Risk Management: Identifying Key Risks in Construction Projects

[1]Divya Gupta, [2]Manoj Sharma, [3]Dr.Ashutosh Shankar Trivedi

[1]PG Student, Construction Technology & Management, Institute of Professional Studies, College of Technology, Gwalior Madhya Pradesh, India
[2]Civil Engineering Department, Institute of Professional Studies, College of Technology, Gwalior Madhya Pradesh, India
[3]Civil Engineering Department, Institute of Professional Studies, College of Technology, Gwalior Madhya Pradesh, India

Abstract: **Managing risks in construction projects has been perceived as a very important management process so as to accomplish the undertaking goals as far as time, cost, quality, safety and environmental sustainability. Projects have become shared effort of multiple parties and construction industry is a good example of an area, where the project outcome is delivered in an extremely complex actor network. By adopting risk management, savings' potentials can be realized in construction projects. For this reason, consideration of the risk management process is worthwhile for project managers as well as real estate developers. The implementation of risk management system in construction projects must be oriented towards the progress of the project and pervade all areas, functions and processes of the project. For analyzing the levels of various risk factors in construction industry, questionnaire surveys were used to collect data. Based on a comprehensive assessment of the likelihood of occurrence of various risks and their impacts on the project objectives, this paper identifies twenty major risk factors. This research found that these risks are mainly related to (in ranking) contractors, clients and designers, with a few related to government bodies, subcontractors/suppliers and external issues. Among them, "Financial Risk" is recognized to influence all project destinations maximally, whereas working in hot areas, closure, defective design and delayed payments on contract are also some important risk factors. This research also found that the risks spread through the whole project life cycle and many risks occur in more than one phase, with the construction stage as the most risky phase, followed by the feasibility stage. It is concluded that clients, designers and government bodies must work cooperatively from the feasibility phase onwards to address potential risks in time. Also contractors and subcontractors with robust construction and management knowledge should be employed early to make sound preparation for carrying out safe, efficient and quality construction activities. The aim of this research is to identify and evaluate current risks and uncertainties in the construction industry through extensive literature survey. It also intends to make a basis for future studies for development of a risk management structure to be adopted by prospective investors, developers and contractors in Developing countries.**

Keywords: **risk, risk management, risk analysis, construction projects.**

I. INTRODUCTION

Risk is defined as an uncertainty of outcome, whether positive opportunity or negative threat, of actions and events. The risk has to be assessed in respect of the combination of the likelihood of something happening, and the impact which arises if it does actually happen. Risk management includes identifying and assessing risks (the "inherent risks") and then responding to them. Project management is the science which applies skills, tools and techniques to fulfill project activities in a way that the expectations and requirements of stakeholders are fulfilled or exceeded. Project risk management is an integral part of the process which aims at identifying the potential risks associated with a project and responding to those risks. It includes activities which aim to maximize the consequences associated with positive events and to minimize the impact of negative events. It is believed generally that risk in an environment is a choice rather than fate, and the inherent uncertainty in the plans can affect the desired outcome of achieving project and business goals. Risk is present in all the activities of a project; it is only the amount which varies from one activity to another. Risks and uncertainties are more inherent in the construction industry than any other industry. The process of planning, executing and maintaining all project activities is complex and time – consuming. The whole process requires a myriad of people with diverse skill sets and the coordination of a vast amount of complex and interrelated activities. The situation is made even more complex by many external factors. The track record of construction industry is very poor in terms of coping with risks, resulting in the failure of many projects to meet time schedules, targets of budget and sometimes even the scope of work. Consuming undertakings The structure must be designed in accordance with applicable codes and standards, culminating in working drawings and specifications that describe the work in sufficient details for its accomplishment in the field. The construction projects have been divided into four main categories: residential construction, building construction, heavy engineering construction and industrial construction.

