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RESEARCH ARTICLE OPEN ACCESS

Construction Risk Management: A Case Study using Questionnaire Method

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ABSTRACT
In this generation of globalization, threat and risk has become new normal in life which can be related to every vicinity of lifestyle. Construction industry is among the most dangerous places to be in with threat as an ever-gift element of puzzle. For the success of any construction project, it is important to map the risks and threats during the planning stage itself and analyzing them properly. Without a proper risk management system in place, the construction projects become vulnerable to risks. Thus, finding a 'golden imply' in risk management can be the effective danger control. This involves a complete qualitative and quantitative analysis of the risks involved and class of danger. Quantitative analysis helps in checking the maximum advantages of the possible risk management choices using mathematical and analytical tools. Thus, an exact evaluation, including stakeholder evaluation, risks at different time points and possible causes offers an opportunity to correctly manage the hazards. The end result of hazard identity and evaluation of the project can be a listing of activities displaying the cause and the opportunity of an event, and it's very last assessment of the effect at the surroundings.
Keywords – Risk Management, Safety Management Practices, Safety Measures, Risk hazards, Project Risk

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I. INTRODUCTION

In this time of creating development it's far hard to maintain a strategic distance from threat, which has come to be a vital piece of standard ways of life. Risk is available anyplace, in everything of our reality. One of such parts is the construction venture, wherein risk is a natural component. Viable danger control does no longer suggest the evacuation of risk, which may supposedly be the least expensive choice. From money related factor of view this alternative is futile because of the reality what is without a doubt gainful is by utilizing definition precarious and diversion that doesn't represent an opportunity isn't in every case monetarily intriguing, and consequently, doesn't convey unmistakable favors.

1.1. WHAT IS PROJECT RISK?

"Risk event" is defined as "an uncertain event or set of circumstances that, should it occur, will affect the accomplishment of at least one of the undertaking's destinations." "Project risk" is defined as "the exposure of stakeholders to the consequences of variations in outcome."

- A situation involving exposure to danger.
- Expose (someone or something valued) to danger, harm, or loss.
- Risk is an uncertain event that may have a positive or negative impact on the project.
- May effect: scope, schedule, cost, performance, and quality.

Fig. 1. Types of project risks

1.2. CONSTRUCTION RISK MANAGEMENT

Construction Risk Management is the way toward recognizing and relocating risk.

- Proper Construction Risk Management implies control of possible future events and is proactive rather than reactive.
- Proper Construction Risk Management will reduce not only the likelihood of an event occurring, but also the magnitude of its impact.

- Construction Risk Management Systems are designed to do more than just identify the risk [1].
- The system must also quantify the risk and predict the impact on the project.
- The outcome is therefore a risk that is either acceptable or unacceptable [2].

1.3. IDENTIFICATION AND RISK ASSESSMENT

Every task has a probability of a risk. Organisations and institutions should to be prepared mentally and financially for ubiquity of the possibility of risks. Generally, a few organizations have a strong approach to bear the threat at the initial stages of their business and thus emerge as bankrupt within a few years.

Financial organisation have a commercial based enterprise for one to resist the dangers as they control their assets in the depositories due to their awful gluttony of risk. They choose to encourage their tasks due their accepted portfolios [3].

Recognisation of risks in construction tasks is relied typically on determination on risks that affect the task in-and, determining their functional parameters and estimation of the probability of their incidence inside the task. The requirement for risk identities the stems of the decision making conditions under which an investor has invested his capital. The results of the task's danger identification and analysis could be listing of incidents displaying their causes, probability and natural effects assessment. In 1921, Frank Knight described truly the distinction between chance and uncertainty: "Uncertainty is to be seen in a decidedly distinct way from the well-known idea of risk, from which it has never simply been separated [4].

In some cases, the risk in conversation might be a measurable entity, and in others it might be very different as critical to the task. It appears that measurable uncertainty or the actual risk, which is a term we're going to use, is so one-of-a-kind from the immeasurable uncertainty that in outcome it does no longer represent uncertainty.

