Proceedings of 12th IOE Graduate Conference
Peer Reviewed
ISSN: 2350-8914 (Online), 2350-8906 (Print)
Year: 2022 Month: October Volume: 12

Risk Management in Building Construction Projects (A case study of Chitawan)

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Abstract
Risk management in building construction projects is recognized as a very important process in order to achieve the objectives of project within predetermined time,cost and standard in terms of safety and environmental sustainability. The main objectives of this study are to evaluate the level of risks in building construction projects and to suggest measures for managing risks in building construction projects.Physical risks, construction risks, financial risks, design risks, political risks, legal risks and environmental risks are found to occur in building construction projects. Financial risks are found to be the most vulnerable. The level of risks is high in most of the financial risks. Physical and building hazards are the next most sensitive ones after financial risks.For the extreme risk, a thorough action or plan is needed. While senior management's attention is required for high risk situations. For low level risks, standard methods can be used to manage them. Specific management is responsible for managing risks at a moderate level. The second goal of the study has been accomplished with the achievement of this outcome. Finally, various measures to manage risks in building construction projects were identified that are; application of risk management by contractors, application of risk management strategies, development of contingency plans and ensuring adequacy of project funding.

Keywords
Risk Management, Financial Risk and Extreme risk

1. Introduction

Because of the rising demand for infrastructure and building construction, the construction sector in Nepal has been increasing its market share. In order to identify, assess, manage, and control risks that might be detrimental to the project goals,one has to contend that risk management must be incorporated into project planning and management in order to keep up with the growth in demand[1]. Risks are defined as the likelihood that a decision will have a negative result[2].

Risk is defined as an exposure to financial gain or loss resulting from participation in the construction process. When a project's goals are achieved within the allotted time frame, within the budgeted cost, and within the necessary criteria, it is said to be successful. Managing risks is one of the most crucial things someone can do to guarantee a project's success. Anything that could negatively impact a project's scope, budget, schedule, or quality is considered a risk[3]. Whether in building projects or any other kind of construction projects, risks are virtually always unavoidable. All human pursuits, including construction activities, carry a certain amount of risk, and those risks might take many different forms. Risk management for construction projects is seen as essential to the success of any project. The research will help to evaluate the level of risks in construction projects and also suggest the mitigation measures. Contractors can make an informed decision about how to manage risks by using the study to identify and quantify any hazards to which the company or project is subject. It must be workable, reasonable, and economical.

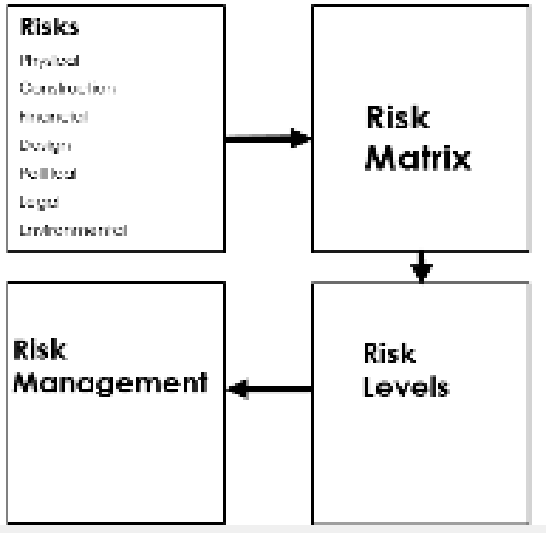

Figure 1: Conceptual Framework for the Research Study

2. Literature Review

2.1 Current Situation of Construction Industry

The building sector of the economy uses a variety of resources to create the built-in physical, economic, and social infrastructure required for socioeconomic growth. It includes the entire planning, design, procurement, construction, alteration, repair, maintenance, and demolition process for physical infrastructure. Another basic economic activity that affects the majority of the economy's sectors is the construction industry. In a nutshell, it is a growth engine[3].

Unfortunately, negative results can frequently plague these ventures and their participants in a highly competitive, complicated, and risky environment. Cost overruns, budget gaps, degraded quality, schedule slips, interference from outside parties, ambiguity over the scope of work, tarnished reputations, damaged relationships, and significant financial hardship are some examples of possible effects[4].

2.2 Risks in Construction Projects

Risk is defined as the likelihood of unfavorable outcomes that only result in harm or loss. Risk is defined as an unpredictable event or circumstance that, if it materializes, may have a favorable or unfavorable impact on the project's goal[3]. Risk is the likelihood that some unclear, unforeseen, and sometimes undesired eve occur and alter the prospects for the likelihood of making a particular investment[4]. Construction project development risks may make it more difficult to meet the project's primary goals of on-time, under-budget, and high-quality completion. All project stakeholders will be affected significantly if the project's goals are not met[3]. Risk management for building projects should be handled on time so that issues can be resolved as they arise. This can be distinguished from the conventional project management method, in which risks are addressed only when they arise. This is inappropriate since it will take a lot of time, money, and effort. Every project stakeholder has a duty for risk management[5].