II. PAST STUDIES ON RISK MANAGEMENT AND ASSESSMENT

Various researchers have done study on risk assessment and management in the past. Prominent among them are detailed below:-

- **1. Alfredo del cano, P.E, M.ASCE, and M.F de la Cruz, P.E. (2002)** - This article presents a generic project risk management process that has been particularized for construction projects from the point of view of the owner and the consultant who may be assisting the owner. The process could also be adapted to the needs of other project participants, and many points referred to in the article can be directly applied to them. Any project risk management process must be tailored to the particular circumstances of the project and of the organization undertaking it. Then the application to a real project is summarized. As a final validation, a Delphi analysis has been developed to assess the project risk management methodology explained here, and the results are presented.
- **Seung H.Han,Jams E. Diekmann, et al. (2004)** - This paper focuses on a financial portfolio risk management for international projects to integrate the risk hierarchy of both individual projects and at the corporate level, which applies a multi criteria decision making method to maximize the total value of firms. To demonstrate the approach, a case study is conducted based on real projects collected from a multinational general contractor. Finally, present lessons learned as well as guidelines for the application of these lessons to future projects through a workshop with industry practitioners.
- **Wenzhe Tang, Maoshan Qiang, Colin F. Duffield, et al. (2007)** – In the discussed paper, an empirical Chinese industry survey on the importance of project risks, application of risk management techniques, status of the risk management system, and the barriers to risk management, which were perceived by the main project participants. The study reveals that most project risks are commonly of concern to project participants; the industry has shifted from risk transfer to risk reduction, current risk management systems are inadequate to manage project risks and lack of joint risk management mechanisms is the key barrier to adequate risk management.
- **Hong-bo Zhou, S.E. M.ASCE and Hui Zhang,(2011) –** Risk assessment and risk management for deep foundation pit engineering are essential for quality and safety in civil engineering owing to the needs of urban construction projects. However, uncertainty and fuzziness continue to challenge studies of the probability and consequences of risks in this area. Therefore, a fuzzy comprehensive evaluation method based on Bayesian networks (BNs) is proposed to assess the risks of deep foundation pit construction. This methodology has five main parts: modelling of BNs, determination of occurrence probabilities of risk events, assessment of consequences, calculations of risk value and membership degree of risk rating, and definitions of risk acceptance criteria. The probability of every risk event is calculated by using deductive BN techniques. Then the consequence of each event is calculated by using fuzzy analysis (i.e., statistical consequence distributions and weight coefficients of risk events are determined through the database). A fuzzy comprehensive evaluation model with a membership function is also presented, and each risk event in the deep foundation pit construction his rated. In addition, risk precautions and control measures are suggested on the basis of the risk assessment results and are applied to risk management in deep foundation pit construction.
- **Closure:**

  Most of the studies as mentioned above are carried out in developed countries. Very few studies are carried out in India. Also, most of the studies are with reference to construction industry in general. Hence, the necessity arises for present study which is specific to building construction industry.

III. DATA ANALYSIS METHOD

In all questionnaires was mailed to fifty organizations/ companies/ personal out of which eighteen has responded. Rate of response is 38%, which may be considered to be fair working to the pre-occupation of the senior personal. To assess the relative significance among risks, previous literatures study suggests establishing a risk significance index by calculating a significance score for each risk. For calculating the significance score, multiply the probability of occurrence by the degree of impact. The significance score for each risk assessed by each respondent can be obtained through the model

$$s_j^i = \alpha_j^i \beta_j^i$$

Where s_j^i= significance score assessed by respondent j for risk i; α_j^ioccurrence of risk i, assessed by respondent j; & β_j^i= degree of impact of risk i, assessed by respondent j. By averaging scores from all the responses, it is possible to get an average significance score for each risk, and this average score is called the **risk index score** and is used for ranking the risks. The model for the calculation of risk index score can be defined as:

$$RS^i = \frac{\sum_{j=1}^{T} s_j^i}{T}$$

Where Rs^i= index score for risk i; S_j^i = significance score assessed by responding j for risk i and T = total number of responses. To calculate $s_j^i$the five point scales for α and β, this will be converted into numerical (Likert scale) scales as shown in Table 1.

Tables 1: Numerical conversion for the rating attributes

α , β	
Ratting Attributes	**Numerical Conversion**
0	0.0
1	0.2
2	0.4
3	0.6
4	0.8
5	1.0

After obtaining index score for each risk factor, standard deviation and coefficient of variation of each risk factor is also determined. Subsequently, ranking of risk factors is done based on Index score.

