take assuming an ideal decision maker who is fully informed, able to compute with perfect accuracy and fully rational. NAS (2005) observed that in decision theory, risk is defined as variation in the distribution of possible outcomes. NAS (2005) observes that in applying the decision theory, risk should be seen as probability distributions with uncontrollable random events; risk management should synthesize individual risk into one factor, quantify risk numerically and emphasized probability distribution over all conceivable outcomes.

Fuzzy set theory

Fuzzy set logic introduced by Zadeh (1965) was to tackle uncertainties related to uncertainties. It consists of a set whose elements have degrees of membership. The above theory was introduced as an extension of the classical set theory to help demystify the challenge of delimiting things not always clear. Minassian and Jergeas (2009) stated that the vagueness or imprecision in communicating arises due to uncertainty resulting from the vagueness of and ambiguity in language. The authors further indicated that uncertainty may come in three basic forms: fuzziness resulting from vagueness, ambiguity resulting from discord (conflict or dissonance) and ambiguity resulting from non-specificity, resulting from not clearly stating or distinguishing alternatives.

Nsirzadeh et al (2008) affirms that the introduction of fuzzy logic system dynamics could provide the decision maker with efficient information regarding uncertainties in system behaviours. Minassian and Jergeas (2009) stated that vagueness is associated with the difficulty of making sharp or precise distinctions (that is anything vague cannot be delimited by sharp boundaries). Thus imprecise subjective information most likely leads to wrong decision been communicated. It is upheld that the challenge over the years is that classical set theory and probability theory failed to provide precise solution for situations described as fuzziness hence the emergence of the fuzzy set theory. In recent times, fuzzy set logic, fuzzy if-then logic rules, the Zedah extension principles and interval arithmetic have been applied in the risk management process. The above process have been used in risk identification, risk analysis, risk response planning and risk control.

Dempster Shaffer theory

The Dempster-Shafer theory (DST) also known as the theory of belief functions is mathematical theory of evidence, a generalization the Bayesian theory of subjective probability. The theory was initially developed by A.P. Dempster (1967) with the seminal work by Glenn Shafer (1976), but the kind of reasoning the theory uses can be found as far back as the seventeenth century, with the theory coming to the attention of researchers in 1980 when they were trying to adapt probability theory to expert systems.

Whereas Bayesian theory requires probabilities for each question of interest, belief function allows one to base degrees of belief for one question on the probabilities for related questions. In the real case scenario, these probabilities may or may not have the mathematical properties of probabilities; how much they differ from probabilities will depend on how closely the two questions are related (Sentz, 2002). Previous research by Nikolov et al (2008) acknowledged that the well known probability theory can effectively model uncertainty. However, there is some information probability cannot describe hence the need for a formalism that helps to overcome the problem. In the traditional probability theory, evidence is associated with only one possible event. In the DST, evidence can be associated with multiple possible events; hence evidence can be meaningful at a higher level of abstraction without having to resort to assumptions about the event within the evidential set.

The Dempster Shaffer theory is based on two ideas: the idea of obtaining degrees for one question from subjective probability for related questions, and the Dempster's rule for combining such degrees of belief when they are based on independent items of evidence (Sentz, 2002). Implementing DST in a specific problem generally involve solving two related problems. First one must sort the uncertainties in the problem into a priori independent item of evidence. Second, one must carry out the Dempster's rule computationally. Interestingly, sorting out the uncertainties into independent items lead to a structure involving items of evidence that bear on different but related questions, and this structure can be used to make computations feasible. Where the evidence is sufficient enough is to permit the assignment of probabilities, to single vents, the Dempster-Shafer model collapses to the traditional probabilistic formulation. (Sentz, 2002) holds that the Dempster's theory is designed to cope with varying levels of precision regarding the information and no further assumption are needed to present the information. It also allows for the direct representation of uncertainty of the system response where an imprecise input can be characterized by a set or an interval and the resulting output is a set or an interval.

