RISK ASSESSMENT AT PUBLIC SECTOR CONSTRUCTION PROJECTS IN BNGLADESH: A CASE STUDY

By

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A thesis submitted to the BIGD in partial fulfillment of the requirements for Degree of

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Declaration

It is hereby declared that The Dissertation submitted is my/our own original work while completing degree at Brac University. The Dissertation does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing. The Dissertation does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution. I have acknowledged all main sources of help.

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Approval

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ABSTRACT

The identification of risk, assessing risk and its proper management is a matter of great concern in risk management of a construction project. Unavailability of risk management or improper management of risk in a project may experience a enormous amount of loss in terms of monetary value. Considering these factors attention to pay to the necessity of risk management, the study has been carried out in the construction projects in Bangladesh especially at Dhaka city. The study is conducted on the basis of global PMI guidelines. For that I took help from PMBOK. The selections of the construction projects are mainly Public projects done by purposive sampling. The main concentration was paid to the identification of different types of risk and rating the various risks arises in a project and assessing major risk factors. Besides, this research developed a risk management framework for proper management of public construction projects and made some recommendation for the construction companies. For the purpose of this study, a questionnaire survey has been conducted and analyzed extensively. Finally study revealed that increase in material cost, increase of labor rate, loss due to corruption & bribery, loss due to political changes, project delay, and short time of tendering, lack of experience, loss due to fluctuation of construction materials, poor communication between stakeholders etc. as the top most risk factors.

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I would like to dedicate this thesis to my parents for their struggle to bring me in this stage. Last but not the least, I concede the hazards and trouble taken by my family memebers especially my dearly loved wife **Mrs. Yeasmin Ema** and my daughter **Zaemah Amanee Yasna.**

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Infrastructure development is an important factor in our economy and its impact is huge in monetary value. Infrastructure development has huge financial involvement and that is why it creates a considerable amount of risk in a project. A construction project has diverse works and lots of stakeholder involvement Due to the multiplicity of works and organizations involved in construction project, the clients are ran into frequent risk to complete the project successfully. Construction personnel have to pay more time & attention to address risk because it has huge impact on cost & time overruns and quality of the project (Akintola & Malcolm, 1997). Risk can be measured as both negative and positive aspect (David, 2002). Response to a risk in according to risk management plan may reduce the impact. The term Project Risk Management includes the processes of conducting risk management planning, identification, analysis, response planning, response implementation, and monitoring risk on a project. The objectives of project risk management are to enhance the probability and/or impact of positive risks and to decrease the probability and/or impact of negative risks, in order to optimize the chances of project success (PMBOK, 2017). The identification of the relevant and potential risks associated with the construction project should be done properly as the risk analysis and management are performed to that identify potential risk. In addition, risk analysis and evaluation is the transitional process between risk identification and management. Once the risks of a project have been identified and analyzed, an appropriate response strategy should be adopted. Within a framework of risk management, one has to decide how to address each risk and invent suitable risk treatment strategies or mitigation measures. The process of risk management should not aim to remove completely all risks from a project as practically it is quite impossible. Its objective is to develop an organized framework to support decision makers to manage the risks effectively and efficiently. There are many researches have been studied worldwide to assess and manage the project risk. The risk

linked with a project largely depends on its type, size, complexity, location, and involvement of parties, number of concurrent activities, type of contract, administrative systems and skilled etc. That is why risks are not identical and universal globally. As there is no exclusive research found in Bangladesh (BD), it was very significant to conduct study in this field. Besides, we are observing numerous problems and facing various risks to finish the project within due time and cost. For that reason objective of the study were to the study objectives were to identify the risk associated with BD construction projects, ranking of risk on the basis of their probability of occurrence and impact, and suggest appropriate response strategy depending on the outcomes of questionnaire survey.

1.2 STRUCTURE OF THE THESIS

The structure of the thesis is as follows-

The first chapter furnishes introduction of the study. The second chapter presents the detail concepts of risk management. The third chapter presents the objective of this investigation. Literature review is in the chapter four. Research methodology is given in the chapter five. The results of survey are in chapter six. Chapter seven presents the conclusion and recommendation drawn from this investigation and suggestions for future work. Finally the references are given at the end.

CHAPTER 2

CONCEPTS OF RISK ANALYSIS AND MANAGEMENT

2.1 RISK CONCEPTS

Risk is intrinsic and complex to deal with, and this requires a proper management framework both of theoretical and practical meanings. Risk management is a process of systematically identifying, analysing, and managing to risks throughout the life-cycle of a project. By adopting appropriate process of risk management one can achieve improvement to construction project management performance.

Exposure to risk is varying from organization to organization. These exposures may be the risk of business failure, the risk of financial losses, the occurrences of major accidents at construction site, default of business associates and dispute and organization risks. It is desirable to understand and identify the risks as early as possible, so that appropriate strategy can be adopted to retain particular risks or to transfer them to minimize any negative aspect they may have. Fig 2.1 depicts the hierarchical risk involved in a project.

