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Model for Identifying the Risk Level in Construction Projects

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Abstract: ***Risk is unexpected or unwanted happening of an event or activity. Risk management aims to identify unexpected happenings in the business or project, so that some decision can be taken to prevent further problems to the business or projects. Risk is categorized based on the influence of the key project objectives and sustaining the environment. Managing the risks successfully in the project leads to achieving the project objectives very quickly. To list out the project objectives, minimizing the risks and enhancing the priorities through questionnaire in the construction industry is planned through this research paper. Significance index score is obtained for each prioritized risk is used for developing a risk management model (RMM). With the help of survey data gathered from construction Industry professionals, risk score (RC) is determined and proposed a remedy for the same to an agreed level to reduce further risk in the projects.***

Index Words: ***Risk Management Model (RMM), construction projects, project objectives, risk score (RC), decision making.***

I. INTRODUCTION

Due to the rapid urbanization in the world, construction activity has enhanced to multiple folds. The construction activities range from small scale to large scale, involves huge amount of money. The construction industry and its promoters like clients and contractors are largely associated with a high extent of risk due to the scope of construction activities execution, objectives, environment and organization. Construction risk is treated as an event that influence project objectives like cost, time and quality [1].

Activities in construction are under high level of uncertainty and risk, since they are initiated under the complex and dynamic environment. Managing the Risk in construction has gained the importance because of time and cost related over runs exists with all types' construction works. Projects in Construction involves lot of time, cost, quality and their associated boundaries like uniqueness, time management, and other high risk undertakings with some expected level of performance. Any new construction project involves some amount of risk from the conceiving stage to completion stage.The concept of current research study is to know some potential risks associated in the construction projects with the help of experts and structured questionnaire method. The questionnaire was floated to the working people in construction companies for their response. The objective of the analysis is to frame the Risk Management Model (RMM), by which the risk can be minimized in the projects, which will help them to direct, for successful completion of the projects. It emphasizes that management of risk is essential in construction activities for minimizing losses and enhancing profitability [2]. In this present research on risk is categorized into 1.Market related 2.Completion 3.Institutional risk. The successful projects are not sealed, but shaped by keeping the risk resolution in mind is the main agenda. Risk management estimates the possibility of various unlikely events and their impact, dynamic interaction may result differently than the expected. The present research focused on risk management approaches like 1. Decision theoretic approaches by assuming that risk are exogenous, probabilistic and partly endogenous, 2.Managerial approach which focuses on the turbulence, front- end issue and shaping of the risk drives [8]. This is one way to manage the risk in large engineering projects.Few researchers applied the goal programming models to mitigate the risk in making the good decisions in the fields of financial aspects, Investments in mitigating natural hazards and asset management [7]. Some authors focused on establishing a two-phase model to identify the financial risk of projects in construction falls, under uncertain construction duration, treated as a random variable in this model, and the outcome results are that construction duration affects the present worth of cash flow in both construction and operation phases of the project[15],[17],[20]. Applying the simulation technique was somewhat useful to identify the effects of uncertain construction durations on the project [5]. The project risk can be optimized by considering these models and randomness can be verified in terms of cost and risk happens towards the closing time of the project. The basis for developing these models are to study the risk in terms of float factor [6][22][23].The success factors for construction project phase's development will be helpful in developing the effective contracting strategy and this may fairly assigns risk involvement and thus encourage the client and contractor teamwork [4]. This analysis is quite helpful for identifying the delay consequences and there by savings in the cost aspects of the project. The high rise building projects are prone to the risks related to load factors, client intervention at high level etc., and this can be minimized by good maintenance practices and use of certified materials[2][19].

II. SCOPE OF THE WORK

Different kinds of risks and uncertainties are present in any construction projects. They may not only helpful in preventing the projects to be completed within budgetlimit and time limit, but also threatens the quality, safety and operational needs.

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It is also essential to identify the significant risks that can influence the objectives as mentioned. The construction industry is performing poor due to improper risk management procedures. There is a need to have a consistent methodology for managing the construction project risk, including a good risk management model to obtain the risk associated with an activity and remedial actions to prevent the further occurrences.

