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Assessment of Risk and Its Application for Residential Construction Projects: A Case Study

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Abstract: ***In construction projects, risks play a significant part in decision making and may affect the performance of a project. The purpose of this study is to identify risk, risk assessment of various risks for 'The Metrozone Project' located at Nashik (M.S.), India; as a case study, which can help in prioritizing risks in case of residential construction project for project parties for effective risk management and successful completion of the project to reach their intended goals with greater efficiency. Risks can be assessed qualitatively and quantitatively. Then this ranking gets converted into score. From this score, the risk factor of each risk type is found out. Risk factor and priority model' technique is used to analyze risk. Risks can be assessed qualitatively and quantitatively. Then this ranking gets converted into score. From this score, the risk factor of each risk type is found out. Risk profile indicates the priorities of risk in order to resolve it, then risk prioritization of various risks is to be found out. The first priority can be interpreted as most critical whereas the last priority can be interpreted as least critical reflects on achieving project success. To achieve objectives of this study, a questionnaire is designed on basis of objectives for the residential construction project. The questionnaire includes total main 15 risks which are project related of major residential construction project.***

Keywords: Risk identification, assessment of Risk, Risk factor, Risk priority

1. Introduction

In construction projects, risks play a significant part in decision making and may affect the performance of a project. If they are not dealt with sensibly, they may cause cost overturns, delays on schedule and even in poor quality. Each project has a different level and combination of risks and sites will adopt different strategies to minimize them because the characteristics of projects are unique and dynamic.

Risks are very common in construction sector. Risk is the possibility of suffering loss and the impact on the involved parties. Risk is identified and then risk assessment and analysis is done. Then risk management and risk mitigation is carried out. Risk affect construction sector negatively and focusing on risk reduction measure it important. Compared with many other industries, the construction industry is subject to more risks due to the unique features of construction activities, such as long period, complicated processes, abominable environment, financial intensity and dynamic organization structures. Hence, effectively identifying and managing risks is very essential in a construction project as to deal with the risks related with variable construction activities. It has been becomes an important issue in project management as to achieve the successful delivery of a project and the objectives in terms of cost, time, quality, safety and environmental sustainability.

Besides, construction industry is also a vehicle through which a country's physical developments are activated by starting projects from the blue print stage to the implementation. The implementation and materialization of such projects inevitably can bring a lot of benefits to the people and the country. Hence, this can satisfy the aspiration of national progress and growth, which also will be uplifting the status of the country economically.

Construction projects are increasingly growing in value and complexity. Most of them are innovative resulting into inclusion of a high level of risk and uncertainty. The management of risks within these projects remains a major factor in their success or failure.

2. Literature Review

Construction companies and firms, such as the government, consultants and contractors, normally face different kinds of risks during construction. Risk identification is the first process in risk management. Risk identification is important to know how the players in the construction industry handle risk identification. Without having any perspective on or approach for risk identification, construction participants cannot make appropriate decisions in other risk management processes.

It is important to notice the difference between risk and uncertainty. Uncertainty can be regarded as the chance occurrence of some event where the probability distribution is genuinely not known. This means that uncertainty relates to the occurrence of an event about which little is known, except the fact that it may occur. Those who distinguish uncertainty from risk define risk as being where the outcome of an event, or each set of possible outcomes, can be predicted on the basis of statistical probability. This understanding of risk implies that there is some knowledge about a risk as a discrete event or a combination of circumstances, as opposed to an uncertainty about which there is no knowledge. In most cases, project risks can be identified from experience gained by working on similar projects.

In some situations the term risk does not necessarily refer to the chance of bad consequences, it can also refer to the possibility of good consequences; therefore, it is important that a definition of risk must include some reference to this point. Risk and uncertainty have been defined as:

Risk exists when a decision is expressed in terms of a range of possible outcomes and when known probabilities can be attached to the outcomes;

Uncertainty exists when there is more than one possible outcome of a course of action but the probability of each outcome is not known (frequently termed estimating uncertainty). [1]

Following considers the difference between risk and uncertainty:

1. Risk – quantifiable, statistical assessment; objective data;
2. Uncertainty – not quantifiable, subjective probability, formed opinion.

According to Padiyar, "risk is a situation where there exists no knowledge of its outcome or exposure to loss resulting from inadequate or failed internal processes, people and systems and from external events". Risk is a function of events, potential loss/gain from events.

The essence of risk is characterized by three factors: the event, the likelihood and the impact of the event.

