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IDENTIFICATION AND ASSESSMENT OF RISKS IN CONSTRUCTION PROJECTS

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Abstract - *Managing risks in construction projects has been recognized as a very important management process in order to achieve the project objectives in terms of time, cost, quality, safety and environmental sustainability. In risk management it is contractor's job to take the risk or to avoid the risk in their construction project. Some of them also may take some action in order to lessen the risk in their construction project. However, until now most research has focused on some aspects of construction risk management rather than using a systematic and holistic approach to identify risks and analyze the likelihood of occurrence and impacts of these risks. The main purpose of this paper is to study structural questionnaire formulated by seeing the relevant literatures in the area of construction management and was administered to the construction professionals to solicit their opinion towards risks associated with construction projects. To accomplish the analysis process, project management software named Statistical Package for the Social Studies (SPSS) will be used along with ANOVA and t-test will also be calculated for factor analysis.*

***Key Words*: Risk Management, Construction Management, SPSS, t-test, ANOVA**

1. INTRODUCTION

In recent years, intensive research and development has been done in the area of project risk management. It is widely recognized as one of the most critical procedures and capability area in the field of project management. Construction projects are characterized as very complex projects, where uncertainty comes from various sources. Construction projects gather together hundreds of stakeholders, which makes it difficult to study a network as a whole. But at the same time, these projects offer an ideal environment for network and risk management research. Additionally, construction projects are frequently used in management research and several different tools and techniques have already been developed and especially for this type of project. However, there is a gap between risk management techniques and their practical application by construction.

1.1 Risk Definition

Risk is a term that has long been studied in different areas. It is defined as the uncertainty that can be measured, and uncertainty is a risk that cannot be measured. To try to mitigate or eliminate the risk, we count on risk management, which is an integral part of project management. Risk management is a positive and proactive process intended to reduce the likelihood of unsatisfactory consequences to the project in its different stages, such as design, construction and operation.

1.2 Risk Management

Risk management (RM) is an important area of project management then, since it allows anticipating the occurrence of events that could adversely affect a construction project and to define actions that could minimize their impacts. One concept which is widely used within the field of RM is called the risk management process (RMP) and consists of four main steps: identification, assessment, taking action and monitoring the risks. In each of these steps, there are a number of methods and techniques which facilitate handling the risks. However, with regard to the construction industry, risk management is not commonly used. More construction companies are starting to become aware of the RMP, but are still not using models and techniques aimed for managing risks. This contradicts the fact that the industry is trying to be more cost and time efficient as well as have more control over projects. Risk is associated to any project regardless the industry and thus RM should be of interest to any project manager. Risks differ between projects due to the fact that every project is unique, especially in the construction industry.

1.3 Major Processes of Project Risk Management

1.3.1 Risk Identification

This is the first stage in risk management and it entails capturing all the potential risks that could arise within the project. To facilitate risk identification, risks can also be broadly categorized as controllable and uncontrollable risks. Further, controllable risks are those risks which a decision maker undertakes voluntarily and whose outcome is, in part,

within our direct control; and uncontrollable risks as those risks which we cannot influence. Risk identification consists of determining which risks are likely to affect the project and documenting the characteristics of each. Risk identification is not a onetime event; it should be performed on a regular basis throughout the project. Risk identification should address both internal and external risks. Internal risks are things that the project team can influence, such as staff assignments and cost estimates. External risks are things beyond the control or influence of the project team, such as government actions.

1.3.2 Risk Analysis

Risk analysis, a component of the risk management process, deals with the causes and effects of events which cause harm. The essence of risk analysis is that it attempts to capture all feasible options and to analyze the various outcomes of any decision. For building projects, clients are mainly interested in the most likely price, but projects do have cost over-runs and, too frequently, the 'what if' question is not asked. Risk analysis involves assessing the identified risks. This first requires that the risks are quantified in terms of their effect on cost, time or revenue. They can be analyzed by measuring their effects on the economic parameters of the project or process.

