Risk Identification and Analysis in the Construction Projects

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Abstract : Risk is present in every construction project and each construction project is unique. The risk factors influencing the projects are also different. If these risk factors are not addressed properly at planning stage, it can adversely affect the project performance. In this study, various risk factors were identified and classified according to their nature. Data related to risk measurement was collected through the questionnaire survey and by meeting personnel working in the construction industry. The risk factors were rated for the likelihood of their occurrence and impact was recorded for the projects under case study. These ratings were analyzed using SPSS software and possible correlations were developed for the critical factors. Findings of this study will help the parties associated with the project management to determine the risk correlations at start of the project to minimize risk through effective planning for the successful completion of the project.

***Keywords* - Cost overrun; Construction Management; Project Planning; Risk factors; SPSS software.**

I. Introduction

Risk is defined as the chance of something happening that will have an impact on objectives; may have a positive or negative impact [1]. In construction industry greatest risks are of completing the project on time and within budgeted cost and with prescribed quality. If these parameters are not met then it will be negative risk and if everything is better than expected it will be positive risk. Every construction project is of unique nature and hence risk associated with each project also varies from one another. Therefore, for successful completion of project in terms of cost, time, quality, environment and safety, analysis of different risks plays vital role.

Risk management is a technique or process which is used to study and prepare the management to reduce, eliminate or transfer the risk [2]. Many industries have become proactive about using these risk management techniques. However, with regard to the construction industry, risk management is not commonly used. Many construction companies are starting to become aware of the Risk Management Process, but are still not using models and techniques aimed for managing risks. This contradicts the fact that the industry is trying to be more cost and time efficient as well as have more control over projects [3]. No project is completely free from risks. [4] If risks are not properly analyzed and strategies are not formulated to deal with them, project is likely to lead to failures.

The construction industry operates in a very uncertain environment where conditions can change due to the complexity of each project. The aim of every organization is to be successful and Risk Management can facilitate it. However, it should be understood that risk management is not a tool which ensures success but rather a tool which helps to minimize risk and increase the probability of achieving success. Risk management is therefore a proactive rather than a reactive concept [5].

Identification and evaluation of various risks and qualitative mitigation framework was prepared and techniques were proposed for developing countries which were considered very beneficial [6]. A risk assessment model was proposed for the user in calculating potential risks involved in the international markets by analyzing the various risks [7]. It has been reported that, influence diagramming technique and Monte Carlo simulation were found to be useful tools for the avoidance, transfer, retention and prevention of risk [8]. Risk management model was proposed for measuring effect of risk management on site and at individual level [9].

Till now, many researchers have presented various risk management models and techniques to minimize risk. But the correlation among various risks and their interdependency is not yet reported. Therefore, the main objective of this study was to identify and analyze the critical risk factors that affect project completion. Moreover, this study has devised relations between various critical risks which will help to estimate the interdependencies that will assist construction parties to mitigate risk at different stages.

II. Materials and methods:

2.1 Data collection

A well designed questionnaire form was prepared by meeting with field personnel to record their opinions and suggestions for addition of new factors. It consists of around thirty questions to record different risk parameters. Primary data associated with risk analysis was collected through questionnaire survey circulated among eight different experts working in construction sector. The respondents rated these risks on basis of likelihood of the occurrence and impact of these risks on the project objectives. Rating of occurrence was done on the scale from 1 to 5, where 1 stands for very low; 2 stands for low; 3 stands for moderate; 4 stands for high and 5 stands for very high. On similar lines, for impact scale of 1 to 5 was decided where 1 stands for negligible; 2 stands for low; 3 stands for moderate; 4 for high and 5 for extreme. Further this qualitative information was converted to secondary data for simplicity of risk analysis.

2.2 Risk factors (RF)

Researchers have identified various *RF* influencing the project performance and their significance towards project success. In the present study, in addition to different *RF* considered on the basis of literature review, some of the *RF* were added after discussion with industry experts. These *RF* were categorized based on their nature and were mainly divided into six categories such as design risks, external risks, organizational risks, construction risks, project management risks and force majeure risks as shown in Table 1.

