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Risk Analysis and Mitigation for Residential Buildings

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ABSTRACT: The construction industry works in a very uncertain environment where conditions can change due to complexity of each project. Therefore number of risks occurred due to this complexity. Risk management is a concept which is used in all industries. The main objective of risk analysis is to evaluate the impact of risk from the activity and to prepare the risk management plan. This project deals with 'Risk management of a residential building. G +11 storied residential building has been selected as a project case study. Risk analysis is done using Probability Impact Matrix method. As per the results risks are categorized as per high to low. The risk response plan is prepared to mitigate the risk. Keywords: Risk Management, Probability Impact Matrix.

KEYWORDS: Construction industry, risk analysis, risk mitigation.

1. INTRODUCTION

The construction industry is often described as defragmented and complex (Osipova, 2015) due to working in a project based format. Within the construction industry, the organization is often small in the early stages and grows throughout the acquisition-, design- and production process. After the goal is achieved and the project is completed, the organization disbands. Within the residential development business, only a small group of individuals from the developer and contractor are left behind to handle any warranty issues. The complexity in the project stems from the final result, where a unique product is constructed to suit the client's needs. The uniqueness of the product and the defragmented work process creates for uncertainties. These uncertainties appear as either risks or opportunities throughout the project life cycle. There are numerous reasons for which uncertainties might appear during a project. Generally, these can be related to either organizational or mechanical conditions. Organizational uncertainties could stem from the alterations in the project group throughout the project timeframe. Moreover, project members can be individuals with quite different backgrounds, experiences and opinions. Mechanical uncertainties, however, are related to the scope and requirements related to a specific site. Regardless if such uncertainties can be forecasted or not, they could pose a significant risk to the project itself. Risk is generally a term used to describe the exposure to danger, the possibility of loss or a potential hazard. The term can be altered and used in a wide variety of aspects, depending on the topic of discussion, even within the construction industry (Akintoye & MacLeod, 1996). The body of academic literature regarding risk management within the construction industry is vast. However, there are uncertainties to what extent the different theories presented on risk management actually work in practice. Even though each project is unique, the project life cycle of residential development projects is similar between different projects. Therefore, it is of interest to explore how risk management is conducted in practice and the reasons behind the adopted approaches.

This research importance stems from the essence of risk management itself, for the reason that risk management has been identified as one of the most important tools in determining any project success; yet, few studies investigate the nature of this relationship. As a result, this research will drive the attention to the importance of a high level of awareness to risk management problems. In addition, studying the relation between risk management and project's success is important because most of projects are operating in a very dynamic and rapidly changing environment not always fixed circumstances and uncertainty factors are surrounding the firm, in such environment adopting changes very quickly is a must for the project overall to grow or even survive. Adopting overall project changes can't be applicable without the management ability to adapt model in risk management and make the new changes. Accordingly, the results of this research may help the managers to better evaluate the risks around them and better respond to these risks, and present them methods that may



enhances their projects risk management.

II.LITERATURE SURVEY

Risk assessment and risk management: Review of recent advances on their foundation [1]

According to [1] the goal of this invited paper is to provide a review of these advancements, with a particular focus on the underlying ideas and thinking that underpin them. We've looked for patterns in perspectives and techniques, and we've considered where more risk research is needed and should be promoted. The document is aimed for readers with a wide range of backgrounds, not only risk professionals. Risk assessment and risk management have established themselves as a scientific area that contributes significantly to the support of decision-making in practice. Fundamental principles, theories, and methods already exist and are being developed. This review paper focuses on recent work and breakthroughs in the risk fields, as well as the underlying principles and thinking that underpin them.