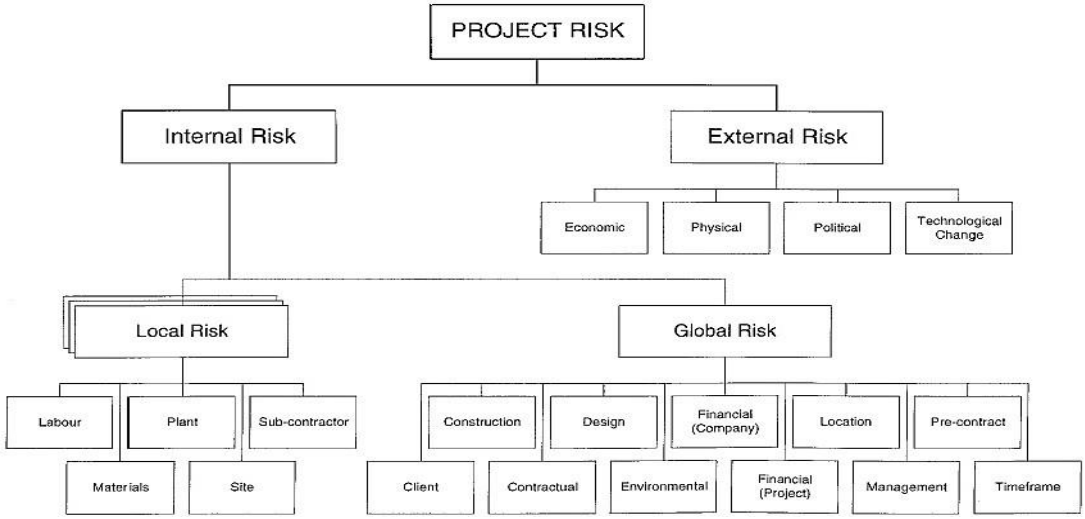

Figure 2.1 Hierarchical risks involved in a project (Deviprasadh A, 2007)

The risk management process includes identification of the potential risks associated with the construction project. The identification process is important as the process of risk analysis & risk response process depends on the identified risk. There are two ways to analyze the

identified risk i.e qualitative analysis & quantitative analysis. The assessment should generally focus on risks with high probabilities, high financial consequences or combinations there of which yield a considerable financial impact. After identifying and analysing the identified risk, an appropriate method of managing risk must be adopted. Within a framework of risk management, one should decide how to treat each risk and plan suitable risk treatment strategies or mitigation measures. Mitigation measures are based on the nature and potential consequences of the risk. The main objective is to minimize potential adverse impact and to enhance to occur positive impact. The measure is effective when control is more. The aim of the risk management process does not to remove completely all risks from a project. Its objective is to manage risks especially the critical ones effectively and efficiently within a organized framework.

2.2 PROJECT RISK MANAGEMENT

Risk management in a project is to identify the influencing factors that impact a project's cost, schedule or quality baselines negatively; quantifying the impact of identified risk and implement measure to manage or mitigate the potential impact. If the decision is not made properly then the consequences of the riskier activity is more accordingly. Businesses have to quantify risk for many reasons. Knowing the intensity of the risk one has to decide whether measure will take to mitigate or eliminate or accept the risk as for every measure cost involvement is associated here. It can also help to decide if sharing of the risk with an insurance company is justified or not. Risks, such as natural disasters, force measure are practically inevitable and have an effect on many people. Risks cannot be totally eliminated, but the choice can be made so that risk is minimized.

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

Graphical representation of risk ratings can be made by plotting graph between probability and seriousness, Figure 2.2 explains this.

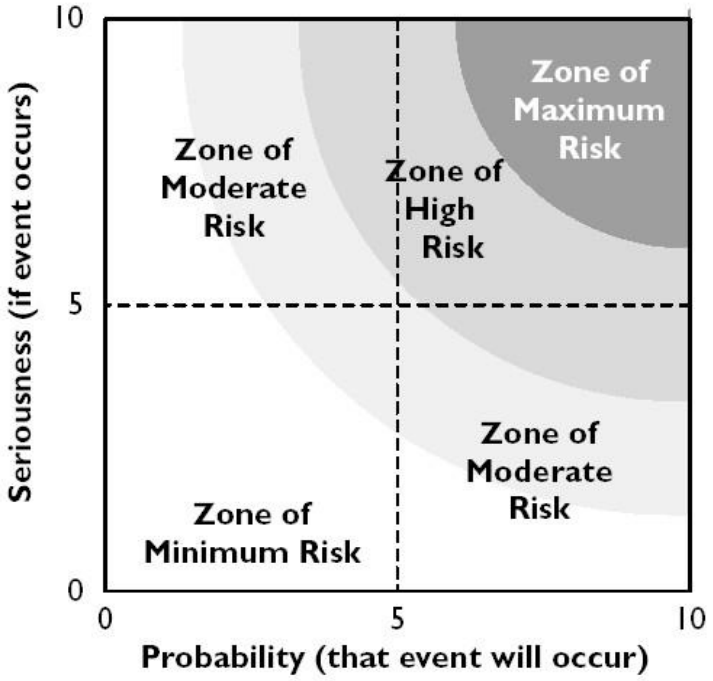

Figure 2.2 Graphical representations of risk rating (Deviprasadh A, 2007)

2.3 RISK ASSESSMENT

In this study Risk assessment is defined as a technique that aims to identify and estimate risks to workers and belongings impacted upon by a project. Conventional risk assessment for construction has been identical with probabilistic analysis. Such approaches need proceedings to be equally exclusive, exhaustive, and with reservations independent. However, construction involves many variables, and it is often difficult to determine causality, dependence and correlations. As a result, qualitative methods that depend on past information and the experiences of individuals and companies have been used to measure the impact of construction risk and ambiguity.

