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Project Cost Contingency Estimation in Ghana: An Integrated Approach

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Abstract- The process of cost contingency estimation has been one process which lacks a well defined framework. Practitioners to date rely on their past experience, historical data and organizational culture to estimate cost contingency. The above mentioned process has detrimental effect on the execution phase of the project since it lacks any scientific basis and a structured risk management approach. This paper discusses the cost contingency estimating process and proposes a framework to improve upon the practice. The paper adopts a mixed approach with the distribution of 204 questionnaires to construction clients, professionals and experts in the built environment receiving a response rate of 57.8%. Findings show that at least 95% of the Engineering Design Actors (EDA) primarily used traditional methods. The research revealed that the reasons why these actors predominantly used the deterministic method was the ease of application, unavailability of any tested and approved framework and finally because most of these actors lacked the requisite knowledge for applying complex risk analysis process. The improvement of the above process relies on the need to develop a framework to suit the Ghanaian environment, re-training professionals to acquire knowledge in risk analysis and the need to re-orient the educational curricula to feature emerging needs of the industry.

Keywords: Engineering Design process, organizational culture, risk analysis, traditional deterministic methods, cost contingency

Introduction

Cost estimating is one of the most important steps in project management. It establishes the baseline of the project cost at different stages of the project development. A cost estimate at a given stage of the project development represents a prediction of the cost by the engineer or estimator on the basis of data available. One of the most difficult and subjective tasks in project cost management is the process of estimating and budgeting. During the process of cost production by cost engineers and value engineers, numerous assumptions are made. For example, for construction projects based on bills of quantities, contractors have been found to base their computations of the price rates for each item of work on many assumptions, a situation which introduces some high degree of subjectivity to the submissions from the contractors. Depending on the completeness of design, predicted design variations and certainty of the construction technology, contingency sums may vary accordingly. The PMI (2004) however holds assumptions as factors which for the purpose of a project are known to be true and justifiable. In project estimation however, most of these assumptions are based on intuition, past experience and forecast.

All businesses are a form of risk taking and have a certain degree of uncertainty associated with them; the construction industry is not an exception. The process of estimation in itself is characterized by uncertainties with a certain degree of risk always associated with it. Since the determination of an adequate risk is very crucial for achieving success in the realization of project objectives, the allocation of low amounts of contingency for projects with high risk may result in significant losses. Differently stated, high amounts of contingency may as well decrease the chances of a contractor winning a contract (Sonmez et al 2007).

Due to the sensitivity of project success to contingency margins, the risk tool employed during the quantitative risk analysis for the determination of contingency is very critical. Tools such as expert judgment, sensitivity analysis, decision tree analysis, expected monitory value analysis and Monte Carlo analysis, come to mind; with each having its own advantages and disadvantages. In recent times, the Monte Carlo simulation technique has been generally used to support contingency decision by modeling major cost components as a random variable (Curran, 1989; Ahmed, 1992; Tuoran & Wiser, 1992). Previous research by Kangari (1995) has suggested that several factors have posed as risk factors. These include defective design, differing site conditions, poor scope definition and delayed payment of the contractors. These factors were presented as high risk importance causing possible cost overruns.

Theoretical Framework

Decision theory is concerned with making decisions, identifying the relevant 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

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(2005) observed that in decision theory, risk is defined as variation in the distribution of possible outcomes. It was further observed that in applying the decision theory, risk should be seen as probability distributions with uncontrollable random.

Conceptual Framework and Empirical Review

Several models have been formulated for managing risk on construction projects. However, since each project is uniquely consistent with varying localized economic indicators, no single risk management process has been able to provide the best logically consistent framework for managing project risk universally. In the traditional deterministic approach of project cost estimating, the most likely cost of the project is estimated and a percentage of the likely project cost is added as contingency to cater for risk and uncertainties. This approach is unscientific and inadequate in handling risk in a logical way as does systematic risk management. To determine a realistic contingency margin, Ali (2005) holds that this must be estimated using risk management process, which he recommended for further research. Consequent to the above, as applied in Ghana, assigning a contingency percentage to the budget for overruns is an overly simplistic approach based solely on experience and intuition; in fact, the very act of assigning some preset percentage denotes the arbitrariness of this system. The absence of any scientific basis of determining contingencies in a third world country like Ghana which is prone to unstable price indicators, saddled with the challenge of a well aggregated scope definition and a proper preliminary risk assessment of cost, leaves much to be desired.