1.3.3 Risk Response

Risk response is the third step of RMP which describes what action should be taken towards the identified risks and threats according to risk assessment methods. The response strategy and approach chosen depend on the kind of risks concerned. Other requirements are that the risk needs to have a supervisor to monitor the development of the response, which will be agreed by the actors involved in this risk management process. Most common strategies for risk response are: avoidance, reduction, transfer and retention. Beyond those types of responses, risk described when there is too little information about a risk; it would be difficult to take decision. This may be avoided by waiting until the appropriate information is available in order to deal with the risk. This way of acting is called "Delay the decision" but this approach is not appropriate in all situations, especially when handling critical risks. Those need to be managed earlier in the process.

1.3.4 Risk Monitoring

Monitoring is the final step of RMP which includes collection and monitoring of all information about the identified risks. New risk can be discovered through the continuous monitoring and supervision over RMP. This process also can be helpful to keep track of identified risks and eliminate past risks from the risk assessment and project. The assumptions for monitoring and controlling are to supervise the status of the risks and take corrective actions if needed.

2. LITERATURE REVIEW

Dr.R.K.Kansal and Manoj Sharma (2012), "Risk Assessment methods and application in the construction projects", aimed to assess the degree of knowledge and utilization of risk identification techniques in the construction projects. The paper suggested risk assessment approaches such as brain storming, checklist; flowchart, Delphi method and risk significant index method which are applied in various areas and the problems are solved. It was observed that currently used risk assessment methods can be integrated into new approach that can aid the decision makers applying the risk assessment effectively.

Alfredo Serpell, Ximena Ferrado et al (2014), "Evaluating risk management practices in construction organizations", this research has been observed that the lack of knowledge about risk management within the domestic construction industry has become a barrier that has prevented the participation of some companies that have been not willing to contribute to the study.

K.Jayasudha, Dr.B.Vidivelli and E.R.Gokul Surjith (2014), "Risk Assessment and management in construction projects", study mainly focused to assist management tin identifying activities where there is a risk of time and financial aspects and hence provide a basis for management to take objective decision on the reduction of risk to an agreed level. These findings are very important for implementing further effective measures to ensure the right direction of future development.

V.Sathishkumar, P.N.Raghunath and K.Suguna (2015), "Critical factors influencing to management risk in construction projects" paper describes largely on the survey questionnaire which was collected from various sources and it seeks to identify and assess the risk and develop a management framework which the investors/developers/contractors can adopt when contracting construction works and the data's were analyzed by descriptive statistics & ANOVA.

Krantikumar Mhetre, B.A.Konnur and Amarsinh.B.Landage (2016), "Risk management in Construction Industry", paper covers the concepts of risk management and various risk analysis techniques to be used for the one stop solution for all the types of hazards most likely to occur during any construction project lifecycle.

Hamzah Abdul-Rahman, Chen Wang, and Farhanim SheikMohamad (2015), "Implementation of Risk Management in Malaysian Construction Industry: Case Studies", this study aims to identify the actual process of risk management that is being applied in the construction projects and to determine the effects of risk management implementation on the performance of the construction projects in terms of time and cost. The data were obtained from four case studies in Kuala Lumpur, Malaysia, through

semi-structured interviews. It was found that the implementation of risk management process in Malaysian construction industry is still at a low level, mainly due to the fact that most of the construction employees involved in risk management are not fully aware of the available risk management techniques that can be applied in construction projects.

Savita Sharma, Pradeep K. Goyal (2015), " Fuzzy Logic: An Appropriate Technique for Effective Risk Analysis and Decision Making for Construction Projects", paper has reviewed the existing literature on the risk assessment theories. The theories have their own advantages and disadvantages. No theory seems to be perfect. Practical experience, personal judgment and intuition play an important role in decision making. Proposed FST as an appropriate theory for tackling the ill-defined and complex problem of construction industry as the theory has the potential to model vagueness intrinsic to human cognitive process. The theory can be applied in various phases of risk analysis in construction. The theory is used to quantify the probability of the project delay and cost overrun risk and therefore plays an important role for decision making and strategic planning in construction projects.