2.4 DETERMINATION OF RISK

The Quantitative and the Qualitative approach is mainly the two major. The quantitative approach depends on statistical calculation to determine risk, its probability of occurrence, and its impact on a project. Examples of the quantitative approach are decision tree analysis,

sensitivity analysis. Another approach is the Monte Carlo simulation, which generates a value from a probability distribution and other factors.

The qualitative approach depends on judgments, using criteria to determine outcome. A common qualitative approach is a precedence diagramming method, which uses ordinal numbers to determine priorities and outcomes.

2.5 RISK EXPOSURE

Factors that can expose projects to higher than normal risk.

• Size of the team - The larger the team, the higher the probability of a problem creating. For example, difficulty in communications increases as the increase of the number of participants.

• History – New Project is always riskier as the process of that project has to define uniquely. The likelihood of the success of new projects depends on the similarity of nature of the projects.

• Staff expertise and experience – lack of staff's experience and knowledge of the subject, people will struggle to learn as they go along, robbing the project of time and possibly introducing errors.

• Complexity - The more the complexity of a project, has greater the opportunity of a mistake or problem.

• Management strength - Management strength implies unity of direction, which in turn means reaching goals. Management tetchiness can lead to impractical scheduling and inefficient use of resources.

• Time compression – more the compression higher the risk.

• Availability of resource - Availability of he more resources has the greater ability to respond any problems when they arise.

2.6 GENERAL TYPES OF RISKS

By studying various research paper, academic book, journal etc. related to project and construction management I identify various types of risk associated with the construction management. These types of risk are listed below-

- Delivery/operation risk
- Technology risk
- Financial risk
- Procurement-contractual risk
- Political risk
- Environmental risk
- Social risk
- Economic risk
- Reserves risk - an operations risk factor
- Credit risk - a financial risk factor
- Engineering risk- a technology risk factor
- Materials risks - a procurement risk factor
- Weather risks - an environmental risk factor
- Insurance risks - an economic risk factor
- People risks - a social risk factor
- Interface risks - a delivery risk factor
- Underground risks - a technology risk factor
- Joint venture risks - a financial risk factor

- Design-build risks - a procurement/contractual risk factor
- Security risks - a political risk factor
- "Green" risks - an environmental risk factor:
- Right of way risks - a social risk factor
- Payment risks - an economic risk factor

2.7 SOURCES OF RISK IN CONSTRUCTION PROJECTS

As a practitioner, through my practical knowledge and surveying various book and research paper i observed that risks that prevail in construction projects have some sorts of source. Below I was trying to listed major few sources of risk.

• Scope- It is always a source of risk. Whether project covers the entire requirement, is there any probability of design changes or errors etc are the source of risk in this category. Misunderstanding of contract terms and conditions.

• Schedule- Poorly estimates task duration i.e project duration, schedule overrun are the source of risk in this category.

• Cost - Poor or flaw estimates, cost overrun are the source of risk in this category.

• Resource- Poorly defined roles and responsibilities, unskilled staff is the source of risk in this category.

• Quality- The deliverable can be of poor quality due to some other imposed factors, making it a huge risk.

• Procurement-. Misunderstanding of contract terms and conditions is the major source of risk in this category.

Besides these Natural Hazards, political and legal problems, poor communication between the stakeholders are also the source of risks in construction industry.

2.8 OVERVIEW OF RISK MANAGEMENT

According to PMBOK(PMI) Project Risk Management comprises the processes of identifying, analyzing, and responding to project risk. It concerns with the maximizing positive events and minimizing the adverse events. Figure 2.3 depicts an overview of the following major processes:

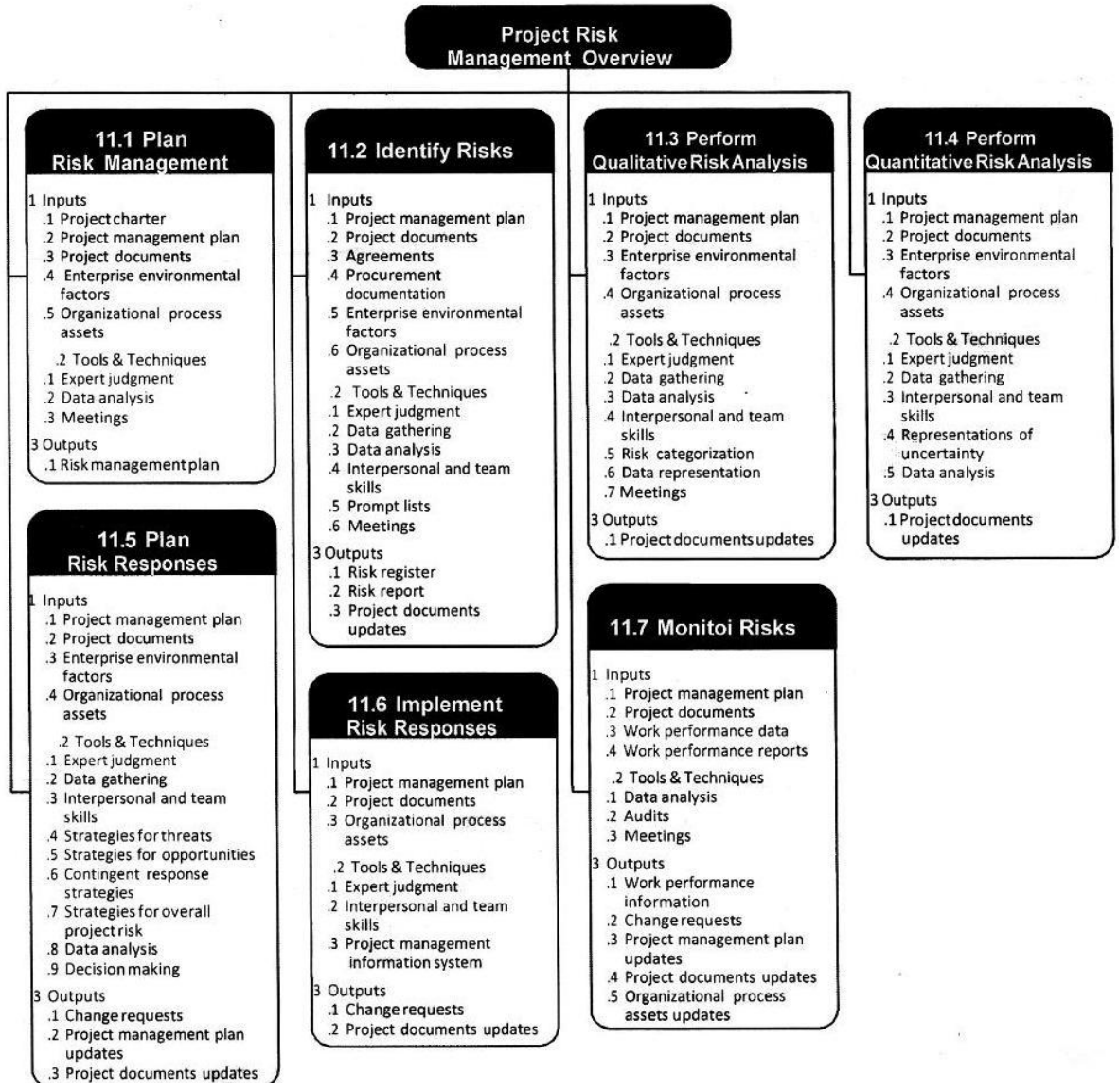

Figure 2.3 an overview of the major processes (PMBOK, 2017)

2.8.1 The Project Risk Management processes

1. Plan Risk Management—The process for defining how to carry out risk management activities for a project.

2. Identify Risks—The process of identifying project risks as well as sources of project risk, and documenting their characteristics.

3.Perform Qualitative Risk Analysis—The process of prioritizing individual project risks for further analysis or action by assessing their probability of occurrence and impact as well as other characteristics.

4. Perform Quantitative Risk Analysis—The process of numerically analyzing the combined effect of identified individual project risks and other sources of uncertainty on overall project objectives.

5. Plan Risk Responses—The process of developing options, selecting strategies, and actions to address overall project risk exposure, as well as to treat individual project risks.

6. Implement Risk Responses—The process of implementing agreed-upon risk response plans.

7. Monitor Risks—The process of monitoring the implementation of agreed-upon risk response plans, tracking identified risks, identifying and analyzing new risks, and evaluating risk process effectiveness throughout the project.

Figure 2.3 provides an overview of the Project Risk Management processes. The Project Management Risk processes are presented as discrete processes with defined interfaces while, in practice, they overlap and interact in ways that cannot be completely detailed in this PMBOK® Guide.

Every process in this process group is output focused. For this there need some input and to formulate this input few tools and technique should be applied. Here below I try to brief few common and important tools & technique below-

2.8.2 Tools & Technique

2.8.2.1 Expert Judgment

Expertise should be considered from individuals or groups with specialized knowledge of similar projects or business areas. Such experts should be identified by the project manager and invited to consider all aspects of individual project risks as well as sources of overall project risk, based on their previous experience and areas of expertise. The experts' unfairness should be taken into account in this process.

2.8.2.2 Data Gathering

-Brainstorming. The goal of brainstorming is to obtain a inclusive list of individual project risks and sources of overall project risk.

- Checklists. A checklist is a list of items, actions, or points to be considered. It is often used as a reminder. Risk checklists based on past information and knowledge that has been accumulated from similar projects and from other sources of information.

- Interviews. Individual project risks and sources of overall project risk can be recognized by interviewing experienced project participants, stakeholders, and subject matter experts. Interviews should be conducted in an environment of trust and discretion to encourage honest and impartial assistance.

2.8.2.3 Data Analysis

-Root cause analysis.

Root cause analysis is naturally used to find out the underlying causes that lead to a problem, and develop preventive action.

-Assumption and constraint analysis.

Every project and its project management plan are developed based on assumptions and constraints. These are often already integrated in the scope baseline and project estimates.

-SWOT analysis.