RISK MANAGEMENT

As project uncertainty increases, there is increased project budget, increased duration, increased planning effort, increased number of project activities in the planning network, increased number of design cycles, increased number of design reviews, delayed final design, increased need for exchange of information outside of formal meeting and documentation, increased management attention and effort, increased system engineering effort and increased quality management effort. There is hence the need to apply appropriate risk management techniques and efforts to minimize the possible impact of high uncertainty and if possible eliminate the risk. The risk management process is described as the systematic application of management policies, procedures and practices to the task of establishing the context, identifying, analyzing, evaluating, treating monitoring and communicating risk (AS/NZS 4360:1999, Risk Management).

Risk Management Planning

It is the first step towards understanding which risk threatens your business or project and how effective your risk treatment strategies might be. The purpose of risk management planning is to profile the risk, to develop a good understanding of the objective of the project to be undertaken, synchronize it with the business plan and concur it with overall risk management plan of the organization. Risk management planning is not concerned with specific project risk but the omnibus risk on the project. It refers to the process of creating a road map for the other listed five (5) risk management processes. By creating a risk management plan for the project, one is being deliberate and proactive with risk on the project. The process of risk management planning defines what level of risk will be tolerated for the project, how risk would be managed, how risk will be categorized, who will be responsible for risk activities, the amount of time and cost that will be allotted to risk activities and how risk finding would be communicated.

Qualitative Risk Management

Qualitative risk analysis includes methods for prioritizing the identified risk for further action such as quantitative risk analysis and risk response planning (PMBOK, 2004). It is the creation of a shortlist of the previously identified risk (Rita, 2005). This is done on the project in order to determine which risks are highest priorities on the project, which risk needs a response, a probability impact on the project (high, low, medium), the overall risk ranking for the project. Qualitative risk analysis assess the priority of identified risk using their probability of occurring, the corresponding impact on the project objectives if the risk do occur as well as other factors such as the time frame and risk tolerance of the project constraint of cost, schedule, scope and quality (PMBOK, 2004). In the application of qualitative risk management, the following tools and techniques are applied:

1. Risk probability and impact assessment;
2. Probability and Impact Matrix;
3. Risk data quality assessment;
4. Risk categorization;
5. Failure Modes and effect analysis;
6. Pareto Diagrams;
7. Project Definition and Rating Index;
8. Risk urgency assessment;
9. Influence diagrams;
10. Root cause analysis.

Quantitative Risk Management

According to Khedr (2006), quantitative risk analysis is the process of quantifying the total impact of risk imposed on the project using various simulation scenarios. This is performed on risk which has been prioritized by the qualitative risk analysis process as potential and substantially impacting the project's competing demands. The quantitative risk analysis process analyses the effect of those risk event and assigns a numerical rating to those risks. It also presents a quantitative approach to making decision in the presence of uncertainty (PMBOK, 2004). Rita (2005) stated that the process seeks to determine which risk event warrants a response, determine the overall project risk, determine the quantified probability of meeting project objectives, determine cost and schedule reserves, identify risk requiring the most attention and creating a realistic and achievable cost, schedule or scope targets. Tah and Carr (2000) postulated that the risk analysis process is the stage at which the various aspects of each risk- likelihood, severity, and timing together- with the risk dependency chain, are used to determine the effect of the risk on the project and the tasks within the project.

In the application of quantitative risk management, the following tools and techniques are applied:

1. Sensitivity analysis;
2. Additive models;
3. System dynamics;
4. Expected monetary values (EMV);
5. Decision tree analysis;
6. Multivariate statistical models;
7. Modeling and simulation;
8. Artificial Neural Networks (ANNs);
9. Analytical Hierarchy process;
10. Fuzzy set theory;
11. Theory of constraints.

Risk Response Planning

Piney (2002) holds that for project risk to be carried out effectively, all the steps from risk management planning to risk monitoring and controlling need to be integrated consistently in line with the project objectives and the risk tolerances of the stakeholders. He affirmed that where a number of potential responses are available for dealing with any risk, an agreed method is required in order to select the preferred choice. According to Schieg (2006), the process involves active influence of the risk determined in the context of the risk analysis. Measures of dealing with the risk can be differentiated between cause related and effect related measures. Cause related measures are supposed to avoid or reduce risk, while effect-related measures serve to reduce or safeguard against the amount of damage or loss to be expected in the event of the damage or loss entailing event.