3. NEED FOR THE STUDY

The purpose of this research is to evaluate how the risk management process is used in the construction industry and how the practitioners are managing risks in everyday situations. The theory of the risk management process will be compared to the actual practice in order to investigate similarities and differences. In other words, the main idea is to see if the construction industry is working with risk management as it is described in the literature regarding the methods and techniques presented. The objective was to know about the concept of RM and the RMP, investigate how the sector manages risks and facilitate the use of RM focused on the construction industry.

4. RESEARCH METHODOLOGY

The methodology adopted in this project is given below:

- Pre-study aimed at defining the theoretical basis, formulating more clearly the research questions and consisted of three steps:
  - Literature review including an inventory of existing research and theory formation in the relevant areas. The purpose was to obtain a theoretical basis for further work and clarify in greater detail the research questions and delimitations.
  - Selecting a number of construction projects to be included in the main study.
  - Preparation of a questionnaire survey, using the results of the literature review.
- Main study involving some undergoing or finished construction projects. The main study aimed at finding out how the risk management process worked in the projects and consisted of following stages:
  - Questionnaire survey and personnel interviews with in charge and managers and collection of data from site
  - Analysis of the gathered data and presentation of the results
  - Determination of major risk factors from studied literature reviews
  - Ranking of various factors of risk are tabulated with its corresponding bar chart, mean, standard deviation, t-test and ANOVA results from SPSS statistical tool are also obtained
  - Presenting the result and suggestions

5. METHOD OF SURVEYING

The general methodology of the study relies largely on the survey questionnaire which will be collected from the different construction sites by personnel meeting. A thorough literature review was initially conducted to identify the factors that affect the performance of construction industry as a whole.

6. ANALYSIS AND RESULTS

The results were analyzed using SPSS software (Statistical Package of Social Studies). This software is one of the management tool that uses five scale Likert factor analysis. Risk factors for this study are of eight categories Design risk, Legal risk, Construction risk, Market risk, Safety risk, Technology risk, Communication risk and Environmental risk. The data collected was analyzed using SPSS software (Statistical Package of Social Studies). This was to determine the ranking of various factors of risk that were then tabulated with its corresponding bar chart, mean, standard deviation, t-test and ANOVA results and further conclusions and recommendations were made.

6.1 Demographical Analysis and Results

Table – 1: Designation of the Respondent

SL NO	DESIGNATION	FREQUENCY	PERCENTAGE
1	Assistant engineer	9	16.7
2	Builder	4	7.4
3	Contractor	10	18.5
4	Executive engineer	9	16.7
5	Site engineer	22	14.7
	Total	**54**	**100**

The table presents the designation respondents relativeness of collected data. It shows that 16.7% of respondents are Assistant engineers, 7.4% of respondents are Builders, 18.5% of Contractors, 16.7% of Executive engineers and 14.7% of respondents are Site engineers. Thus more percentage is occupied by Contractors.

Table - 2: Experience of the Respondent

SL NO	EXPERIENCE	FREQUENCY	PERCENTAGE
1	from 1 to 3 years	22	40.7
2	more than 3 to 5 years	18	33.3
3	more than 5 to 10 years	12	22.2
4	over 10 years	2	3.7
	TOTAL	54	100

The table reveals that 40.7% respondents have experience of 1 to 3 years, 33.3% respondents are experienced more than 3 to 5 years, 22.2% respondents have more than 5 to 10 years of experience and 3.7% respondents have over 10 years experience. So the majority of the respondents have only 1 to 3 years of experience in construction sector.

Table - 3: Age of the Respondent

SL NO	AGE	FREQUENCY	PERCENTAGE
1	Below 30 years	21	38.9
2	30 to 35 years	14	25.9
3	35 to 40 years	8	14.8
4	Above 40 years	11	20.4
	TOTAL	54	100

The table reveals that 38.9% of the respondents are aged below 30 years, 25.9% of the respondent lies in between 30 to 35 years of age, 14.8% are of age between 35 to 40 years and 20.4% of the respondents are above 40 years of age. The majority of respondents are of age below 30 years.

