

A Study on Qualitative Risk Analysis in Residential Building Construction Project

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Abstract - A Construction is risk-prone activity. The risks present in construction activity affects the quality, profits, performance and productivity. All the risks present in construction cannot be eliminated. As it will be time-consuming and expensive to deal with all the risks. That's why the analysis is done on the risks to know the risks causing high effect on construction. The risks having very low effect are ignored. Risk management is necessary at all stages of construction. This study focuses on risk management of residential building construction. The study of various literature review is carried out in this paper. Based on that study the risks are identified for residential building project. The data is collected regarding the risks and analysis is done. The analysis will be done using Qualitative risk analysis method. The probability impact matrix will be used to categorize the risks. At last the conclusions and suggestions will be drawn out.

Key Words: Risk management, Qualitative risk analysis, Probability-Impact matrix, Data collection techniques, Questionnaire Designing, Literature reviews.

1. INTRODUCTION

Risk: Risk is an uncertain event which, if it occurs causes the positive or negative impact on the project. It is unpredictable and unexpected. For example: theft, earthquake, injury, etc. If these things happen, it can cost money, bad reputation, damage the organization or can cause closing of organization too.

Risk management: Risk management is a procedure of identifying all the possible risks causing negative impact on the project and prioritizing the risks by conducting the analysis on risk. After categorising the risks, procedure is set to avoid the risks or minimise its impact.

Risk management in construction: Risk management is necessary for a construction project. Due to risk management initial cost of construction increases. But given the advantages of risk management, the extra cost spent on risk management is worth it. At the initial stage of construction, if we do risk analysis, risks and expenses incurred due to it are avoided.

Risk management in residential building construction:

The construction of housing projects is a fast-growing sector in India. It is also facing many risks. Therefore to avoid and minimize the risks in the construction of the residential building, risk analysis and management are necessary.

1.1 Types of risk analysis:

For conducting risk analysis on various construction project, there are two types of risk analysis techniques:

1) Qualitative Risk Analysis: The process of prioritizing project risks for further analysis by evaluating their probability of existence and impact. Rank is given according to the judgement of experts. In qualitative risk analysis, impacts and likelihood is found out using some entrenched method. After evaluation, we describe them in terms such as high, moderate low.

2) Quantitative Risk Analysis: The process of numerically investigating the probability and impact of individual risk using mathematical and simulation tools is known as quantitative risk analysis.

Table -1: Difference between qualitative and quantitative risk analysis:

Qualitative Risk Analysis	Quantitative Risk Analysis
In qualitative risk analysis all the risks identified in the risk identification stage are considered.	In quantitative risk analysis, the risks marked for further analysis in qualitative risk assessment are considered only. The risk causing high impact are generally marked.
It does not include mathematical calculation of the probability and likelihood. Instead of that, it uses stakeholder's inputs and expert's judgments to rank the likelihood and impact	It uses the probability distributions to evaluate the risk's probability and impact. It also uses the project model, mathematical and simulation tools to calculate the probability and impact.
In this, ranking generally from 1 to 5 is given to all identified risks for its	It estimates the likelihood and impact of the risk. It predicts project outcomes in terms of

probability and impact. Where 1 is lowest and 5 is highest.	money or time on risks.
It is applied to almost all projects.	It is generally applied to complex projects.

1.2 Methods used for qualitative risk analysis:

Different types of methods used for qualitative risk analysis are:

1) Root Cause Analysis: A root cause analysis technique reduces the occurrences of risks instead of reacting to it when they occur. A root cause analysis identifies the basic causes and common sources of risks. Risks related due to common causes are also identified. Preventive actions are taken to avoid the sources of risks which eventually minimises risks.

The disadvantage of this technique is that other potential causes may be overlooked and after the identification of root causes there is no specific strategy to address the risks.

2) Estimating Techniques Applied to Probability and Impacts:

This technique addresses both the degree of uncertainty and its effect on the project's scope that is probability and impact. Impact value is represented by a range of values. It cannot be represented by specific impact levels such as 'moderate impact on cost.' Risk estimation helps the experts to assess the probability and impact in terms of range instead of the specific value of probability and impact. The impact level definitions are project-specific and dependent on time and cost. The values used in definitions show the same level of impact over the project objectives as anticipated by management and stakeholders. If the risk's impact is uncertain and can be represented by more than one impact level such as moderate to high, then the risk is assigned by the impact level showing average or expected impact level.