Table1. Categorization of Risks and codes

Code	**Design Risks**	**Code**	**Construction Risks**
D_1	Design Alteration	C_1	Construction time overruns
D_2	Design process takes longer	C_2	Construction cost overruns
D_3	Stakeholder requests late changes	C_3	Labor problems
Code	**External Risks**	C_4	Mechanical machines overstay
Ex_1	Public objections, political events	C_5	Changes in materials
Ex_2	Surrounding structure affected by initial design	**Code**	**Project Management Risks**
Ex_3	Law, local standard changes	PM_1	Failure to comply with contractual quality
Ex_4	Tax changes	PM_2	Scheduling errors
Ex_5	Government approvals	PM_3	Project team conflicts
Code	**Organizational Risks**	PM_4	Tight project schedules
O_1	Inexperienced workforce, staff turnover	**Code**	**Force Majeure Risks**
O_2	Delayed deliveries	F_1	Heavy rains and water logging
O_3	Lack of protection on site	F_2	Extreme heat conditions

Further each of these main *RF* discussed above were divided into sub-categories. Design risks include risks related to design which include the alterations identifies as (D_1), longer time taken for design as (D_2) and late changes in designs requested by the stakeholders as (D_3). Similarly other sub-factors were coded according to their nature as shown in Table1. External risks include political events, public objections, changes in standards and laws and government approval risks. Then there are organizational risks stating risks such as the workforce problems and lack of protection on site. Next is construction risk, which is actually related to the construction process. Such as the time and cost overruns, labour problems and materials and machines related risks. The next category is related to the project management risks which are scheduling risks, project team and quality of the work. The last category is of force majeure risks which are natural risks of extreme rains and heat conditions.

The responses of the experts in the form of likelihood of the occurrence and impact of these risks were recorded in Table 2 and data was processed through SPSS software (Statistical Package for Social Sciences).

Table2. Response of the experts from different projects

Risk factors	**Respondents**							
	R1	R2	R3	R4	R5	R6	R7	R8
D1	(2,5)	(3,5)	(2,5)	(3,4)	(4,5)	(4,4)	(5,5)	(5,4)
D2	(2,4)	(2,3)	(3,4)	(2,3)	(4,4)	(4,5)	(5,4)	(4,4)
D3	(3,4)	(2,3)	(3,3)	(3,3)	(4,5)	(4,4)	(5,4)	(4,5)
Ex1	(4,4)	(4,5)	(5,4)	(4,4)	(5,4)	(5,5)	(4,5)	(5,4)
Ex2	(1,2)	(2,1)	(2,1)	(1,1)	(5,4)	(4,5)	(5,5)	(4,5)
Ex3	(3,3)	(3,3)	(3,4)	(2,3)	(3,3)	(4,3)	(3,3)	(3,4)
Ex4	(2,3)	(1,2)	(2,2)	(1,2)	(2,3)	(3,3)	(3,3)	(2,3)
Ex5	(4,5)	(5,4)	(4,5)	(5,4)	(5,5)	(4,5)	(5,4)	(4,5)
O1	(4,3)	(3,3)	(4,3)	(3,4)	(3,3)	(3,4)	(4,3)	(3,3)
O2	(3,3)	(4,3)	(3,4)	(3,4)	(3,4)	(4,3)	(4,3)	(3,4)
O3	(3,4)	(3,3)	(2,4)	(3,4)	(3,4)	(4,4)	(4,3)	(3,4)
C1	(5,4)	(4,5)	(5,5)	(5,4)	(5,4)	(4,5)	(5,5)	(5,4)
C2	(5,5)	(4,5)	(5,4)	(5,5)	(5,4)	(5,5)	(5,5)	(4,5)
C3	(4,5)	(4,4)	(5,4)	(4,5)	(5,4)	(5,4)	(4,5)	(4,4)
C4	(4,5)	(4,4)	(3,5)	(4,4)	(5,4)	(4,5)	(4,4)	(4,5)
C5	(2,3)	(3,2)	(2,3)	(3,3)	(4,3)	(3,3)	(4,3)	(4,3)
PM1	(2,4)	(3,3)	(3,4)	(2,3)	(3,4)	(3,3)	(4,4)	(3,3)
PM2	(3,4)	(4,4)	(4,3)	(3,4)	(3,4)	(4,3)	(4,3)	(3,4)
PM3	(3,3)	(3,2)	(2,3)	(3,3)	(3,3)	(4,2)	(3,3)	(4,2)
PM4	(4,4)	(3,4)	(4,4)	(4,5)	(4,5)	(4,4)	(4,5)	(4,5)
F1	(4,5)	(4,5)	(5,4)	(4,4)	(3,3)	(3,4)	(4,3)	(3,3)
F2	(4,4)	(5,4)	(5,4)	(5,4)	(3,2)	(2,3)	(3,2)	(3,2)