6.2 Descriptive Analysis and Results

Totally for 75 companies the questionnaire were given, out of which fifty four had an effective reply. Thus the response rate is 72% which is considered as a good response in this type of questionnaire survey. The questionnaire was done form contractors, site engineers, builders, assistant engineers of different construction projects. The provided risk factors were discussed by the respondents and majority has faced these risk constraints during the construction phase. The results are shown in the tabulated form.

As far as the construction risk is concerned recurring design errors, late arrival of some construction materials cause the major risk. In market risk unexpected increased in material cost is one of the serious concerns. Quality variation by labours (3.27), modification on design made during execution (2.39) is having lesser risk among design risk. Changes on law and regulations are considered least agreed risk in legal risk. Communication risk factors including lack of open communication between the engineers (1.78) is least affected than monopoly of some material type. Noise pollution happened due to projects (1.72) and waste disposal (1.41) has greater influence than ground water pollution happened due to project (2.00) when considering environmental risk factors. Safety risks includes pollution and safety rules (1.59), workers having less knowledge in their own safety (2.13) and absence of health insurance (2.00). Among these risk factors all the three selected factors assumes to have equal importance in the construction project risk as far as concerned. Influences of difficulties to access location (3.43) part less importance in construction phase than lack of human resource to support the technological investments in the technological risk. The above mentioned selected risk factors in construction projects analyzed are tabulated and given in table.

Table - 4: Overall Risk Factors Ranking and Mean Values

SL NO	RISK FACTORS	MEAN	STANDARD DEVIATION	RANK
	DESIGN RISK			
1	Inadequate specification	1.67	0.673	1
2	Incomplete design	2.89	0.883	6
3	Quality variation by labours	3.28	0.452	7
4	Changes in material type and specification during construction	1.96	0.951	3
5	Modification on design made during execution	2.39	0.712	5
6	No regular tests for materials	2.07	0.508	4
7	Unsuitable technical solutions or specification	1.67	0.476	2
	LEGAL RISK			
8	Requirement for permit and late approval	2.00	0.673	1
9	Excessive approvals procedure in administrative government departments	2.11	0.634	2
10	Poorly written contracts	3.28	0.452	3
11	Change in laws and regulations	4.15	0.529	6

12	Improper verification of contract documents	3.76	0.432	4
13	Breach of contract by project partner	3.85	0.408	5
CONSTRUCTION RISK				
14	Issue with sub contractors and suppliers	1.93	1.061	1
15	Some material do not arrive at assigned site	2.00		3
16	Recurring design errors	2.61	1.204	4
17	Limited construction area	3.81	0.617	6
18	Crack formation due to improper construction	1.94	0.231	2
19	Leakage due to lack of supervision	3.37	0.623	5
MARKET RISK				
20	Selection of material and equipments	1.48	.504	1
21	Unexpected increase in material cost	2.24	.432	2
22	Monopoly of some material type	3.80	.407	3
SAFETY RISK				
23	Pollution and safety rules	1.59	0.496	1
24	Absence of health insurance	2.00		2
25	Workers having less knowledge in their own safety	2.13	0.339	3
TECHNOLOGY RISK				
26	Influences of difficulties to access location	3.43	0.499	2
27	Lack of human resource to support the technological investments	2.00		1
COMMUNICATION RISK				
28	Local people support for project	3.78	0.816	2
29	Lack of open communication between the engineers	1.78	0.420	1
ENVIRONMENTAL RISK				
30	Noise pollution happened due to project	1.72	0.811	2
31	Ground water pollution happened due to project	2.00		3
32	Waste disposal	1.41	0.496	1

