

# A STUDY ON RISK ASSESSMENT USING PROBABILITY-IMPACT MATRIX METHOD FOR A MULTI-STOREYED RESIDENTIAL BUILDING

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**Abstract** - In construction industry, projects demand for risk assessment as they are the key reasons for cost and time overruns. So, risk management is considered as the fundamental part of project management. This case study consists of theoretical procedures regarding risk assessment. This is done by using qualitative risk analysis with the application of probability-impact matrix. Different types of risks are to be categorized and a Risk Response Sheet is being prepared considering aspects of Project Management, Resource Management, Contractual Issues, Political & Economical issues, Human Errors and Climatic Conditions which may have an effect on the progress of the project. With the help of this Risk Response Sheet, reviews were taken from senior most professors, experienced site engineers and contractors. Based on these reviews the risks get segregated into low, medium and high level risks depending upon which mitigation measures can be easily planned.

**Key Words:** Risk Assessment, Risk Response Sheet, Probability-Impact Matrix, Risk Priority Number.

## 1. INTRODUCTION

The construction industry plays an important role in the progress of the economic and financial status of the country. Completion of projects in time is signs of efficient ways of construction. When the projects are delayed, they result in extension or acceleration, which leads to cost overruns. The construction process is subjected to many uncertain factors. The date of delivering a project and the date of completion of the project may not be same all the time. For a project to get successful mainly the three parameters that is cost, quality and time should be taken into account and it is in the major concern of the clients in the construction industry. Among these three parameters, cost and time constraints are the main reasons for cost overruns and main reason behind it is poor application of the management skills. Risks in Project is referred to a condition or an event which is uncertain, it will either have a negative effect or a positive effect on the cost, schedule, scope and quality of a construction project on its occurrence. The reason for the uncertainty may be potential requirements, assumptions made, conditions and constraints which may decide whether the outcome will be negative or positive. It may be anything like lack of personnel for designing a project or permission from the environmental department i.e. more time taken than expected to grant the permission, such things might have impact on the projects schedule, cost, scope, performance or quality.

## 1.1 General

Delays and cost overruns influences the economic aspects of the project. The growth potential of the economy is hindered, whereas due to cost overruns there will be reduction in the aggressiveness of the economy. Efforts have been put to compile the risks that cause the cost overruns and delays along with the actual schedule of the project in practice. Different types of risk which could encounter during the pre-construction and post-construction periods. The possibility of occurrence of the listed risks can be found out by conducting interviews, opinion polls or questionnaire surveys. The risks turning out to be with highest probabilities are segregated and the reasons for their occurrence and measures to be taken to avoid their occurrence or are about to occur are to be concluded.

## 1.2 Objectives of the Project

- To identify and prioritize the risks which might and/or have been faced on the present site under consideration.
- To prepare the risk response sheet with the help the prioritized list of risks and to get 50 odd reviews to have reliable results.
- To apply the method of probability-impact matrix onto this project, to show its ease of use and implementation for segregating highly probable risks resulting from this process of qualitative risk analysis.

## 2. RISK ASSESSMENT

Project Risk Management is a process which consists of planning, identifying, analyzing and terminating/controlling the risks concerned with the project. The main objective of project risk management is to increase positive events which help in faster progress of the project and decrease the chances of negative events in the project. The outline of the process of risk management is as shown in the figure 1. The reason for the risks in the project may be project. So, here the risk factor is the more time taken to grant the permission; or additional employment is generated which is specialized in design part of the work. If anyone of these risks occurs then it will directly affect the project schedule, scope, quality, performance or cost. The reasons for any type of constraints or assumptions which results in positive or negative outcomes. For example, it may be the permission to be given from environmental department for work to progress or lack of expertise assigned on to a risks in projects may be its environment such as inappropriate

practices of project management, simultaneous ongoing projects and more dependency on external project participants those who are not in direct control of the project.



Fig. -1: Outline of process of Risk Management

### 2.1 Planning Risk Management

The process of risk management is one such process where the procedure of the risk management for a project is defined. This process helps the organization to ensure that the type of risks, its intensity and its impact are corresponding to the risks and to the project's scope. A risk management plan is very much necessary to obtain an agreement, to communicate and to get stakeholder's support so that the project progresses effectively over its life cycle.

### 2.2 Identify Risks

The project manager, team members responsible for respective activities, a separate team for risk management (optional), end users, experts from outside to deal with the project queries and stakeholders are included in the participation of the identification of the risk. This set of participants is key members in the process of identification of the risk, but overall potential risks should be allowed to be identified by the other personnel concerned with the project. The process of risk identification is a process of iterations, as new risks emerges during the progressing stage of the project because various type of situations are faced everyday on the site. There should be consistency in the risk statements so that all the risks can be understood clearly and measures for its development of response can be taken. If at all risks had to be compared with each other on a single project then the risk statement should be able to support it. The project team should be involved in this process so as to maintain and develop a sense of responsibility and

ownership related to the risks and its respective risk response actions. Additional information may be obtained from the external stakeholders.