1.4. TYPES OF RISKS IN CONSTRUCTION:

Risks can be classified into various sub-risks (Fig. 2), like the following:

Fig. 2. Types of sub-risks associated with

I. Design Risk
a) Inappropriate or inadequate design
b) Design scope creep
c) Survey and assessment of site
d) Delay in designers' response
e) Innovative construction methods required
II. Construction Risk
a) Shortage of labour
b) Labour conflicts and disputes
c) Safety and medical outbreaks of workers
d) Mistakes and errors of labour
e) Non-availability of resources
f) Quantified change of work
g) Fluctuation of labour costs
III. Environmental Risks
a) Weather conditions – Temperature, Precipitation and Humidity
b) Effects due to natural hazards/act of god – Earthquakes, Flood, Wars etc..
c) Pollution due to construction waste
IV. Financial Risks
a) Economic crisis
b) Delay of cash-flow by the contractor
c) Fluctuation in prices due to inflation
d) Taxation risk- Rise in tax, customs
e) Foreign currency risk- unsteady exchange rates
f) Increment for staff benefits
g) Corruption by contractor/mid-men
V. Management Risks
a) Communication between project stakeholders

b) Disorganized structures and inadequate qualified staff
c) Inspection and testing staff
d) Use of WBS (Work Breakdown Structure)
VI. Political Risks
a) Political instability
b) Corruption of higher officials
c) Failure in obtaining permits
d) Import material restrictions
e) Union issue
VII. Procurement/Equipment Risks
a) Logistics delay and failure
b) Temporary demand of increase in materials
c) Delay in spare-part delivery
d) Lack of operator's competency
e) Improper maintenance of equipment
VIII. Sub-contractor Risks
a) Walk-out
b) Delay in work execution
c) Revision of price
d) Low-credibility
IX. Technological Risks
a) Lack of knowledge in equipment
b) Service of damaged machinery
c) Loss of data or software
X. Owner-generated Risks
a) Unqualified owner representatives
b) Delay/Refusal of compensation to the contractor
c) Owners' ultra-standard expectation
d) Delay to provide full-possession of site
XI. Other Risks
a) Theft risk
b) Accidental risk
c) Interference by public
d) Security of property/site
e) Pandemic risks

1.5. RISK MAKING PLANS AND REACTING

Planning a way to deal with likelihood could be a terribly exhausting mission, that needs to be undertaken already on the degree of endeavour preparing. The degree of involvement on the preliminary section in most cases interprets into the threat cope methodology. so as to properly bear the whole manner of danger management at intervals the settlement you would like to start out from a similar place to start, particularly the advance of an opportunity management plan [5].

As we tend to shall see later, this arrange can appear once more and once more in various studies and studies ways. the bottom factors of this type of arrange square measure unremarkably the principle assumptions of the mission, that define the character and path of the venture.

within the resultant level you need to decide the prospect management policy of the organisation/entity in order that it'll allot and description the roles and responsibilities of staff within the endeavor.

At the equal time, we tend to severally take a glance at the angle of task's contributors for you to dispose of negative emotions to the task as early as attainable. Obviously, it's generally a completely tough mission thanks to the very fact in most instances the threat is related to the chance of dropping edges, that as we tend to acknowledge is associate degree incorrect thought.

1.6. QUALITATIVE AND QUANTITATIVE RISK ANALYSIS:

Qualitative risk analysis can be particularly based totally on the right estimation of undertaking's risk chance and scale of ascertained effects. It'll conjointly facilitate confirm that of the power hazards got to be analyzed and incontestible first and which of them is also put away in time as a result of slight chance of incidence. The results of qualitative-evaluation will form the basis for taking key decision on which risk factors:

- Continous monitoring is required to incluse stops for planning suspension, and decision making which are regarded as categorized risk.
- It can be eradicated as a result of trade due to undertaking's profile or completion of withdrawal.
- It may be continued to other entities that are a part of the concerned task, so that one is capable to deal with ensuing effects.
- Requirment of compensated moves underneath the project that is to be carried out.