An example of impact level definitions is shown below. For positive risks consider the saving in cost or time and increased functionality. For negative risks consider time delay, increased cost, and reduced functionality

Table -2: Estimating probability and impact:

Scale	Probability	Impact on Project objectives		
		Cost	Time	Quality
Very High	>61%	>15000000	>48 days	Very significant impact on overall functionality
High	41-60%	7500001-15000000	24-48 days	Significant impact on overall functionality
Medium	21-40%	3750001-7500000	12-24 days	Some impact on key functional

				areas
Low	11-20%	750001-3750000	7-12 days	Minor impact on overall functions
Very Low	1-10%	75000-750000	1-6 day	Minor impact on secondary functions
Nil	<1%	No change	No change	No change in functionality
Medium	21-40%	3750001-7500000	12-24 days	Some impact on key functional areas

3) Post-project reviews/ Lessons Learned/ Historical Information:

The risk database containing historical information of risks within an organization or industry, post-project reviews or lessons learned of previous projects gives significant information for the current project. This technique helps to prevent the same risks from happening or missing on same opportunities. The effectiveness of this technique can be increased by the participation of team members from previous projects and a well-structured risks and lessons database. This technique has some disadvantage such as only the risks which have occurred previously can be identified. The information which is available from previous projects may also be incomplete or missing some details.

4) Analytic Hierarchy Process (AHP):

In this technique relative weighing factors for the project, objectives are determined. Relative weighting factors indicate the priorities for cost, time, scope, and quality for the project. The list of risk priorities is developed concerning the individual scopes of the project. The effectiveness of this method depends on the proper use of suitable methods and AHP software.

Table -3: Preference factors:

1	Equally Preferred
2	Mildly Preferred
3	Moderately Preferred
4	Greatly Preferred
5	Always Preferred

Table -3: Preference factor matrix:

	Cost	Time	Scope	Quality
Cost	1.00	0.25	0.33	0.20
Time	4.00	1.00	1.00	0.25
Scope	3.00	1.00	1.00	0.25
Quality	5.00	4.00	4.00	1.00
Sum of column	13	6.25	6.33	1.70

Note: Preference factors input is given in red colour. By definition the diagonal values is set to 1. Other cell values are calculated by 1/ preference factor for same objective.

Table -4: Weighting factors:

Calculated factors (Preference factor / Column sum)					Weighting Factors
	Cost	Time	Scope	Quality	Average
Cost	0.08	0.04	0.05	0.12	1
Time	0.31	0.16	0.16	0.15	0.2
Scope	0.23	0.16	0.16	0.15	0.2
Quality	0.38	0.64	0.63	0.59	0.6

5) Probability and Impact Matrix (P-I Matrix): This technique is used to prioritize the risks for further analysis such as qualitative risk analysis and risk response. Impact and likelihood of risks are effectively ranked in this technique. Organizations should rank the risks properly so that the effectiveness of this method increases. Generally, the ranking is given by numbers e.g. 1 to 5, where 1 represents 'very low' whereas 5 represents 'very high'. The ranking should be given by considering suggestions of experts, the organization's management, and project stakeholders. In this paper, we have used this method.

2. LITERATURE REVIEW

There was plenty of work done in the field of risk management. While studying about risk analysis we came across various project works, thesis papers and research papers accompanied with various review papers too. We will be discussing some of the papers and their content.

Qualitative Risk Analysis for construction project[1] – By Jameelahammad Nadaf, Mahaboobali Nadaf, Balasaheb Jamadar, K. P. Thejaswi. In this paper study of various risks present in construction projects, their likelihood and impact on the project is carried out. Recognition of risks in the construction project is done. For the data collection, the distribution of questionnaire survey to the various contractors and consultants of the project is conducted. In this paper, the qualitative risk analysis method is used. Matrix for probability-impact, impact-urgency, probability-urgency, and priority-urgency are plotted. High risks are marked and a graph is plotted for high risks.

Risk Management in housing project [2] – By Vyas Nipul D, Jitendrasinh D, Raol. In this paper risk management is done on the specific area of the project of housing schemes. In this study, various literature reviews and information related to risk management are included. A study of various risks encountered during the housing project is done. Appropriate techniques and methods for the housing project are suggested. The methodology of this paper includes interviews and data collection from the selected sites, analysis of data using a risk matrix. As per the analysis conclusion and suggestions and drawn.

