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Identification of Risk in Construction Projects

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Abstract - *The Identification of Risk is a very Important Process in Analysis of Risk. Risk management forms a part in of the nine knowledge areas covered by the Project Management Institute .In the past risk management in construction projects has been tackled using a complex approach that produces results which are deficient and also reduce the quality of project management. This research addresses the problems of risk management in construction projects using a knowledge-based approach. It proposes a methodology base on an arrangement that includes determining the risks by analyzing challenges faced in case projects and claims of settled arbitration cases by grounded theory approach, suggest a priority list of causes and develop an expert system for risk mitigation. Through the application of the proposed approach it is expected that it will help the two important project participants, clients and contractors to develop a project's risk management function that is based on best practices, and also contribute to the improvement of the performance of this function.*

Key Words: **Risk Assessment, Risk Identification, Risk Management, Project Management, Knowledge Base, Risk Claim, Risk Mitigation.**

1. INTRODUCTION

In India, construction industry is the second largest industry after agriculture and contributes exhaustively to increase India's overall GDP growth. Problems and challenges are faced by the construction industry everywhere. However, in developing countries, these struggles and complications occur parallel to a general scenario of socio-economic stress, highly persistent shortage of resources, institutional weaknesses and a general incapacity to deal with and address the key issues. The extent and severity of these events and incidences is noticed to be evidently increasing in the recent years. Enterprise risk management emerged in the late 1980's as an extension of hazard risk management. It argues that an organisation should manage enterprise risks in a single, comprehensive program and coordinate ERM with hazard management, internal control processes, internal audit and compliance. ERM is a concept that reaches into every major area of an organisation because of its broadness and capacity of encompassing complexity. Many definitions of ERM are given which fall into three categories. A strategic definition focuses on results. A functional definition describes ERM in terms of activities that reduce risk. A process definition focuses on actions undertaken by managers to manage risks. A consensus definition says. "ERM is the process of identifying major risks that confront an organisation, forecasting the significance of those risks in business processes, addressing the risks in a systematic and coordinated plan, implementing the plan, and holding key individuals responsible for managing critical risks within the scope of their responsibilities." Leading Project Risk Management guidelines have included a definition of a higher level of risk in projects, called "overall project risk", different from individual risks. For example, the PMI A Guide to the Project Management Body of Knowledge (PMBOK Guide) – Fifth Edition (PMI, 2013) defines individual risk as "an uncertain event or condition that, if it occurs,has a positive or negative effect on one or more project objectives," whereas overall project risk is defined as "the effect of uncertainty on the project as a whole, more than the sum of individual risks within a project, since it includes all sources of project uncertainty, it represents the exposure of stakeholders to the implications of variations in project outcome, both positive and negative." Risk management forms a part in of the nine knowledge areas covered by the Project Management Institute. Also, management of risks in the context of construction project management is comprehensive and systematic method of identifying, analysing and responding to risks to achieve the project objectives. The advantages of the risk management process include identifying and analysing risks, and contribution to improvement of construction project management processes and effective use of resources. Construction projects can be extremely complex and fraught with uncertainty. Risk and uncertainty can potentially have damaging consequences for the construction projects.

1.1 Grounded Theory For Analysis of Cases

The process of grounded theory, from the report of a search practical experience performed in Southern Brazil. It presents conceptual and structural aspects of grounded theory, focusing on the description of the research process, fieldwork, which was carried out in order to understand the implementation phase of improvement programs in organizations. The study presents the research process of grounded theory, highlighting the use of analytical tools and research steps, considering the reality of the administration area. From the results, it is possible to provide some important tips about the way of conducting the method

considering the specificities of the organizational studies. Lack of empirical and theoretical foundations as one cause of sufferings in PM methods like lack of acceptance in practice, limited effectiveness, and unclear application scenarios. Based on a review of existing PM literature and a thorough analysis of other successful prescriptive disciplines, developing a framework can be designed to serve as a guideline for theoretically grounded prescriptive PM research. The framework outlines how theories and empirical investigations can help build applicable and useful prescriptive research results. .

Research results have shown that both, owners and contractors do not systematically apply risk management practices, resulting in negative consequences for projects' performance. The problems of risk management in construction projects have been addressed using a knowledge-based approach, and proposes 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. A major conclusion of this research is the fact that risk management in construction projects is still very ineffective and that the main cause of this situation is the lack of knowledge. This approach allows clients and contractors to develop a project's risk management function based on best practices, and also to improve the performance of this function.

Some of the methods mentioned in PMBOK include Risk and probability impact assessment, probability and impact matrix, risk and data quality assessment, risk categorisation etc. Root cause analysis is one of the powerful 7QC tools used to identify the causal factors of risks.