III OBJECTIVES OF THE STUDY

- To design and develop an organizational risk management process.
- To synthesize the key risks that have the influence in the project objectives and environmental sustainability.
- To develop a RMM to estimate the risk associated and to provide a level of risk acceptability

IV RISK ASSESSMENT

Risk estimation is an approach for gauging and managing the risks associated with in the projects. The construction project phases consists of contractual planning and design, construction, Operation and Maintenance. The risks assessment in the project can be evaluated as the project moves forward then more information available. The "risk assessment analysis" [19],[24]is usually carried out at the pre contract phase to identify the costs that may cause due to accidents. Good bidding strategy is essential to reduce risk in project [10]. Hence it is better to estimate the technical and other aspects by using a specific technique [3],[21].

V RISK ANALYSIS

Risk analysis is to determine the effects of the risks on the project tasks within the project [3],[11].The probable Project risks are analyzed and potential consequences are identified for eventually managing the risks to plan response strategies. The impact of any risk is not constant and changing in a time frame, they must be evaluated regularly with recent information of projects [16]. The risk analysis techniques are broadly grouped into two categories namely, qualitative and quantitative [12].

VI. RISK EVALUATION

After calculating the project risk, then projected risk Vs risk criteria is compared through which the organization has been well-known. The risk criteria is articulated on associated cost and benefits, legal requirements, socio-economic benefits and environmental factors, concerns related to stakeholders, etc... Risk evaluation is further helpful to the organization and whether each identified risk should be accepted or treated way. The evaluation stage estimates the risk level from the previous stage. Initially data is gathered about the risk involved in the models with and without risk responses, in different scenarios. It consists various combination of responses to carry out partial and global calculations, restructuring the possible model and diagnosis that includes a sensitivity analysis stage into the models defined in the modeling stage to evaluate the project's risk [12] [18]. The evaluation stage is essentially quantitative; it can be reduced to a minimum in the case of certain projects and organizations. The objective of this carrying out a quantitative analysis for every model [13][14] as mentioned in the table 1.

Table 1: Risk Evaluation

SL.NO	EVALUATION OF RISK	REMARKS
1	Scope	Event description, dependency etc.
2	Risk nature	Strategic, operational, financial etc.
3	Stakeholders	Expectations of Stakeholders
4	Qualitative Risk	Significance
5	Tolerance of Risk	Loss potential and financial impact of risk value
6	Treatment & Control Mechanisms of Risk	The risk level is currently manageable or not, Documentation of protocols for monitoring purpose
7	Improvement measure	Suggestions to lower the risk
8	Policy	Identify the function responsible in developing strategy

The impact of risk on project objectives, significance score for each one is assessed by each respondent can be evaluated through the Eq. (I)

$$\gamma^{k}_{ij} = \alpha_{ij}\, \beta^{k}_{ij} \quad \text{.....(1)}$$

Where γ^{k}_{ij}= score awarded by respondent j for the impact of risk I on each project objective mentioned k; i= ordinal number assigned to risk, iϵ (1,p); p= number of risks exists; k= ordinal number given to each project objective, kϵ (1,5); j = ordinal number of valid feedback given to risk i, j ϵ (1,q); q= total number of valid feedbacks obtained for risk i; αij = likely occurrence of i^{th}, risk given by j^{th} respondent; β^{k}_{ij} consequence of level of risk i on project objective k, rated by respondent j.The mean value for each assessment and its magnitude on each project objective can be evaluated through Eq. (2). This mean value is called the risk "significance index score (SIC)"[19] and can be used to provide rank among all risks on a particular project objective.

$$R_i^k = \Sigma^{n}_{j=1} * R_{ij}^k / q = 1/n\, \Sigma^{n}_{j}\, \alpha_{ij}\, \beta^{k}_{ij} \quad \text{....} \quad (2)$$

Where R_i^k = Significance Index Score (SIC) for I^{th} risk w.r.t k^{th} project objective .

Risks are prioritized in order with their significance index R_i^k w.r.t each project objective is calculated as considered in this research.

VII. RESULTS AND DISCUSSIONS

All questions asked in the questionnaire can be applied to any construction project. The investigation objective is to identify the list of risks and the risks that can significantly influence the delivery of projects in construction and to find the SIC of each risk which contributed to develop a RMM. The results of the rankings presented in the following tables3 to table 7.

VIII RISK MANAGEMENT MODEL (RMM)

Risk Management Model proposed to determine the risk associated with a particular factor and its' justification with a suitable remedy. It provides acceptable level of risk acceptability. The SC for each factor is obtained from the questionnaire survey used for developing the model [19].