Qualitative risk analysis as a stage of risk management in investment projects: advantages and disadvantages of selected methods – theoretical approach [3] – By Anna

korombel, Piotr tworek. In this paper, it is mentioned that in an investment project the risk analysis is done in the combination of both qualitative and quantitative methods. The advantages and disadvantages of this method depend on the scope and type of project. This paper focuses on qualitative risk analysis in investment projects. The strengths and weaknesses of specific methods and their differences are mentioned.

Risks in Housing and Real Estate Construction Project [4] – By Madhav Prasad Koirala. In this paper, the identification of risks involved in housing construction and real estate projects in Nepal and their ranking according to severity is done. With the help of professional expertise, the risks present in the construction project life cycle are identified. Then these risks are verified with the help of housing professionals. The data collection is done with the help of literature reviews and questionnaires. The collected data is analyzed and results are drawn. Finally, the conclusion is made according to the results.

Risk Management in Residential Construction [5] – By Johan Bonander, Hampus Ulriksson. In this master thesis, a large Swedish construction company having both a residential development unit and a constructing unit is studied. This thesis focuses on the risk management process when a residential project is developed and constructed by the same company. The study will include both the perspective of the constructor and the developer and also their separate and joint processes facilitating risk management. This model includes four steps: Risk identification, risk assessment, risk mitigation, and risk monitoring. The results from this study show that risk management in residential construction depends on the personal knowledge and experience of project members.

Qualitative Risk Assessments in Project Management in Construction Industry [6] – By Vladimir Burkov, Irina Burkova, Reza Barkhi, Mikhail Berlinov. In this paper risk management is applied to Russian construction companies. This article defines qualitative and quantitative risk assessments as well as complex risks in the construction field. In this paper, the methodology used for risk management is described. Algorithms which are used for solving problems in the construction sector are proposed.

A Comprehensive Literature Review on Construction Project Risk Analysis [7] – By Ermias Tesfaye, Eshetie Berhan, Daniel Kitaw. In this paper, the presentation of the development of risk assessment techniques and models undertaken in the construction project for the past two decades is made. The paper includes browsing related researches and publications, screening articles, identifying the domains and attributes. The conclusion is drawn that the popular risk assessment tools used for the past twenty years are statistical analysis and fuzzy expert systems.

Assessment of Risk and Its Application for Residential Construction Projects: A Case Study [8] – By Prof. Mohan M. Dusane, Prof. Pankaj P. Bhargale. This paper proposes a case

study on Metrozone Project located at Nashik (M.S.), India. The objective of this study is to identify risks, prioritizing risks, analyzing risks qualitatively and quantitatively. The ranking is given to risks according to risk score from most critical to least critical. The questionnaire is made based on 15 project-related risks.

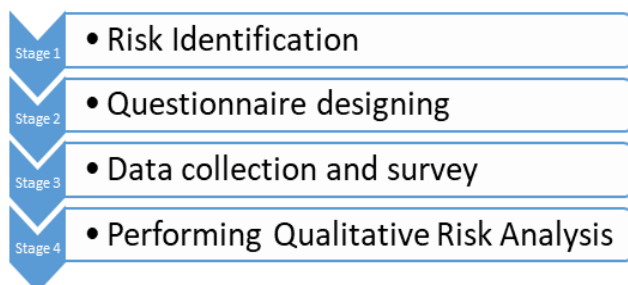
3. OBJECTIVE OF THE STUDY

By studying the various literature reviews and actual circumstances in the construction of residential building projects, we have identified the following objectives of the study.

- 1) Identifying various risks which are unsure occur in the construction of residential buildings.
- 2) Categorizing the risks in terms of probability and impact as very high, high, moderate, low, and very low.
- 3) Performing qualitative risk analysis for finding out high risks.

4. METHODOLOGY

In this section, we have stated the stages generally preferred for qualitative risk analysis on the residential building project. The methodology adopted for data collection is the distribution of the questionnaire survey. The analysis is done by using a risk matrix.