Qualitative analysis is used in evaluation and class of chance. The maximum essential of those are the following:

- Impact and indicative analysis of probable danger issue prevalence.
- Threat index analysis matrix.
- Estimated the assessment of likelihood and importance to the assignment.
- Understanding and enterprise assumptions with stability and venture sensitivity to any reasonably changes to those assumptions.
- Techniques of knowledge ranking in terms of risk analysis in usability.
- Determining risk index because the resultant of the likelihood of a specific risk issue incidence and therefore the significance of risk to the project just in case of incidence of a specific risk issue.

On the premise of that analysis we are able to conjointly develop the dimensions of risk impact. A comprehensive risk analysis has got to be among a

quantitative methodology of study which is able to detail the thought of issue. To see risk supported measurement it's necessary to own such information as: likelihood of risk in an exceedingly thought of project that's best determined on the premise of a sufficiently giant, unvaried and reliable information sample, and valuation of risk consequences.

1.7. RISK MANAGEMENT CYCLE:

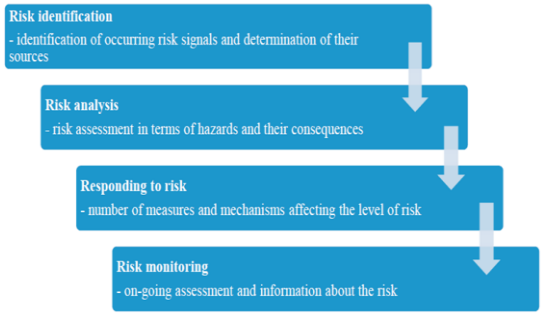

Fig. 3: An example risk management cycle consisting of four main stages.

Thoughtful and strategic risk management primarily maximizes the effect of positive events and minimizes the negative effects, thus increasing the chance of project's success. Effective actions are possible if we have developed a proper project management cycle [6].

Properly adopted theme not solely facilitate build troublesome and contentious choice show ever specially give priceless data to investors on what action to require and per that theme to realize the simplest results with token effects of negative risk.

II. LITERATURE REVIEW

Gaps and inconsistencies within the information and treatment of construction and project risk are known. The project describes, on the premise of a form survey of general contractors and project management practices in metropolis, Gurugram, Faridabad, the development trade's perception of risk related to its activities and also the extent to that the industry uses risk analysis and management techniques. It concludes that risk management is crucial to construction activities in minimizing losses and enhancing profitableness. Construction risk is mostly perceived as events that influence project objectives of value, time and quality. Risk analysis and management in construction rely in the main on intuition, judgment and knowledge. Formal risk analysis and management techniques are seldom used because of an absence of information and to doubts on the quality of those techniques for housing industry activities.

2.1 CASE STUDIES:

Alfredo Federico et.al., (2014) [7]: One of the foremost roles undertaken by a project manager is that the management of the danger of a project. However, this duty is especially advanced and inefficient if smart risk management has not been done from the start of the project. economically good and efficient risk management approach needs a correct and systematic methodology and, a lot of significantly, information and skill. This paper addresses the issues of risk management in construction comes employing a knowledge-based approach, and proposes a strategy supported a three-fold arrangement that has the modelling of the danger management perform, its analysis, and therefore the accessibility of a best practices model. a serious conclusion of this analysis is that the incontrovertible fact that risk management in construction comes remains ineffective thanks to lack of information.

C. Borysowich (2008) [8]: Most organizations are aware that risks don't seem on a linear basis and for this reason risk cannot be known and measured during this means. Assessing and understanding the interrelationship of risk and their associated related to impact is that the real challenge. These complicated relationships need a special set of tools. Through the utilization of tools to simulate multiple risk eventualities and correlating risk interdependencies the organization will begin to make an efficient map of their risk landscape. The goal of study was to know the additive impact of risks on performance and price so as to pick out the acceptable combine between risk retention and risk treatments.

Franck Taillandier et.al., (2014) [9]: An economical risk management is obligatory to project success. However, implementing such a management is complicated due to the variety and also the dynamic nature of the danger. Moreover, every of the project stakeholders has his/her own risks; his/her own vision and his/her own action on the project and on risks. during this paper, we have a tendency to propose associate agent-based model referred to as SMACC to assess the impact of risks on the project. This model permits testing completely different risk mitigation methods to live their impact on the project.

