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ESTIMATING COST CONTINGENCY FOR CONSTRUCTION PROJECTS: THE CHALLENGE OF SYSTEMIC AND PROJECT SPECIFIC RISK

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Abstract
The challenge of poor scope definition resulting in scope creep is recognized as the major driver for construction project and cost overruns. All construction projects are associated with both systemic uncertainty and project specific uncertainty. The epistemic ambiguity in risk estimation could be considered as an opportunity or threat, a gain or loss, positive or negative; while project specific risk are in relation to project cost which makes its estimation untoward. Out of 204 questionnaires distributed to the Built Environment Professionals to determine the impact of systemic and project specific risk factors on the estimation of cost contingency, 118 were retrieved representing 57.8%. Data analysis using FMEA as a qualitative risk tool and univariate statistical analysis as a quantitative risk tool revealed that systemic risk accounted for approximately 64% of the cost drivers related of the construction cost uncertainty whilst projects specific risk accounted for 36% of the risk impact. Scope changes, incomplete scope definition, design status and changes in specification were revealed as high-impact systemic risk which has a high propensity of cost overrun effect on cost contingency. The impact of systemic risks can be managed through a design management effort by confirming the certainty of owner related issues during project definition and planning stage through historical based models relying on organizational process asset. The research revealed that the effect of project specific risk including natural and force majeure conditions and economic indicators are beyond the prediction and stochasticity effort of the project team. Project specific risk can be managed only through collaborative communicative effort of the project team with simulation to enable the right construction technologies to be selected and risk impact to be curtailed.

Key words: Risk, Uncertainties, Project specific, Systemic risk, Contingency, Epistemic uncertainty

INTRODUCTION

Perminpova et al. (2008) postulate risk as an event having a negative impact on the project outcomes, or opportunities, as events that beneficial impact on project performance. The above is in contrast with uncertainty perceived as an event or situation which was not expected to happen, regardless of whether it could have been possible to consider in advance. Thus all projects are affected by a myriad of risk and uncertainties, hence the need for contingencies to curtail the risk of cost overruns. Hervert (2011) holds that a contingency is an amount of money that must be added to a project base line to account for the impact of uncertain conditions which excludes major scope changes, force majeure events and escalations. Thus the essence of economic factors on the total success of infrastructural projects cannot be overemphasized. Xuequing (2005) after studying the critical success factors of infrastructural projects; held that most projects are abandoned at just 30% completion way with just a few going through to completion thus meeting the stipulated contract duration and project characteristics. Park et al (2005) posits that more than 60% of construction contractors' failure is due to economic factors. These economic factors include a myriad of cost risk that are poorly perceived and scoped at the onset of the project. A poor scope definition and scope planning results in difficulties in managing contingencies associated with the project with the possibility of cost overruns. Hart, (2007) holds that the subject of cost overruns is the results of poor contingency planning and cost management. It can be established that a sound cost base line and cost budgeting following a good risk assessment and analysis results in a coherent cost control mechanism (Hendrickson, 2008). Most projects have historically experienced increases resulting from persistent cost estimation and traditional deterministic conservative approach in estimating cost contingencies (Keith, 2005).

Many factors necessitate the need to include a contingency sum in a contract. Patrascu (1988) postulate that factors that may result in the need to include contingency are minor design changes, lack of experience, underestimation of cost and quantities, unanticipated price changes, corrections of some erroneous assumptions, abnormal schedule slippage, lack of scope definition and changes in scope definition, unforeseen regulations, safety requirement and other circumstances. Since a contingency is the amount of funds or, budget needed above the estimate to reduce the risk of overruns of a project objective to a level acceptable to the organization or project team, a contingency sum may or may not include a management reserves which allows for unplanned but potentially required changes in scope and cost.

THEORETICAL FRAMEWORK AND EMPIRICAL REVIEW

The use of theories in research work varies between its application in theory guiding the design and collection of data, theory as an interactive process of data collection and analysis and theory as an outcome of a case study. Two theories which hinge the decision making process with respect to the estimating of construction cost contingency would be detailed in this research: the decision theory and Failure Mode Effect Analysis.

The decision theory is concern with making decisions, 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. It was further observed 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.

Thus based on the decision theory, it is evident that the process of estimating construction cost contingency is undertaken freely by professionals based on their perception, understanding of risk, enterprise environmental factors and organisational process assets.

The Failure Mode Effect Analysis (FMEA) is a particular way in which an item fails independent of the reason for failure. This relates to how the item fails not why the item failed. An FMEA is a procedure by which each credential failure mode of each item from a low indenture level to the highest is analysed to determine the effect on the system and to classify each potential failure mode in accordance with severity of its effect. Thus in applying FMEA, each potential contingency factor which has a high potential of causing cost overruns when not mitigated is a potential failure mode.

The Failure mode and effect analysis (FMEA) aims at identifying the root causes of risk which may affect the project as a whole. It is a systematic approach of risk identification used to avoid omission of certain risk which may eventually be critical. One's ability to mitigate the risk is based on impact, likelihood, and "detectability"/"hideability" of the most serious risk, these rated on a scale of 1 to 10. Generically, FMEA is for distinguishing between high and low risk factor and for follow-up purpose. In the use of the FMEA, the level of risk is determined qualitatively using risk priority numbers (RPN).

The Risk Priority number (RPN) is calculated as:

$RPN = P \times I \times H$ ……………………………… (1)

Whereas risk was estimated as:

$Risk = P \times I$ …………………………………(2)

With

$$\text{Probability of occurrence of Risk} = \frac{\text{Risk}}{\sum \text{Overall risk}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where P is the possibility of occurrence,

I is the financial impact of the risk should it occur, H is the hideability of the risk factor

CONCEPTUAL FRAMEWORK

According to Ali (2005) 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. One would agree with Lhee et al (2009) that applying deterministic approaches is vague and lacks scientific basis.