Crowe (2000) summerised the process of risk response planning as the process involves making negative risk smaller or eliminated entirely, finding ways to make positive risk more likely or greater impact, determine which risk to accept through strategies are agreed upon in advance, determine primary back-up strategies and assign risk to individuals or group (risk owners). Several risk response strategies are available, and a strategy or mix of strategy most likely to be effective should be selected for each risk.

Risk Monitoring and Controlling

According Tah and Carr (2000), risk monitoring and controlling represent the final stage of the risk management process but does not represent the end of the risk management cycle, since this stage is very important and probably second only to the risk identification process. The risk monitoring and controlling is the process of identifying, analyzing and planning for newly risk arising, keeping track of the identified risk and those on the watch list, reanalyzing existing risk, monitoring trigger conditions for contingency plans, monitoring residual risk, and reviewing the execution of the risk response while evaluating their effectiveness. Other purposes of risk response planning are to determine if assumptions are still valid, communicate risk status to stakeholders, revise risk ranking as necessary, taking corrective action to adjust risk severity, update risk and project plan as necessary, create a database of risk data to be used in organization and other projects. According to Schieg (2006), since the goal of risk management is to eliminate all risk completely from the project, if it is possible, it is imperative to monitor all risk to guarantee that the risk position of the project corresponds to the risk situation strived for.

RESEARCH METHOD

Population

This paper is based on a mix methodological approach of data collection: quantitative and qualitative procedures. With the application of the quantitative data collection, a survey questionnaire was designed and administered to stakeholders and professionals in the built environment working on developmental projects in Ghana to gather data to determine the risk impact of scope changes in the various work sections and its eventual effect on the contingency margins of the project. The sample size for this work was determined using the statistical relation by Kumar (1999); Clarke and Cook (1998). In all, 204 questionnaires were distributed and 118 (57.8%) were retrieved as depicted in table 1.

Table 1: Questionnaire Distribution by Demography

Type of Respondent	Total Out	No. Of Responses	Proportion of total Sample Size (%)
Consultants	115	58	50.43%
Client's firms	40	34	85.00%
Contractors	49	26	53.06%
Total	**204**	**118**	**57.84%**

Questionnaire Design and Data Collection

Various risk factors were identified during literature review, and these factors together with expert knowledge based on ethnographic studies enabled the identification for further field studies. The instrument listed risk management techniques and for respondent to indicate their conversance with the techniques and whether or not they have applied it before. Respondents were given three weeks to fill the questionnaires after which the questionnaires were personally collected for analysis.

DATA ANALYSIS

Professional background of respondents

Analysis of responses indicates that 62% of the respondents were quantity surveyors, the principal consultants who deal with cost studies of construction projects, 24% Engineers and 7% Architects.

Table 2: Questionnaire Response by Profession

Profession	Total Responses	Proportion of total Response (%)
Quantity surveyors	74	62.71%
Architects	9	7.63%
Civil/structural Engineers	29	24.58%
Others	6	5.08%
Total	118	100%

Engineers and Architects of most firms' visited were hesitant in collecting the forms indicating that the scope of the above studies with risk analysis as focus should be limited to quantity surveyors further holding that they don't have enough theoretical and practical knowledge about risk management. The category above indicated as others includes Professional Builders, Project Managers, Arbitrators, etc who are also party to the construction process.

Reliability of Respondents

Membership of professional bodies and years of experience was used a means of assessing respondents' competency and expertise.

Of those who practice as quantity surveyors, 58% were professional members of the Ghana Institution of Surveyors, of those practicing as Engineers who filled the questionnaires, 62% were practicing as professional members of the Ghana Institution of Engineers. Of those who practice as Architects, 33% were professional members of the Ghana Institution of Architects. In terms of years of experience, it was observed that 42.5% respondents had between 2 to 5 years of experience. While 19% had practiced for between 6 to 10 years, 7% of respondents had practiced for 16 to 20 years while 9% had practiced for 25 years as depicted in figure 2 below.