Top ten risk factors using root cause analysis for issues faced in construction industry. This study deals with identification & analysis of various risk factors, classification of risk, quantification of risks and problems by way of conducting a detailed survey among the engineers, contractors, and experts belong to various construction firms in the form of questionnaires. The above questionnaire was conceived in such a manner that it has the details of profile of construction firm, their understanding about productivity and various risk factors. The collected data through the above survey the ranking was done to find the greater risk factors which affect the construction project. Finally the rank index (I) formula for productivity risk index was arrived. The formula arrived from this research paper is implemented in construction industry to hit the root causes identified and enhance the risk management process.

The Ishikawa or fishbone diagram method of cause effect analysis using capture recapture techniques. According to this research, when a problem occurs in a system, its causes should be identified for the problem to be fixed. Ishikawa Cause and Effect diagrams are popular tools to investigate and identify numerous different causes of a problem. A CE diagram can be used as a guideline to allocate resources and make necessary investments to fix the problem. Although important decisions are based on CE diagrams, there is a scarcity of analytical methodology that supports the construction of these diagrams. A methodology was proposed based on capture-recapture analysis to analytically estimate the causes of a problem and build CE diagrams. An estimate of the number of causes can be used to determine whether the CE study should be terminated or additional iterations are required. It is shown that integration of Capture-Recapture analysis concepts into CE diagrams enables the users to evaluate the progress of CE sessions.

The ishikawa diagram for risk assessment to identify potential risk factors in the Quality by design process. This analytical method can be decomposed in a flow- chart highlighting the main steps of the procedure from sample preparation to data analysis. This allows identifying parameters that should be studied during the risk assessment. This diagram classifies risks in groups related to instrumentation, materials, methods, chemicals and reagents, measurements, human factors, environmental issues (e.g., laboratory temperature, relative humidity, and light). Having defined the risk factors, they can be ranked and prioritized using dedicated approaches. Dobrusskin (2016) identified cause effect analysis as a powerful problem solving tool. The Cause Effect Chain Analysis has proved to be one of the more popular tools for a number of reasons: its principles are easy to learn and use, it is extremely flexible in that it can be applied to a variety of problems of differing nature, it can drill deep-to the size of atoms if necessary -where other tools often stop, and its results are easy to communicate. The Fishbone Diagram was stated as an excellent way to represent an easy and standardized way of investigating the underlying causes, be they of a technical or other nature.

one of the major roles undertaken by a project manager is the management of the risk of a project. However, this duty is particularly complex and inefficient if good risk management has not been done from the beginning of the project. According to the author, an effective and efficient risk management approach requires a proper and systematic methodology and, more importantly, knowledge and experience.

An integrated knowledge-based system that aids project managers to determine potential risk factors and the corresponding proJect risks. Based on the analysis of cause and risk mechanisms for acquired knowledge from previous experiences, a project risk identification model was developed. The knowledge is then represented by rules and systematically stored in the computer system to function as a knowledge-base. A forward chaining search process is used to link the relationships between risk factors and the corresponding project risks and related work packages. In this fashion, potential risk factors and the corresponding project risks as well as the related work packages were identified by using the knowledge-based project risk identification model.

A number of areas where KBSs could assist project managers in indicating what is liable to happen in future, presenting facts in a manner that makes judgment easier, retaining project managers' expertise for future uses, showing what has happened and why, and finally in implementing and managing projects. They are also useful in training inexperienced project managers. Expert systems can provide a knowledge-base which manages complex risk problems that requires an expert's interpretation. As they reported, they provide project managers with the ability to analyse overall risk of a project before and during the operation. To respond to a problem, the system asks the user a series of questions, then refers to the knowledge-base to derive a solution.

The methodology adopted to achieve the set objectives is described in Figure 1.

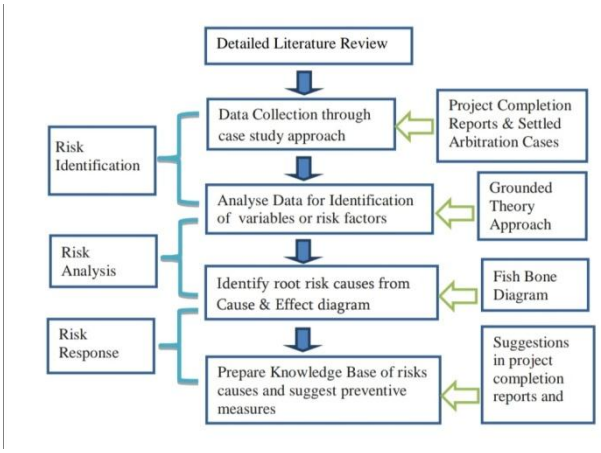

Figure 1: Flowchart for research methodology

The most commonly used methods for data collection and analysis includes:

- Collecting expert opinions
- Conducting questionnaire surveys
- Personal interviews (Structured and unstructured)
- Case study approach (for selected specific projects)

Analysis of data collected is also an important step for deriving the conclusions and validation of the results. Data analysis can be carried out by either statistical or qualitative tools or a combination of the both. Keeping this in mind, the averall research approach has been divided into three major steps -

i. Detailed literature review for understanding existing risk management scenario.

ii. Project specific case oriented approach using Grounded theory technique.

iii. Selection and use of analytical and qualitative tools for analysis.

Stage	Purpose of the stage
Codes	Open coding to identify key points for data collection
Anchors	Collection of codes similar in concept
Categories	Broad groups of similar concepts that are used to generate a theory
Theory	A collection of similar explanations to explain the subject of research

Table 1. Stages of Grounded theory study

An Ishikawa Cause and Effect diagram was designed to sort the potential causes of a problem while organizing the causal relationships. Professor Kaoru Ishikawa developed this tool in 1943 to explain to a group of engineers at Kawasaki Steel Works how various manufacturing factors could be sorted and interrelated. The original intent of the CED was to solve quality related problems in products caused by statistical variation, but Ishikawa quickly realized it could be used for solving other types of problems as well. The tool later came into widespread use for quality control throughout Japanese industry (Ishikawa 1982). As its use spread to other countries, it became known as the Ishikawa diagram, or more informally, the "fishbone" because of its appearance once complete.

CEDs are drawn primarily to illustrate the possible causes of a particular problem by sorting and relating them using a classification scheme. The construction and study of the diagram is intended to stimulate knowledge acquisition and promote discussion, but it can also educate others about a process or problem. The CED encourages data collection by highlighting areas of expertise or by showing where knowledge is lacking. Consequently, the CED attempts to show related causes so that action can be taken. Taking cues from these researches, the risk factors that were identified have been used for cause effect analysis using Ishikawa CED method.

1.2 Identification of Claim and Risk Factors

Large building projects have been selected as an array of projects for the present study. The projects selected have been implemented across various states of the country namely Karnataka, Maharashtra, Orissa, Gujarat, Delhi, Uttar Pradesh, Rajasthan and Kolkata. A total of twenty five (25) Project Completion Reports and twenty seven (27) settled arbitration cases were selected for obtaining variables for further analysis.

The projects selected for current study have been studied in detail from the relevant project documents. A project completion report is a comprehensive document consisting of all important project details relevant for this study. Settled arbitration case documents also Comprise the all relevant data required. A list of projects studied to identify the risk factors relevant to Indian building sector and to identify mitigation measures are presented in Table 2.

S. No.	Project Notation	Nature of Building Project	Type of Contract	State
1.	Project A	Residential	Lump sum	Karnataka
2.	Project B	Commercial	Lump sum	Maharashtra
3.	Project C	Residential	Lump sum	Orissa
4.	Project D	Commercial	Lump sum	Karnataka
5.	Project E	Commercial	Lump sum	Orissa
6.	Project F	Commercial	Item-Rate	Maharashtra
7.	Project G	Commercial	Item-Rate	Orissa
8.	Project H	Commercial	Item-Rate	Gujarat
10.	Project J	Commercial	Item-Rate	Gujarat
11.	Project K	Residential	Item-Rate	Karnataka
12.	Project L	Residential	Item-Rate	Karnataka
13.	Project M	Commercial	Lump sum	Orissa
14.	Project N	Commercial	Lump sum	Orissa
15.	Project O	Residential	Lump sum	Uttar Pradesh
16.	Project P	Residential	Item-Rate	Karnataka
17.	Project Q	Commercial	Item-Rate	Delhi
18.	Project R	Commercial	Item-Rate	Gujarat
19.	Project S	Residential	Lump sum	Gujarat
20.	Project T	Commercial	Lump sum	West Bengal
21.	Project U	Residential	Lump sum	Uttar Pradesh
22.	Project V	Residential	Item-Rate	Karnataka
23.	Project W	Residential	Item-Rate	Karnataka
24.	Project X	Commercial	Item-Rate	Karnataka
25.	Project Y	Commercial	Item-Rate	Gujarat

First stage data collection phase of the research included an in depth literature review and identification of risk factors. This stage of inquiry also used the PMI and ERM framework for identification of challenges and risk factors of projects. Collection of all granular text data available from literature and case projects, were termed as "open codes". A total of 105 open codes have been identified at the first stage of data collection. Identification of these challenges and risk factors was followed by selective coding using grounded theory approach wherein, the collections of similar open codes in concept were grouped together as anchor. The information not relevant to Indian building projects and current study perspective was left out using this approach.