III. Data Analysis

Data Analysis was carried out using SPSS software. All the 22 factors' likelihood and impact were multiplied and entered in the SPSS spreadsheet. The output results were generated from SPSS demonstrates correlation between various risk factors (Table 3). All these relations were established between -1 to +1. Extreme negative as well as positive value indicates stronger correlations among risks.

Negative sign indicates that if one risk increases then other risk decreases. In the present study, it can be clearly seen that this correlation (-0.655) was found between PM_4 and C_1. Similarly, when the correlation value become close to zero, it indicate that the correlation becomes null and it symbolizes no correlation the between the two risks. It was observed that correlation between FM_2 & C_2; PM_1 & O_3; PM_2 & Ex_1 and O_3 & O_2 having values of +0.076, +0.053, -0.054 and -0.063, respectively showing weaker correlation between them (Table 3). However, positive correlation value implies that as one risk will increases, corresponding risk will also increase in proportion. From table 3 it is seen that stronger correlation was observed between, Ex_4 & D_2 having a value of +0.895. Similarly for pairs of risks D_1 & Ex_2 and D_1 & D_3 also the value of correlation is very strong having values +0.864 and +0.806 respectively. Also, for pair of risks of Ex_3 and Ex_1 the value of correlation is moderately strong having a value of +0.697. Finally, the table also shows that Ex_1 and D_1 have less strong value of +0.377.

By the use of software, correlations between 10 risks were obtained. The table below shows the correlation between these risks.

Table3. Correlation between Risks obtained from SPSS

	Risk	Risk	Correlation
1.	Tax changes (Ex_4)	Design process takes longer (D_2)	+0.895
2.	Design Alteration (D_1)	Surrounding structure affected by initial design (Ex_2)	+0.864
3.	Design Alteration (D_1)	Stakeholder requests late changes (D_3)	+0.806
4.	Law, local standard changes (Ex_3)	Public objections, political events (Ex_1)	+0.697
5.	Public objections, political events (Ex_1)	Design Alteration (D_1)	+0.377
6.	Extreme heat (FM_2)	Construction cost overruns (C_2)	+0.076
7.	Failure to comply with contractual quality (PM_1)	Lack of protection on site (O_3)	+0.053
8.	Scheduling errors, contractors delay (PM_2)	Public objections, political events (Ex_1)	-0.054
9.	Lack of protection on site (O_3)	Delayed deliveries (O_2)	-0.063
10.	Tight project schedules (PM_4)	Construction time overruns (C_1)	-0.655

IV. CONCLUSIONS

Findings of this study indicate that there exists certain relation between the various risks. However, these relations were varying from positive to negative. Negative correlation between two risks state that if one risk decrease other increases and vice versa. Positive correlation shows that both risk increase and decrease simultaneously. Weak correlation between risks was observed when value reaches to zero. The findings of this study show that 50% of risk pairs have positive correlation, whereas about 40% of risk pairs have null correlation. Negative correlation was observed in only 10% of risk pairs. This analysis can help the project administrator not only to reduce or control the risk but to understand the consequences of risk variation at different degree of correlation.

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