Hervert (2011) postulate that risk identification has revealed two categories of risk: systemic and project specific risk. Systemic risk are those risk which can be identified at the onset of project and can be predicted to have an impact a project which would likely result in a cost overruns if good planning is not made towards it. Systemic risk are said to be an artifact of the project system, culture, process, technology or complexity. Systemic risks are thus measurable and predictable, even at the very earliest stage of the project definition, with cost impact stochastic in nature, thus making it very difficult for individual team members to determine impact at the earliest project stage (AACE, 2009). Hervert (2011) agrees with the AACE (2009) that systemic risk affects the artifact of the system; with systemic risk affected by the estimation approach, understanding of scope, and alignment of stakeholders, project team experience and completeness of engineering drawings. Thus systemic risks are more inclined to design factors, scope definition and factors within the direct control of the project team.

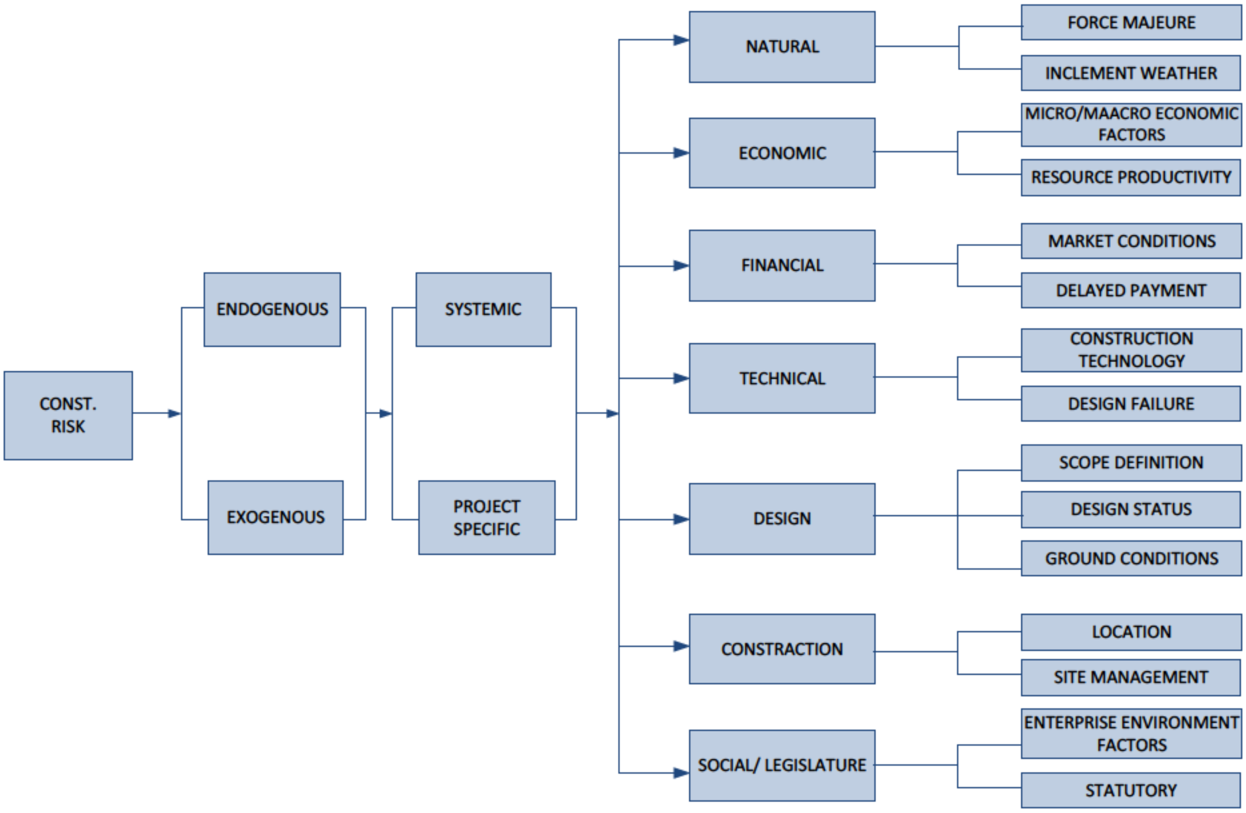

Figure 1: Conceptual Framework: Risk Breakdown Structure

Project specific risks are factors which may affect the artifact of the project. these includes delivery delays, constructability, site conditions, terms and conditions and can be termed as factors beyond the domain of the design team (Hervert, 2011). These risk factors are associated with the construction which can neither be determined now nor be predicted in the future. These are project related uncertainties which may occur on a project which an estimator at the point of estimation neither has an idea about the type of risk nor the magnitude of the risk nor the impact of the risk nor the cost to be associated with it. Project specific risk which are also called project specific risk are risk that are specific to projects, with the impact of these highly unpredictable between projects of within a system or industry as a whole (AACE, 2009). The impact of project specific cannot be thoroughly measured but can identified using risk riggers and early warning signs of probable impact to enhance mitigation.

Systemic risk drives having possible effect on cost growth includes basic design, level of technology, process complexity, material quality, soil requirement, engineering design, schedule development, team experience, cost information, bidding and labor climate, and cost information available (Hollmann, 2007). Thus during the estimation process, systemic risk results in the estimation of definitive budget hence (Hervert, 2011). Unpredicted project specific risk results in additional cost growth shifting the total cost curve outwards. The implication of the above is that systemic risk can be predicted empirically using historical data whereas project specific risk can only be predicted by simulation.