(a) The event: A possible occurrence which could affect the achievement.
(b) The likelihood: The chance (or probability) of the risk event occurring within the time period.
(c) The impact: The financial value of the effect of the risk event. [2]

2.1 Source of Risks in Construction Projects

Risk source is defined as any factor that has a potential to cause harm to a project either owing to an adverse change from initial project conditions or an unexpected situation.

Construction projects are characterized as complex and unique where a risks rise from a number of different sources. The construction industry has many sources of risk some of which can be attributed to the complexity of processes, the environment of construction projects, financial aspects, organizational structures and technology usage. In the success of construction projects, the importance of identifying and managing risks is widely acknowledged.

Delays in time and cost overrun have become the most common risks facing the industry worldwide. However, they are particularly prevalent in developing countries where adversities such as shortage of materials, lack of management skills, unskilled labour as well as socio economic and political problems must be dealt with; all of which make construction projects more difficult to manage.

Risks involved in construction industry:

- Technical Risk
- Logistical Risk
- Management Related Risk
- Environmental Risk
- Financial Risk
- Socio-Political Risk
- Common Source of Risk
- Other

In large construction engineering projects, sources of risks can be categorized as:

1. **Market risk-** Market risk is mainly caused by the demand uncertainty.
2. **Completion risks-** Completion risks refer to technical risks during and after the completion of a project.
3. **Institutional risks-** Institutional risks are related to the political uncertainties in a specific situation.[2]

2.2 Identify the Risk

According to Mehadi Tadayan (2012), Risk identification is an iterative process that involves the project team, stakeholders and other managers affected by or who affect the project, and finally outside individuals who can comment on the completeness of the risk identification based on their similar experiences.

Risk Identification: Level 1 characteristics:

1. There is no defined and documented process for identifying risks.
2. Project team members occasionally suggest potential risks to the project manager.
3. Project teams initiate risk discussions on an as-needed and when-needed basis.

Risk Identification: Level 2 characteristics:

1. There is a defined and documented process for risk identification.
2. The project team examines the WBS, cost, schedule and other relevant aspects of the project plan to identify the operative risks.
3. Risk identification includes input from clients and stakeholders.
4. Risk discussion includes cost, schedule and scope.
5. The project team may rely on industry lessons to identify risks.

Risk Identification: Level 3 characteristics:

1. There is a documented standardized risk identification process in place that is used by all projects.
2. There is a historical database of risks that project teams can use as a template.
3. Interproject risks are identified.

Risk Identification: Level 4 characteristics:

1. The risk identification process is fully integrated into other corporate processes and procedures.
2. Lessons learned and best practices are captured and made available to other projects.

Risk Identification: Level 5 characteristics:

1. A program is in place for the continuous collection and analysis of risk identification process performance data

and used to improve the process.
2. Lessons learned and best practices are used to improve the risk identification process.

By identifying risks at an early stage of planning a construction project or a tender and assessing their relative importance, the project management can be adapted to reduce the risks and allocate them to the parties best able to control them or absorb them should they occur. Studies should be carried out early in the life of a project, well before decisions are made to proceed with the project. [4]

2.3 Qualitative Assessment

Qualitative risk analysis covers a range of techniques for assessing the impact and likelihood of identified risks. These approaches can be used to prioritize the risks according to their potential effect on project objectives and is one way to determine the importance of addressing specific risks and guiding risk responses [2]. In performing a qualitative analysis, an indication based on size or magnitude is used to determine which risks are most important. In this method of analysis, the probabilities and the consequences of the risks are not described in terms of exact numerical value: rather, textual assessments are used like 'a lot/very little, 'more/less and division into classes of probability and consequence. In general, the consequences of a risk are expressed in terms of time and/or money. In some projects the consequences are expressed in terms of quality, environmental obstacles and safety [3].

2.4 Quantitative Assessment

Quantitative analysis uses numerical ratio scales for likelihood and consequences, rather than descriptive scales. There are many tools available for evaluation of risks and risks controls, ranging from experience-based judgment, checklists and risk matrices [2]. A quantitative analysis is usually performed when a basis for an estimate or planning has to be supplied. It is also used when insight into feasibility of the estimate or schedule is required. The probability and the consequence are described precisely through the use of numbers. Using these estimates, calculations can be performed

3. Methodology

This deals with the details & information about risk assessment and analysis for different types of risk involved in the construction projects considered for the study. This deals with the study which is based on questionnaire survey wherein the questionnaire developed is used to collect data from project managers, planning managers, project coordinators regarding the impact and occurrences related to risks involved in case study project (major residential construction project). For the formulation of questionnaire, opinions of experts are taken for identifying the prominent risks involved and accordingly 15 questions are formulated, wherein, the issues related to risks are considered and are used for preparing 'questionnaire' to get the responses from the respondents for the same.