Irem Dikmen et.al., (2004) [10]: Risk management paradigms exist as methodologies instead of systems which might totally support the chance management method. the prevailing risk management support tools area unit typically supported quantitative risk analysis whereas the opposite phases area unit distributed external to the package. Risk registers and risk assessment tools area unit planned as call support systems which

might solely be used at specific stages of a construction project for specific functions like time/cost estimation at the bidding stage, country risk assessment throughout international market choice etc. Moreover, the planned risk management support tools typically don't foster integration of risk management activities between the parties concerned within the construction provide chain, don't contemplate impact of risks on all of the project success criteria, and can't handle judgment. the foremost objective of this paper is to form a criticism of existing risk management support tools and propose development of a risk management company memory not to mention a call support tool for fortunate management of risk.

Josef Oehmen et.al., (2015) [11]: Risk management is receiving abundant attention, because it is seen as a way to enhance value, schedule, and technical performance of recent development programs. However, there's a scarcity of inquiry that investigates the effective integration of specific risk management practices planned by varied standards with new development programs and their association with varied dimensions of risk management success. supported a survey of 291 new development programs, this paper investigates the association of risk management practices with 5 classes of development program performance: A. Quality higher cognitive process, B. High program stability; C. Open, drawback finding organization; D. Overall NPD project success and E. Overall product success. The results show that six classes of risk management practices are most effective: one. Develop risk management skills and resources; two. Tailor risk management to and integrate it with new product development; three. Quantify impacts of risks on your main objectives; four. Support all vital selections with risk management results; five. Monitor and review your risks, risk mitigation actions, and risk management process; and half-dozen. produce transparency relating to new development risks. the information shows that the chance management practices are directly related to outcome measures within the initial 3 classes (improved higher cognitive process, program stability and drawback solving). there's conjointly proof that the chance management practices indirectly keep company with the remaining 2 classes of outcome measures (project and merchandise success).

III. METHODOLOGY

3.1 IDENTIFICATION OF RISKS BY VISITING SITES:

The risk identification is a unique phase of the method, that is, once the risks are identified, this will no longer be executed during the application of the proposed method in the organizations. This identification is based on survey and site visits.

3.2 RISK ASSESSMENT AFTER IDENTIFYING RISK:

Identification of dangers in construction tasks is based generally on determining what sorts of dangers may also affect the task, figuring out their function parameters and estimating the chance of their incidence inside the assignment. The need for risk identity stems from the decision making conditions under which an investor is in the meanwhile. The result of the task's danger identification and analysis is a listing of incidents displaying their causes, chance and very last environmental effect assessment.

3.3 PREPARING A QUESTIONNAIRE:

A questionnaire of approximately 150 questions was prepared based on the understanding of risks from visiting construction sites.
The questions were first categorized in the following risk categories (Table 1):

Table1: Categorized risks

Design
Construction
Financial
Management
Political
Procurement
Sub-contractor
Technology
Owner
Environmental
Others

For the probabilistic risk analysis, the questionnaire was also categorized on two factors:

1) Chances of occurrence and
2) Impact of the risk

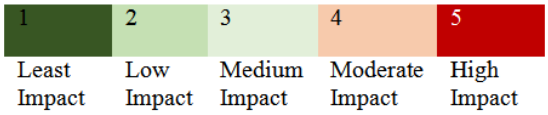

Fig. 4: Scale for response (Chances).

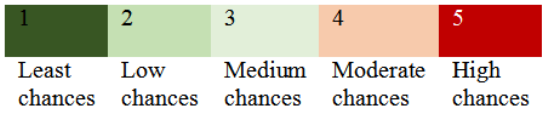

Fig 5: Scale for response (Impact).

The questionnaire was distributed among various management officials from various construction companies of different financial segments. The response was recorded through Google form and were analyzed for further analysis.

3.4 Probabilistic Risk Analysis through Questionnaire:

The questions were categorized under the above-mentioned categories. The analysis was done based on the probabilistic analysis based on the chance and impact of the risk.