Keith (2011) posits that in the estimation of contingency using risk analysis, three-tier risk must be used. She defined risk type 1 as risk identification using contingency and percentage, type II qualitative risk analysis and identified contingency items and type III a quantitative risk analysis and active contingency management. Keith (2007) holds that uncertainty in cost growth decreases as one travels along the project trajectory with significant risk unveiling. The distinction between known-known (quantifiable cost), known-unknown (known but non- quantifiable cost) and unknown-unknown (unrealized cost) brings to fore the need for contingency and management allowance.

The conceptual framework for the above work as depicted in figure 1 reveals the most important aspect of project risk management as risk identification which commences contemporaneously with risk management planning. The process of risk identification brings to fore the need for risk categorization and the eventual development of a risk breakdown structure. During the process of risk identification, risk can be categorised as endogenous and exogenous risk, i.e. internal or external, enterprise environmental factors or organisational process asset. Considering the predictability of the risk in relation to the project, a further sub-categorization is systemic and project specific groupings.

As already discussed systemic risk are related to the artifact of the system which can be predicted across projects while project specific has their impact varying by project. The essence of the risk breakdown structure in figure is to enable further assessment of the risk based on their likelihood of occurrence magnitude/consequence, to enable further risk response planning decision to be taken.

RESEARCH METHOD

This paper is a preliminary work of an ongoing research work. It is based on a mix methodological approach of data collection: quantitative and qualitative procedures (desktop literature review). 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 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 and 118 (57.8%) were retrieved.

Table : 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%**

Field survey, 2011

Risk factors affecting project cost contingency were identified during literature review and these factors together with expert knowledge and tabulated for respondents respondent to rate. Respondents were requested to rate factors affecting cost contingency against a 10 point scale with 1= low probability/severity/impact and 10= high probability/severity/impact. The 10 point scale is based on the theoretical framework (FMEA) which sought to determine RPN qualitatively.

DATA ANALYSIS AND DISCUSSIONS

Likelihood of Occurrence of Risk Factors Affecting Contingencies

As shown in table 3, five out of the eight design factors had a modal rating of very relevant and highly relevant. At least 74% of respondents indicated that differing site conditions has a very relevant likelihood of occurrence (4.15% likelihood), 90% indicated that changes in scope is a highly relevant likelihood factor affecting contingency and 92% of respondents indicated that incomplete scope definition has the highest likelihood of 5.4% of effecting cost contingency. From table 2, design risk showed the highest likelihood of occurrence with most of these factors systemic in nature. The systemic related factors classified as very relevant in terms likelihood of occurrence are of design completeness (4.27% likelihood), changes in specification (3.84% likelihood), and delayed payment problems (4.29% likelihood). Project specific factors which were rated very relevant in terms of likelihood of occurrence included changes in inflation and micro economic indicators (4.15%) and global economic factors (3.59% likelihood).

Possible Severity Impact of Risk Factor Affecting Contingency

The nature and effect of risk varies from one factor to the other. Though a risk factor may have a very high probability of occurrence but its impact when it occurs may be negligible hence may require little if any risk response planning for the said risk. The survey results revealed that issues related to natural risk including inclement weather and force majeure, though may have a low probability of occurrence, has a significant impact on the contingency thresholds should it occur. As shown in table 4, Project specific risks were accounted for high impact risks. 93% indicated that inclement weather was highly relevant in terms of severity, 87% of respondents indicated as highly the impact of earthquakes and other force majeure risk. To confirm the relevance of these factors, a further statistical test was conducted. The z-test yielded p-values of approximately zero for these factors. Systemic risk such as delayed payment and differing site conditions, design completeness and status, changes in scope, incomplete scope definition, and changes in specifications were also indicated as very relevant factors having relatively significant impact on cost contingency.

Table 2.0 Risk Register: Factors Affecting Contingency Estimation

Item	**Possible Risk Factor**	**POSSIBILITY LIKELIHOOD**	**IMPACT (SEVERITY)**	**HIDEABILITY**	**RISK (%)**	**PROBABILITY**	**RPN**	**INTERPRETATION**
A	**Natural/ Env. Risk**					**0.0777**		
1	Floods	2.00%	0.0372	10	0.0744	0.0222	74	Mod. Relevant
2	Earth quakes, volcanic, landsides	1.66%	0.0451	8	0.0749	0.0224	60	Mod. Relevant
3	Inclement weather	2.38%	0.0466	10	0.1109	0.0331	111	Mod. Relevant
B	**Technical Risk**					**0.0789**		
4	Design Failure/ Defective design	3.20%	0.0383	3	0.1226	0.0366	37	Mod. Relevant
5	Human resource management challenges	2.74%	0.0256	1	0.0701	0.0209	7	Irrelevant
6	Equipment Failure	2.63%	0.0272	1	0.0715	0.0214	7	Irrelevant
C	**Economic Risk**					**0.1106**		
7	Material supply challenges	2.64%	0.0278	3	0.0734	0.0219	22	Irrelevant
8	Labour Supply challenges	2.46%	0.0264	1	0.0649	0.0194	6	Irrelevant
9	Equipment availability challenges	2.18%	0.0264	1	0.0576	0.0172	6	Irrelevant
10	Equipment productivity	2.40%	0.0275	1	0.0660	0.0197	7	Irrelevant
11	Market conditions	3.13%	0.0347	6	0.1086	0.0324	65	Mod. Relevant
D	**Financial Risk**					**0.1744**		
12	Interest rate challenge	3.26%	0.0384	8	0.1252	0.0374	100	Mod. Relevant
13	Delayed payment problems	4.29%	0.0383	5	0.1643	0.0491	82	Highly Relevant
14	Inflation and Micro-Economic Challenges	4.15%	0.0423	2	0.1755	0.0524	35	Mod. Relevant
15	Global economic pressure	3.59%	0.0332	3	0.1192	0.0356	36	Mod. Relevant
E	**Design Risk**					**0.3779**		
16	Differing site conditions	4.15%	0.041	10	0.1702	0.0508	170	Highly Relevant
17	Design completeness or status	4.27%	0.0465	9	0.1986	0.0593	179	Highly Relevant
18	Changes scope	4.99%	0.0485	6	0.2420	0.0723	145	Highly Relevant
19	Project complexity	3.57%	0.0264	4	0.0942	0.0281	38	Irrelevant
20	Incomplete scope definition	5.40%	0.0484	2	0.2614	0.0780	52	Highly Relevant
21	Construction technology	2.97%	0.0256	3	0.0760	0.0227	23	Irrelevant
22	Changes in specification	3.84%	0.0334	3	0.1283	0.0383	38	Highly Relevant
23	Estimation errors/ method	3.40%	0.0279	1	0.0949	0.0283	9	Irrelevant
F	**Legal/Social Risk**					**0.0905**		
24	Contractual/procurement related	3.28%	0.0282	1	0.0925	0.0276	9	Irrelevant
25	Governmental influence/intervention	3.47%	0.0264	1	0.0916	0.0274	9	Irrelevant