2.3 Risk Identification Methods

Organizations and researchers have established or quoted a number of models of risk management to provide a systematic approach to risk. However, systematic risk management may often be broken down into three parts : Identification, Analysis, Response actions and control[6].

2.4 Risk Management

Risk management is a significant part of project management in the construction industry. Planning, identifying, evaluating, designing risk handling techniques, monitoring, and controlling are all part of risk management. A prioritization approach is used in optimal risk management, where risks that have the highest loss potential and the highest likelihood of occurrence are treated first and risks that have a lesser likelihood of happening but lower potential losses are handled afterwards. The procedure can be highly challenging, and it's common to make mistakes when balancing hazards with a high likelihood of occurrence but lower loss against those with a high likelihood of occurrence but higher loss. A challenge for risk management is correctly allocating resources[7].

2.5 Risk Management Process

The actions necessary to identify, monitor, and control risk are described by the risk management process. Any future event that could hinder the team from achieving its goals is considered a risk in the risk management process. Using a risk management process, one may identify each risk, determine its

potential impact, and take immediate steps to both prevent it from happening and lessen its effects if it does[8]. To limit and mitigate potential hazards, the risk management process typically includes identifying construction risks and exposures, analyzing those risks and developing effective risk management solutions. The following are the processes and steps for risk management[8]:

- Establish goals and context
- Acknowledge and Identify risks
- Analyze and prioritize risks
- Evaluate the risks
- Treat risks

3. Research Methodology

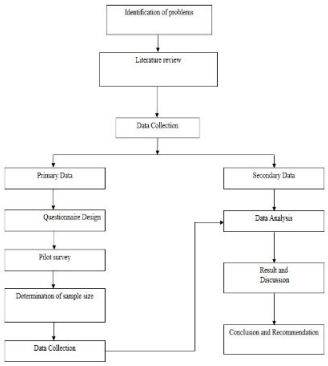

Figure 2: Research Framework

The study looks in to find out what the building contractors know about risks and risk management processes. By using questionnaires to examine a sample of a population, one can infer that the population as a whole has the same traits. To become familiar with the body of knowledge that is currently available in the field of interest, literature review is a crucial first step. A thorough literature evaluation is essential to the entire research process and helps with each practical stage. A questionnaire consists of a list of questions that are asked and then answered by the respondent. The respondents read the questions, comprehend the expectations, and then record their own responses in writing. The different risk types encountered at the project level are recognized in the questionnaire through research and interaction with industry practitioners. In this study, two-dimensional ways to measuring risk are used, in which case the impact in the event of an occurrence as well as the possibility or probability of the risk occurring will be taken into account. One of the most popular ways to collect data is through interviews which is a wonderful strategy that provides individualized data. This way is adopted as well[9].

3.1 Study Population

The stiudy includes contractors in Chitawan as respondents. The sample size for questionnaire was computed using Cochran's Formula based on precision and confidence level for infinite population: n0=z*z*p*q/(e*e) z = value from table (depend upon confidence level= 90The sample size is 68.

3.2 Data Analysis

For this study, respondents are asked to assess, using a two-dimensional scaling, the likelihood that the identified risk factors will occur and their perceived consequences if they do, on a scale of 1 to 5. A low likelihood of occurrence or impact is represented by a score of 1, while a very high likelihood of occurrence or impact is indicated by a score of 5. This provides the measurement scale, which enables the qualitative examination of the gathered data. The likelihood and the effects of the risk factors are two different sorts of variables, as follows:

DESCRIPTOR	EXPLANATION
Rare	Not expected to happen
Unlikely	Small likelihood but could well happen
Possible	Less than 50 – 50 chance
Likely	More than 50 – 50 chance
Almost Certain	Almost certain that it will happen

Figure 3: Likelihood of Risk Events

DESCRIPTOR	EXPLANATION
Insignificant	Negligible effects
Minor	Small/slight effects
Moderate	Moderate/reasonable effects
Major	Serious threat
Catastrophic	Totally unacceptable impact

Figure 4: Consequences of Risk Events

The mean of the scores is derived using the questionnaire replies. The following is the mean index formula:

$$\text{Mean Index} = \frac{\sum a_i x_i}{N}$$

Where,
a_i = constant expressing weight of response (1-5)
x_i = frequency of the responses
N = Total number of responses

The ratings of likelihood and consequences are then assigned using the data to perform a risk matrix analysis. The findings of the matrix analysis will be graded as follows:
1.0-1.5: Rare / Insignificant / Low
1.5-2.5: Medium / Moderate
2.5-3.5: Major / High
3.5-5.0: Extreme / Catastrophic

Rating	Description
Low	manage by routine procedures
Moderate	specify management responsibility
High	needs senior management attention
Extreme	detailed action / plan required

Figure 5: Risk Control Measures

From literature review, for control measures of risk, risks with different levels have different measures.