This technique assesses the project from each of the strengths, weaknesses, opportunities,

and threats (SWOT) perspectives.

- Document analysis.

Risks may be recognized from a planned reassess of project documents, including, but not limited to, plans, assumptions, constraints, previous project files, contracts, agreements, and technical documentation.

- Risk data quality assessment.

Risk data quality assessment evaluates the degree to which the data about individual project risks is accurate and reliable as a basis for qualitative risk analysis. The use of low-quality risk data may lead to a qualitative risk analysis that is of little use to the project. If data quality is unacceptable, it may be necessary to gather better data. Risk data quality may be assessed via a questionnaire measuring the project's stakeholder perceptions of various characteristics, which may include completeness, objectivity, relevancy, and timeliness. A weighted average of selected data quality characteristics can then be generated to give an overall quality score.

-Risk probability and impact assessment.

Risk probability assessment considers the likelihood that a specific risk will occur. Risk impact assessment considers the potential effect on one or more project objectives such as schedule, cost, quality, or performance. Impacts will be negative for threats and positive for opportunities.

- Assessment of other risk parameters.

The project team may consider other characteristics of risk (in addition to probability and impact) when prioritizing individual project risks for further analysis and action. These characteristics may include but are not limited to: Urgency, Proximity Dormancy. Manageability. Controllability. Detect ability, Connectivity. Strategic impact. Propinquity.

- Monte Carlo cost risk analysis

Simulations are typically performed using a Monte Carlo analysis. When running a Monte Carlo analysis for cost risk, the simulation uses the project cost estimates. When running a Monte Carlo analysis for schedule risk, the schedule network diagram and duration estimates are used. An integrated quantitative cost-schedule risk analysis uses both inputs. The output

is a quantitative risk analysis model.

Computer software is used to iterate the quantitative risk analysis model several thousand times. The input values (e.g., cost estimates, duration estimates, or occurrence of probabilistic branches) are chosen at random for each iteration. Outputs represent the range of possible outcomes for the project (e.g., project end date, project cost at completion). Typical outputs include a histogram presenting the number of iterations where a particular outcome resulted from the simulation, or a cumulative probability distribution (S-curve) representing the probability of achieving any particular outcome or less. An example S-curve from a Monte Carlo cost risk analysis is shown in Figure 2.8

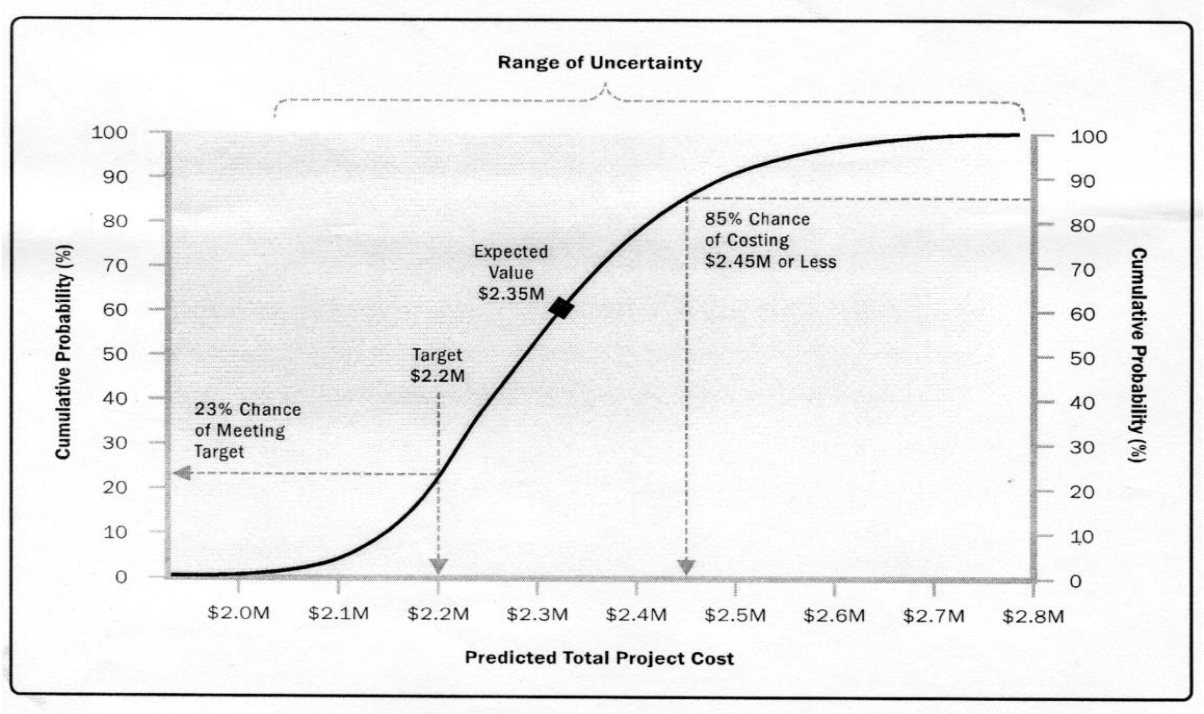

Fig. 2.4 S-Curve(PMBOK, 2017)

-Sensitivity analysis.