26	Legislative/ statutory	2.95%	0.0237	1	0.0699	0.0209	7	Irrelevant
27	Customary rights and litigation	2.49%	0.0197	1	0.0491	0.0146	5	Irrelevant
G	**Construction Risk**					**0.0900**		
28	Defects in supervision	3.91%	0.0212	5	0.0829	0.0248	41	Irrelevant
29	Safety	2.85%	0.0248	4	0.0707	0.0211	28	Irrelevant
30	Quality of work	2.68%	0.022	1	0.0590	0.0176	6	Irrelevant
31	Location	*3.51%*	0.0253	3	0.0888	0.0265	18	Irrelevant
GRAND TOTAL					3.349	1		

“Hideability” of Risk Factor Affecting Contingency

Analysis in table 5 indicates that project specific risk had the highest difficulty in terms of been detected before they occur. 94% of respondents rated force majeure factors as highly relevant. 77% had modal rating of highly relevant for floods and inclement weather. At least 64% of respondents changes in micro economic indicators as very relevant. The above analysis was confirmed by a z-test which yielded p-values of approximately zero indicating the relevance of the factors. Thus natural, and environmental risk considered as project specific were rated to be the most difficult to detect hence very difficult to plan or predict its occurrence. Systemic risk including design and scope related risks were considered to factors that can be planned and prevented. Differing site conditions had a modal rating of highly relevant due to uncertainties that could arise in ground conditions.

Discussions and Practical Application

Using the risk priority number in table 2 contemporaneous with the relevant risk levels, the first five most probable factors that may affect cost contingency are systemic related. These factors with their corresponding probabilities are differing site conditions, 0.051; design status and completeness, 0.059; changes in scope, 0.0723; incomplete scope definition 0.078; changes in specification, 0.038, and delayed payment, 0.524. Further analysis from table 2 reveals that project specific risk such inclement weather (0.0331); market conditions (0.0324), changes in micro-economic indicators (0.0524) and design failure (0.0366) have a compelling relevant effect worth considering.

Statistical analysis of possible effect of risk factors affecting contingency from table 3 indicates that the six factors are scope related, two are project management related and two project specific risks. Analytically, with the exception of the effect of the inflation and market conditions, the impact of the remaining systemic risk factors can be estimated stochastically to enable the impact minimized. In relation to severity effect of risk factors as indicated in table 4, natural risks which are project specific were identified to have very highly relevant severity effect. Design risks which are scope related were mostly indicated to have moderately relevant severity effect and economic risk having moderately relevant severity effect.

The possibility of detection of a risk factor allows the project team to put in place prepared measures to forestall its occurrence or to mitigate its impact. Some risk factors are very difficult to detect hence leaving very little room for planning and mitigative actions. Risk which are unlikely to be detected before their occurrence but very probable of occurring on a project should be given great prominence taking into consideration their possible severity effects. Respondents held that for all the risk factors, there is a great difficulty in one's ability to determine risk triggers.

Based on analysis using the Failure Mode Effect and anlaysis in table 2, during the estimation of project cost contingency, the overriding factors are the systemic risks which are design and scope related. A thorough design process in this regards can reduce if not eliminate the uncomfortable challenge of cost growth resulting from risk drivers such as a result of poor scope definition resulting in uncomfortable scope creep.

Based on risk categorization for the purpose of estimating the probability of occurrence, natural risk accounted for a probability of 0.070, whilst economic was 0.11, financial risk, 0.174; technical risk 0.079; design risk 0.378; and construction risk 0.090. Summarily curtailed, project specific risk accounted for an accumulated probability of 0.363 (36% impact of all risk). The corresponding cumulative probability for systemic risk is 0.637; accounting for approximately 64% of all risk on the projects which could hitherto be prevented.

Keith (2007) proposed with various tools, a risk management framework of risk identification, risk analysis, risk mitigation and plan, risk allocation and risk monitoring and control. Hollmann (2007) postulates that whereas the best approach to measuring systemic risk is by the use of empirically based parametric models, an expected monetary value can be deduced from Monte Carlo Simulation for the estimation of project specific risk.

A thorough risk management framework for the estimation of project cost contingency estimation as depicted in figure 2 below would be by the application of a systematic risk management process as discussed below. Risk identification for the process of contingency estimation must start as early as the project conception and ignition stage. This would help unveil all possible risk factors incident to the project adopting the appropriate risk categorization (exogenous and endogenous risk). Using a coherent risk breakdown structure, all possible risk related to the project can be discovered by the project team.