Special studies in management of construction project risks, risk concept, plan building, risk quantitative and qualitative analysis, risk response strategies [2]

According to [2] Project risk management is one of the most critical aspects of project management, particularly in this time of many unexpected events. This includes risk classification, analysis, planning, identification, assessment, and risk response and avoidance methods. Analysis of deviations is one of management's most significant responsibilities, as are the compilation of controlling reports and taking the required steps to remedy them. The initial focus of the search was on the meaning of the concepts of project and project management, as well as the importance of their studies; after that, the concept of risk and its sources, as well as how to plan for it, was reviewed, as well as how to diagnose and measure quantitatively and qualitatively. When various types of risks are identified, the primary goal is to discover effective solutions to combat or avoid them, or at the very least minimize the severity, or transferred altogether to the other hand, the following are the most important research conclusions.

Risk management in construction projects: a knowledge-based approach [3]

According to [3] The provides a methodology based on a three-fold arrangement that includes the modelling of the risk management function, its evaluation, and the availability of a best practices model to handle the difficulties of risk management in construction projects using a knowledge-based approach. This method is being tested as part of a* research project. The fact that risk management in construction projects is still very poor, and that the main reason of this condition is a lack of information, is a major preliminary finding of this research. It is predicted that using the proposed technique, clients and contractors would be able to build a project's risk management function based on best practices, as well as improve the function's performance.

Evaluating risk management practices in construction organizations [4]

According to [4] The paper presents the creation of a risk-management capability assessment tool based on an organizational maturity model for construction firms. This tool has been used with both clients and contractors, and it is part of a larger knowledge-based system. The findings of this study will enable a client or contractor to first create or improve their project risk management capabilities based on worldwide and local best practices, and then to constantly improve this function's performance when new projects are implemented. This technique is unique in that it approaches risk management from a knowledge-based perspective and is built on a web application that will be accessible to any enterprise. Risk management should be an element of the organizational culture in both the construction industry and construction projects. This would allow for its development and implementation, as well as the establishment of a standard for project planning and execution. An important component of this is to develop an effective knowledge management system that can store and distribute lessons learnt so that they can be shared and reused in future initiatives. It's also critical to have effective risk communication channels between project partners, as well as risk management training.

Project risk time management—a proposed model and a case study in the construction industry [5]

According to [5] a mathematical model that aids in project risk management The model distinguishes between risks that must be accepted and risks that can be avoided at a cost, assisting in determining which risks should be avoided in order to meet client expectations for project completion time at a low cost. The model is based on a PERT method modification that may be reduced to a mixed linear programming issue. The model is demonstrated using a real-world building project as an



example. A novel quantitative model based on stochastic programming and a variation of the PERT method that varies from previous models in that it allows different risk categories to be treated differently; existing models do not explicitly do so, to the authors' knowledge. Because some construction project risk categories may be better suited to one risk management technique at a given time and in a certain circumstances, and others may recommend a completely other risk management method, the differing treatment of distinct risk categories is critical.

Risk management of construction works by means of the utility theory: a case study [6]

According to [6] Based on the application of utility theory, a suggested technique of risk analysis has been proposed. Statistics regarding construction circumstances, data about the economic situation, including a supply-demand link, and seasonality are all part of this method. Aside from decision variations, historical data, conditional probability, and utility function are included in this technique. The following is a quick description of the procedure for defining the utility function: The decision maker (for example, a contract engineer or a construction site manager) must choose between the certainty of a particular result (a monetary value) and the chance of extreme results in a lottery. The two contrasting (but practical) situations of function of utility, namely, a decision maker with an aversion to risk and a decision maker with a preference for risk, are next thoroughly examined. Following that, the economic consequences of their decisions are presented.

Risk analysis in construction project-chosen methods [7]

According to [7] shows three alternative risk analysis approaches, as well as their shortcomings, advantages, and key application areas (selection or pre-estimation). The methodology of these methods differs from one another. The verification process began with the most basic procedures and qualitative factors. Although it is very straightforward and easy to use, this strategy is predicated on a decision maker's considerable subjectivity. The statistical method was employed to complete the study, which determines the type of data used and hence impacts the quality of the results. The application regions and analytical capabilities of the mentioned methods are demonstrated with short examples, while their characteristics from the analysis are outlined. The research questions that serve as the canvas for implementing the approaches outlined are not mutually exclusive. They show various characteristics of different investment processes.

