Risk Assessment and Its Application for Residential Construction Projects

Prof. Mohan M. Dusane[#], Prof. Pankaj P. Bhangale*

[#]*Department of civil engineering, MET's IOT-Polytechnic, Nashik, India*

** Department of civil engineering, SSGB College of Engineering and Technology, Bhusawal, District-Jalgaon, India*

Abstract- **All projects are subject to risk. The world is in a state of constant change and survival relies on the ability to adapt to changes. Unfortunately, many project managers have not yet realized that there is a need to include project risk as a key process. It is well known facts that managing risk has two major objectives are to avoid the downside risks and to exploit opportunities. The purpose of this study is to identify risk, risk assessment of various risks which can help in prioritizing risks in case of residential construction projects 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. This research extracted most important types of risks according to the literature and then assessment and analyzes the different types of risks which were the most influential for achieving success in construction project. To achieve objectives of this study, a questionnaire is designed on basis of objectives using a comprehensive literature review for the survey in residential construction project. The questionnaire includes total main 15 risks which are project related of major residential construction project.**

Keywords- Risk, Risk identification, assessment of Risk, Risk factor, Risk priority.

I. INTRODUCTION

Construction industry plays an important role in any country's economic development. It establishes the infrastructure required for socioeconomic development while being a major contributor to overall economic growth. Construction output is referred to as growth-initiating and growth-dependent. As development progresses, the construction industry needs to satisfy the expansion and changes in construction demand. Construction is a complex and dynamic industry.

Delays and disruptions have been the hallmark of the construction projects in many countries. The construction industry is large, volatile and requires tremendous capital outlays. Project delays have been a topic of concern in the construction industry. They have become universal phenomenon and are almost always accompanied by cost and time overruns. Indian construction industry has been no exception to such delays. 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.

II. LITERATURE REVIEW

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]

Risks in Construction Projects:

The perception that the construction industry is the most exposed to risks and uncertainty is a consensus among authors because of the very nature of its activities.

Still, it found different approaches in literature with regard to the factors and characteristics of projects that expose the construction industry to mount risks. Changes in the environment, the complexity of planning and design, the presence of various interest groups, resource availability, climate change, economic instability and political and regulatory statutes..[3]

Identification of risks associated with a particular project commences with an understanding of the project itself; its scope and objectives. [6]

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. [5]

It involves a description of the risks how the risks may be identified for a project. This step involves taking stock and making lists. It closely resembles a brainstorming process. A thinking model is used. The main rule is that selection and prioritization of activities does not take place in this phase, so as to avoid any interference with the brainstorming and broad list-making process.

Probability and consequences may be identified within this definition. The probability aspect is reflected in the statement 'an event that may or may not occur'- it may not happen. Therefore something that is certain is not a risk. It is very important to be aware that current bottleneck or concerns are often labeled as risks. Consequences indicate where the risk may lead. [4]

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. [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 judgement, 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

III. 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 informations through different person relating to the projects like project managers, planning managers, project coordinators, site engineer, administrative persons, supervisors and suppliers. After getting different informations 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 I is as shown below-

Table I
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 II
Questionnaire Response

Question Number	Question relating with the type of Risk	Response	
		Case study	
		Occurrence	Impact
1	Land acquisition Risk- Commencing the project work due to land acquisition.	2	2
2	Delays in construction project- During the development phase due to requisite approvals and clearance.	5	5
3	Project completion Risk- Possibility of non-completion of project within the designated time	4	4
4	Project cost Risk- Change in cost of inventories and services, shortage or non-availability of required materials/items	3	3
5	Technology Risk- Change in design or incomplete design, incorrect estimation	1	5
6	Regulatory and administrative Risk- Cost of complying with regulatory requirements of government affecting financial viability of project	5	3
7	Commercial Risk- Economic rationale for the project like realization of demand as projected.	2	4
8	Operation and maintenance Risk- Loss of quality, breakdown of machinery, instruments and equipments	1	2

Question Number	Question relating with the type of Risk	Response	
		Case study	
		Occurrence	Impact
9	Financial Risk- Project financing, interest rate risk, foreign exchange exposure, employee stock options, labor and material stock fluctuation	4	4
10	Political and social Risk- Instability of government, Inconsistent policy, civil/political problems	1	1
11	Force majeure Risk- Natural disaster- earthquake, floods, tsunami (Natural calamity)	1	1
12	Market Risk- Fluctuation in share market, Bank's policies	1	1
13	Corruption Risk- Bribes, local authorities, unconditional requirement	3	3
14	Internal Risk- Internal mismanagement of company, disputes, vandalism, theft or like court matters	2	2
15	Health and Safety Risk Unforeseen circumstances, improper safety majors- relates with health and safety	1	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,