1. Risk identification: Risk identification is a continuous and iterative process. New risks are identified as the project progresses. This stage involves project team members, stakeholders, managers, and outside experienced individuals who can comment on the identified risks based on their experiences. Different levels of risk identification are:

- 1) Risk identification - Level 1: Project team members suggest potential risks occasionally to the project managers. As needed by the project, project teams carry out risk discussions when needed. There is no defined process for risk identification.
- 2) Risk identification - Level 2: The project team checks the cost, scope, schedule, etc. of the project plan for the identification of risks. It includes suggestions of stakeholders and clients. Industry lessons are considered by the project team while the identification process.

3) Risk identification - Level 3: It is a standardized documented risk identification process. A historical database of risks is used by project teams as a template.

4) Risk identification - Level 4: The lessons learned and risk database is made available for other projects. The risk identification process is fully used by large companies.

5) Risk identification - Level 5: The continuous process of risks' data collection, analysis of the performance of methods used for risk identification, and improvement of the process is carried out. For improvement of process best practices and lessons learned are considered.

The identified risks in the construction of residential building project are:

- 1) Financial risks
- 2) Environmental risks
- 3) Labour risks
- 4) Force major risks
- 5) Material risks
- 6) Project management risks
- 7) Legal risks etc.

2. Design of questionnaire: For the risk analysis, first, we have to collect data. For the data collection, we prepare questionnaires and checklists. Questionnaires are based on identified risks and previous experience. There are two types of questionnaires. The first is the general one. This questionnaire can be used for all types of projects. The second is a project-specific questionnaire. This is a detailed questionnaire. It is used for a particular project only. Questionnaires help for data gathering for further analysis.

3. Data collection: Data collection risk analysis is a method of collecting accurate information regarding the risks present in the project. Different methods used for collection of data are listed below.

1) Conducting interviews: This is the historical method of data collection. An interview is a conversation between two parties where one party asks questions and the other party answers them. There are two types of approaches for interviewing. The first is one to one approach and the second is many to one approach. In many to one approach, interview of all the project members from different disciplines is conducted simultaneously. In this technique, in-depth information gets collected. The accuracy of data is also high. But this method is time-consuming.

2) Brainstorming: It is a technique where a conclusion is found out for a problem by a contribution of spontaneous ideas from group members. Brainstorming is used for the risk identification process where a group of people focuses on identifying risks in the project. Everyone in the project team participates in it. Round-table iterations are carried out to generate new ideas. Everyone is given a fair chance to

express his ideas. In this technique quantity of risks is given preference first. After that, the quality is addressed. No criticism is expected during the session. As it will prevent the open participation of members. Recording the session for capturing all ideas can be helpful.

3) Delphi technique: In this technique panel of independent experts carry out discussions to find out the result. It is an interactive method. This technique is used to identify risks. But it is more suited for finding out the probability and impact of the risks on the project. In this technique, questionnaires are forwarded to all the project members by the risk manager. They give their response to it. The questionnaire with the response is taken back by the risk manager. After that, all the questionnaires are redistributed so that each member receives a different set from the previous one. After that, the members are asked to reconsider their views and make relevant changes to them. The questionnaires are resubmitted by the members. The revised results are again redistributed by the project manager in the same manner as discussed above. It is an iterative process. The process is repeated until the risk manager thinks that consensus of views is reached.

4) SWOT Analysis: In a SWOT analysis, the strengths, weaknesses, opportunities, and threats associated with the company's ability are listed. Strengths and opportunities are considered positive risks. Positive risks cause a positive effect on project objectives. Whereas, weaknesses and threats are considered as negative risks. Negative risks affect the project adversely. In SWOT analysis, opportunities and threats are external factors, and strengths and weaknesses are internal factors. Strength represents the things in which the project team is good at and their capability. It represents the skills and valuable resources of the organization. Weaknesses contain the things which the team lacks. It represents the thing at which the team does poorly. Opportunities contain the positive risks that cause positive effects on project objectives. E.g. Buying in bulk reduces the cost price. Threats include external obstacles to achieve the project goals. The process of SWOT analysis starts with listing strengths. The round-table iterations are carried out. All the members are asked to suggest the strengths one by one. If someone runs out of ideas he/she may pass. All the strengths suggested are noted down. After capturing all the strengths, similar strengths are combined. Then the strengths are ranked according to priority in descending manner. After strength similar process is carried out for weaknesses, opportunities, and threats respectively. Risks are identified and captured in the risk register. Strengths, weaknesses, opportunities, and threats are analysed for creating strategies. Strengths are used to overcome weaknesses and opportunities are used to reduce threats. Such a risk response plan is developed.