IV. RESULT AND DISCUSSION

Analysis of Data:

Total eighteen respondents have filled up the questionnaire. Subsequently for analysis of responses following steps are followed:

I. Responses were converted into numerical values based on their rating attributes. A sample is shown in Table 2.

II. After that mean of numerical values of all eighteen responses is determined.

III. Then, Standard deviation and coefficient of variation for each risk factor is determined.

IV. Afterwards, Index Score for each risk is calculated by using RI Method.

Table 2: Conversion of response into numerical values (Questionnaire 1)

Types of risks	Probability level of the risk occurrences (α)		Degree of impact or the level of loss if the risk occurs (β)		Significance Score
	Rating attribute in Lickert Scale	Numerical Value	Rating attribute in Lickert Scale	Numerical Value	
Financial Reasons	3	0.6	4	0.8	0.48
Availability of Commodity/ Resource	2	0.4	1	0.2	0.08
Quality of Commodity/Resource	4	0.8	5	1.0	0.80
Problem during execution of construction work	1	0.2	1	0.2	0.04
Due to policy & Hedging Management	2	0.4	2	0.4	0.16
Nature of Human Behaviour	2	0.4	1	0.2	0.08
Due to delay of work	4	0.8	3	0.6	0.48
Due to variation of cost from current position to after completion of work	4	0.8	4	0.8	0.64
Contract management	2	0.4	1	0.2	0.08
Availability Fire controlling panel	1	0.2	2	0.4	0.08
Life safety management	4	0.8	5	1.0	0.80
Delay of work due to Information/Communication problem from top Management to lower management	2	0.4	3	0.6	0.24
Due to lack of labour and engineer	5	1.0	5	1.0	1.0
Due to quality of labour and engineer	2	0.4	1	0.2	0.08
Handover of the project after its completion	2	0.4	1	0.2	0.08
Due to lack of availability of highly effective equipment	1	0.2	2	0.4	0.08
Due to surrounding local body	2	0.4	1	0.2	0.08
Due to environmental issue	1	0.2	2	0.4	0.08
Due to demanding the project before completing time	3	0.6	5	1.0	0.60
Due to transfer of the project to other contractor because of any reason	4	0.8	5	1.0	0.80

Above calculation is shown in table 3.

S.No.	Questionnaire	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total	Index Score (μ)	SD(σ)	C.O.V= (σ/μ)
1	Financial Reasons	.48	.24	.36	.64	.08	.08	.80	.36	1.0	.08	.36	.08	.08	1.0	.48	1.0	1.0	.80	8.92	.50	.35	.71
2	Availability of Commodity/ Resource	.08	.36	.36	.24	.04	.36	.04	.64	.08	.08	.24	.04	.16	.80	.48	.64	.08	.08	4.80	.27	.23	.87
3	Quality of Commodity/Resource	.80	.48	.24	1.0	.16	.08	.08	.48	.16	.48	.16	.16	.24	.32	.80	.80	.04	.64	7.12	.40	.29	.74
4	Problem during execution of construction work	.04	.64	.48	.08	.64	.16	.08	.08	.08	.24	.64	.60	.08	.24	.36	.24	.24	.08	5.00	.28	.22	.79
5	Due to policy & Hedging Management	.16	.24	.08	.08	.80	.80	.40	.80	.80	.36	.48	.40	.24	.48	.32	.24	.80	.08	7.56	.42	.26	.63
6	Nature of Human Behaviour	.08	.36	.16	.08	1.0	.08	.24	.08	.64	.80	.24	.12	.04	.24	.36	.12	.08	.12	4.84	.27	.27	.99
7	Due to delay of work	.48	.80	.48	.48	1.0	.80	.16	.04	.80	1.0	.80	.08	.04	.80	.48	.60	.08	.48	9.40	.52	.32	.61
8	Due to variation of cost from current position to after completion of work	.64	1.0	.36	.64	.08	.08	.48	1.0	.24	.80	.64	.16	.60	.08	.08	.04	.36	.64	7.92	.44	.31	.71
9	Contract management	.08	.08	.24	.24	.36	.80	.64	.48	.08	.08	.24	.80	.08	.16	.08	.24	.48	.08	5.24	.29	.24	.83
10	Availability Fire controlling panel	.08	.04	.24	.04	.04	1.0	.04	.04	.08	.08	.24	.08	.12	.08	.24	.04	.04	.08	2.60	.14	.22	1.57
11	Life safety management	.80	.08	.64	.80	.08	.64	.04	.16	.08	.16	.36	.80	.60	.48	.48	.08	.08	.80	7.16	.40	.29	.74
12	Delay of work due to Information/Communication problem from top Management to lower management	.24	.36	.36	.36	.80	.64	.60	.80	.48	.48	.08	.80	.08	.48	.80	.64	.36	.48	8.84	.49	.22	.46
13	Due to lack of labour and engineer	###	.48	.48	.48	.04	.08	.48	.08	.48	.24	.80	.08	.32	.48	.08	.16	.24	.24	6.24	.35	.26	.74
14	Due to quality of labour and engineer	.08	.64	.24	.16	.08	.04	.12	.04	.08	.36	.48	.04	.12	.80	.64	.48	.04	.36	4.80	.27	.24	.90
15	Handover of the project after its completion	.08	1.0	.32	.08	.48	.16	.48	.48	.80	.80	.80	.36	.08	.64	.24	.08	###	.36	8.24	.46	.31	.68
16	Due to lack of availability of highly effective equipment	.08	.48	.48	.24	.64	.36	.08	.04	.24	.08	.08	.04	.32	.80	.08	.12	.08	.16	4.40	.24	.22	.90
17	Due to surrounding local body	.08	.48	.36	.08	.60	.48	.04	.04	.08	.08	.08	.24	.20	.36	.80	.04	.12	.12	4.28	.24	.22	.92
18	Due to environmental issue	.08	.24	1.0	.04	.08	1.0	.16	.04	.04	.16	.36	.04	.24	.36	.36	.32	.08	.40	5.00	.28	.28	1.0
19	Due to demanding the project before completing time	.60	.24	.12	.64	.04	.08	.04	.80	.04	.08	.24	.48	.24	.16	.08	.08	.48	.80	5.24	.29	.26	.90
20	Due to transfer of the project to other contractor because of any reason	.80	.64	.48	1.0	.08	.08	.80	.48	.08	.24	.24	.80	.64	.48	.80	.48	.80	.60	9.52	.53	.28	.53