Ford (2002) held that there is no evidence of formal standardized models or prescriptive contingency management method, or advanced objective analysis tools directed at the contingency management. The above hypotheses was evaluated and tested to be true, which was further confirmed by Touran (2003), Rifat et al (2007), Suat (2007) and Keith (2011). Cost contingency is an essential part of project cost estimating; which in turn is the keystone of cost engineering and Total Cost Management (TCM), a thorough integrated risk approach is essential in the process of estimating cost contingencies.

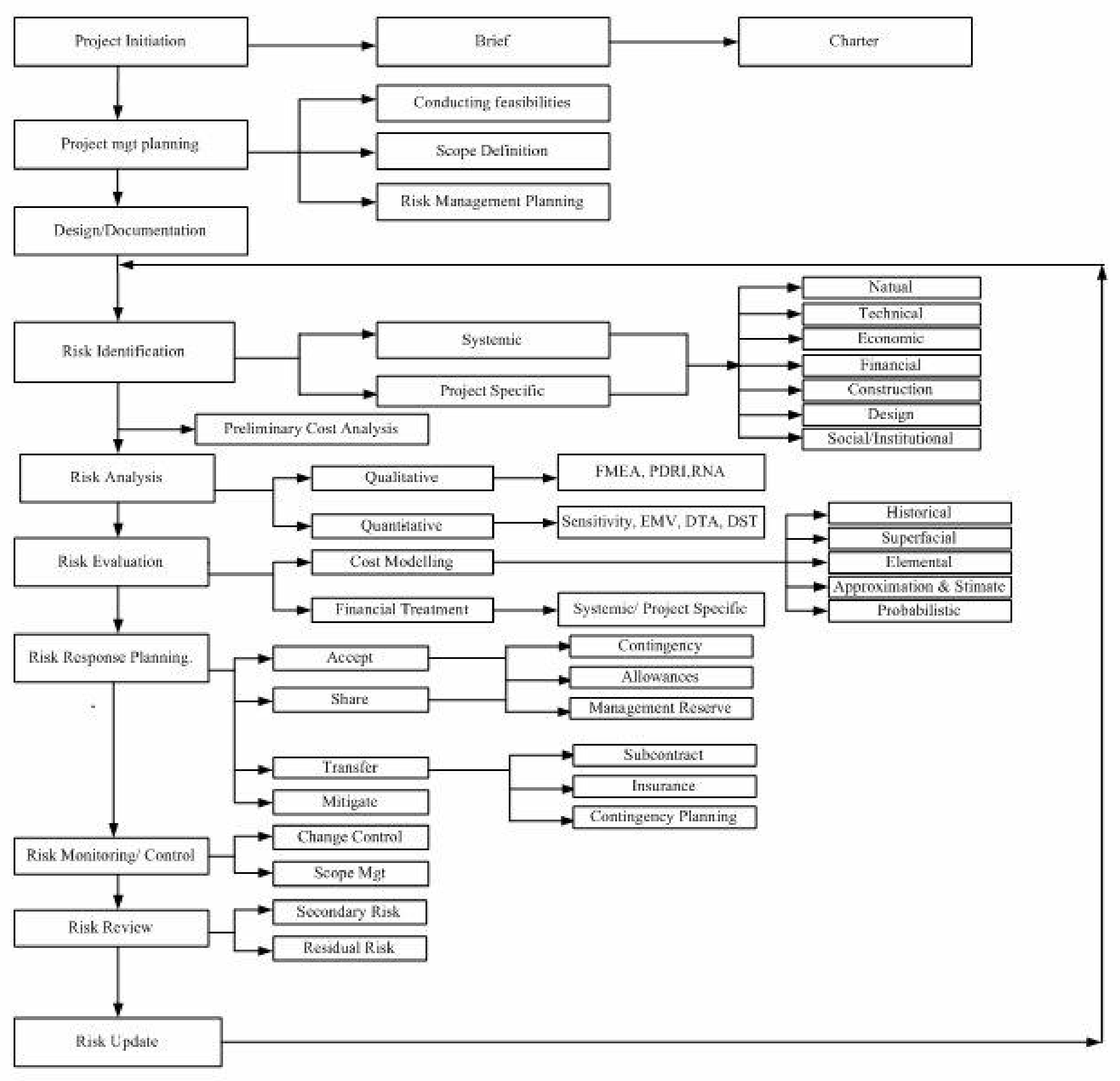
The challenge for lack of basis for the determination and provision of adequate contingency results in:

- Cost overruns in the project
- Time overruns, due to the delays in payment resulting from disputes over the contractors' claims
- No basis for the contingency management
- Abandonment of the project due to lack of adequate funds
- A delay in the use of the project for downstream business or social benefit
- Characterization of the construction industry as a high risk industry due to loan defaulting by contractors and client

Buertey et al (2012d) from Ali (2005) postulates that most firms have adopted a rule of thumb which is applied during estimation to take care of risk in relation to cost on the project. Gunhan and Arditi (2007) posits that one of the simplest methods of estimating contingency margins for construction projects is to consider a percentage of the estimated contract value such as 10% across the entire project commissioned by the owner typically derived from intuition, past experience and historical data, thus making the application of the deterministic approaches vague and without scientific basis. The allocation of small amounts of contingency for projects may result in significant losses. On the other hand, high amounts of contingency may decrease the chances of winning the contract. Rifat et al (2007) from Kangari (1995), studied to determine the risk factors that affect the construction projects. They identified 23 risk descriptions including survey, labor, equipment availability, labor and equipment productivity, differing site conditions, safety, defective design, changes in work, delayed payment of the contractor, and quality of work as the high important risk factors.

Whereas Keith (2005) posits the estimation of cost contingency using a three-tier cost risk process of risk identification, qualitative risk analysis and quantitative risk response planning, this research postulates a six phase risk process. The first phase involves risk planning to determine how risk would be tackled on the project and the risk tools to be used. The second stage involves risk identification which would enable EDAs develop a risk breakdown structure for the purpose of risk categorization. The third phase involves qualitative risk analysis (QlRA) using a preferred tool like the FMEA for the purpose of risk priorisation to select highly significant risk. The fourth stage involves quantitative risk analysis (QtRA) which involves probabilistic risk analysis to determine the impact of cost risk. The fifth stage involves risk response planning, with the final stage involving risk monitoring and control, risk review and update to enable a comprehensive cost modeling approach to be employed for the project as depicted in figure 1.

Figure 1: Conceptual Model Proposed for Estimating Cost Contingency by Client



Source: Authors Construct

Methodology

The main objective of this paper is to determine:

- How cost contingency estimation is undertaken in Ghana
- Why cost contingency is estimated that way and
- How the process of cost contingency estimation can be improved

The research is descriptive in nature and applied the mix methodological approach of data collection: quantitative and Qualitative procedures. Regarding qualitative methods, a semi structured interview was undertaken with respondent which led to a content analysis. On the quantitative data method, 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 impact systemic and project specific risk on the cost estimating process of cost contingencies. 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, out of which 118 (57.8%) were retrieved.

Table 1: Questionnaire Distribution by Demography

Type of Respondent	Total Out	No. Of Responses	Proportion of total Sample Size (%)
Consultants	115	58	50.4%
Client's firms	40	34	85.0%
Contractors	40	26	53.1%
Total	**204**	118	**57.8%**