In this study, a scale for likelihood is prepared and according to it concern persons of project ranked it and responses were received. After that, risk is quantified in form of likelihood of occurrence and potential consequences based on all available information about the risk under consideration. On the basis of responses received, the scores for occurrences and impact for risks and risk factors are calculated. Risk matrices are plotted using two dimensional scales. Risk profile can also be plotted with respect to the decreasing order of calculated risk factors. Then this work reflects the risk prioritization of the various risks for case study project by which it can be interpreted that which risks are most critical.

In this study, by collecting information's through different person relating to the projects like project managers, planning managers, project coordinators, site engineer, administrative persons, supervisors and suppliers. After getting different information from various persons, I and project managers of the projects decided and finalize to give up a rank (score) for each type of risk from 1 to 5 which means as the number increased the effect of risk is also increases. Accordingly this, for the risk responses a number from 1 to 5 needs to put. In this way a Likert scale for likelihood is prepared and according to it concern persons of project ranked it and responses were received.

Following is the 'Questionnaire' which is prepared by me and ready to use for further Risk assessment. The concern persons of project ranked (scores) the questions from 1 to 5 according to the value scales used for likelihood and impact. The table 1 is as shown below.

Table 1: Scales for Likelihood

Value scale	Assessment of Likelihood (P)	Assessment of Impact (C)
1	Rare	Nil/Very minor effect
2	Considerable	Low effect
3	Medium	Medium effect
4	Frequent	High effect
5	Always	Extreme high effect

Details of Questionnaire – Responses Received From Case Study

Table 2: Questionnaire Response

Q. No.	Question relating with the type of Risk	Responses	
		Case study	
		Occurrence	Impact
1	Land acquisition Risk- Commencing the project work due to land acquisition.	2	3
2	Delays in construction project- During the development phase due to requisite approvals and clearance.	3	5

3	Project completion Risk- Possibility of non-completion of project within the designated time	4	5
4	Project cost Risk- Change in cost of inventories and services, shortage or non-availability of required materials/items	2	3
5	Technology Risk- Change in design or incomplete design, incorrect estimation	1	3
6	Regulatory and administrative Risk- Cost of complying with regulatory requirements of government affecting financial viability of project	4	5
7	Commercial Risk- Economic rationale for the project like realization of demand as projected.	2	3
8	Operation and maintenance Risk- Loss of quality, breakdown of machinery, instruments and equipments	1	2
9	Financial Risk- Project financing, interest rate risk, foreign exchange exposure, employee stock options, labor and material stock fluctuation.	3	4
10	Political and social Risk- Instability of government, Inconsistent policy, civil/political problems	1	2
11	Force majeure Risk- Natural disaster- earthquake, floods, tsunami (Natural calamity)	1	2
12	Market Risk- Fluctuation in share market, Bank's policies	1	1
13	Corruption Risk- Bribes, local authorities, unconditional requirement	2	3
14	Internal Risk- Internal mismanagement of company, disputes, vandalism, theft or like court matters	2	3
15	Health and Safety Risk- Unforeseen circumstances, improper safety majors- relates with health and safety	1	2

3.1 Calculation of Risk Factor

The significance of risk is termed as 'Risk Factor' and is expressed in terms of its consequences or impacts on project objectives and the likelihood or occurrences of those consequences arising. The numerical scores for occurrences and impact for risks are converted from scale 1 to 5 to scale 0 to 1 by using following formula,

$$\text{Required score} = \frac{(\text{Responded Score} \times 2)}{10}$$

To calculate Risk Factor or levels, the descriptive likelihood assessment are converted to numerical measures, 'P'. A similar process is followed for the consequence assessments, to give an average consequence measures, 'C'. A risk factor RF or combined risk measures is then calculated for each risk by following equation.

$$RF = P + C - (P \times C)$$

Where,

RF= Risk factor
P = Probability (Occurrences) measure on a scale 0 to 1
C = Consequences (Impact) measure on a scale 0 to 1

The risk factor RF, from 0 (low) to 1 (high), reflects the probability of a risk arising and the severity of its impact.