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

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 III shows the Risk Factors which are calculated as stated above for Case Study

Table III
Calculation of Risk Factors for case study

Question Number	Occurrences		Impact		Risk Factor
	Responded Score	Scores (P)	Responded Score	Scores (C)	
1	2	0.4	2	0.4	0.64
2	5	1.0	5	1.0	1.0
3	4	0.8	4	0.8	0.96
4	3	0.6	3	0.6	0.84
5	1	0.2	5	1.0	1.0
6	5	1.0	3	0.6	1.0
7	2	0.4	4	0.8	0.88
8	1	0.2	2	0.4	0.52
9	4	0.8	4	0.8	0.96
10	1	0.2	1	0.2	0.36
11	1	0.2	1	0.2	0.36
12	1	0.2	1	0.2	0.36
13	3	0.6	3	0.6	0.84
14	2	0.4	2	0.4	0.64
15	1	0.2	1	0.2	0.36

Risk Matrix for Case Study

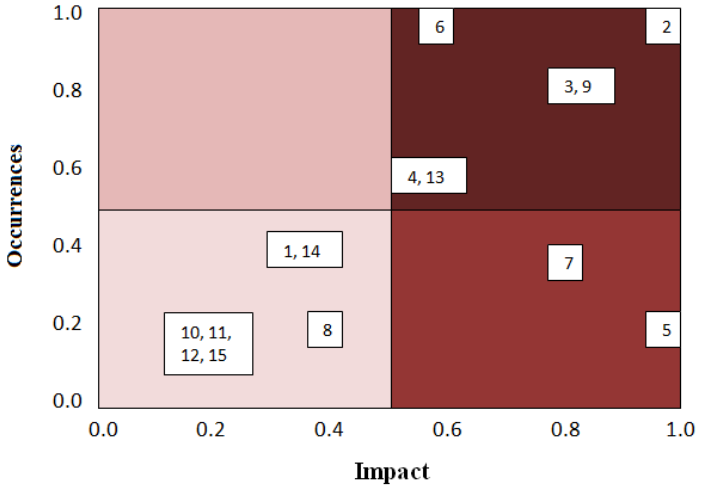

Fig.2 Risk Matrix for Case Study

From above figure 2, 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, 4, 6, 9 &13. The right hand bottom corner of matrices indicates high risk which is highlighted in dark colour. i.e. risk relating Q.No. 5 & 7. 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 risks which are highlighted in light colour i.e. risks relating Q.No. 1, 8, 10, 11, 12, 14 & 15.

Risk Profile for Case Study

Figure 2 shows the Risk Profile for Case Study

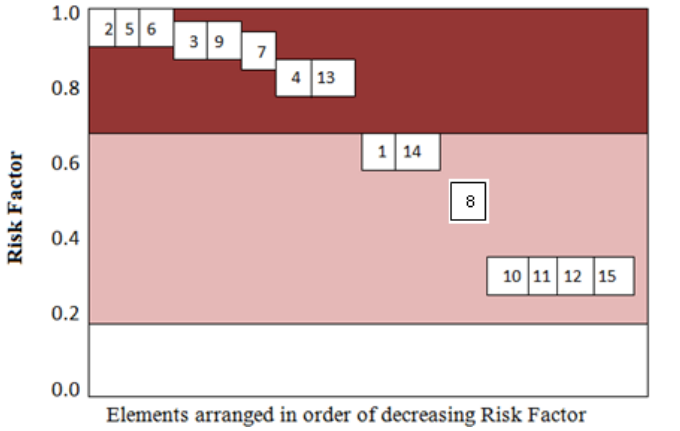

Fig. 3 Risk Profile for Case Study

Low priority Medium priority High priority

From above figure 3, 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 4.5, the risks which are having high risk factor are highlighted in very dark colour. i.e. risk relating Q.No.2, 3, 4, 5, 6, 7, 9 &13. These risks treated as High priority. Risks which are having medium risk factor are highlighted in dark colour. i.e. risk relating Q.No.1, 8, 10, 11, 12, 14 & 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.

Risk Prioritization for Case Study-

Here in order to find Risk Priority in case study Risk factors which are calculated in table III 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.