### 2.3 Performing Qualitative Risk Analysis

This is a process in which the risks are given priority and action is taken by analyzing their impact and probability of its occurrence. Main advantage of this kind of process is assisting project managers in reducing the levels of uncertainty and focusing on the risks with higher priority. In this method of analysis risks which have been identified are assessed as per their priority on relationship with the likelihood of their occurrence and its impact on the particular activity of the project. When this approach towards the risks is biased, attention should be given in correcting all such biased identification of the risks. This influence of biasing can be reducing by properly defining the probability and impact levels. This method of qualitative analysis is cost effective, quick enough and also lays a foundation for performing quantitative risk analysis. As per the plan of risk management the quantitative risk analysis is performed at regular intervals of time during the execution period of the project.

### 2.4 Performing Quantitative Risk Analysis

The Process of quantitative risk analysis consists of application of numerical methods for analyzing the identified risks of the project. Its key benefit is that it produces information which is quantitative so that it supports the decisions taken to reduce the percentage of uncertainty throughout the project. In this method the risks prioritization has been done based on qualitative risk analysis process and have an impact on the demands of the project. Here the risks that have an effect on the project objectives are analyzed and the average effect of the overall risks of the project is evaluated. This process actually follows the qualitative risk analysis in general. Due to lack of data it may be impossible to perform the quantitative risk analysis. After getting suggestion from the experts, it becomes the duty of the project manager to work on the judgments of the experts to know whether the project scope is viable or not. The time and budget of the project, whether quantitative or qualitative method of risks and their impacts is needed will be determine which method to be implemented on the project. This process of analysis should be repeated on regular basis with an intension of reducing overall risks of the project as a part of controlling risks process.

### 2.5 Plan Risk Response

While reducing threats that affect the main objectives of the project by developing actions and options which in turn might increase the availability of the opportunities. The resources allocated, priority of those risks, budgeted activities, management plan and scheduling of the project are addressed and this is said to be one of the key benefits of this process. Each and every plan of risk

response should be analyzed by understanding its mechanism so that the risk can be encountered appropriately as a result of which will get to know whether the risk response plan is desirable or not. In this mechanism the person responsible for all funded risks and agreed to plans of the risk response who is said to be a Risk Response Owner is identify and assigned. The risk response should be such that it should meet the challenges of cost effectiveness signify the risk, should be realistic with respect to the context of the project, retained by a responsible owner and all the parties in agreement with the risk response plan. The most common approaches in planning the risk responses are applied. As each and every risk listed has an opportunity and threats along with them, so risk responses for all of them are to be discussed.

### 2.6 Control Risks

The process of implementing of risk response plans, monitoring those risks, effective risk process evaluation, tracking the identified risks and identification of new risks throughout the project is called Controlling Risks. In this process the efficiency of the approach towards the risks is improved to optimize the risk response continuously throughout the project's life cycle which is one of the key benefits of this process. To keep a track of new risks, changing and/or outdated risks the project work should be monitored continuously though the risk response plans which are considered in the register where all the risks are filed and performed throughout the execution period of the project. Controlling risks include choosing of alternative strategies, execution of fallback plans, modifying project management plans and taking corrective measures can be done to control the risks. The owner of the risk response plan always reports to the project manager at regular intervals of time so that the plan can be more effective, unanticipated and corrections in the risks to be handled appropriately. This process of controlling risks also includes updating of the assets of the organizational process, templates of risk management and project database so that it can be used for the benefit of the future projects.

## 3. METHODOLOGY

### 3.1 Prioritization of Risks

The risk prioritization which has been categorized into a no. of sections and a risk response sheet has been prepared and is based on three constraints time, cost and quality. Based on these three constraints and its network of different aspects of construction project management, an opinion poll has been listed down in a risk response sheet by classifying it in such a way that cover all possible categories due to which risks might occur in a construction projects. With the help of this risk response sheet the risk assessment is conducted. This is done by rating the risk response sheet on the basis of its probability and severity if at all it occurs for that particular risk.