Risk Factor for Case Study

Following table 3 shows the Risk Factors which are calculated as stated above for Case Study

Table 3: Calculation of Risk Factors for case study

Q. No.	Occurrences		Impact		Risk Factor
	Responded Score	Scores (P)	Responded Score	Scores (C)	
1	2	0.4	3	0.6	0.76
2	3	0.6	5	1.0	1.0
3	4	0.8	5	1.0	1.0
4	2	0.4	3	0.6	0.76
5	1	0.2	3	0.6	0.68
6	4	0.8	5	1.0	1.0
7	2	0.4	3	0.6	0.76
8	1	0.2	2	0.4	0.52
9	3	0.6	4	0.8	0.92
10	1	0.2	2	0.4	0.52
11	1	0.2	2	0.4	0.52
12	1	0.2	1	0.2	0.36
13	2	0.4	3	0.6	0.76
14	2	0.4	3	0.6	0.76
15	1	0.2	2	0.4	0.52

3.2 Risk Matrix for Case Study

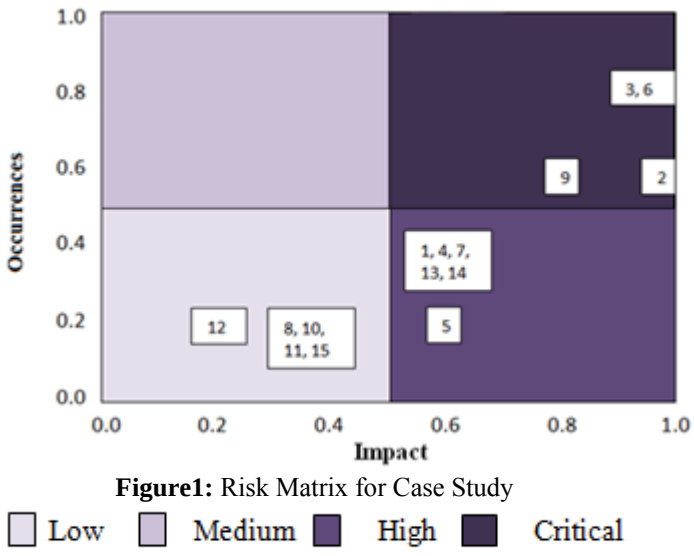

Figure1: Risk Matrix for Case Study

From above figure 1, risks occurrences and its impact are observed. Risks are distributed among the matrices according to two dimensional scales 0 to 1 of impact/consequences and occurrences/probability. The right hand top corner of

matrices indicates most critical risk which is highlighted in very dark colour. i.e. risk relating Q.No.2, 3, 6, 9. The right hand bottom corner of matrices indicates high risk which is highlighted in dark colour. i.e. risk relating Q.No. 1, 4, 5, 7, 13 & 14. The left hand top corner of matrices indicates medium risk which are highlighted in medium colour but none risk relates to this. The left hand bottom corner of matrices indicates low risk which is highlighted in light colour i.e. risks relating Q.No. 8, 10, 11, 12 & 15.