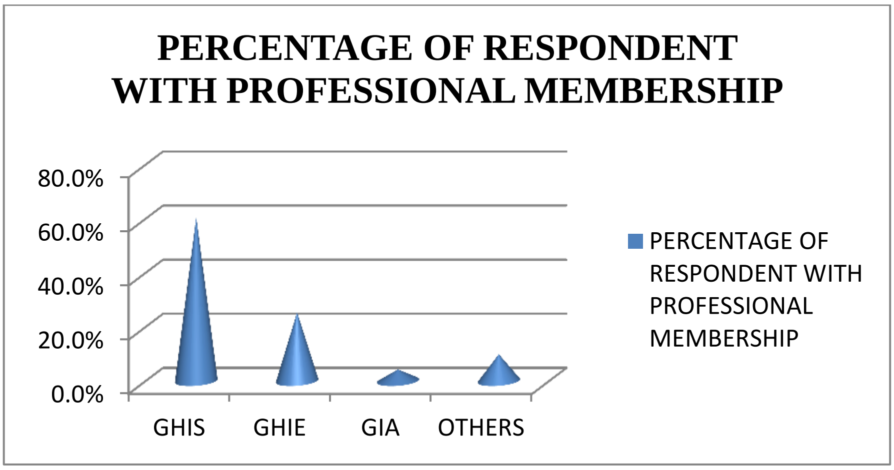

Fig 1: Representation of Respondents with professional membership.

The reason for majority, over 60%, of responses being in the category 2 to 10 years in practice is that most practitioners direct questionnaires to field staff of the modal years of experience to handle them whilst they direct them in filling them, while they concentrate on other duties. With the majority of respondents having affiliation with professional bodies who have tested them through both written and oral examinations coupled with modal level of experience of the majority of respondents, we are sure to have a true picture of the facts on the ground in terms of estimating contingencies for construction projects.

Types of Projects executed by Respondents' firms

An average of 69 out of 115 (60%) respondents practice in the building industry, some 34 out of 115 (38%) are into the design, construction and management of roads, bridges, culvers, drains and other civil engineering projects. This indicates that the building construction industry represents a greater portion of the infrastructural drive in Ghana. The above is evident in the level of development with respect to roads, drains, railways and ports in Ghana.