The following steps were followed to analyze the risks:

1) Significant and insignificant risks were identified based on the probability total probability of chance and impact.
2) Then further these risks were classified in three different sub-categories:
    a. Risks needed to be considered during the planning of the construction sites.
    b. Risks needed urgent action while at the beginning and during the construction process.
    c. Risks which should not be considered until encountered.
3) Risk urgency assessment was carried out to identify the urgency of risks.

3.5. Monitor and Control of Risk:

Once these risks are identified and being recommended to the construction companies, there still remains a need for the regular monitoring and control the risks. To ensure this, following recommendations has been made:

1) A regularly scheduled risk reassessment which would involve the identification of new continuous risks which could arise during the operations on site.
2) To examine the effectiveness of planned risk response, risk audit needs to be undertaken on a serious note.
3) To understand and monitor the regular performance of the project, trend need to analyzed based on the identified risks above.

Monitoring is crucial for proper implementation of risk management practices. These recommendations will be based on several aspects associated with the project and construction company.

IV. Results and Discussions:

4.1 Questionnaire Preparation:

A questionnaire of approximately 150 questions was prepared based on the understanding of risks from visiting construction sites.

The list of questions prepared was prepared as per the methodology and distributed among the construction companies and responses were gathered through google form. The questions were prepared after a thorough understanding from the visit to construction sites, literature survey and discussions with various stakeholders. The questionnaire was a representation of all the categorized risks and every risk was subclassified into further possibilities to prepare the questionnaire. The risks were given equal amount of questions for an unbiased analysis. Responses were obtained from following six different construction companies (Table 2).

Table 2: List of companies participated in the study

Sr. No.	Company Name	Type of Company
1	Ridhi Sidhi Infra Projec	Real Estate
2	PNC Infratech Ltd.	Construction
3	Hindustan Construction Company	Construction
4	Afcons Infrastructure Limited	Construction
5	Kundu construction company	Construction
6	PATH India Ltd.	Construction

4.2 Probabilistic Risk Analysis:

The responses from the companies were analyzed for the probability of occurrence of risk and the impact they can cause if occurred:

1) Chances of occurrence and
2) Impact of the risk

For this purpose, we gave a weightage to the questions according to the significance of the questions and then used that to calculate the

probabilities of each risk group. The result of which is shown in Table 3:

Table 3: The probabilities of chances and impact of the identified risks

Risks	Chances	Impact
Design	0.37037037	0.75555556
Construction	0.42051282	0.66666667
Financial	0.52380952	0.67619048
Management	0.31818182	0.63030303
Political	0.44761905	0.59047619
Procurement	0.42592593	0.53333333
Sub-contractor	0.43333333	0.60833333
Technology	0.4	0.66666667
Owner	0.36666667	0.59166667
Environmental	0.45185185	0.60740741
Others	0.35555556	0.61111111

After calculating the values further analysis was done to identify the significance of risks and divided these risks into three different sub-categories of risks as per the urgency to be dealt with and the time at which these risks are needed to be considered during the project.

The risk associated with finances was the most probable risk followed by environmental and political. The complete order of chances of occurrence of risks is presented in table below (Table 4):

Table 4: The probabilities of chances of the identified risks

Risks	Chances (Decreasing order)
Financial	0.52380952
Environmental	0.45185185
Political	0.44761905
Sub-contractor	0.43333333
Procurement	0.42592593
Construction	0.42051282
Technology	0.4
Design	0.37037037
Owner	0.36666667
Others	0.35555556
Management	0.31818182

It is important also to consider the impact a risk can have on the project. Though a risk with less probability of occurrence might cause a major damage and threat to the project. Thus, it becomes crucial to consider the impact of the risks associated with the projects. From this study, the risk associated with design, finance, construction and technology were found to have major impact. Thus, require brainstorming and thorough consideration even before the project has started, during the pre-planning stages. The table below shows the order of impacts a risk can cause to the project (Table 5).