3.3 Risk Profile for Case Study

Figure 2 shows the Risk Profile for Case Study

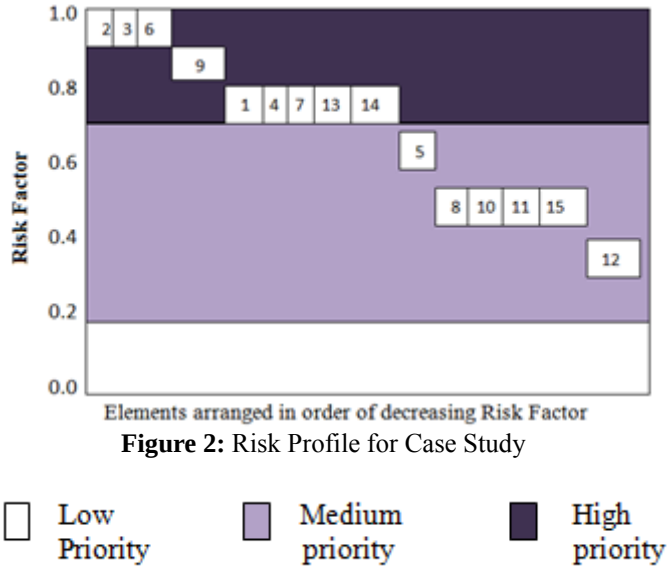

Figure 2: Risk Profile for Case Study

From above figure 2, risks are plotted according to their risk factor to observe risk profile. Risk having highest risk factor is on top and lowest at the bottom. As the risks are arranged in descending risk factor, risk profile shows the nature of risks that are hampered on the project. This profile helps for risk prioritization. From above figure 2, the risks which are having high risk factor are highlighted in very dark colour. i.e. risk relating Q.No.1, 2, 3, 4, 6, 7, 9, 13 & 14. These risks treated as High priority. Risks which are having medium risk factor are highlighted in dark colour. i.e. risk relating Q.No.5, 8, 10, 11, 12 & 15. These risks treated as Medium priority. There are none any risk that comes in low priority. Here, risk factor ranging from near about 0.2 to 0.7 is indicated as medium priority & risk factor ranging from near about 0.7 to 1.0 indicates as a high priority.

3.4 Risk Prioritization for Case Study-

Here in order to find Risk Priority in case study Risk factors which are calculated in table 3, Risk profile drawn for case study are took into account. The entire questions (risks) which are mentioned in questionnaire are prioritized according to calculated risk factor values in decreasing order which are also shown by risk profile.

Following table 4 shows the Risk Prioritization of the various questions (Risks) included in questionnaire for case study.

Table 4: Risk Prioritization for case study

Priority Number	Question Number (Risk type)
I Priority	2nd, 3rd and 6th risk
II Priority	9th risk
III Priority	1st, 4th, 7th, 13th and 14th risk
IV Priority	5th risk
V Priority	8th, 10th, 11th and 15th risk
VI Priority	12th risk

From table 4, it has been observed that total 6 priorities are formed in case study. Each priority is having particular type of risk. The top three priorities are most important which affect on project.

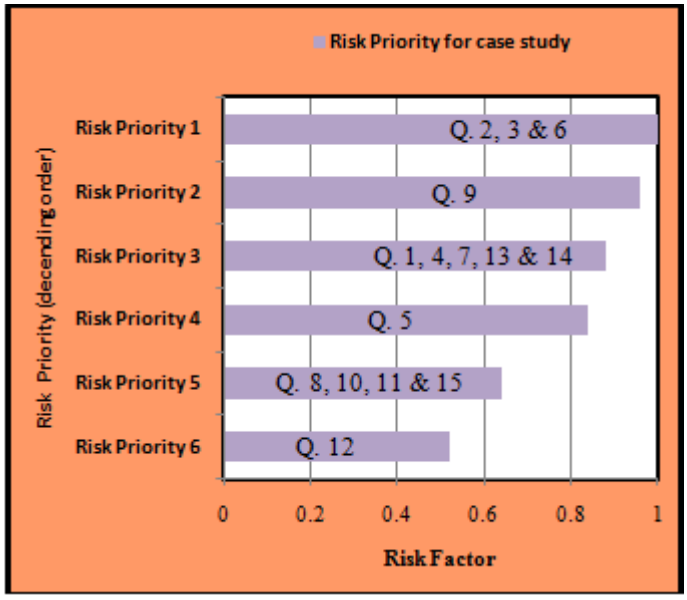

Figure 3: Risk Priorities for Case Study

4. Conclusion

1. The number of risks involved during the construction of the project, are large, and if not treated or mitigated properly, the probability of successful completion of the project within the stipulated time and cost frame will reduce.
2. 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.
3. The risk management framework for construction projects can be improved by combining qualitative and quantitative methodologies to risk analysis.
4. Qualitative methods of risk assessment are used in construction companies most frequently, ahead of quantitative methods. In construction project risk management, risks may be compared by placing them on a matrix of risk impact against a probability.

5. In case study, the overall cost of the project incurred due to the risk in project such as project completion risk, regulatory and administrative risk, delay in construction project risk and financial risk. To minimize the negative effects of risks, appoint risk analyst for better results so that less time will be require for completion of the project in project cost. Also minimize the threat of risk by risk insuring company.
6. In case study, the resultant risk matrix and resultant risk profile for the projects should be prepared by the project manager by considering the present situations of the project for cost-benefit ratio. Otherwise cost and time will affects on the total project cost.
7. Risk management in the construction project management context is a comprehensive and systematic way of identifying, analyzing and responding to risks to achieve the project objectives. To management the risk effectively and efficiently, the contractor must understand risk responsibilities, risk event conditions, risk preference, and risk management capabilities.

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