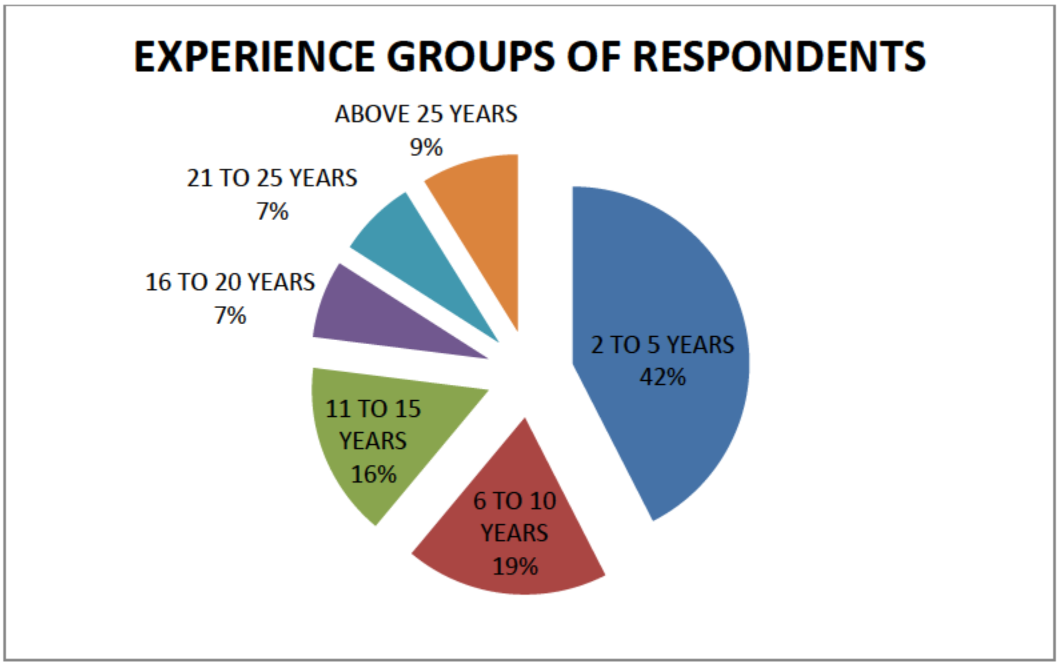

Figure 2: Experience of Respondents

Knowledge about Risk Management Methods and Techniques

Concerning the general knowledge about risk management techniques, some 18 out of 30 responds indicated that they have used sensitivity analysis before. Interestingly however, only 27 out of 118 (22%) of respondents have knowledge about root cause analysis out of the 27 some 15 have applied the method before. The study further revealed that 9 out of the 118 (7.63%) respondents had knowledge about the additive models, of which none of the respondent has actually applied the method before. Study further revealed that out of the 22 respondents who have knowledge about project simulation before, only 7 had have applied the risk method before. Again, some 20 respondents (16.95%) had knowledge about stochastic simulation, with 6 out of twenty having applied the method before. Analysis of the field survey indicates that out of the 16 respondents who have knowledge of system dynamics, only 1 has actually applied the risk management method before. The artificial neural network is the least known risk management method with only 3 people having knowledge of it and 1 respondent having used the method before. Some 3 out of the 20 respondents who have knowledge about Pareto diagrammes have actually applied the method on one or more construction projects before.

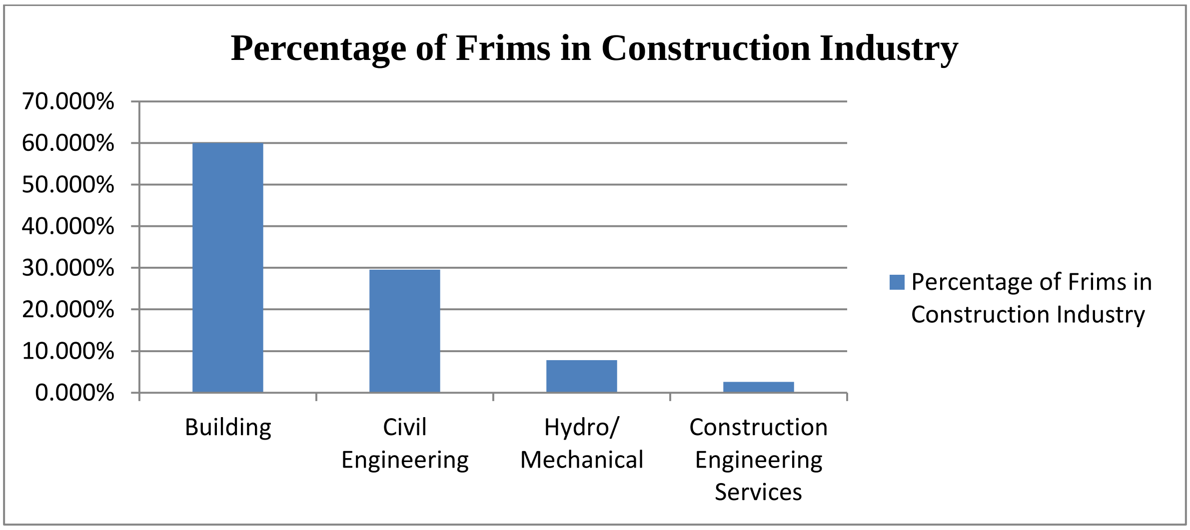

Figure 3: Representation of firms various segments of the Construction Industry

On the average some 16 out of 118 (13.6%) respondents have knowledge of at least one the 19 risk management technique list in question 2 of the questionnaire. Out of the 16, an average of 7 (43%) respondents has applied the said risk management technique on a construction project at one time or the other. In relation to the total responses, 7 out 119 (5.88%) have used a risk management tool before.