Further risk factors were characterized into 12 broad categories: Challenges due to initial delay Scope Changes, Procurement related, Logistics related, Weather related, Execution related Design related, Financial, Manpower related, Plant and machinery related, Quality related Miscellaneous factors.

1.3 Root Cause Analysis of Risk Factors

After carrying out a detailed analysis of the case studies, it was required to take up fish bone analysis approach to assess the causes that need to be addressed so that the risks can be prevented from occurring at first place. This methodology is well recognized and widely accepted approach in qualitative construction management researches. Various researchers have explored and analysed their data successfully using this approach. This method also provides much wider view point in generic approach where generally a team works for identification of causal factors. On the other hand this research being an individual study, thorough literature survey was done to overcome the limitation of absence of multiple brains. Fishbone (Ishikawa) diagram is used here mainly to represent a model of suggestive presentation for the correlations between an event (effect) and its multiple happening causes. The structure provided by the diagram helps thinking in a very systematic way. It helps determining the root causes of a problem or quality characteristic using a structured approach, encouraging group participation and to utilize group knowledge of the process. It also Identifies areas where data should be collected for further study.

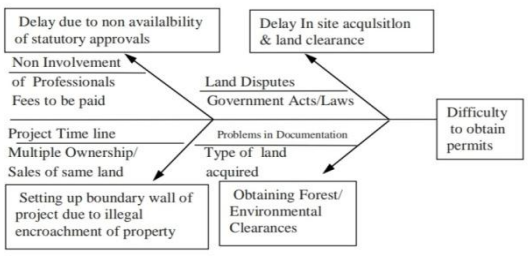

Figure 2: Fishbone diagram for causes of challenges due to initial delay

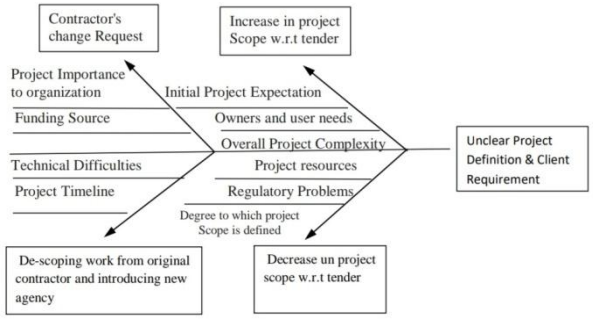

Figure 3: Fishbone diagram for causes of risks due to scope changes

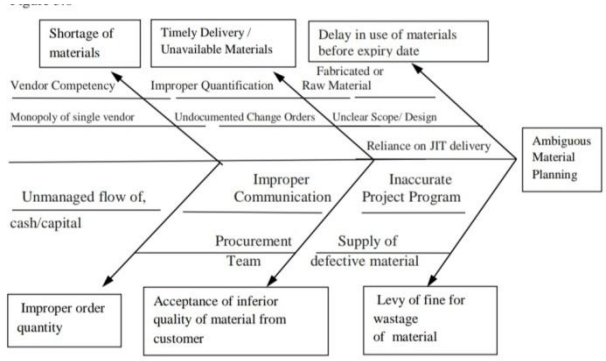

Figure 4: Fishbone diagram for causes of risks in procurement

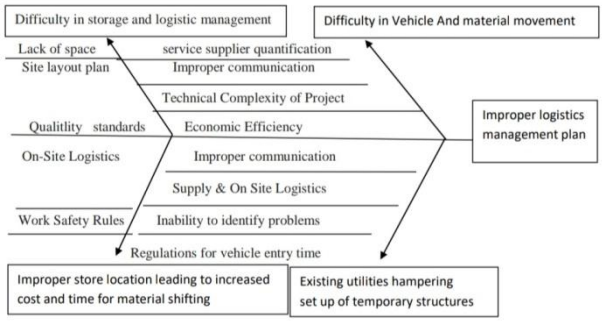

Figure 5: Fishbone diagram for causes of risks related to logistics

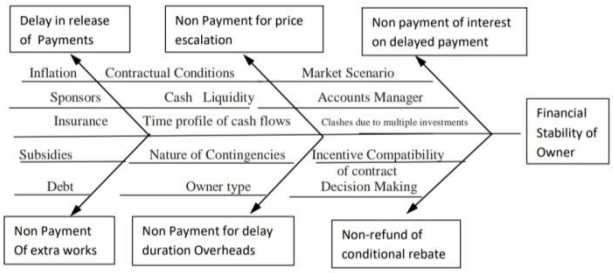

Figure 6: Fishbone diagram for causes of financial risks.