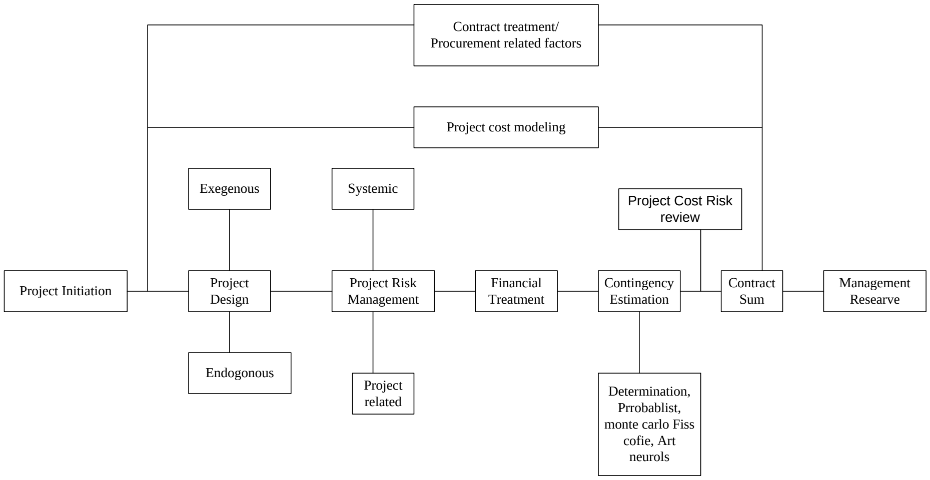

Figure 2: Project Risk Framework for Contingency Estimation

Table 3A Statistical Analysis of Likelihood Risk Factors Affecting Contingency Margins

Item	Possible Risk Factor	Mode	Mode Freq	Rating < Mod Freq	Rating > Mod Freq	Mode <= Mod fr	Total Resp	Mode %	%Rating < Mod Freq	%Rating > Mod Freq	%Mode <= Mod fr	Mean	Average Dev	Interprt of Mode	Rel Imp Indx	Rank	p-value
A	**Natural/ Environmental Risk**																
1	Floods	1	38	97	14	104	118	0.322	0.822	0.119	0.881	2.415	0.692	IR	0.518	30	0.344
2	Earth quakes, volcanic, landsides	1	54	105	11	107	118	0.458	0.890	0.093	0.907	2.025	0.863	IR	0.435	31	0.318
3	Inclement weather	1	31	87	22	96	118	0.263	0.737	0.186	0.814	2.737	0.781	IR	0.587	28	0.267
B	**Technical Risk**																
4	Design Failure/ Defective design	4	26	67	35	83	118	0.220	0.568	0.297	0.703	4.051	0.658	RR	0.869	15	0.133
5	Human resource management challenges	1	26	73	26	92	118	0.220	0.619	0.220	0.780	3.475	0.764	IR	0.745	21	0.184
6	Equipment Failure	1	27	79	28	90	118	0.229	0.669	0.237	0.763	3.220	0.646	IR	0.691	24	0.254
C	**Economic Risk**																
7	Material supply challenges	1	31	80	30	88	118	0.263	0.678	0.254	0.746	3.381	0.661	IR	0.725	23	0.226
8	Labour Supply challenges	1	31	85	27	91	118	0.263	0.720	0.229	0.771	3.059	0.793	IR	0.656	25	0.225
9	Equipment availability challenges	1	45	85	18	100	118	0.381	0.720	0.153	0.847	2.712	0.706	IR	0.582	29	0.298
10	Equipment productivity	1	38	86	26	92	118	0.322	0.729	0.220	0.780	2.839	0.757	IR	0.609	27	0.263
11	Market conditions	1	21	69	39	79	118	0.178	0.585	0.331	0.669	3.907	0.693	IR	0.838	16	0.145
D	**Financial Risk**																
12	Interest rate challenge	1	26	65	45	73	118	0.220	0.551	0.381	0.619	4.161	0.608	IR	0.893	14	0.127
13	Delayed payment problems	8	22	45	65	53	118	0.186	0.381	0.551	0.449	5.576	0.622	VR	1.196	4	0.000
14	Inflation and Market conditions	7	18	42	61	57	118	0.153	0.356	0.517	0.483	5.390	0.474	VR	1.156	6	0.001
15	Global economic pressure	3	21	57	48	70	118	0.178	0.483	0.407	0.593	4.441	0.368	RR	0.953	11	0.140
E	**Design Risk**																
16	Differing site conditions	7	26	33	62	56	118	0.220	0.280	0.525	0.475	5.525	0.464	VR	1.185	5	0.000
17	Design completeness or status	8	18	27	80	38	118	0.153	0.229	0.678	0.322	6.297	0.573	VR	1.351	3	0.000
18	Changes scope	10	19	23	87	31	118	0.161	0.195	0.737	0.263	6.822	0.410	HR	1.464	2	0.000
19	Project complexity	3	21	59	48	70	118	0.178	0.500	0.407	0.593	4.449	0.436	RR	0.955	10	0.116
20	Incomplete scope definition	10	19	16	89	29	118	0.161	0.136	0.754	0.246	6.898	0.227	HR	1.480	1	0.000
21	Construction technology	2	21	70	37	81	118	0.178	0.593	0.314	0.686	3.686	0.598	IR	0.791	18	0.202

22	Changes in specification	8	19	50	57	61	118	0.161	0.424	0.483	0.517	5.017	0.380	VR	1.076	8	0.001
23	Estimation errors/ method	4	19	58	42	76	118	0.161	0.492	0.356	0.644	4.398	0.592	RR	0.944	12	0.094

Table 3B Statistical Analysis of Likelihood Risk Factors Affecting Contingency Margins