From the foregone discussions based on analysis of the field survey coupled with the supplementary information from respondents, some 90% of the respondents have knowledge about the deterministic methods out of 98% of this number some use percentages (deterministic methods) of determining contingencies on their daily projects. It is interesting to note that based on ethnographic studies on some 20 consultancy firms visited for discussions and interviews, 18 uses the deterministic methods, while one uses Monte Carlo simulation and the last uses detailed percentages which is still a form of deterministic method.

FINDINGS

The study has shown that out of those practicing in the main line professional firms, at least 51% are members of recognised professional institution such as the Ghana institution of Engineers, Ghana institution of Architects and the Surveyors. This means they are held to experts in the professions they belong to and cane be relied for professional competence.

Table 3: Respondents Knowledge about Risk Management Techniques

Item	Method	Have Knowledge of	Have Knowledge of (%)	Applied Before	Applied Before (%)
1	Sensitivity analysis	30	26.09%	15	13.00%
2	Root cause analysis	27	23.48%	15	13.00%
3	Additive models	9	7.83%	0	0.00%
4	Risk buffering	15	13.04%	5	4.30%
5	Project simulation	22	19.13%	7	6.10%
6	Stochastic simulation	20	17.39%	6	5.20%
7	Repeated risk assessment	14	12.17%	6	5.20%
8	System dynamics	16	13.91%	1	0.90%
9	Multivariate/ statistical analysis	10	8.70%	7	6.10%
10	Artificial Neural network	3	2.61%	1	0.90%
11	Pareto diagrams	20	17.39%	3	2.60%
12	Influence diagrams	17	14.78%	5	4.30%
13	Root cause analysis	20	17.39%	9	7.80%

14	Impact and Probability analysis	20	17.39%	11	9.60%
15	Failure modes and effect analysis	11	9.57%	3	2.60%
17	Project definition rating Index	14	12.17%	5	4.30%
18	Methods of moments	12	10.43%	6	5.20%
19	Analytical hierarchy process	10	8.70%	5	4.30%
20	Monte Carlo simulation	19	16.10%	3	2.64%
21	Factor rating	15	12.71%	9	7.83%
22	Range estimating	20	16.95%	10	4.63%
23	Fuzzy sets/logic	8	6.78%	1	0.85%
24	Theory of constraints	17	14.41%	4	3.39%
25	Deterministic estimation (Percentages)	105	88.98%	103	87.29%