5) Risk Register: The risk register is a document that is updated by the new risks occurring in the project throughout the project life cycle from project initialization to the completion of the project. After completion of the project, the risk register is included in the historical database of the

organization. The risk register contains identified risks, description of that risks, level of risks, probability and impact of that risks, sources of risks, and mitigation measures of the risks. For making a risk register, at first, we have to identify the risks which can occur during the project, at the initialization of the project. The organizations generally work for similar types of projects. Therefore, the historical database can be used for identifying the risks. Also, some new risks can be identified depending on weather, market condition of that time, etc. After identification, risks are documented. Documentation of the risk includes its impact on the project, the likelihood of that risk to occur, the person who identified that risk, and the person assigned to manage that risk. Regular monitoring of risks is mentioned in the risk register. If the person assigned to resolve the particular risk takes some action against it, then it is documented in the risk register. After resolving those risks, it is marked as resolved. This action avoids the expenses spent on resolved risks.

4. Performing qualitative risk analysis: Qualitative risk analysis involves estimating the probability of occurring the risk and impact of the risk of the project. In this technique, the exact numerical value of the impact and probability is not found but it is expressed in terms of very high, high, moderate, low, very low, etc. according to the reviews of experts and stakeholders. This technique is used to prioritize the risks according to their potential effects on the project functioning and the project objectives. Prioritizing is necessary to plan the risk response for the various risks. In this paper for qualitative risks analysis, we are going to use a risk matrix (P-I matrix) to prioritize the risks.

Probability-Impact matrix: Probability is the likelihood of the risk to occur whereas impact is the effect of the risk on project functioning. Before making the P-I matrix, we have to identify risk, collect risk data, determine probability and impact levels. After doing these tasks, the P-I matrix is made. First, the probability and impact are given ranking generally from 1 to 5. The ranking is given by considering the below tables:

Table -5: Probability and impact scale:

Scale	Probability	Impact
1	Rare	Very low
2	Occasional	Low
3	Somewhat frequent	Moderate
4	Frequent	High
5	Very frequent	Very high

After ranking the risks according to their probability and impact levels, the risk matrix is made by taking impact ratings on X-axis and probability ratings on Y-axis. The matrix is divided into 3 colour codes for representing 3 categories of risks. The sample of the risk matrix is as follows:

Table -6: Risk Matrix:

Very frequent	5	5	10	15	20	25
Frequent	4	4	8	12	16	20
Somewhat frequent	3	3	6	9	12	15
Occasional	2	2	4	6	8	10
Rare	1	1	2	3	4	5
Probability/ Impact	1	2	3	4	5	
	Very low	Low	Mode rate	High	Very high	

The risk score is calculated by multiplying the probability and impact ratings. According to risk scores. Risks are categorized into 3 colour codes.

- 1) Red represents risks that need an immediate response (Risk score 15-25)
- 2) Yellow represents risks that require further analysis and investigation (Risk score 5-14)

Green represents risks that can be ignored. (Risk score 1-4)

5. CONCLUSIONS

- 1) Risk largely affects the project objectives such as scope, time, cost, and quality. Therefore for increasing the project's performance, proper mitigation of risks is necessary
- 2) For planning risk response, risk categorization is necessary. Risk categorization can be done using risk analysis techniques. The difference between qualitative and quantitative risk analysis is stated in this paper. It will help to select the best analysis technique for various projects.
- 4) Residential construction projects are generally not that complex that's why the qualitative risk analysis method is preferred. As this paper focuses on risk analysis in a residential building construction project, the qualitative risk analysis technique is further elaborated in this paper.
- 5) Various methods of data collection are mentioned in detail in this paper. It will help to decide the method well suited for the project. The method which is best suited by considering the circumstances is preferred.
- 6) Various methods to perform qualitative risk analysis are stated in detail. Out of which probability-impact matrix method is generally used for housing projects. Therefore it is elaborated in-depth.
- 7) Risk management is very vital for construction projects. Before resolving the risks, risk analysis is necessary. In this paper, all the information needed for risk analysis is provided. After analysing the risks, risk management is done.

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