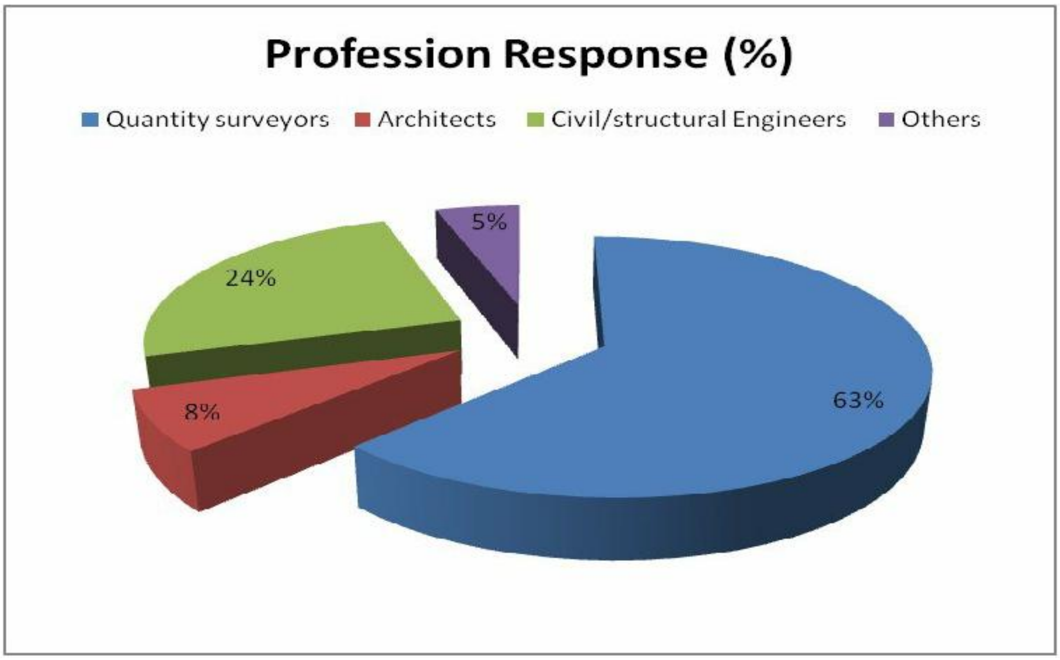
Table 2: Data Analysis

Item	Method of Estimating Cost Contingency	Have Knowledge of	Have Knowledge of (%)	Applied Before	Applied Before (%)
1	Deterministic estimation	113	95.8%	112	94.9%
2	Methods of moments	12	10.2%	10	8.5%
3	Detailed percentage	21	17.8%	15	12.7%
4	FMEA	17	14.4%	5	4.2%
5	Monte Carlo simulation	19	16.1%	3	2.5%
6	Factor rating	15	12.7%	9	7.6%
7	Range estimating	20	17.0%	10	8.5%
8	Regression Analysis	18	15.3%	4	3.4%
9	Artificial neural network	4	3.4%	1	0.9%
10	Fuzzy sets/logic	8	6.8%	1	0.9%
11	Influence diagrams	14	11.9%	5	4.2%
12	AHP	9	7.6%	5	4.2%
13	Individual risk (Expected Value)	23	19.5%	6	5.1%
14	Theory of constraints	17	14.4%	4	3.4%
15	Other Methods ***Historical data and experience***	15	12.7%	15	12.7%
16	Other Methods ***Unstructured risk analysis***	5	4.2%	5	4.2%
17	Other Methods (specify).....	0	0.0%	0	0.0%
18	Other Methods (specify).....	0	0.0%	0	0.0%

Data Analysis

Data analysis was undertaken by simple percentages and content analysis as depicted in the tables and figures below.

Figure 2: Proportion of Respondents



Experience, Background and Reliability of Respondents

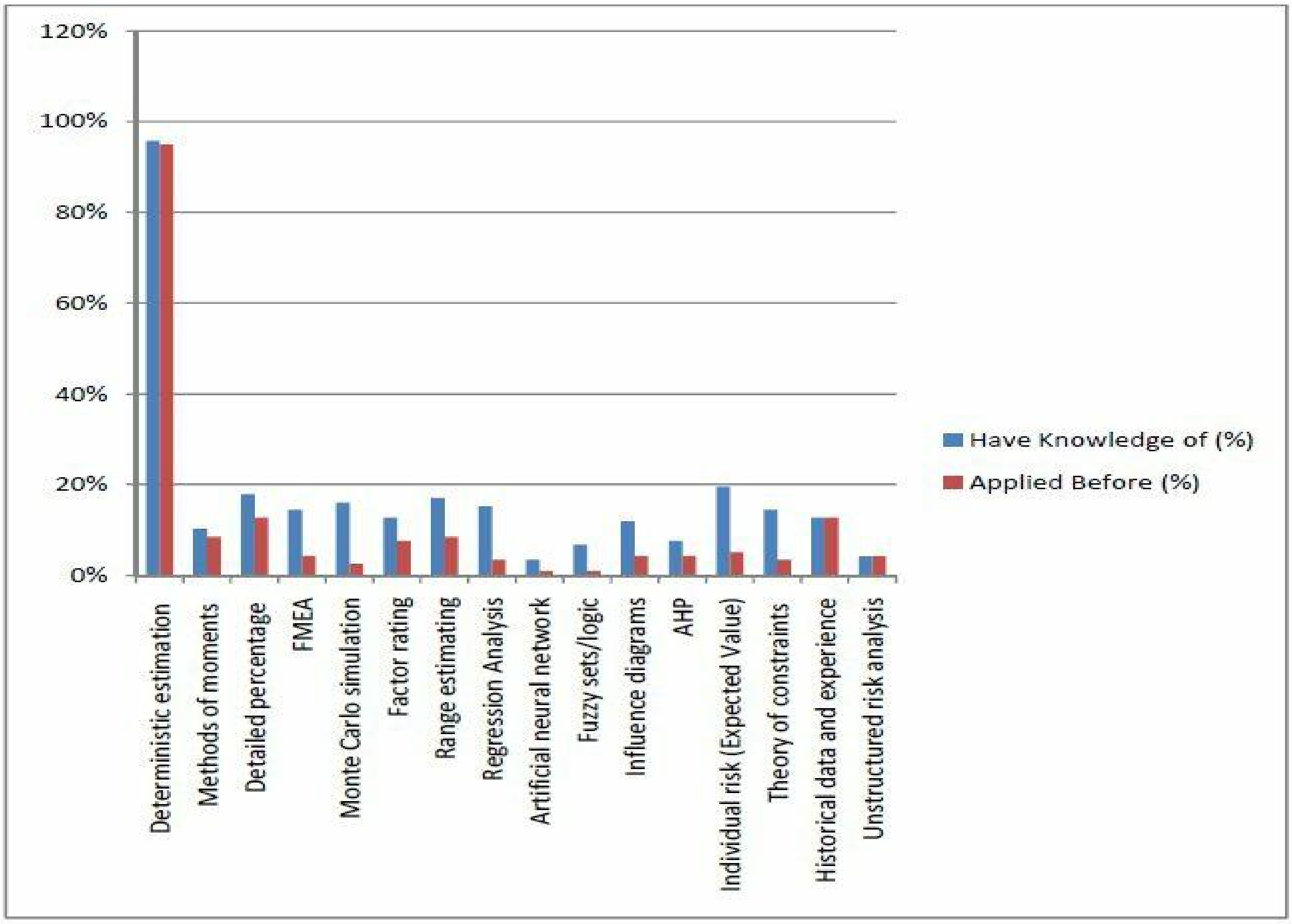
As depicted in figure 1, an average of 62% of the respondents interviewed during the survey was practicing in the building construction industry, while an estimated 38% were practicing in the civil engineering set-up. An average of 24% of respondent are practicing civil/ structural engineers, 62% were practicing quantity surveyors and cost engineers, 7% were project managers and architects. 58% of the practicing quantity surveyors were members of the Ghana Institution of Surveyors while 62% of the practicing engineers were professional members of the Ghana Institution of Engineers. In all, an average of 51% of the respondents was professional members of a recognized professional body. In terms of years of experience, 42% of the respondents had practiced for between 2 to 5 years, 19% of respondents had practiced for between 6-10 years while the rest had practiced for over 10 years.