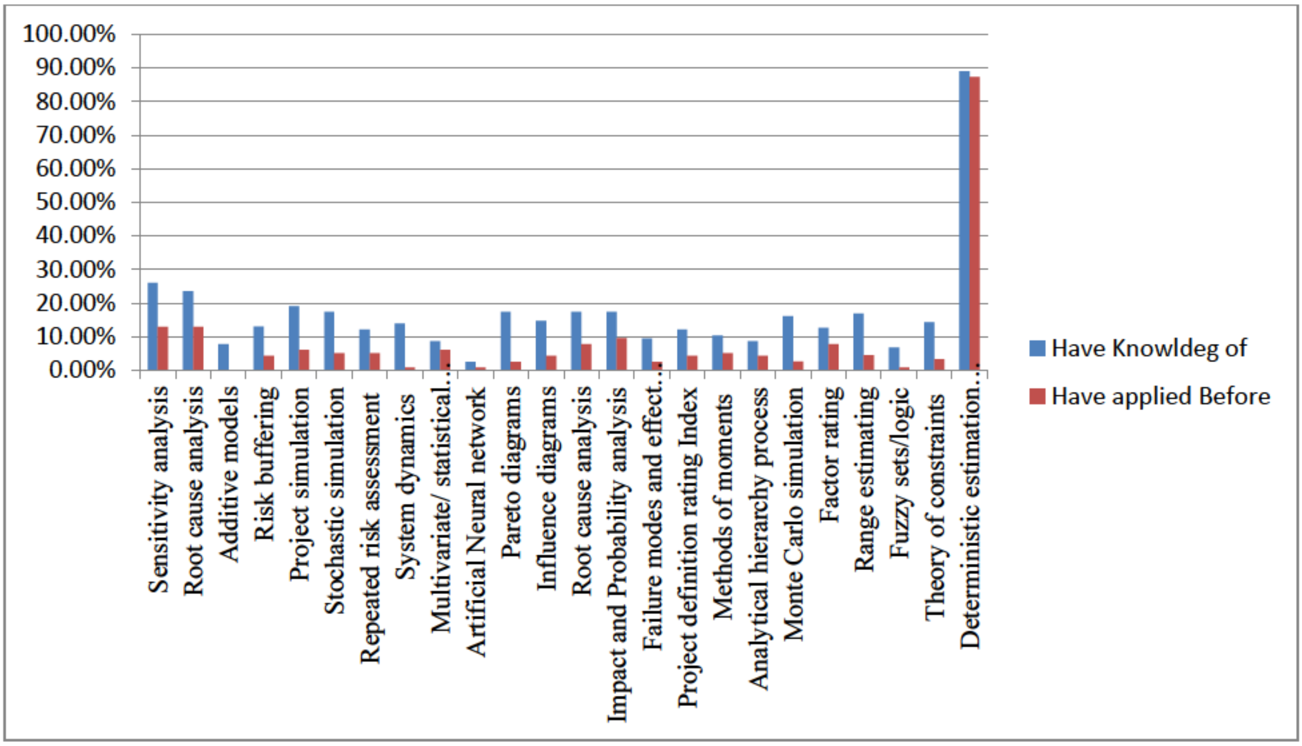

Fig 4: Proportion of Respondents with Knowledge about Project Risk Management

Secondly, it can be held that though a sizeable professionals practicing have 10 years of experience in the field and have worked on most projects before, their knowledge base about risk management techniques in the construction profession is shallow. Findings show that only 13.9% of respondents have knowledge in particular risk management techniques. It can be held further that only 7.07% of the respondents have applied these risk management techniques before. The least known methods are the additive models, system dynamic, artificial neural network, failure modes and effect analysis an 98% of respondents are used to the deterministic method of contingency estimation. The above is the method applied on a day to day basis in construction and consultancy firms during tender and contract documentation. The above is the highest rated risk management technique since that is what is known applied in most offices of the built environment, to estimate contingencies.

On the question what was the average deterministic percentage used and why, 85% of respondents indicates that they use 10% of the total project as contingency, 10% uses 20% of the total project as contingency and, some 2% uses 5% with the remaining 3% either 15% or greater than 20% but none indicated that they used contingency less than 5%. On the basis of determination the contingency sums, the respondents indicated that these were based on experience from past projects, current prices indices and the volatility of the economy, extent of scope definition and completion of design and the nature/type of the client. Private clients are known not to face financial challenges and complete projects on time hence not affected much with price fluctuations, though they are known to issue so much variation and change orders. The public sector client however always has challenge of finance hence experiencing extended delays and price fluctuations hence have higher contingency margins.

During field survey, majority of respondents returned the questionnaires unfilled indicating that they neither have no knowledge about risk management nor have applied a risk management technique before making their ability to respond to the questionnaire very abysmal. Some 21 questionnaires were not filled because respondents could not comprehend the risk related nature of the exercise.

Pedagogy of Risk Education at The Tertiary level Built-Environment Programmes in Ghana

The above issue of knowledge about risk management brings to the fore the content of the courses students go through at the tertiary level. A quick review of the content of Built environment programmes at the Higher National Diploma (HND) level for Building/ Construction Technology (BT) / and Civil Engineering reveals that little education and application of certain project management knowledge areas are available. Risk as a knowledge area in project management is shallow however other knowledge areas such as procurement, quality, schedule and cost are taught in detail with respect to the construction technology programme.

At the degree level, programmes such as Architecture, Construction Technology, Quantity Surveying and Engineering showed no evidence of a formal unit of Project Management until recently. The courses in Construction Technology, Quantity Surveying have isolated traces of risk in Construction Economics with emphasis on investment appraisal and development economics. The content of Risk as a knowledge area in project management is however on the marginal side.