Item	Possible Risk Factor	Mode	Mode Freq	Rating < Mod Freq	Rating > Mod Freq	Mode <= Mod fr	Total Reponse	Mode %	%Rating < Mod Freq	%Rating > Mod Freq	%Mode <= Mod fr	Mean	Average Dev	Interprt of Mode	Rel Imp Indx	Rank	p-value
F	**Governmental/Social Risk**																
24	Contractual/procurement related	1	19	65	42	76	118	0.161	0.551	0.356	0.644	4.220	0.587	IR	0.905	13	0.002
25	Governmental influence/intervention	2	18	58	49	69	118	0.153	0.492	0.415	0.585	4.492	0.695	IR	0.964	9	0.006
26	Legislative/ statutory	2	21	73	35	82	117	0.178	0.619	0.297	0.695	3.644	0.617	IR	0.782	20	0.202
27	Customary rights and litigation	1	29	85	25	93	118	0.246	0.720	0.212	0.788	2.907	0.650	IR	0.624	26	0.296
G	**Construction Risk**																
28	Defects in supervision	5	21	41	58	60	118	0.178	0.347	0.492	0.508	5.068	0.563	MR	1.087	7	0.001
29	Safety	4	27	76	25	93	118	0.229	0.644	0.212	0.788	3.593	0.756	RR	0.771	19	0.171
30	Quality of work	2	24	80	29	89	118	0.203	0.678	0.246	0.754	3.449	0.648	IR	0.740	22	0.221
31	Location	3	21	69	35	83	118	0.178	0.585	0.297	0.703	3.763	0.686	RR	0.807	17	0.166

Table 4A Statistical Analysis of Possible Severity Effect of Risk Factors Affecting Contingency Estimating

Item	Possible Risk Factor	Mode	Mode Freq	Rating < Mod Freq	Rating > Mod Freq	Mode <= Mod fr	Total Response	Mode %	%Rating < Mod Freq	%Rating > Mod Freq	%Mode <= Mod fr	Mean	Average Dev	Interprt of Mode	Rel Imp Indx	Rank	p-value
A	**Natural/ Environmental Risk**																
1	Floods	7	17	43	64	54	118	0.144	0.364	0.542	0.458	5.305	0.496	VR	1.138	11	0.057
2	Earth quakes, volcanic, landsides	7	19	32	70	48	118	0.161	0.271	0.593	0.407	5.839	0.604	VR	1.253	7	0.001
3	Inclement weather	8	24	25	86	32	118	0.203	0.212	0.729	0.271	6.890	0.338	VR	1.478	3	0.001
B	**Technical Risk**																
4	Design Failure/ Defective design	5	17	38	63	55	118	0.144	0.322	0.534	0.466	5.517	0.228	MR	1.184	9	0.001
5	Human resource management challenges	1	25	77	27	91	118	0.212	0.653	0.229	0.771	3.483	0.764	IR	0.747	25	0.183
6	Equipment Failure	1	23	71	34	84	118	0.195	0.602	0.288	0.712	3.627	0.534	IR	0.778	18	0.037
C	**Economic Risk**																
7	Material supply challenges	2	23	73	35	83	118	0.195	0.619	0.297	0.703	3.712	0.638	IR	0.796	17	0.186
8	Labour Supply challenges	1	24	75	30	88	118	0.203	0.636	0.254	0.746	3.568	0.758	IR	0.765	21	0.174
9	Equipment availability challenges	2	24	75	34	84	118	0.203	0.636	0.288	0.712	3.559	0.640	IR	0.764	22	0.207
10	Equipment productivity	3	25	75	34	84	118	0.212	0.636	0.288	0.712	3.517	0.660	RR	0.755	24	0.207
11	Market conditions	8	13	50	58	60	118	0.110	0.424	0.492	0.508	4.915	0.557	VR	1.055	12	0.014
D	**Financial Risk**																
12	Interest rate challenge	5	18	38	62	56	118	0.153	0.322	0.525	0.475	5.517	0.440	MR	1.184	10	0.108
13	Delayed payment problems	6	16	43	67	51	118	0.136	0.364	0.568	0.432	5.534	0.625	MR	1.187	8	0.001
14	Inflation and Market conditions	7	23	34	75	43	118	0.195	0.288	0.636	0.364	6.051	0.361	VR	1.298	5	0.000
15	Global economic pressure	4	17	59	50	68	118	0.144	0.500	0.424	0.576	4.627	0.491	RR	0.993	13	0.070
E	**Design Risk**																
16	Differing site conditions	7	18	29	71	47	118	0.153	0.246	0.602	0.398	6.025	0.414	VR	1.293	6	0.000

17	Design completeness or status	10	28	25	83	35	118	0.237	0.212	0.703	0.297	6.831	0.537	HR	1.465	4	0.000
18	Changes scope	10	23	16	92	26	118	0.195	0.136	0.780	0.220	7.212	0.265	HR	1.547	1	0.000
19	Project complexity	1	24	75	34	84	118	0.203	0.636	0.288	0.712	3.610	0.484	IR	0.775	19	0.264
20	Incomplete scope definition	10	30	22	87	31	118	0.254	0.186	0.737	0.263	7.144	0.194	HR	1.533	2	0.000
21	Construction technology	1	24	75	29	89	118	0.203	0.636	0.246	0.754	3.441	0.674	IR	0.738	26	0.213
22	Changes in specification	7	18	56	52	66	118	0.153	0.475	0.441	0.559	4.568	0.368	VR	0.980	14	0.108
23	Estimation errors/ method	2	25	70	36	82	118	0.212	0.593	0.305	0.695	3.873	0.644	IR	0.831	16	0.161

Table 4B Statistical Analysis of Possible Severity Effect of Risk Factors Affecting Contingency Estimating