Based on Index Score, ranking of risk factors is done in descending order. It is shown in Table 4.

With respect to the magnitude of risk index, an average Index Score of 0.25 (Medium likelihood of occurrence 0.5 × medium level of impact 0.5) can be regarded as high as per (AS/NZS4360, 2004).

It is determine that out of 20 risk factors considered, 18 are having a risk index score of 0.25 or more and hence they are significant risks for building construction industry.

S. No	Sub risk	Index Score	Rank order
1	Due to transfer of the project to other contractor because of any reason	0.529	1
2	Due to delay of work	0.522	2
3	Financial Reason	0.496	3
4	Delay of work due to Information/Communication problem from top Management to lower management	0.491	4
5	Handover of the project after its completion	0.458	5
6	Due to variation of cost from current position to after completion of work	0.440	6
7	Due to policy & Hedging Management	0.420	7
8	Life safety management	0.398	8
9	Quality of Commodity/ Resources	0396	9
10	Due to lack of labour and engineer	0.347	10
11	Contract management	0.292	11
12	Due to demanding the project before completing time	0.291	12
13	Problem during execution of construction work	0.279	13
14	Due to environmental issue	0.278	14
15	Nature of Human Behaviour	0.269	15
16	Availability of Commodity/ Resources	0.268	16
17	Due to quality of labour and engineer	0.267	17
18	Due to lack of availability of highly effective equipment	0.244	18
19	Due to surrounding local body	0.238	19
20	Availability Fire controlling panel	0.144	20

V. CONCLUSION

In this study, identifying the risk factors faced by construction industry is based on collecting information about construction risks, their consequences and corrective actions that may be done to prevent or mitigate the risk effects. Risk analysis techniques were investigated too. However, determination of severity and allocation of these risk factors was the main result of this research on the basis of a survey with industry practitioners owning robust experience and knowledge of construction projects, 20 key risks were highlighted on a comprehensive assessment of their likelihood of occurrence and level of impacts on project objectives.

REFERENCES

[1] Alfrdel Cano, and M. Pilar de la Cruz, (2002) "Integrated Methodology for Project Risk Management", journal of Construction Engineering and Management, ASCE, PP.473-485.