3.3 Risk Matrix

The Risk Matrix is an illustration of a qualitative approach. It employs a subjective evaluation table of low, moderate, high, and extreme indications to depict the degree of each type of risk that is being given. An indicative level of risk will be provided using a risk analysis matrix to reflect the level of risk in each area[8].

LIKELYHOOD	CONSEQUENCES				
	INSIGNIFICANT 1	MINOR 2	MODERATE 3	MAJOR 4	CATASTROPHIC 5
ALMOST CERTAIN 5	M	H	H	E	E
LIKELY 4	M	M	H	H	E
POSSIBLE 3	L	M	M	H	E
UNLIKELY 2	L	M	M	M	H
RARE 1	L	L	M	M	M

Figure 6: Risk Matrix Table

E – Extreme Risk
H – High Risk
M – Moderate Risk
L - Low Risk

4. Result and Discussion

4.1 Demographic Data

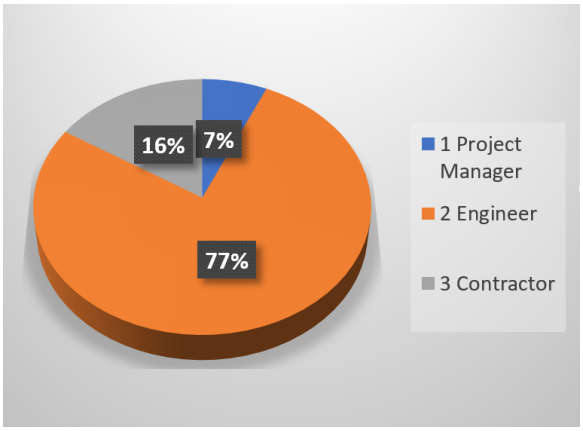

Figure 7: Participants on the basis of works

A total of 7 percentage of the contractors are project manager whereas 16 percentage of the contractors are contractors. However, 77 percentage of contractors are found to be engineers working as contractors.

4.2 Level of Risks

ID	Risk	Likelihood	Consequences	Level
PR01	force *majeure* (acts of God), i.e. inclement weather, fire, landslip,	1.13	5	Moderate
PR02	Pestilence or deadly disease,	1.5	4.88	Moderate
PR03	Disease	2.63	3.3	Moderate
PR04	Injury	2.38	4.38	High
PR05	Unexpected events or unforeseen circumstances, for instance aero plane crashed at the construction site	1.00	4.88	Moderate
PR06	Death	1.63	5	High
PR07	Theft	2.75	4.25	High

Figure 8: Level of Physical Risks

Three of the risks mentioned under this category for physical risks in construction projects have a high level of risk. While each and every form of risk in this

category has rather significant repercussions that could have an impact on the building project, the remainder have a moderate level of risk because there is a lower possibility that it will occur. When a risk is moderate, it needs particular management oversight, however when a risk is high, senior management should be alerted and suggested countermeasures should be taken.

ID	Risks	Likelihood	Consequences	Level
CR01	Ground conditions–inadequate site investigation, inadequate information in documents, unforeseen problems	2.13	4.38	High
CR02	Mistakes while performing work	3.63	3	Moderate
CR03	Poor relationship of professional staff to each other–consultants, architects, subcontractors, etc.	2	4	Moderate
CR04	Delay in possession of site	2.13	4.38	High
CR05	Possible failure of equipment which will affect the productivity of the work	2.5	3.38	Moderate
CR06	Errors or omissions and additions in bills of quantities	2.5	3.88	High
CR07	Inappropriate equipment, poor inventory management, late ordering of materials and components, etc	1.5	3.13	Moderate

Figure 9: Level of Construction Risks

For construction risks in projects, there are many types of risks identified. For the purpose of this study, seven of them have been mentioned. Three categories of dangers have been recognized as having high risks among them. Inadequate site investigation, mistakes or omissions, modifications to the bill of quantities, and a delay in taking control of the site are the three risk kinds with the highest level of risk. High risk levels suggest that senior management's attention is required to monitor these types of risk for control measures since doing so will take a lot of time and money. Because the building stage is a physical stage where cost, time, and quality should be taken into consideration before making any decisions, this will most likely result in delays, disputes, bad product quality, going over budget, and other issues. The remaining risk categories included in this category are thought to have a moderate level of risk, necessitating special management responsibilities.