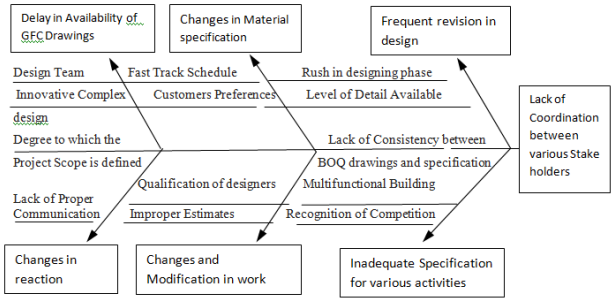

Figure 7 Fishbone diagram for causes of design risks

Various sub causes and major root causes have been identified for risks occurring in building construction projects by cause effect analysis technique. Viewpoint of various researchers and risk specific expert experience was captured for identification of causes and these are helpful in recognition of preventive measures.

The experiences of experts and information comprehended by various researchers have been captured to serve as a knowledge base for future projects. These suggested risk mitigation measures can be very helpful in preventing the occurrence of many common risks discussed here and in turn help in preventing their negative impact on project cost and time. These risks can be identified at their root cause and be dealt with at their source. The next chapter summarises the entire research work and important conclusions drawn from this study along with recommendation for future work.

2. CONCLUSIONS

The conclusions which can be inferred from this study are summarized below:

The Grounded theory and case study approach adopter for identification of risk factors allowed the researchers to understand the critical issues pertaining to specific cases which could only be extracted from natural settings of the case.

Some new issues that have been emerged from the case studies claim factors leading to risks which emerged from case analysis of arbitration cases and not highlighted in project completion reports were: Transportation of materials at own expenses to remote locations, hindrance in excavation and dewatering due non-availability of underground utility drawings and imposition of liquidated damages on grounds of slow progress.

Based on the case studies analysis the identified risk factors were characterized into 12 broad categories: Challenges due to initial delays, Scope Changes, Procurement related, Logistics related, Weather related, Execution related, Design related, Financial, Manpower related, Plant and machinery related, Quality related and Miscellaneous factor.

Total of 71 risk factors have been identified under the above 12 categories out of which 68 risk factors were recognized from case analysis of project completion

Reports and 3 extra claim factors emerged from arbitration case analysis along with 23 concurrent risk factors with case projects.

The impact of risks on construction project's performance in terms of cost and time was analysed and it was found that:

60 out of 68 risk factors have an impact on project cast out of which 14 factors are such that their impact can be transferred to clients.

49 out of 68 risk factors have an impact on project duration out of which 11 factors are such that their impact can be transferred to clients

23 risk factors are concurrent to claim factors of arbitration cases which often lead to disputes between the client and contractor

3 claim factors which cannot be categorized as risks but appear significantly in arbitration cases have an impact on overall project cost and budget.

The six major causes behind occurrence of listed risk factors are: Difficulty in obtaining permits; unclear project definition and client requirements; ambiguous material planning; improper logistics management plan; financial stability of owner; and lack of coordination between stakeholder. Additionally many other causes and sub causes have been identified which affect the construction projects time to time.

Risk mitigation measures were identified from expert experiences and literature survey for almost all risks listed except for a few which are: Environmental pollution with AQI reaching exceptionally high unsafe values leading to ban on all construction activities, Specialised agencies not showing interest to quote prices due to delay in project and non-availability of work front, Subcontractors not willing to increase manpower due to low rates and late payment issues, In spite of EOT submission, client demanded handover at an earlier date.

3. Contribution of this Study

The major contribution of this research to the construction industry and to the research community includes:

A case study based methodology for risk management which helps in capturing the practical challenges faced by construction projects allowing in-depth, multi-faceted explorations of complex issues in their real- settings.

Cause-Effect analysis approach for risk assessment is used to identify the major causes that led to various problems in construction projects.

A relation between claim management and risk management has been identified which provides a new dimension for identification and assessment of risks.

A Knowledge-Base which captures the knowledge from previous experiences is developed which could assist project managers in indicating what is liable to happen in future, what has happened in the past and how to efficiently manage such situations.

Providing a consistent and fair CV ranking policy. The presented system automates the processes of requirements specification and applicant's ranking. This system can be used in many business sectors that may require expert candidates and also reduce workload of the human resource department

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