Educational simulation in construction project financial risks management [8]

According to [8] Even more crucial is the adoption of systematic methodologies to financial planning, scheduling, and project monitoring. The project managers should have the appropriate skills to carry out these operations. The development of financial management skills cannot be accomplished in traditional educational settings utilizing typical information transmission methods. Instead, project financial management should be taught in an active, hands-on manner, encouraging students to think imaginatively and act appropriately as project managers. In this approach, educational simulations are extremely beneficial. The paper describes the experiences gained throughout the master's degree in construction project management at the Technical University of Civil Engineering in Bucharest. The authors created a simulation environment based on the most important worldwide project management skill requirements and relevant educational experiences. The architecture and capabilities of this platform are presented in this paper. As a case study, a simulated scenario is shown.

Guidelines to Aid Project Managers in Conceptualising and Implementing Risk Management in Building Projects [9]

According to [9] Project managers are in charge of the day-to-day management of construction projects and must be skilled in risk management. Given the high frequency of project failure in the construction industry, as well as the fast-changing and uncertain construction markets, a better understanding of risk, as well as project managers' assessments and perceptions of it, has the potential to improve risk decision-making in complex environments. Risk management in building construction projects isn't limited to jotting down all the advantages and disadvantages or labeling every upsetting and exciting event as a "negative risk." Management is a complicated, long-term, and wide-ranging process that begins well before the investment and might continue long after it is completed. Risk management does not imply avoiding it; rather, it entails correctly identifying it and determining the associated opportunities and risks.

Risk management in construction projects [10]

According to [10] presents the results of a questionnaire-based survey on risk management in construction projects in Pakistan, including the importance of various types of risk, ultimate responsibility for them, and the efficacy of some of the most prevalent risk management approaches used in the industry. Preventive risk management approaches were explored, which can be utilized before the commencement of a project to manage risks that are predicted during project execution, and

remedial risk management approaches, which are used after a risk has already happened during the execution phase. According to the report, the most major hazards influencing most construction projects are financial concerns, on-site accidents, and flawed design. According to the report, the contractor is responsible for managing the majority of risks that arise at the job site during the implementation phase, such as issues with subcontractors, labor, machinery, material availability, and quality, while the client is responsible for risks such as financial issues, design document issues, code and regulation changes, and scope of work.

II. RESEARCH METHODOLOGY

Research Approach The application of theory in research can be managed in different ways; the most common of these are known as the deductive approach and the inductive approach. While the deductive approach develops a theory that is then tested through research, the inductive approach uses data collection in order to develop a theory from the results. However, there is another concept that combines both of these approaches; the abductive approach. Abduction is similar to induction in the sense that it starts with empiricism, however, it still takes theory into account in a manner that is similar to deduction.

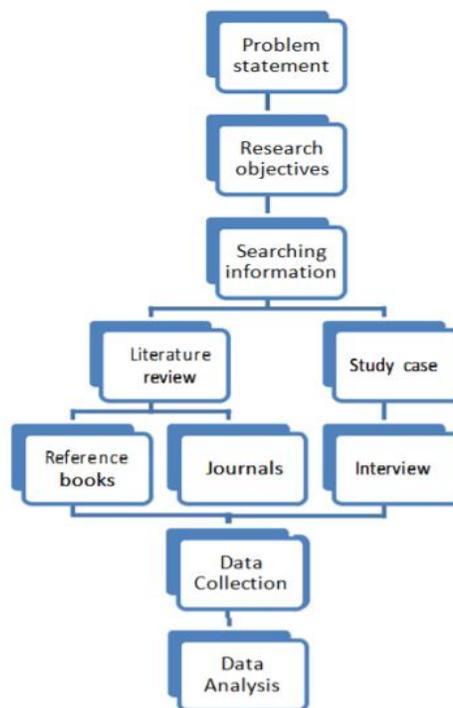


Figure 1: Proposed research method

The process of risk management could be seen as a single part in the overall process of project management. However, in order to better analyse risk management it is possible to delineate the process into several steps. This has been done by several researchers previously, in a variety of different ways. Common traits in many previous articles on the subject identify the following four step. Together, these steps reflect the key aspects of risk management. Most, if not all, activities that relate to risk management in projects can be tied to these categories. The model below shows the different steps within the risk management process.

