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APPLICATION OF SAFETY AND RISK MANAGEMENT IN CONSTRUCTION PROJECTS

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Abstract – *Construction projects are initiated in complex and dynamic environments resulting in circumstances of high uncertainity and risk , which are compounded by demanding time constraints. Construction Industry has changed significantly over the past several years. Thus risk management and assessment need arise.*

Safety Concerns have always been paramount in the construction industry. Construction sites are complex environments, with workers from multiple trade interacting in challenging physical environment. The construction industry is changing in ways that have strong implications for site safety. Some of the key trends that have implications for safety include the use of new and unfamiliar products and technologies to achieve green goals on projects.

The objective of this project was to study the technique of implementation of safety aspects and various risks in construction projects, their importance and impact on the project. The general methodology of this study relies largely on the survey questionnaire which was collected from the local building contractors of different sizes by mail or by personnel meeting. A thorough literature review is initially conducted to identify the risk factors that affect the performance of construction industry as a whole. The survey questionnaire is designed to probe the cross sectional behavioural pattern of construction risks construction industry.

***Key Words*: Dynamic Environments, Risk Management, Construction Sites , Safety Concerns , Green Goals**

1.INTRODUCTION

Construction Industry is an important part of the economy in many countries and is often seen as a driver of economic growth especially in developing countries. Owing to its relatively labour intensive nature, construction work provide opportunities for employment for a wide range of people skilled, semi-skilled, unskilled. Despite its importance, construction industry are considered risky with frequent and high accident rates and ill health problems to workers, practitioners and end users.

1.1 Importance of Safety

Safety in construction is a prime requisite but it often gets neglected on work sites. With the advancement in construction technology, the need for proper attention to safety aspects has become essential for human, economic and other considerations, The wide range of construction and building activities involving complex techniques have led to many new problems of safety. Proper steps should be taken to improve safety on construction sites. Promotion of safety measures at site will result in better work environment, higher productivity and greater contentment among workers.

Most of the accident in the construction industry happen due to lack of proper education and training in regard to safety measures and also because of negligence and ignorance on the part of either the worker or management or both. It is well known fact that the construction industry in India employs more labour than any other industry. The construction industry is also one of the least organized and as a result there is scope for the exploitation of labour. In a country like India, safety is all the more important because of lack of social security to the family left behind. Thus, it becomes necessary to consider certain safety measures to prevent accidents.

1.2 Safety Measures

Prevention of accident is a major aim of construction management, both for human and financial considerations. Whatever the nature of construction projects, accidents are likely to occur causing physical injuries, casualties and loss of money. In order to prevent accident at construction sites, certain safety measures need to be taken in the following major activities prone to risks of accidents:

- Excavation
- Drilling and Blasting
- Hot Bituminous Works
- Scaffolding
- Ladders
- Form-work and other equipment
- Fabrication and Erection
- Storage
- Demolition

Over the last 20 years, the practice of construction has undergone profound changes. The type of projects, the manner in which those projects are delivered and the tools used for design and communication, all have changed dramatically. Therefore, it is essential for contractors to have a fully integrated, extensive safety program that can respond to evolving industry needs and allow them to stay competitive.

Table -1: Percentage of Fatal Accidents and their Causes in the Construction Industry

Sr. No.	Causes	Percentage (%)
1	Falling Persons	45
2	Falling Materials	14
3	Transport	14
4	Lifting Equipment	7
5	Excavation	7
6	Electricity	6
7	Other Causes	7

1.3 Project Risk Management

Risk is a multi-facet concept. Some categorize risks in construction projects broadly into external risks and internal risks while others classify risk in more detailed categories of political risk, financial risk, market risk, intellectual property risk, social risk, safety risk etc. Risk management in a project encompasses identifying influencing factors that could potentially negatively impact a project's cost schedule or quality baselines; quantifying the associated potential impact of the identified risk; and implementing measures to manage and mitigate the potential impact. The riskier the activity is, the costlier the consequences if the wrong decision is made. Businesses would like to quantify risk for many reasons. Knowing how much risk is involved will help decide if costly measures to reduce the level of risk are justifiable. It can also help to decide if sharing the risk with an insurance company is justified. Some risks, such as natural disasters, are virtually unavoidable and affect many people. All choices in life involve risk. It is vulnerable to the numerous technical and business risks that often represent greater exposure than those are traditional. Risks cannot be totally avoided, but the choice can be made so that risk is minimized.

$$\text{Risk} = \frac{\text{Probability of an event} \times \text{Consequence of loss due to that event}}{\text{Per Event}}$$

Graphical representation of risk rating can be made by plotting graph between probability and seriousness.