Sensitivity analysis helps to determine which individual project risks or other sources of uncertainty have the most potential impact on project outcomes. It correlates variations in project outcomes with variations in elements of the quantitative risk analysis model. One typical display of sensitivity analysis is the tornado diagram, which presents the calculated correlation coefficient for each element of the quantitative risk analysis model that can

influence the project outcome.. An **example tornado diagram is shown in Figure 2.9**

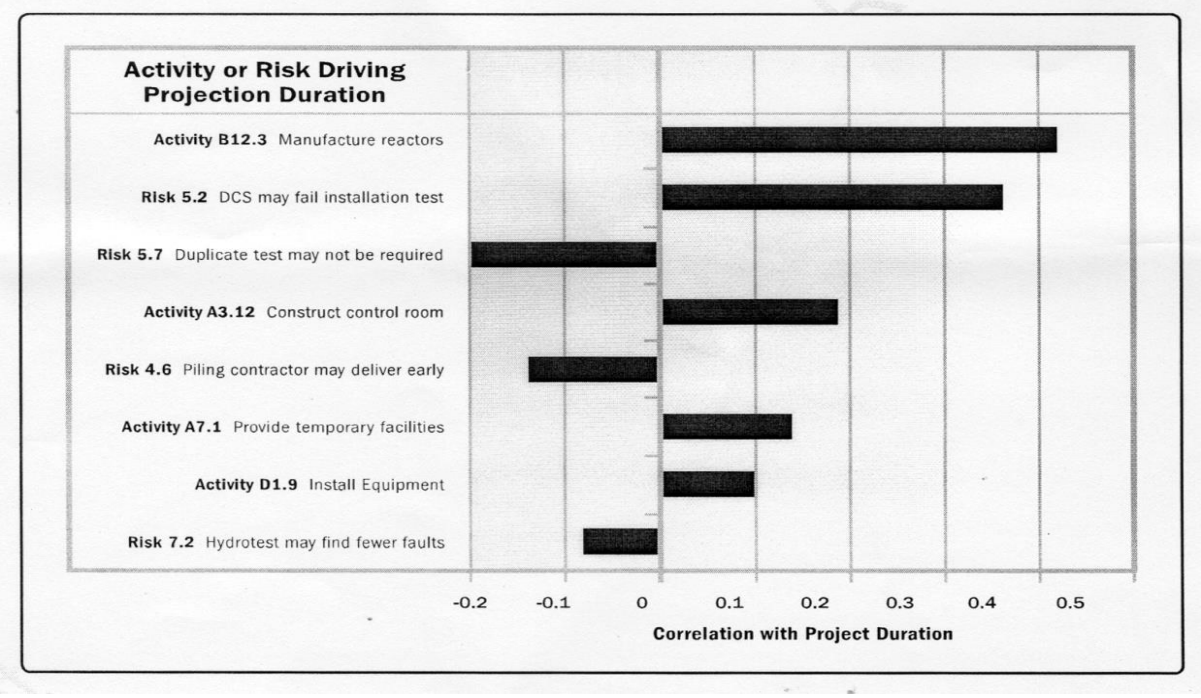

Figure 2.5 tornado diagram(PMBOK, 2017)

-Decision tree analysis.

It is used to support selection of the best of numerous alternative courses of action. Branches of decision tree representing different decisions or events, each of which can have associated costs and related individual project risks (including both threats and opportunities). The end-points of branches represent the outcome from following that particular path, which can be negative or positive. The decision tree is evaluated by calculating the expected monetary value of each branch, allowing the optimal path to be selected. An example decision tree is shown in Figure 2.10

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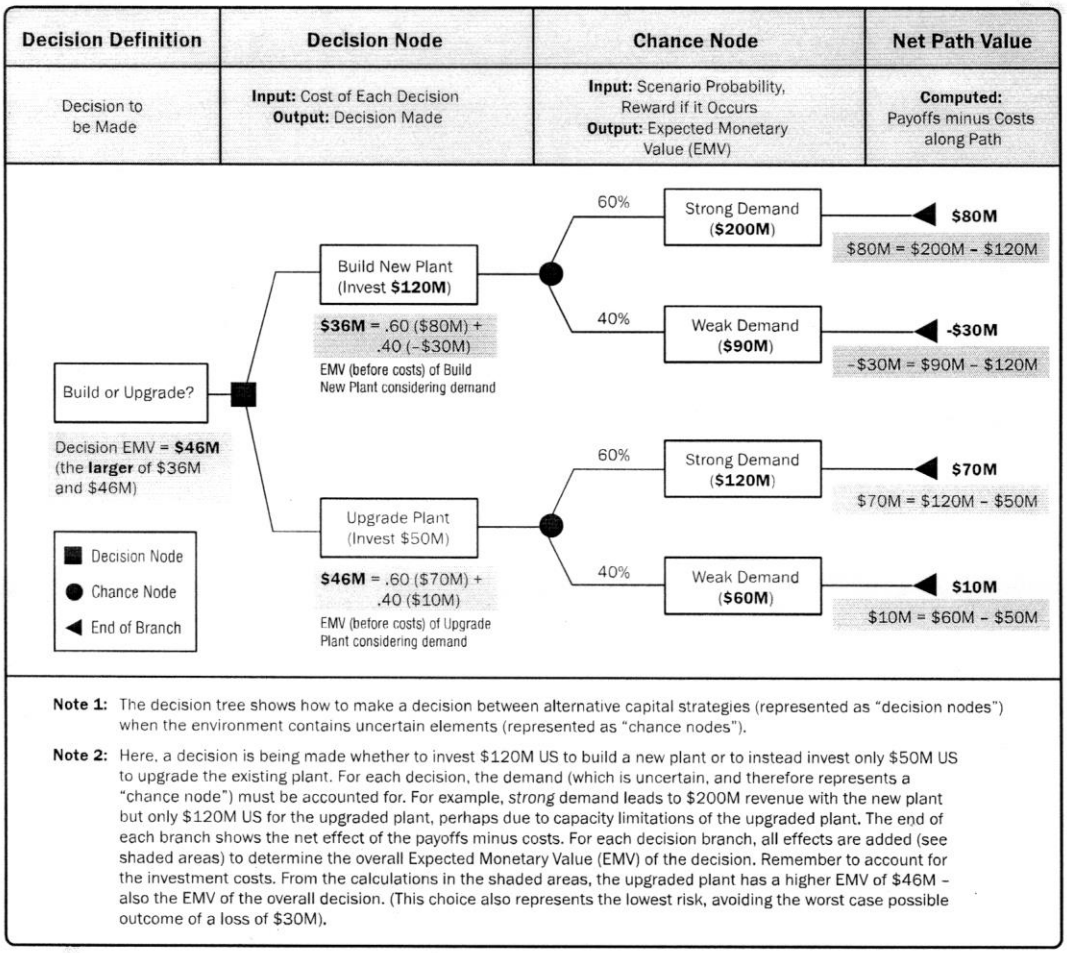