ID	Risks	Likelihood	Consequences	Level
FR01	Availability of funds	2.38	3.88	High
FR02	Failure of low bidder to enter Construction contract	2	2.38	Moderate
FR03	Cash flow problems due to slow payment & dispute	2.75	4.25	High
FR04	Loss due to default of contractor, supplier, etc.	2.5	3.25	Moderate
FR05	Inflation	3.75	4.38	High
FR06	Exchange rate fluctuation	3.13	3.88	High
FR07	Business disruption	1.5	4.75	High

Figure 10: Level of Financial Risks

There are seven different categories of dangers in the financial realm. Five of these risk categories have a high degree of risk, while the remaining four have a moderate level.

ID	Risks	Likelihood	Consequences	Level
DR01	Incomplete and poorly defined design scope	2	3.88	Moderate
DR02	Unavailability of information and incomplete design information	2.38	3.63	Moderate
DR03	Design errors and frequent changes resulting in variations	3.38	4	High
DR04	The risk of late confirmation and approval of design	2	3.75	Moderate
DR05	Appropriateness of specification	1.75	4	Moderate
DR06	Interaction of design and constructability	2	3.88	Moderate
DR07	Quality control exercised–inspection & late confirmation & approvals	2.13	3.13	Moderate

Figure 11: Level of Design Risks

The design risk associated with building construction projects is broken down into a total of seven different kinds in this study. Only one of them is regarded as having a high degree of danger, while the rest all have a moderate level. When a risk is moderate, it needs particular management oversight, however when a risk is high, senior management should be alerted and suggested countermeasures should be taken.

ID	Risks	Likelihood	Consequences	Level
PoR1	Changes in law	1.38	3.63	Moderate
PoR2	War, revolution, civil disorder	1	5	Moderate
PoR3	Constraints on the availability of Labor	1.75	3.75	Moderate
PoR4	Customs and export restrictions & Procedures	1.75	3.25	Moderate
PoR5	Requirement to use local labor or Management	1.63	2.25	Moderate
PoR6	Requirements on hiring foreign Workers	1.13	2.63	Moderate

Figure 12: Level of Political Risks

Political hazards of all stripes are seen as carrying a moderate level of risk. The possibility of the dangers falling under this category occurring is fairly low, despite the fact that some of them have significant magnitude repercussions, hence they are regarded as having a moderate level of risk. Because this sort of risk is moderate, particular management responsibilities are required to manage it.

ID	Risks	Likelihood	Consequences	Level
LR1	Direct liability	3.38	3.63	High
LR2	Liability to others	3.25	3.63	High
LR3	Local law and codes	2.13	3	Moderate
LR4	Legal differences between countries of client, contractors, consultants suppliers, etc.	2	2.88	Moderate
LR5	Conditions of contract i.e. Maintenance Changes to 'expected risks' etc.	2.25	3.25	Moderate

Figure 13: Level of Legal Risks

Legal risks include five types of risks. Among them, a couple of risks are recognized as having high level of risk.

ID	Risks	Likelihood	Consequences	Level
ER1	Ecological damage	2.63	4	High
ER2	Pollution	2.25	3.25	Moderate
ER3	Waste treatment	2.13	3.25	Moderate
ER4	Public enquiry	2.38	2.25	Moderate
ER5	Regulations and possible changes	1.63	2.75	Moderate
ER 6	Recording and preserving historical finds	1.63	1.88	Low
ER 7	Minority interests	2.25	2.5	Moderate

Figure 14: Level of Environmental Risks

One of the dangers has a high risk rating. Other dangers are regarded as being of moderate concern. One form of danger, namely the risk associated with recording and conserving discoveries, is considered to be low risk. Among all risks across all categories, only this risk is regarded as being low risk. High levels of risk suggest that senior management's attention is required to monitor these forms of risk for control measurement since doing so will take a lot of time and money. Because this sort of risk is moderate, particular management responsibilities are required to manage it.

4.3 Measures to be taken so as to manage risks in Building Construction Projects

The measures that need to be taken by contractors to manage risks are:

- Application of risk management
- Application of risk management strategies
- Development of contingency plan
- Ensuring adequacy of project funding

5. Conclusion

Various risks exist in building construction projects with some serious threats. The majority of respondents indicated that financial risks were more vulnerable in projects involving the construction of buildings, hence they need more attention. Following the financial risks; construction risks, physical risks and design risks are also considered fairly vulnerable as well. To mitigate or control high rated risks, senior management attention is needed. The study is limited to Chitawan only and only respondents of this region are chosen.

5.1 Limitations

Potential research constraints include the following:

- Only building constructions are considered.
- Respondents are limited to a small boundary

5.2 Recommendations for further study

- Study on 'Managing construction risks in building construction projects for other stakeholders such as consultants, employers, etc can be done.
- Detailed study on financial risks can be done.

6. Acknowledgements

The authors are thankful to Assistant Professor Mahendra Raj Dhital for his invaluable assistance in getting this research done in the allotted period.

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