With the above background one can be sure that responses from these respondents can be reliable based on their years of practice and their affiliation with professional bodies which regulates professional practice and conduct of these professional.

How Cost Contingency is Estimated

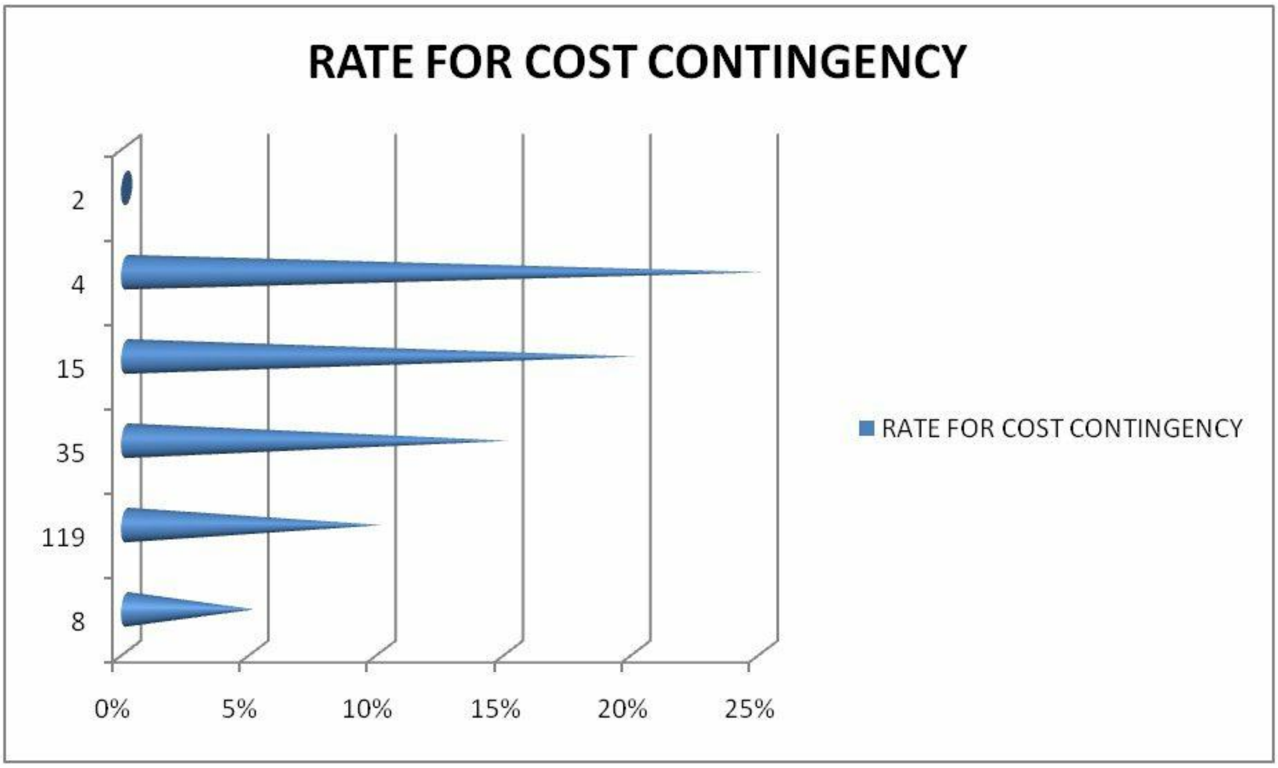
Analysis of structured questionnaire to enquire from practicing firms how cost contingency is estimated in their institutions is displayed in table 2. Sixteen (16) possible methods of determining cost contingency were listed for respondents to indicate their knowledge of these methods and possible application in the determination of cost contingency. Approximately 95% of respondents indicated that they applied deterministic estimation based on organizational process asset. Some 12.7% of respondents also indicated that they use detailed percentages in the determination of cost contingency. Respondents were given the opportunity to indicate the other methods (not listed herein) applied in the estimation cost contingency in their firms. From table 2 above, it can be realized that the knowledge of respondents in risk analysis is very low. Most of these methods were neither known nor had been applied before by the responding practitioners.