Item	**Possible Risk Factor**	Mode	Mode Freq	Rating < Mod Freq	Rating > Mod Freq	Mode <= Mod fr	Total Reponse	Mode %	%Rating < Mod Freq	%Rating > Mod Freq	%Mode <= Mod fr	Mean	Average Dev	Interprt of Mode	Rel Imp Indx	Rank	p-value
F	**Governmental/Social Risk**	1	23	66	38	80	118	0.195	0.559	0.322	0.678	3 983	0.628	IR	0.855	15	0.009
24	Contractual/procurement related	2	24	74	32	86	118	0.203	0.627	0.271	0.729	3 576	0.758	IR	0.767	20	0.173
25	Governmental influence/intervention	2	26	87	21	97	118	0.220	0.737	0.178	0.822	3.119	0.678	IR	0.669	28	0.255
26	Legislative/ statutory	1	38	93	17	101	118	0.322	0.788	0.144	0.856	2.669	0.700	IR	0 573	31	0.306
27	Customary rights and litigation																
G	**Construction Risk**	1	29	88	20	98	118	0.246	0.746	0.169	0.831	2.712	0.765	IR	0 582	30	0.275
28	Defects in supervision	1	23	76	27	91	118	0.195	0.644	0.229	0.771	3 339	0.774	IR	0.716	27	0.198
29	Safety	1	38	80	23	95	118	0.322	0.678	0.195	0.805	3.110	0.755	IR	0.667	29	0.230
30	Quality of work	2	28	76	35	83	118	0.237	0.644	0.297	0.703	3 542	0.675	IR	0.760	23	0.199
31	Location	1	23	66	38	80	118	0.195	0.559	0.322	0.678	3 983	0.628	IR	0.855	15	0.009

Table 5A Statistical Analysis of Hideability of Risk Factors Affecting Contingency

Item	**Possible Risk Factor**	Mode	Mode Freq	Rating < Mod Freq	Rating > Mod Freq	Mode <= Mod fr	Total Reponse	Mode %	%Rating < Mod Freq	%Rating > Mod Freq	%Mode <= Mod fr	Mean	Averag Dev	Interprt of Mode	Rel Imp Indx	Rank	p-value
A	**Natural/ Environmental Risk**																
1	Floods	10	26	29	63	36	118	0.220	0.246	0.534	0.305	7.669	0.353	HR	1.645	3	0.000
2	Earth quakes, volcanic, landsides	8	26	16	85	19	118	0.220	0.136	0.720	0.161	7.881	0.466	VR	1.691	1	0.000
3	Inclement weather	10	28	31	59	42	118	0.237	0.263	0.500	0.356	7.720	0.205	HR	1.656	2	0.000
B	**Technical Risk**																
4	Design Failure/ Defective design	3	24	51	55	61	118	0.203	0.432	0.466	0.517	6.373	0.348	HR	1.367	7	0.000
5	Human resource management challenges	1	24	85	31	103	118	0.203	0.720	0.263	0.873	3.992	0.729	IR	0.856	25	0.127
6	Equipment Failure	1	26	82	35	97	118	0.220	0.695	0.297	0.822	3.958	0.503	IR	0.849	27	0.191
C	**Economic Risk**																
7	Material supply challenges	3	19	68	48	86	118	0.161	0.576	0.407	0.729	4.907	0.540	RR	1.053	15	0.016
8	Labour Supply challenges	1	26	76	39	88	118	0.220	0.644	0.331	0.746	4.331	0.706	IR	0.929	20	0.087
9	Equipment availability challenges	1	27	76	40	90	118	0.229	0.644	0.339	0.763	4.237	0.586	IR	0.909	24	0.120
10	Equipment productivity	1	24	75	41	86	118	0.203	0.636	0.347	0.729	4.305	0.581	IR	0.924	22	0.110
11	Market conditions	6	19	58	57	74	118	0.161	0.492	0.483	0.627	5.280	0.506	MR	1.133	12	0.051
D	**Financial Risk**																
12	Interest rate challenge	8	15	48	61	62	118	0.127	0.407	0.517	0.525	6.076	0.436	VR	1.304	8	0.000
13	Delayed payment problems	5	19	68	46	86	118	0.161	0.576	0.390	0.729	4.864	0.670	MR	1.044	17	0.019
14	Inflation and Market conditions	2	16	58	48	71	118	0.136	0.492	0.407	0.602	5.466	0.392	IR	1.173	11	0.109
15	Global economic pressure	3	16	58	51	73	118	0.136	0.492	0.432	0.619	5.508	0.499	RR	1.182	10	0.000
E	**Design Risk**																
16	Differing site conditions	10	19	36	63	46	118	0.161	0.305	0.534	0.390	7.195	0.377	HR	1.544	4	0.000
17	Design completeness or status	9	22	44	55	57	118	0.186	0.373	0.466	0.483	6.873	0.534	HR	1.475	5	0.000
18	Changes scope	6	17	39	67	51	118	0.144	0.331	0.568	0.432	6.678	0.310	MR	1.433	6	0.000
19	Project complexity	4	19	47	66	66	118	0.161	0.398	0.559	0.559	6.034	0.404	MR	1.295	9	0.000
20	Incomplete scope definition	2	17	58	57	71	118	0.144	0.492	0.483	0.602	5.254	0.423	IR	1.127	13	0.055
21	Construction technology	3	21	64	52	76	118	0.178	0.542	0.441	0.644	4.907	0.447	RR	1.053	16	0.019
22	Changes in specification	3	21	61	55	76	118	0.178	0.517	0.466	0.644	5.203	0.444	RR	1.116	14	0.042
23	Estimation errors/ method	1	27	93	24	110	118	0.229	0.788	0.203	0.932	3.593	0.587	IR	0.771	29	0.221

Table 5B Statistical Analysis of Possibility of Hideability of Risk Factors Affecting Contingency