Note 1: The decision tree shows how to make a decision between alternative capital strategies (represented as "decision nodes") when the environment contains uncertain elements (represented as "chance nodes").

Note 2: Here, a decision is being made whether to invest $120M US to build a new plant or to instead invest only $50M US to upgrade the existing plant. For each decision, the demand (which is uncertain, and therefore represents a "chance node") must be accounted for. For example, *strong* demand leads to $200M revenue with the new plant but only $120M US for the upgraded plant, perhaps due to capacity limitations of the upgraded plant. The end of each branch shows the net effect of the payoffs minus costs. For each decision branch, all effects are added (see shaded areas) to determine the overall Expected Monetary Value (EMV) of the decision. Remember to account for the investment costs. From the calculations in the shaded areas, the upgraded plant has a higher EMV of $46M – also the EMV of the overall decision. (This choice also represents the lowest risk, avoiding the worst case possible outcome of a loss of $30M).

Figure 2.10 Decision Tree (PMBOK, 2017)

-**Influence diagrams.** Influence diagrams are graphical aids to decision making under uncertainty. An influence diagram represents a project or situation within the project as a set of entities, outcomes, and influences, together with the relationships and effects between them.

2.8.2.4 Strategies for Threats

- Escalate

-Avoid

- Transfer.

- Mitigate.

- Accept

2.8.2.5 Strategies for Opportunity

- Escalate.
- Exploit.
- Share.
- Enhance.
- Accept.

2.8.2.6 Strategies for overall project risk

-Avoid.

-Exploit.

-Transfer/share.

-Mitigate/enhance.

-Accept.

2.9 ADVANTAGES OF RISK MANAGEMENT

Risk management process is considered as an important Process in the real life project management. Nowadays many organizations have a propensity to realize the advantages of risk management. By conducting brainstorming to the concerned personnel of the such organization following are few benefits of risk management in projects are listed below

- Benefits of risk identification- As there is a repository of identified risk it fosters the vigilance in times of discipline and calm at the times of crisis.
- Treatment of Risks – It helps in treating one's own risks that are the subset of implementing a plan.
- Successful business strategies- As there is a repository of risks one can easily explore plan for mitigate the negative risk which leads to implement successful business strategies.
- Reduction of capital cost and saving time- it will be easy to Pre measure at identified risk which will subsequently reduce the time for further risk identification and cost for unknown-unknown reserve.

- Less Uncertainty- It dictates the clear possibilities of risk that are managed within the severity or impact of the organization that are updated to own risk strategies. It has insight of real balance sheets that supports the culture of risk management.

Besides these, risk management helps to achieve the objective of the projects, lessen uncertainty of the projects, create value, create new opportunity, harvesting knowledge, create stakeholders reliability.

2.10 LIMITATIONS OF RISK MANAGEMENT

If risks are inappropriately assessed and prioritized, time can be wasted in dealing with risk of losses that are not likely to occur. Spending too much time assessing and managing unlikely risks can redirect resources that could be used more profitably. Implausible events do occur, but if the risk is implausible enough to occur, it may be better to simply keep the risk, and deal with the result if the loss does in fact take place.

CHAPTER 3

OBJECTIVE OF THE STUDY

3.1 PURPOSE & SCOPE OF STUDY

Infrastructure development is one of the key activities to enhance business of many industries which subsequently increase the nation gross development (GDP). In Bangladesh weight on development budget i.e infrastructure development is increasing day by day. Such infrastructure development or projects consume lot of money. These small to mega projects experiences lots of problems from land acquisition, wastage, unforeseen delay natural disaster etc. lead to time and cost overrun in the projects. The cost overrun has the huge magnitude in projects at monetary value. Hence to reduce the losses a comprehensive management of construction is required. Application of different management techniques thus have to make from inception to completion of the project which includes managing the various risks associated with the project in its every stage. Risk Management can be viewed as an integral part of project management, as shown in the Figure 3.1.