Figure 3: Method of Determining Cost Contingency



Some 12.7% of respondents indicated that they used historical data and experience in their cost contingency estimation process. The above method is seemingly the same as the deterministic method as it lacks any scientific basis and risk analysis. Some 4.2% of respondents indicated that they used unstructured risk analysis. In a further interview with these respondents, they indicated that they estimated cost contingency based on a list of risk factors including: possible material handling and damage, weather, theft, delayed payment, interest level, weather, experience of the estimator, level of design completeness, the nature of the client, the nature and complexity of the project, level of scope definition, certainty in ground conditions, availability and reliability of historical data. These respondents indicated that based on the certainty of these factors a high or low cost contingency factor would be allocated to cater for cost uncertainty and risk.

Fig 4: Prevailing Rates used in the Determination of Cost contingency



Based on ethnographic studies, figure 4 above displays the rates of percentages used in some 183 project documentation executed from 2008-2012. These projects varied from private projects, individual projects and public projects. Out of these projects, 8 (4.3%) used 5%; 119 (65.03%) used 10%; 35(19.13%) used 15%; 15(8.2%) used 20%; 4(2.19%) used 25%. Only 2 of these documents were determined independent of percentages. The contingency figures for these two projects and inserted by the consultants independent of the contractors rate. The remaining 181 contingency figures inserted by the consultants were based on the contractor's rates.

Supplementary interviews with respondents during the retrieval of these questionnaires revealed that none of the respondents had developed a scientific method of estimating cost contingency in their organization. As a follow up to the above ethnographic study, some very large and well known firms were visited to interact with estimators and quantity surveyors on their mode of determining cost contingency in Ghana. The results revealed that these firms had no structured models except for their reliability on historical data, organizational process asset and reliance on expert knowledge.

Some respondents indicated that for project extending beyond Six (6) months, their practice was to allow between 5-10% contingency for physical works and another 10-15% for price contingency to cater for price fluctuations.

On the question whether the estimated cost contingency was adequate at the project closure, 85% of the responses indicated that the contingency was never adequate due to changes in scope, incomplete scope definition, scope creep, unstable prices indices, delayed payment issues and variations. The respondents indicated that contingency sums for renovations works was higher than new works using between 25-40% contingency sums for renovation and alteration works due to the unpredictable nature of these projects.