Item	**Possible Risk Factor**	Mode	Mode Freq	Rating < Mod Freq	Rating > Mod Freq	Mode <= Mod fr	Total Reponse	Mode %	%Rating < Mod Freq	%Rating > Mod Freq	%Mode <= Mod fr	Mean	Average Dev	Interprt of Mode	Rel Imp Indx	Rank	p-value
F	**Governmental/Social Risk**																
24	Contractual/procurement related	1	25	82	35	95	118	0.212	0.695	0.297	0.805	3.890	0.668	IR	0.835	28	0.153
25	Governmental influence/intervention	1	23	76	41	94	118	0.195	0.644	0.347	0.797	4 398	0.702	IR	0 944	19	0.079
26	Legislative/ statutory	1	24	74	42	90	118	0.203	0.627	0.356	0.763	4.407	0.659	IR	0 945	18	0.083
27	Customary rights and litigation	1	29	85	32	100	118	0.246	0.720	0.271	0.847	3 966	0.629	IR	0.851	26	0.151
G	**Construction Risk**																
28	Defects in supervision	5	27	76	40	86	118	0.229	0.644	0.339	0.729	4 280	0 591	MR	0 918	23	0.112
29	Safety	4	28	93	24	106	118	0.237	0.788	0.203	0.898	3.432	0.767	RR	0.736	31	0.188
30	Quality of work	1	27	92	25	109	118	0.229	0.780	0.212	0 924	3.492	0.662	IR	0.749	30	0.210
31	Location	3	22	77	39	91	118	0.186	0.653	0.331	0.771	4 314	0.623	RR	0 925	21	0.101

Using the appropriate quantitative and qualitative risk measurement tools, the impact of systemic and project specific risk could be estimated to enable the adoption of an appropriate financial treatment. Concurrent to the above process, a comprehensive scope definition and cost modeling process would be critical for issues related to technology, specification, procurement and contract type to be adopted for the project. The procurement process for any construction project is not sacrosanct; every system may have some flaws and challenges associated with it. Owners always strive to provide adequate contingency through their representatives to address risk related issues and to provide a safeguard for the contractor, designer and owner to complete the project on budget.

It is interesting to note that the cost modeling process adopted by the designers is significantly affected by the availability, reliability and quality of cost data. The experience and skill of the estimator, organizational process asset and enterprise environmental factors. The contingency estimation process is set in motion by the adoption of appropriate risk management effort which together with a reliable cost modeling technique allows an adequate contingency sum to be determined. Subsequent to the above, a management reserve is estimated to allow to unknown unknowns which are project specific risk for enhance project team confidence. During qualitative and quantitative risk analysis process; project specific risk cannot be predicted to allow for adequate risk response planning. These are however monitored by risk owners using prompt risk triggers to allow prompt responses to these risks. The monitoring of these risk by risk owners taking into consideration of the performance of other risk allows the project team to review cost risk appropriately.

It must be argued since systemic risk can be estimated based on the scope definition by aligning stakeholder alignment, precision and completion of engineering work, the use of organistional process asset is critical. On the other hand, the challenge of predicting project specific risk due its inherence with the artifact of the project demands the need for the project tea to watch out for delivery delays, constructability, site conditions, force majeure and unstable economic factors.

SUMMARY AND CONCLUSION

In summary, the major divers for systemic project risk are scope, technology and complexity which whose contingency can be empirically estimated as “known-knowns” and “known-unknowns”. Project specific uncertainties are driven by uncertainties and events which are difficult to determine hence termed “unkown-unkown” determinable only through simulation and a careful risk ownership. Since design flexibility and risk management are complementary in the managing of projects, the client and design team need to emphasize cooperation and shared goals to reduce project uncertainty to decrease the rigidity of product designs.

This paper briefly reviews the concept of project cost contingency, the methods of estimation of cost contingency and the effect of systemic and project specific risk on the estimation process of cost contingency. It has been established that about 64% of the risk factors affecting cost contingency are systemic risk which are related to the culture, technology, complexity and project definition. It has again been shown that five out of the eight most significant factors affecting cost contingency are as a result of poor design and scope definition. These factors include differing site conditions, design completeness and status, changes in scope, incomplete scope definition, and changes in specification, the result if which is scope creep. To adequately estimate the cost contingency of projects, thus an estimator must be able to identify the most significant risk design factors, economic and risk factors. The impact of project specific risk can adequately be catered for by management contingency after a through estimation process for the systemic related risk.

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SURVEY INSTRUMENT

Please indicate by ticking in the appropriate boxes according to ratings scale of 1 to 10, the probability of occurrence, possible severity effect and the possibility of detection of each of the risk factors which affect the Construction Cost contingency margins. Please you may add additional factors in rows 32-3. Please tick only one rating scale per factor

1-3 = Rarely probable 4-7 = Moderately probable 8-10= Highly probable

Item	**Possible Risk Factor**	**Possibility of occurrence (1-10)**	**Likelihood of occurrence (1-10)**	**Detectability (1-10)**	**Remarks)**
A	**Natural/ Environmental Risk**				
1	Floods				
2	Earth quakes, volcanic, landsides				
3	Inclement weather				
B	**Technical Risk**				
4	Design Failure/ Defective design				
5	Human resource management challenges				
6	Equipment Failure				
C	**Economic Risk**				
7	Material supply Challenges				
8	Labour Supply challenges				
9	Equipment availability challenges				
10	Equipment productivity				
11	Market conditions				
D	**Financial Risk**				
12	Interest rate challenge				
13.	Delayed payment problems				

14	Inflation and Market conditions				
15	Global economic pressure				
E	**Design Risk**				
16	Differing site conditions				
17	Design completeness or status				
18	Changes scope				
19	Project complexity				
20	Incomplete scope definition				
21	Construction technology				
22	Changes in specification				
23	Estimation errors/ method				
F	**Governmental/Social Risk/ Legislative**				
24	Contractual/procurement related				
25	Governmental influence/intervention				
26	Legislative/ statutory				
27	Customary rights and litigation				
G	**Construction Risk**				
28	Defects in supervision				
29	Safety				
30	Quality of work				
31	Location				
32					
33					

Any other comments

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