Identify risk of a residential building

There are various methods of risk identification. Such as questionnaire survey, documentation review, brainstorming, Delphi technique, interviewing, root cause identification, checklist analysis etc. Appropriate method should be selected on the basis of requirements or scope of project.



Documentation review

A well-structured review can be performed on project documents along with plans, previous project files and alternative information. The quality of the plans and consistency between those plans and with the project requirements and assumptions are considered as risk indicator of any project.

Brainstorming

The aim of brainstorming is nothing but to get the list of project risks. It is nothing but the discussion carried out within the project team. The ideas about the project risks are shared during brainstorming.

Delphi technique

In this technique the questionnaire survey is conducted among the expert peoples. The responses from those experts are collected and after that those responses are recirculate among them. By this method we can get a various perspective about the same risks as everyone’s review may differ.

Interviewing

Interviewing with experienced project participants, stakeholders and experts is one of the main source of risk identification.

Root cause identification

It is nothing but the detailed inquiry about project’s particular risk. It sharpens the definition of the risk and allows grouping of risks by causes. After getting the root cause of a risk; we can prepare a detailed mitigation plan.

Checklist Analysis

The checklist for risk identification can be developed on the basis of information available and the knowledge gathered from previous projects the checklist should be quick and simple. It should be reviewed during project closure as it will be helpful for future projects.

III.RESULTS AND DISCUSSION

Respondent sheet is form of giving major causes of risk for construction of buildings. These causes were determined as major affecting overall causes to construction industry from previous literature study as well as agreed same by organization. Respondent sheet is circulated through experts to fill the sheet as per their experience. And finally while taking that risk for the project the average of responses collected has been considered. Respondents are required to fill the response sheet in terms of type of risk (Threat or Opportunity), probability, impact on cost and impact on schedule. After preparing risk response plan we have reduced the risks to some extent. Now again the average of each risk category is calculated, because of which we can understand the reduction in each risk category after applying the risk management plan

Table1-Results of risk category

Riskcategory	Average	Percentage	Results
Time	19.67	10.70%	M
Quality	17.86	9.72%	L
ProjectManagement	28	15.23%	H
Contract	42	22.85%	H
People	28	15.23%	H
Market	21	11.43%	M
Environment	12.67	6.89%	L
Cost	14.56	7.92%	L
Total=	183.76	100%	

**Table 2- Average of risk category**

Riskcategory	Average
Time	10.33
Quality	12.43
ProjectManagement	24
Contract	20
People	17.14
Market	12
Environment	10.33
Cost	10.22

Therefore the following table indicates the reduction of each risk category.

Table 3 : Reduction in risk score

Riskcategory	Average(Before risk response plan)	Average(After risk response plan)	Reduction(In terms of risk score)
Time	19.67	10.33	9.34
Quality	17.86	12.43	5.43
ProjectManagement	28	24	4
Contract	42	20	22
People	28	17.14	10.86
Market	21	12	9
Environment	12.67	10.33	2.34
Cost	14.56	10.22	4.34
Total	183.76	116.45	67.31