To date however, programmes in Architecture and Engineering do not have any formal modules in project management. It is interesting to note that the aforementioned professional plan and design phase of projects before cost estimates are evolved to enable physical execution. One would thus wonder the extent of risk management process considered before the final designs are completed.

Based on the framework in figure 5 below, a minimum composite risk management process involving risk identification, qualitative risk management, quantitative risk management, risk quantification, cognitive risk response planning, risk monitoring and control and risk review are important aspect of the risk management process recommended by the authors for incorporation into the curricula built-environment courses. It is interesting to note that for each of the above mentioned process, there are corresponding techniques which are very important practitioners to know. The risk techniques are the rudiment which are used to the practice risk management at all levels of practical lives.

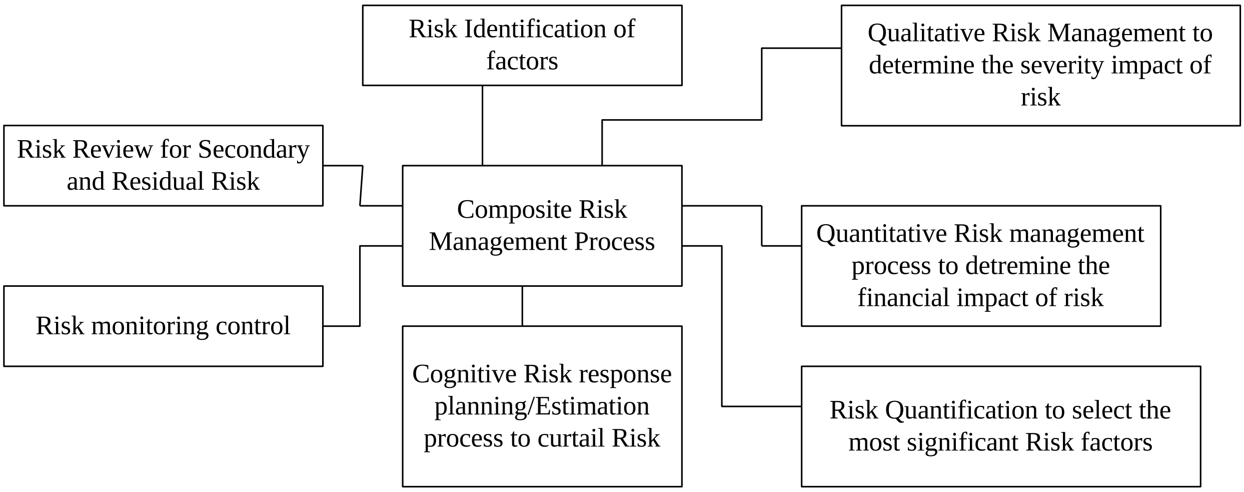

Fig 5: Framework for the Introduction of Risk Management into Educational Curricula

IMPLICATION AND CONCLUSION

Park et al (2005) in Russel (1991) observed that more than 60% of construction contractor's problem is due to economic factors. Xuequing (2005) observes after studying critical success factors of infrastructural projects held that most projects are abandoned at just 30% way completion. Danso et al (2000), held that at least 25% of all project executed in Ghana are completed behind schedule. The above could be attributed to lack of knowledge of appropriate risk management techniques and appropriate skills to be applied by practioners for assessing the success and viability of a project or otherwise.

The success or otherwise of developmental project depends on the extent to which key parameters to the project are analysed, modeled and subjected to risk. From the data gathered it can be concluded that most construction professionals are shallow in the application of risk techniques to infrastructural projects. The above challenge cannot however be directly attributed to them since the content of their educational carrier did not include enough risk methodologies. The challenge of the application of risk has the potency of producing challenged projects. Since the stakeholder satisfaction is the key to project management, the deviation of any project attribute from the optimum expectation of the stakeholder is a challenge. The total project success and satisfaction is thus the achievement of the omnibus project objective, achievable though a systematic risk management process.

Though in Ghana, knowledge of the application of risk is gained through experience, the inclusion of certain project management knowledge areas in the built environment programmes if very critical, which would eventually enhance the success of the total project since risk is anything that affect a project good or bad.

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