Why Contingency is Estimated Based on Percentages

This objective examines the reason why practitioners use percentages in the estimation of cost contingency. Findings to this objective would enable the development of a very useful model for future use. A summary of the key views expressed by respondents are indicated in the accounts below:

- the industry lacks a cogent and reliable data for use in the estimation of cost contingency
- Percentages is the simplest and the best method since every figure can be expressed that way for comparative purposes and easy application
- the contractor is the best person to estimate the project cost hence the contingency figure must be factor on his estimate
- the knowledge about risk modeling in the industry is low hence limited in application
- Research on cost contingency is not far-fetched in Ghana with any reliable models to rely on
- Lessons learned and experience from previous projects is the best way to improve on subsequent projects hence the use of previous projects data as a basis of determination of subsequent project contingency
- External research undertaken are based on information from other countries and hence cannot be applied in Ghana
- Some of the risk methods of determining cost contingency are cumbersome and too mathematical and difficult to comprehend and apply.
- The industry players are adamant to change and not ready to embrace new research which has not been tested and proven to accurate
- The industry players do not have enough time for such research and would rely on the academics for new ideas.
- The practice over the years has been based on percentages (it is an industry practice), and it has worked.

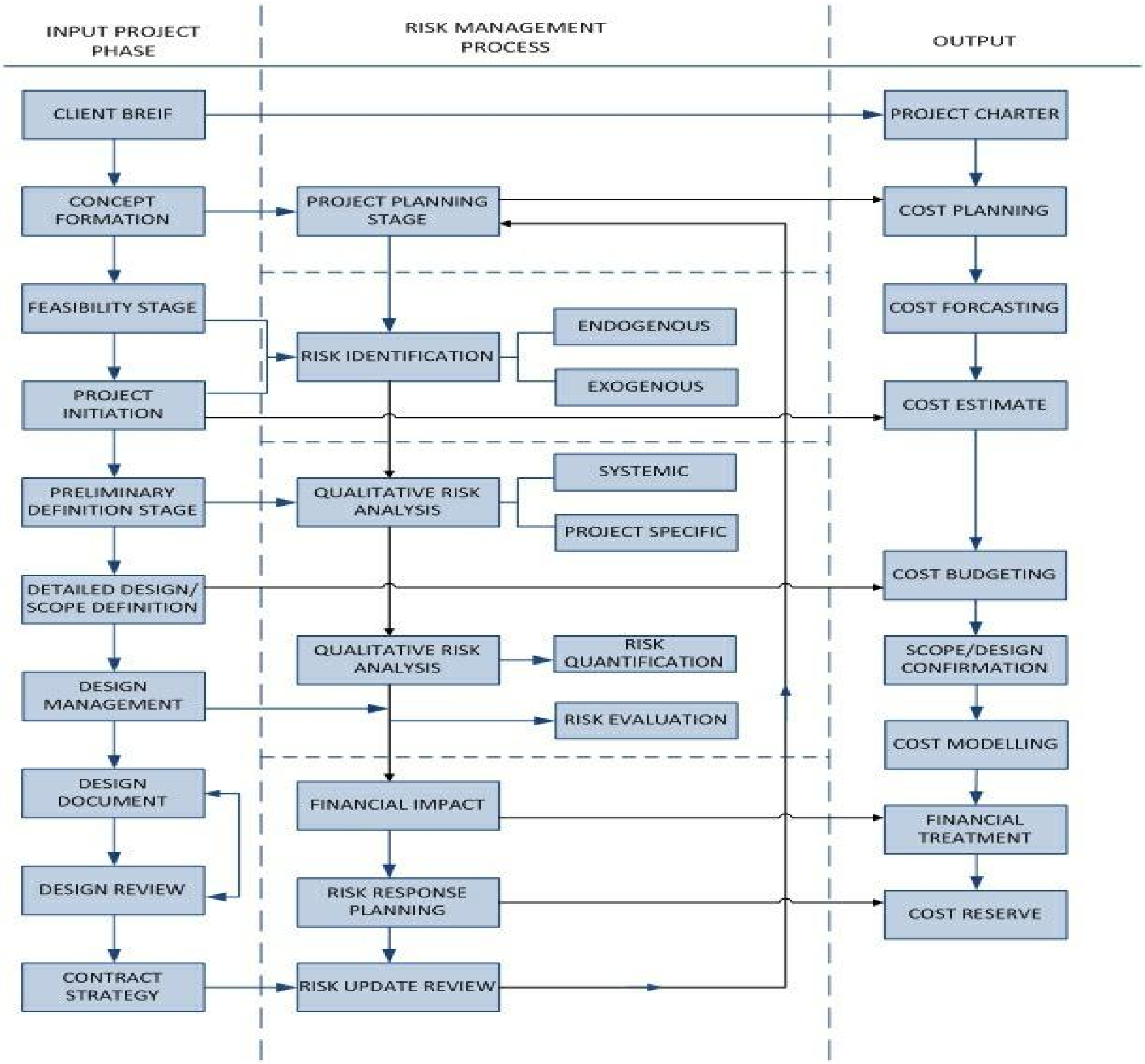
It can thus be summerised that practitioners use traditional deterministic methods because of it is simplicity, without toil and devoid of cumbersome mathematical functions with the challenge of no serious model developed that suits the industry. Finally, most practitioners through their academic carriers have not been acquainted with the knowledge and application of risk modeling hence not conversant with the application.