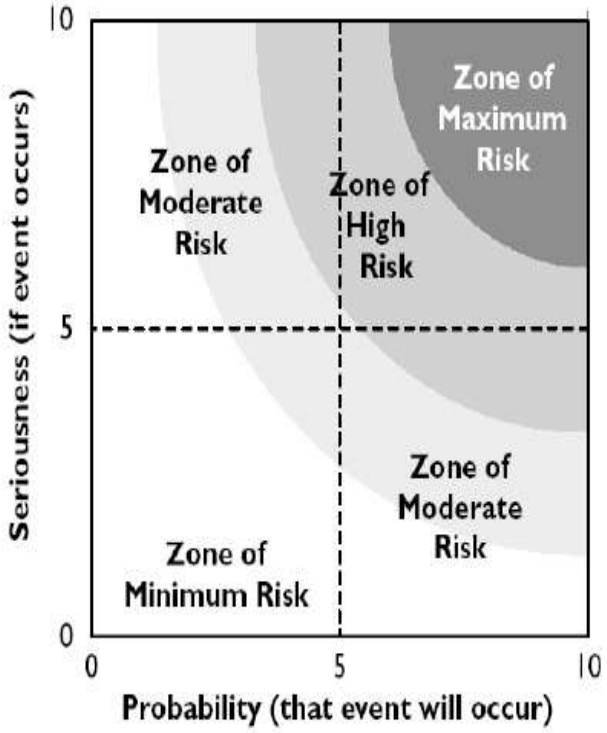

Fig -1: Graphical Representations of Risk Rating

1.4 Sources of Risk in Construction Projects

The common sources of risk in construction projects are listed below:

- Misunderstanding of contract terms and conditions.
- Design changes and errors.
- Poorly coordinated work.
- Poor estimates.
- Unskilled staff.
- Poorly defined roles and responsibilities.
- Natural hazards.
- Political and legal problems.

1.5 Major Processes of Project Risk Management

Risk management involves four processes, namely

1. Risk Identification

   Determining which risks are likely to affect the project and documenting the characteristics of each.

2. Risk Quantification

   Evaluating risks and risk interactions to assess the range of possible project outcomes.

3. Risk Response Development

   Defining enhancement steps for opportunities and responses to threats.

4. Risk Response Control

   Responding to changes in risk over the course of the project.

1.6 Objectives of the Study

The construction industry, perhaps more than most, is overwhelmed by risk. Too often this risk is not dealt with satisfactorily and the industry has suffered poor performance as a result. Infrastructure projects being huge in nature and involving a large amount of money, any sort of wastage (either time, resources etc.) would lead to huge monetary losses. The losses are due to various risks associated with such mega projects.

These risks are to be identified and mitigated to avoid the losses. Proper safety techniques should be used and safety aspects should be taken in consideration. Research on risk management has been done by various people, mostly on developed countries. In India, only few research works have been done in this area. Thus this study focuses safety application and risk management in India in field of construction.

2. LITERATURE REVIEW

The following are the past research survey based on the identification of construction risks at every stage.

Alfredo del Can et.al (2002) presented a generic project risk management process that has been particularized for construction projects from the point of view of the owner and the consultant who may be assisting the owner. First, the authors explains a complete or generic project risk management process to be undertaken by organizations with the highest level of risk management maturity in the largest and most complex construction projects. After that, factors influencing possible simplifications of the generic process are identified, and simplifications are proposed for some cases. Then the application to a real project is summarized. As a final validation, a Delphi analysis has been developed to assess the project risk management methodology explained here, and the results are presented. The appropriate contracting method and the contract documents for any construction project depend on the nature of the project, but an appropriate contracting method coupled with clear and equitable contract documents do not by themselves ensure project success where people work together in the face of uncertainty and complexity with diverse interests and conflicting agendas. The attitudes of the contracting parties and the co-operative relationships among the project participants are important for successful project delivery. These are examined in the light of transaction cost economics and relational contracting (RC) principles. It is found that RC may well be a useful route towards reduced transaction costs, while also fostering co-operative relationships and better teamwork that in turn facilitate joint risk management (JRM).The usefulness of the latter is reinforced by relevant observations from a recent Hong Kong-based survey, followed by a case study in Mainland China.