Table 5: The impact of the identified risks on project

Risks	Impact (Decreasing order)
Design	0.75555556
Financial	0.67619048
Construction	0.66666667
Technology	0.66666667
Management	0.63030303
Others	0.61111111
Sub-contractor	0.60833333
Environmental	0.60740741
Owner	0.59166667
Political	0.59047619
Procurement	0.53333333

Considering both the chances of occurrence and the impact individual risk can cause, the urgency and priority for handling risks was identified as a combined effect of both chances and impact. Risk urgency was calculated and it was found that financial, design, construction, environment and technology related risks were the most urgent ones. It is recommended to consider these risks on a priority basis. The table below shows the order of Risk Urgency (Table 6).

Table 6: Risk Urgency

Risks	Risk Urgency (Decreasing order)
Financial	0.354
Design	0.280
Construction	0.280
Environmental	0.274
Technology	0.267
Political	0.264
Sub-contractor	0.264
Procurement	0.227
Owner	0.217
Others	0.217
Management	0.201

The risks were further classified into three sub-categories based on the time point when these risks become more important to be considered and dealt with. The category is shown in (Fig. 6.), where the risks are divided on a time scale of the project.

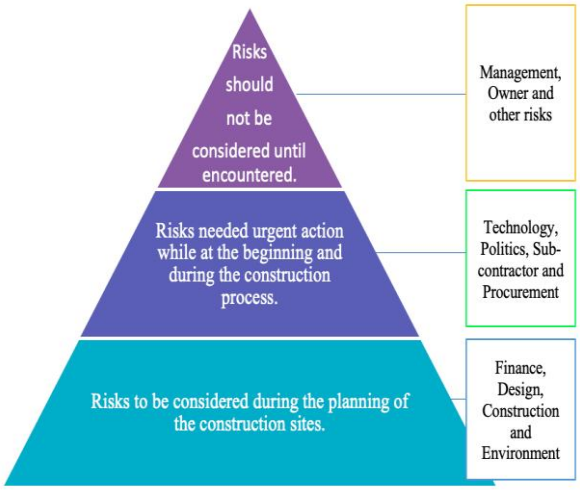

Fig. 6: Sub-categories of Risks based on time scale of project

4.3 Monitoring and Control of Risks:

Based on the study conducted through a questionnaire survey, it is identified that the risks are associated with urgency, priority and risks to be considered at different time scale of the project.

There becomes a need for continuous monitoring of the risks to avoid/control occurrence of risks. Based on the study, it is suggested that there should be formation of proper committees for risk analysis much prior to the project planning. The risk factors associated with finance, design, construction and environment has to considered at an even early stage of planning to avoid any kind of delay in the project.

The role of the committees should not be just limited to risk identification and analysis but also identification of new risks and regular monitoring of the steps taken. This would ensure that these risks are minimized and thus the losses can be avoided.

V. Conclusion:

Probabilistic risk assessment of the responses from the questionnaires gave insights that the interventions needed for risk management are associated with urgency, priority and time scale of the project. According to the risk urgency calculation it was found that financial, design, construction, environment and technology related risks were the most urgent ones. Thus, it is recommended to consider these risks on a priority basis. Based on the study, it is suggested that there should be formation of proper committees for risk analysis much prior to the project planning. The risk factors associated with finance, design, construction and environment has to considered at an even early stage of planning to avoid any kind of delay in the project.

The role of the committees should not be just limited to risk identification and analysis but also identification of new risks and regular monitoring of the steps taken. This would ensure that these risks are minimized and thus the losses can be avoided.

FUTURE SCOPE OF WORK:

The future scope of this work is to identify the causes and providing the best solutions to the risks associated with the construction project. Based on the identified risks in the study organizations and individuals can develop proper risk management practices for every construction project. Realistic and practical approaches and goals can be established to reduce the uncertainty associated with risks in construction industry.

REFERENCES

This heading is not assigned a number.

A reference list **MUST** be included using the following information as a guide. Only *cited* text references are included. Each reference is referred to in the text by a number enclosed in a square bracket (i.e., [3]). References **must be numbered and ordered according to where they are first mentioned in the paper,** NOT alphabetically.

Examples follow:

Journal Papers:

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