Following graph indicates the reduction of each risk category

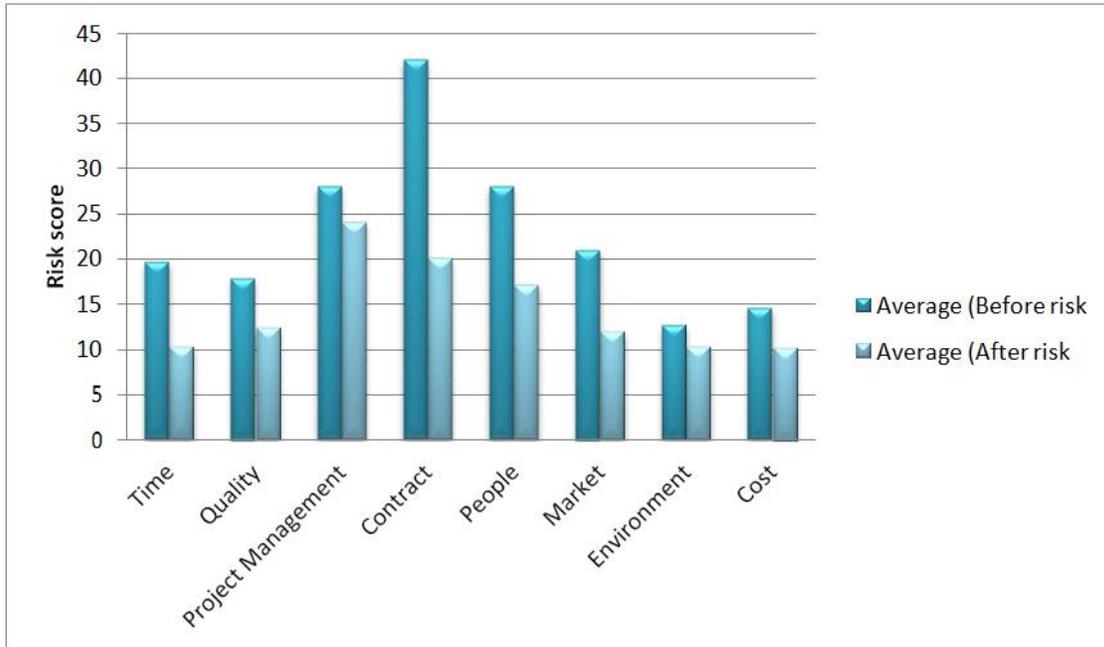


Figure 4-Graphical Representation of Risk Categories

As we have reduced the risks core for risk category, similarly we have reduced the exposure cost also. Therefore following table indicates the reduction in cost before and after risk management plan.

Table 4: Category wise Cost reduction

Risk category	Cost before Risk Management	Cost after Risk Management
Time	2,83,750.00	1,85,000.00
Quality	4,33,000.00	2,77,000.00
Project Management	2,10,000.00	1,75,000.00
Contract	1,50,000.00	1,00,000.00
People	6,15,000.00	4,10,000.00
Market	90,000.00	48,000.00



Environment	75,000.00	75,000.00
Cost	3,81,750.00	2,56,000.00
Total =	22,38,500	15,26,000

IV. CONCLUSION

- Risk is a crucial part of any construction project. Therefore construction companies must include risk management process in their project management. The risk identification and risk assessment of project risks are the critical procedure for any successful project.
- In this case study risk categories such as project management, contract and people comes under high risk causing factor. Medium risk categories are time and market. Whereas low risk categories are quality, environment and cost.
- Risks are more in the beginning of the project. It will get reduced towards the closure of the project. Therefore risk should be identified throughout the project and risk register should be maintained.
- Some risks that we cannot avoid or transfer, so we have to accept those risks.
- Probability and impacts for various risks may change in another project. Therefore Probability Impact Matrix will also change for another project.
- If possible risk manager should be appointed.
- Therefore after adopting risk management process we can save Rs. 7,12,500 in this project.
- Financial savings by using risk management can increase the productivity of an organization and also it improves the success rate of new project and improves decision making process of an organization.

V. FUTURE SCOPE

Future scope of this project is wide as same model can be applied in similar type of construction to avoid the risks. The model can be easily modified and applied in any construction project where risks are involved. It will be easier and it will save the time as modified model can be used for the risk analysis purpose. Quantitative Risk Analysis methods can be used in addition to the various project management tools.

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