Terry Lyons and Martin Skitmore (2004) conducted a survey of senior management involved in the Queensland engineering construction industry, concerning the usage of risk management techniques. Their survey results are compared with four earlier surveys conducted around the world which indicates that: the use of risk management is moderate to high, with very little differences between the types, sizes and risk tolerance of the organization , and experience and risk tolerance of the individual respondents; risk management usage in the execution and planning stages of the project life cycle is higher than in the conceptual or termination phases; risk identification and risk assessment are the most often used risk management elements ahead of risk response and risk documentation; brainstorming is the most common risk identification technique used; qualitative methods of risk assessment are used most frequently; risk reduction is the most frequently used risk response method, with the use of contingencies and contractual transfer preferred over insurance; and project teams are the most frequent group used for risk analysis, ahead of in-house specialists and consultants.

3. METHODOLOGY

The methodology adopted in this project is given below:

- Study of literature related to Risk Analysis and Risk Management capabilities
- Preparation of Questionnaire.
- Site visit to major construction project sites.
- Questionnaire survey and personnel interviews with in-charges and managers and collection of data from site.
- Analyzing the Questionnaire.
- Qualitative analysis of data obtained from site and to identify the root cause.

- Remedial measures to be suggested and the present data to be recorded for future reference.
- Conclusion ,recommendations and suggestions for future study.

3.1 Method of Surveying

The general methodology of this study relies largely on the survey questionnaire which will be collected from the local building contractors of different sizes by mail or by personnel meeting. A thorough literature review was initially conducted to identify the risk factors that affect the performance of construction industry as a whole. Also some interviews with industrial practitioners were conducted to produce to check effectiveness of questionnaires.

3.2 Questionnaire Structure

The questionnaire was tested with a pilot survey for clarity, ease of use, and value of the information that could be gathered. The questionnaire survey is divided into two parts. The first part consists of general information like type of company, experience, value of their project etc. and the second part consists of the construction risk factors and safety consideration for evaluation.

Risk factors for this study are classified into eight categories, namely:

1. Financial risk
2. Legal risk
3. Management risk
4. Market risk
5. Policy and political risk
6. Technical risk
7. Environmental risk
8. Social risk

3.3 Design of Survey

The respondents were requested to judge the significance or ''expected loss'' of each risk. There are many criteria that respondents may need to consider. One alternative approach adopted by previous researchers (Shen et.al 1998) is to consider two attributes for each risk: the probability level of the risk occurrence, denoted by α ; and the degree of impact or the level of loss if the risk occurs, denoted by β. The same type of evaluation is followed in this study also. Therefore, risk significance, denoted as RS, can be described as the function of the two attributes RS = f (α,β). By applying this approach, the respondents were asked to respond to the two attributes for each risk. For considering α, the respondents were required to judge the probability level of risk occurrence by selecting one from among five levels, namely, Very small, Small, Normal, Large and Very large. For considering β, the respondents were required to judge the degree of impact if the risk concerned occurs, by selecting one from among five grades, namely, Very low, Low, Medium, High, and Very high.

3.4 Analysis of Survey Result

To assess the relative significance among risks, previous literatures study suggests establishing a risk significance index by calculating a significance score foreach risk. For calculating the significance score is to multiply the probability of occurrence by the degree of impact. Thus, the significance score for each risk assessed by each respondent can be obtained through the model

$$S_j^i = \alpha_j^i \beta_j^i$$

where S_i = significance score assessed by respondent j for risk i; α_j= probability of occurrence of risk i, assessed by respondent j; andβ_i= degree of impact of risk i, assessed by respondent j. By averaging scores from all the responses, it is possible to get an average significance score for each risk, and this average score is called the risk index score and is used to rank among all risks. The model for the calculation of risk index score can be written as

$$RS^i = \frac{\sum_{j=1}^{T} S_j^i}{T}$$

Where RS^i= index score for risk i; S^i= significance score assessed by respondent j for risk i and T = Total number of responses. To calculate S^i, the five point scales for α and β, this will be converted into numerical (Likert scale) scales.