[2] Abdou, O.A. (1996) Managing Construction Risks, Journal of Architectural Engineering, vol.2(1), pp.3-10.2.

[3] Ahmed, S.M., Ahmad, R. and Saram, D.D. (1999) Risk Management Trends in the Hong Kong Construction Indus try: a Comparison of Contractors and Owners Perceptions, Engineering, Construction and Architectural Management, vol.6(3), pp.225-234.

[4] Akintoye, A.S. and MacLeod, M.J. (1997) Risk Analysis and Management in Construction, International Journal of Project Management, vol.15(1), pp.31-38. AS/NZS 4360 (1999) Australian / New Zealand Standard on Risk Management, Standards Australia and Standards New Zealand.

[5] Baker, W. and Reid, H. (2005) Identifying and Managing Risk, Frenchs Forest, N.S.W.: Pearson Education.

[6] Berkeley, D., Humphreys, P.C. and Thomas, R.D. (1991) Project Risk Action Management, Construction Management and Economics, vol.9(1), pp.3-17.

[7] Chapman R.J. (2001) The Controlling Influences on Effective Risk Identification and Assessment for Construction Design Management, International Journal of Project Management, vol.19, pp.147-160.

[8] Chen, H., Hao, G., Poon, S.W. and Ng, F.F. (2004) Cost Risk Management in West Rail Project of Hong Kong, 2004 AACE International Transactions.

[9] Flanagan, R. and Norman, G. (1993) Risk Management and Construction, Victoria: Blackwell Science Pty Ltd, Australia.

[10] He, Z. (1995) Risk Management for Overseas Construction Projects, International Journal of Project Management, vol.13(4), pp.231-237.

[11] McIntosh, K. and McCable, B. (2003). Risk and Benefits Associated with International Construction-Consulting Joint Ventures in the English-Speaking Caribbean, Canadian Journal of Civil Engineering, vol.30, pp.1143-1152.

[12] Moser, C. A. and Kalton, G. (1971) Survey Methods in Social Investigation, UK: Heinemann Educational.

[13] Perry, J.H. and Hayes, R.W. (1985) Risk and Its Management in Construction Projects, Proceedings of the Institution of Civil Engineering, Part I, Vol.78, pp.499-521.

[14] Schuyler, J. (2001). Risk and Decision Analysis in Projects (second edition), Pennsylvania: Project Management Institute, Inc, USA.

[15] Shen, L.Y. (1997). Project Risk Management in Hong Kong, International Journal of Project Management, vol.15(2), pp.101-105.

[16] Shen, L.Y., Wu, G.W.C. and Ng, C.S.K. (2001) Risk Assessment for Construction Joint Ventures in China, Journal of Construction Engineering and Management, vol.127(1), pp.76-81.

[17] Smith, N.J. (2003). Appraisal, Risk and Uncertainty (Construction Management Series), London: Thomas Telford Ltd, UK.

[18] Tam, C.M., Zeng, S.X. and Deng, Z.M. (2004) Identifying Elements of Poor Construction Safety Management in China, Safety Science, vol.42, pp.569-586.

[19] Uher, T. (2003) Programming and Scheduling Techniques, UNSW Press, Sydney Uher, T.E. and Toakley, A.R. (1999) Risk Management in the Conceptual Phase of a Project, International Journal of Project Management, vol.17(3), pp.161-169.

[20] Wang, J.Y. and Liu, C.L. (2004) Risk Management for Construction Projects, Beijing: China Water Publication.

[21] Ward, S.C. and Chapman, C.B. (1995) Risk-Management Perspective on the Project Lifecycle, International Journal of Project Management, vol.13(3), pp.145-149.

[22] Tiendung Le, Carlos, H.Caldes et al. “Assessing Scope and Management Risk in the Highway Project Development Process” Journal of Construction Engineering and Management Vol.135,No.9,pp.900-910

[23] Wenzhe Tang, Maoshan Qiang et. Al (2007) “ Risk Management in the Chinese Construction Industry” Journal of Construction Engineering and Management, Vol.No.133,No.12,pp.944-956

[24] Yasser Abdelghany, A.Samer Ezeldin (2010) “Classification of risks for International construction Joint Ventures (ICJV) Projects” Construction Research Congress