The RMM calculates the risk score and the justification factor using the equations mentioned:

Risk score = Likelihood (α) * Impact (β) * Severity (s)

Significance Index Score (SIC) = Likelihood (α) * Impact (β)

Risk score (Sc) = Significance Index Score (SIC) * Severity (s)…… (3)

Justification factor (J) = Risk score (Sc) / [Cost factor (C) * Degree of Correction (D)]

Where: Severity (S) = severity of hazard linked with the activity; Impact (β) = Degree of result of risk associated with the activity; Likelihood (α) = Probability of harm ness, if a hazardous event takes place; Cost factor (C) = Estimated cost in rupees incurred for corrective action; and Degree of Correction (D) = The proposed level of corrective action to eliminate the hazard. The same is calculated and portrayed in the table 3 to table 6 respectively based on table 2.

IX CONCLUSION

The main project objectives mentioned can influence the performance of the project. Risk assessment process therefore becomes ongoing activity throughout of the life of the project. One major drawback of risk management technique is that more the powerful and sophisticated is the technique, the more data and time is required. Risk management is an essential concept for every construction project. Estimating the level of risk, based on the probability of an event occurring and the significance of any further consequences of any such events. A risk management model (RMM) is an authenticated approach to determine the risk score, which provides acceptability level for the risks through a quantitative justification for the proposed remedy. The RMM will help the management to take concurrent decision for reduction of risk to an acceptable level. This is one model to know the magnitude of the risk persisting in projects.

Table 2. Category of risk significance score

α	β		
	MAGMITUDE- HIGH (1)	MAGNITUDE-MEDIUM (0.6)	MAGNITUDE-LOW(0.2)
ACCEPTABLE- HIGH(1)	1	0.6	0.2
ACEPTABLE (0.6)	0.6	0.3	0.06
NOT ACEPTABLE (0.2)	0.2	0.1	0.02

Table 3: Risk significance on project objective as cost

COST		
SL NO	**KEY RISKS**	**SIC**
1	Closer schedule for Project	0.63
2	Labor market and labor cost increase	0.60
3	Market related	0.59
4	Non availability of sufficient amount of skilled labor	0.57
5	Price inflation	0.56
6	Excessive procedure of Government approvals	0.53
7	Inaccurate cost estimation	0.51
8	Bureaucracy of Government	0.44
9	Design variation	0.43
10	Project Funding Problem	0.42
11	Low Productivity & Efficiency of equipment	0.42
12	Fluctuation in currency and interest rate	0.39
13	Poor Management Ability	0.38
14	Poor Site Condition	0.38
15	Contractual Risks	0.37
16	Whether Effect	0.36
17	Variation by the Client	0.36
18	Not following the Specification or Standards	0.35
19	Geotechnical Risk	0.34
20	Inadequate Safety Measures or Unsafe Operation	0.33
21	Employee do not buy the Safety Insurance	0.31
22	Contractors difficulty in Reimbursement	0.31
23	Poor Project Scope and definition	0.30
24	Lagging of safety regulation and legislation	0.28
25	Lagging of readily available utilities on site	0.28
26	Noise pollution due to construction	0.28
27	No safety awareness at top level	0.26
28	Air pollution	0.25
29	Political instability	0.21
30	Pollution due to water	0.20

Table 4: Risk significance on project objective as Quality

QUALITY		
SL NO	**KEY RISKS**	**SIC**
1	Non availability of sufficient amount of skilled labor	0.56
2	Close project schedule	0.51
3	Poor Management Ability	0.42
4	Market related	0.41
5	Not following the Specification or Standards	0.39
6	Project Funding Problem	0.39
7	Inadequate Safety Measures	0.38
8	Lack of safety regulation and legislation	0.37
9	Labor market and labor cost increase	0.37
10	Excessive procedure of Government approvals	0.36
11	Low Productivity & Efficiency of equipment	0.36
12	Poor Site Condition	0.35
13	Whether Effect	0.35
14	Geotechnical Risk	0.34
15	Price inflation	0.33
16	Inaccurate cost estimate	0.33
17	Design variation	0.32
18	Contractual Risks	0.32
19	Variation by the Client	0.32
20	Bureaucracy of Government	0.30
21	No safety awareness at top level	0.28
22	Poor Project Scope and definition	0.28
23	Shortage of readily available utilities on site	0.26
24	Contractors difficulty in Reimbursement	0.26
25	Noise pollution due to construction	0.25
26	Pollution due to water	0.25
27	Air pollution	0.25
28	Employee do not buy the Safety Insurance	0.24
29	Fluctuation in currency and interest rate	0.24
30	Political instability	0.17