7. CONCLUSION AND SUGGESTIONS

There are two dimensions of risk in theory although it is perceived as a negative term. As risk management is still a new word in the construction sector and this should be changed as soon as possible. The participants participated in questionnaire has very limited knowledge about risk management but they evaluated this knowledge highly. The owners and contractors expend little time and effort on assessing and strategically planning for known, probable, or even unknown risks. Without a proactive risk management process, problems that occur on a project are likely to increase delays and costs. Identifying, allocating, and managing risks at the front end of the project planning process can improve project performance. Some risks remain constant while other arise and diminish as projects progress. Improvements in project performance can be achieved by recognizing which risks occur across the entire project life cycle and giving them due consideration. Within the project life cycle, optimal risk identification and assessment procedures and timing, as well as the identification of the most favorable decision points need to be outlined.

1. In design risk aspect:
    - Inadequate specification with mean value (1.67) and SD value (0.673)
    - Changes in material type and specification during construction with mean value (1.96) and SD value (0.951)
    - Unsuitable technical solutions or specification with mean value (1.67) and SD value (0.476)

Conclusion for the above factors as follows:

- Supervision for the implementation of workers after the training.
- Regular test of materials should be ensured.
- Proper supervision should be given from the management.
- Proper training should be allotted for the workers.
- Checks in the drawing and specifications provided should be done regularly.

2. In legal risk aspect:
    - Requirement for permit and late approval with mean value (2.00) and SD value (0.673)
    - Excessive approval procedure in administrative government departments with mean value (2.11) and SD value (0.634)

Conclusion for the above factors as follows:

- Approvals from the administration should be provided prior to work begins.
- Instantaneous changes in laws and regulations will cause time and cost delay.
- Overall legal risk is very low, but the implementation of court directive is not proper which one of the recommendations from the survey was.

3. In construction risk aspect:
    - Issue with sub contractors and suppliers with mean value (1.93) SD value (1.061)
    - Some materials do not arrive at assigned site with mean value (2.00) and SD value (0.496)

Conclusion for the above factors as follows:

- Sub contractor related risks are high, since most of the sub contractors are not able to meet the standards of the main contractors and client due to the work stress.
- Long distance between project site and resources cause delay in project duration.

4. In market risk aspect:
    - Unexpected increase in material cost with mean value (2.24) and SD value (0.432)
    - Selection of material and equipments with mean value (1.48) and SD value (0.504)

Conclusion for the above factors as follows:

- Sudden increase in the market cost cause shortage in material during the construction thus leading to financial crisis.

5. In safety risk aspect:
    - Pollution and safety rules with mean value (1.59) and SD value (0.496)
    - Absence of health insurance with mean value (2.00) and SD value (0.469)

Conclusion for the above factors as follows:

- Safety risk is high in rating, due to lack of safety measures practiced within the construction sites.
- Higher percentages of the workers are not ensured with the health insurance, thus causing extremity in safety risk.

6. In communication and technology risk aspect:
    - Lack of open communication between the engineers with mean value (1.78) and SD value (0.420)
    - Lack of human resource to support the technological investments with mean value (2.00) and SD value (0.469)

Conclusion for the above factors as follows:

- Communication between the engineers and authorities has a great significance in the construction work.

7. In environmental risk aspect:
    - Noise pollution happened during the project with mean value (1.72) and SD value (0.811)
    - Waste disposal with mean value (1.41) and SD value (0.496)

Conclusion for the above factors as follows:

- There are few environmental effects due to the projects, but say it cannot be nullified, but only can be reduced by introducing new technological improvements.

Few suggestions formulated from the study scenario:

- Specification or dimension changes to be recorded in register.
- Disputes and errors to be solved with record proofs.
- Technical skilled person to be execute the work.
- Do not award the work to inadequate experienced contractor.
- Highly technical experienced person to be administrate the project.
- Necessary technical trainings to be provided to the workers.
- High tech technology equipment and machineries to be selected for faster and accurate working.
- Risk Register can be used in each project to identify, assess and mitigate the risks.
- Contractors should be aware of risk management process.
- Even organization could train to get them the knowledge of RM.

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