An Integrated Approach to the Estimation of Cost Contingency

Some 65% of respondents indicated the process of cost contingency can be improved. The gradual shift in approach can begin with the issue of risk education being introduced gradually into the curricula of built environment programmes. The above would make future graduates aware of the use of risk tools for managing uncertainties in projects. The use of risk management process as a better tool to predicting project "known unknowns" and "unknown unknowns" should gradually begin through competency based training programmes and professional enhancement courses in the built environment.

One of the best processes of improving the process of estimation is through enhanced project integration and communication. The disintegrated nature of the design process leaves many risk uncovered and project coordination poor. The isolated nature of the design team actors in Ghana results in the impeded flow of design information. Through the process of coordination, the supply chain of information flow is enhanced to help uncover all risk. Project organisations have a duty to develop a data base of project information on previous projects to provide a rich stock of organizational process asset for future projects.

Figure 5: Integrated Cost Contingency Model



An integrated risk management approach for the estimation of project cost contingency is displayed in figure 5. The model synchronises the design phase by the project team actors with a risk management process and the cost management phase. The design and planning phase of the project commences simultaneously with risk planning and cost management planning process. The process of design planning commences with the design brief, concept formation and project feasibility. The above process thus gives way to cost planning to agree on the cost parameters to use for the cost estimation, budgeting and cost modeling. Due to the importance of the risk identification process, this process should begin at the project planning phase to help with the early identification of potential risk on the project.

The process of risk identification would help in the further categorisation of risk to enable a risk break down structure to be developed for qualitative risk analysis to commence. Qualitative risk analysis enables the likelihood and severity of risk to be analysed to enable risk prioritization to take place. The process of quantitative risk analysis gives rise to the estimation of the probabilistic impact of the high priority risk to enable a risk response planning strategy to be prepared to help mitigate the selected risk.

Simple qualitative methods such as the failure mode effect analysis (FMEA), Pareto Diagrammes, and risk probability and impact assessment can be used to select high priority risk for further risk analysis to take place. With respect to quantitative risk analysis, decision tree analysis and the expected monitory values can be used. To help estimate risk for the purpose of cost contingency, a systematic process of project design is crucial to enhance scope definition through a design management effort of the project team to help unveil hidden risk

The process of cost budgeting would be enhanced by the development and use of the Risk Breakdown Structure (RBS) and the Work Breakdown Structure (WBS) and their associated dictionaries, by the cooperate effort of the project team actors. The process of cost modeling determines the final shape in which the cost data should be presented, packaged and rolled up. The financial impact of risk at the terminal stages of the risk management process determines the financial treatment to be adopted for these risk and hence the risk response planning strategy.

Conclusions

This paper briefly reviews the concept of project cost contingency estimation as part of the decision making process of the project design actors. A conceptual framework was developed followed by empirical review on the subject. Data analysis shows that most projects executed in Ghana relied on the use of traditional deterministic methods for the estimation of cost contingency. The use of the above method is primarily due to the unavailability of data in the industry with no industry benchmarks to be adopted. Again industry players lacks knowledge in risk management with little research undertaken characteristic of the Ghanaian industry. Finally most practitioners believe that some of these models and too complex with heuristic mathematic functions that is incomprehensible to apply. It can thus be concluded that the knowledge of risk management in the Ghanaian construction industry is low hence the need to propose a simple integrated model which integrates the process of design, cost estimation and risk modeling as presented in figure 5 of the above research. The model is a sublime process which has the potential to help identify all possible risk to enable response planning strategies to help mitigate these risks. To enhance project risk identification and successive management, there is the need for collaborative team effort by the project team actors to enhance the supply chain of information along the project trajectory. The traditional isolated nature of the design process and team actors in Ghana results in the impeded flow of design information and challenge in communicating risk. The use of concurrent engineering is crucial.

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