Table 5: Risk significance on project objective as time

TIME		
SL NO	**KEY RISKS**	**SIC**
1	Closer schedule for Project	0.68
2	Unavailability of sufficient amount of skilled labor	0.66
3	Market related	0.62
4	Excessive procedure of Government approvals	0.61
5	Labor market and labor cost increase	0.52
6	Whether Effect	0.50
7	Project Funding Problem	0.48
8	Inaccurate cost estimation	0.46
9	Bureaucracy of Government	0.45
10	Low Productivity & Efficiency of equipment	0.44
11	Design variation	0.43
12	Management Ability	0.43
13	Variation by the Client	0.41
14	Meager Site Condition	0.41
15	Geotechnical Risk	0.38
16	Contractual Risks	0.37
17	Price inflation	0.36
18	Inadequate Safety Measures	0.35
19	Lack of safety regulation and legislation	0.34
20	Poor Project Scope and definition	0.34
21	Contractors difficulty in Reimbursement	0.34
22	Lack of readily available utilities on site	0.31
23	Not following the Specification or Standards	0.30
24	Change in currency and interest rate	0.29
25	No safety awareness at top level	0.29
26	Noise pollution due to construction	0.27
27	Political instability	0.26
28	Air pollution	0.24
29	Employee do not buy the Safety Insurance	0.23
30	Pollution due to water	0.20

Table 6: Risk significance on project objective as Safety.

SAFETY		
SL NO	**KEY RISKS**	**SIC**
1	Insufficient Safety Measures	0.56
2	Absence of safety regulation and legislation	0.49
3	No safety awareness at top level	0.46
4	Closer schedule for Project	0.44
5	Non availability of sufficient amount of skilled labor	0.44
6	Poor Site Condition	0.41
7	Air pollution	0.39
8	Employee do not buy the Safety Insurance	0.39
9	Geotechnical Risk	0.36
10	Whether Effect	0.34
11	Low Management Ability	0.33
12	Serious noise pollution caused by construction	0.32
13	Pollution due to water	0.29
14	Flat Productivity & Efficiency of equipment	0.28
15	Lack of readily available utilities	0.27
16	Excessive procedure of Government approvals	0.26
17	Labor cost is more	0.24
18	Variation by the Client	0.24
19	Contractual Risks	0.23
20	Project Funding Problem	0.23
21	Not following the Specification or Standards	0.21
22	Contractors difficulty in Reimbursement	0.20
23	Design variation	0.19
24	Market related	0.19
25	Price inflation	0.18
26	Bureaucracy of Government	0.17
27	Poor Project Scope and definition	0.15
28	Fluctuation in currency and interest rate	0.15
29	Inaccurate cost estimate	0.14
30	Political instability	0.12

Table 7: Risk significance on project objective as Environment.

ENVIRONMENT		
SL NO	**KEY RISKS**	**SIC**
1	Air pollution	0.47
2	Noise pollution due to construction	0.45
3	Narrow project schedule	0.42
4	Inadequate Safety Measures	0.40
5	No safety awareness at top level	0.35
6	Whether Effect	0.32
7	Lack of safety legislation	0.32
8	Pollution due to water	0.32
9	Poor Site Condition	0.29
10	Poor Management Ability	0.28
11	Non availability of sufficient amount of skilled labor	0.26
12	Geotechnical Risk	0.26
13	Employee do not buy the Safety Insurance	0.25
14	Variation by the Client	0.23
15	Excessive procedure of Government approvals	0.22
16	Design variation	0.21
17	Contractors difficulty in Reimbursement	0.21
18	Bureaucracy of Government	0.20
19	Not following the Specification or Standards	0.20
20	Inaccurate cost estimate	0.20
21	Contractual Risks	0.20
22	Project Funding Problem	0.20
23	Low Productivity & Efficiency of equipment	0.19
24	Price inflation	0.18
25	Lack of readily available utilities	0.18
26	Labor cost is more	0.18
27	Market related	0.17
28	Fluctuation in currency and interest rate	0.14
29	Poor Project Scope and definition	0.13
30	Political instability	0.12

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