5.RESULT AND DISCUSSION

The result of the survey done on various construction companies and their average results are shown below. As far as safety aspects are concerned various , based on the questionnaire survey various factors affecting safety aspects are find out .

5.1 Factors affecting Safety

Various factors affecting safety can be categorized in to three categories:-

- Psychological Factors

- Physiological Factors
- Technological Factors
- **Psychological Factors :-** These may be categorized in two types.

Negative Factors:-

- Aggression and overconfidence in judgement.
- Negligence and accident proneness.
- Indifference to own and other safety.
- Wrong motivation about productivity at cost of safety.
- Decisions made in emotional state.
- Impulsiveness and to escape the control of authority.
- Frustration, Anxiety and Tension.

Positive Factors:-

- Right attitude and sense of belonging.
- Motivated for safety achievement by incentive and reward.
- People don't hear what you say, they see what you do.

Physiological Factors:- These are as follows.

- Physical Characteristics, size, height and limitations.
- Effect of hot and cold weather, needs of rest and sleep.
- Biological needs of food, water and hygiene.
- Human ability in application of force.
- Movement, response and frequency.
- Manual dexterity and visual abilities.
- Effect of winds, dust and rains.
- Behavior under stressed conditions.
- Biomechanics and Ergonomic Application.

- **Technological Factors:-** Inevitable risk and hazard to all persons due to presence of force, pressure, energy, movement, electrical shock, impact, which are present whenever technology is applied to obtain the useful work.

5.2 Ranking of Various Risks :- The ranking of some types of risks is shown below:

Financial Risk :-

SUB RISK		MEAN
1.	Loss due to fluctuation of inflation rate	3.05
2.	Loss due to fluctuation of interest rate	2.99
3.	Loss due to rise in fuel price	2.75
4.	Bankruptcy of project partner	1.69
5.	Loss due to fluctuation of exchange rate	1.43
6.	Change in Bank formalities and regulations	0.93
7.	Low credibility of shareholders and lenders	0.86

Market Risk:-

SUB RISK		MEAN
1.	Competition from other companies	3.51
2.	Fall short of expected income from project	1.15
3.	Increase of accessory facility price	1.54
4.	Increase of labour cost	2.95
5.	Increase of material price	3.07
6.	Inadequate forecast about market demand	1.33
7.	Unfairness in tendering	1.26
8.	Local protectionism	0.98

Legal Risk:-

SUB RISK		MEAN
1.	Improper verification of contract documents	3.83
2.	Breach of contract by project partner	2.91
3.	Lack arbitration clause in agreement	2.13
4.	Lack of enforcement of legal judgement	1.26
5.	Uncertainty and unfairness of court justice	1.04

Political Risk:-

SUB RISK		MEAN
1.	Cost increase due to change of govt. policies	2.24
2.	Loss due to bureaucracy for late approvals	1.73
3.	Loss incurred due to corruption and bribery	0.78
4.	Loss incurred due to political changes	0.68

Environmental Factors:-

SUB RISK		MEAN
1.	Any adverse impact on project due to climatic condition	2.50
2.	Any adverse impact on environment due to project	0.80
3.	Healthy working environment for the workers	0.80

6. CONCLUSIONS

As far as India is concerned risk management is still a new word in the construction sector and this should be changed as soon as possible. Currently the Government of India has proposed a risk rating system will help the developers to develop projects at a faster pace by taking quick decisions. Each rating agency will have its own methodology to rate projects. The system will help government to develop a strategy to mitigating risk. This will encourage more response from developers and investors for public-private partnerships projects. It could make the bidding projects more competitive. The system will enable bankers to take quick decisions for lending finances, which could lead to the financial closure of the project at a faster pace. Third party risk rating would certainly raise critical points, which are not normally raised during finalisation of project.

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