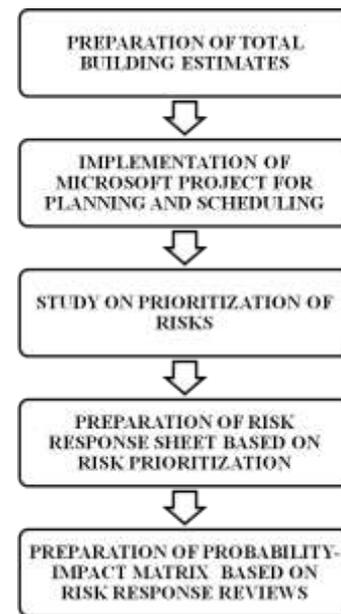


Fig. -2: Flowchart representing methodology process

### 3.2 Probability-Impact Matrix

Probability-Impact Matrix is a type of qualitative method which is most commonly used in risk assessment. To calculate the intensity of a particular risk from the Risk Response Sheet prepared, the probability and impact for a particular activity is to be considered. It provides the easy and a powerful tool to Identify, Manage and Control risks. It demands a briefly categorized classification of various risks which are meant to affect construction projects very often. This technique can help to identify risks, prioritize risks; allocate the resources and taking decisions regarding controlling measures. This technique can be applied event wise or else a project as a whole.

### 3.3 Application of Probability-Impact Matrix

Prepare a matrix may be of size 3x3, 4x4, 5x5 etc. with probability and severity as its axes. Allot the suitable color code to the matrix which may indicate the low, medium and high level risks. By clubbing the reviews obtaining from the risk response sheet along with this matrix the level of risk can be classified easily [2]. For a schematic representation of the matrix and the table to be referred for rating the risk should be in corporation with each other. Using the risk response sheet the no. of reviews taken should of considerable count so as to produce desired and reliable outcome. The risk response sheet should cover maximum areas of a construction project, so that the results are applicable before and after the commencement of the project and also during the execution period of the project work.

#### 4. RESULTS AND DISCUSSIONS

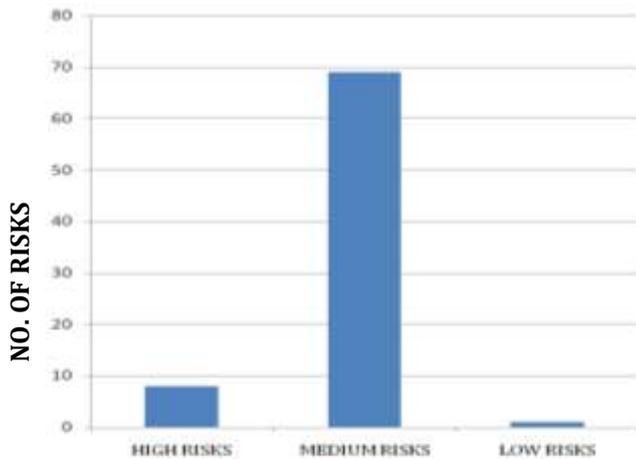


Fig. 3- Graph representing review results

These are the results obtained from the Risk Response Sheet, which is represented in the form of a Bar Graph. The Bars indicate how many risks come under High, Medium and Low Risks. With the help of this graph, Time and cost overruns caused due to the Risks with high probability and severity which have occurred on site are recorded. For Medium and Low Risks mitigation measures are listed down. The risk response sheet had 13 different main categories under which a no. of sub-categories were included which could possibly occur in construction projects. Among the 13 main categories 6 categories were said to be having high probability and severity. The problems faced on site have been compared with the risks with higher RPN.

#### 5. CONCLUSIONS

From the analysis and discussions which have been done in the above chapters we notice the effect and extent of the risks in construction industry which makes way for a no. of risks of different levels which results in affecting the project from all perspectives. Some of the points which were observed are:

- The risks which were most probable to occur on a construction project were identified and prioritized; the cost overruns and delays due to these risks encountered up to the first floor level are listed.
- As a result of 40 reviews received which was circulated in the form of risk response sheet (opinion poll or questionnaire survey), it was categorized into 77 sub-categories out of which **10.25%** of sub-categorised risks turned out to be of high level, **88.46%** of medium risks and remaining as low level risks.
- The use of probability-impact matrix for the present work for the purpose of rating, the risk response sheet makes it very easy in understanding the probability and

severity of the encountered risk. It is one of the easiest ways to assess risks and is reliable as it goes through the detailed analysis of the risks by gauging its probability of occurrence and its impact due to its severity. Thus it was easy to illustrate schematically with different colour codes for low, medium and high level risks, how the risk priority number is calculated using the probability-impact matrix.

- The risk priority number which is the product of probability and severity of an event/task. The reason behind considering this concept is that it will directly indicate whether an event/task is risky due to its high probability or due to high severity or due to both. For example: if the probability of occurrence of a task is low but its severity is high then it can be neglected as the possibility of its occurrence of that particular risk is itself too low.
- From the 40 odd reviews which were received from the risk response sheet, most of the time the event/task has been highly risky only when probability and severity of an event/task are of analogous magnitude. So we can easily conclude that the risk is high or low level directly, based on the average values of the probability and severity for that particular event/task. In general it allows us in assessing and handling risks by prioritizing them, as in which one of them should be considered first for mitigation.

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