Risk Prioritization for Case Study

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

Table IV
Risk Prioritization for case study

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

From table IV, it has been observed that total 7 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.

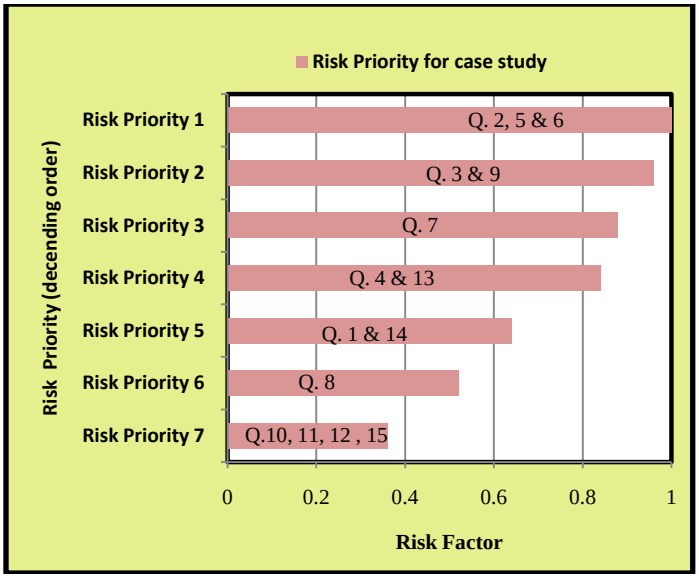

Fig.4 Risk Priorities for Case Study

CONCLUSION

1 .Construction industry is highly risk prone, with complex and dynamic project environments creating an atmosphere of high uncertainty and risk. Major construction projects are faced with a series of critical issues. For many institutions,

capital expenditures are reaching an all time high, and represent a potential substantial risk in nearly all aspects of project delivery.

2. The first rule of risk management is to identify and analyze risk. For a project manager, this involves understanding a complex range of dynamic processes that occurs during all the phases of the project.

3. The risk management framework for construction projects can be improved by combining qualitative and quantitative methodologies to risk analysis.

4. In case study project, the cost involved in the risks are high; the project controller should look in to the minor aspect of risk to save the overall cost incurred due to the risks in project such as project completion risk, delay in construction project risk, financial risk, regulatory and administrative risk.

5. In case study 1, to make the project performance better and to complete the activity within the project duration in time, project manager should revise the schedule of balance activity. Also, arrange team members meeting periodically by project manager. This will helpful to control the forthcoming harm on project. Apart from that, 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.

REFERENCES

[1] Nigel J. Smith, Tony Merna, Paul Jobling, (2006), "Managing risks in construction projects", Blackwell Publishing, 2nd edition, pp 1-4

[2] N. B. Chaphalkar, C.A. Shelar, Smita K.Patil, (July-September 2011), "Risk assessment for managing risks in real estate construction project", NICMAR Journal of Construction Management, ISSN No. 0970-3675, Volume XXVI, Number 3, pp 15-26

[3] Morano Cassia Andrea Ruotolo, Ferreira Miguel Luiz Ribeiro, Haddad Asses Naked, Martins Claudia Garrido, (November 2011), "Risk identification techniques knowledge and application in the Brazilian construction", Journal of Civil Engineering and Construction Technology, Vol, 2 (11), pp 243-245

[4] Bouke van den Bunt, Suzanne van Kinderen, Fianne Lindenaar, Daniella van Well-Stam, (2008), "Project risks management", Kogan page limited, 1st south asian edition reprint, pp 33-45,61-64

[5] Mehdi Tadayon, Mastura Jaafar and Ehsan Nasri, (2012), "An Assessment of Risk Identification in Large Construction Projects in Iran, Journal of Construction in Developing Countries, Supp.1, pp 58-59

[6] Saleh Alawi Ahmad, Usama H. Issa, Moataz Awad Farag, Laila M. Abdelhafez, (September-October 2013), "Evaluation of Risk Factors Affecting Time and Cost of Construction Projects In Yemen, International Journal of Management (IJM), ISSN 0976 – 6502(Print), ISSN 0976 - 6510(Online),Volume 4, Issue 5, pp169-171

[7] Dale Cooper, Stephen Grey, Geoffrey Raymond, Phil Walker, (2005), "Project Risk Management Guidelines- Managing Risk in Large Projects and Complex Procurement", John Wiley & Sons, Ltd; pp 46-48, 53