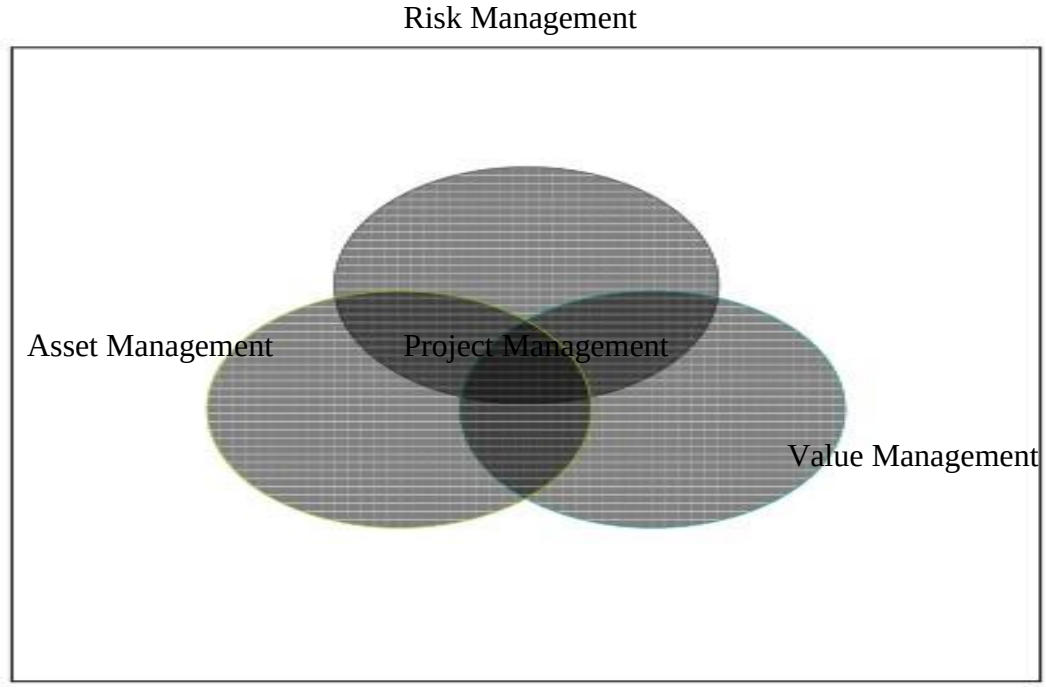

Fig 3.1 Risk Management as an Integral Element of Project Management (Deviprasadh A, 2007)

In my paper the scope of Risk Assessment and Mitigation is limited to the construction of large building projects like Residential Tower, Multiplexes, Malls, Large residential townships, Academic & Administrative buildings etc.

3.2 OBJECTIVE

Most of the construction industry is inundated by risk. Many of the time these risk are not dealt with satisfactory and thus industry suffers poor performance. Infrastructure projects are huge in nature and involve a large amount of money. Shortage in either time, resources (men, materials, method, money & machines) would lead to loss in huge monetary value. The losses occur due to various risk allied with such projects. Such risks should be identified and response in plan wise to minimize losses. The cycle of identification, assessment, response and monitoring the risk in a plan process is called risk management. Mostly on developed countries research on risk management has been done by various scholars. In Bangladesh research on risk management is rear to watch. That is why this study focuses risk management in Bangladesh in the field of construction. Main objectives of this thesis are-

1. To identify the risks associated with the construction industry.

2. To rank the identified risks so that I becomes easy to assess risk impact and its intensity.

3. To suggest the appropriate response strategy.

CHAPTER 4

LITERATURE REVIEW

4.1 LITERATURE REVIEW

A wide-ranging review of international project risk assessment and management was conducted during the initial phase of the research effort. Previous research recommends that construction activity is mainly subject to more risks than other business activities because of its complexity in nature; a construction project usually requires a large number of people with diverse skills and interests and the synchronization of a wide range of distinct, yet interrelated, activities. Such complexity is further amalgamating by the unique features of a project and many other external uncertainties. And also, in general, there is an non-existence of literature that has focused on the practices, results or development of risk assessment and management techniques for Bangladesh construction projects.

4.2 PAST RESEARCH WORK ON RISK ASSESSMENT AND MANAGEMENT

In Bangladesh Analytic Hierarchy Process (AHP) was introduced by Mohammad & Jamal (1991) as an approach for assessing risk at initial stage of project instead of traditional methods. They conducted the research of using AHP to calculate the risk of a Jamuna bridge construction project in Bangladesh and concluded the project as low risk one. Besides, research found AHP is a useful method of Project manager or Subject matter experts for the project manager to make conclusion for bid appraisal, selection of equipment and staff, business performance and challenge etc. However **Roozbeh kangari (1995) emphasized on the contract management. In this regards he** examined the thoughts of large U.S construction firms toward risk and determined how the contractors carry out construction risk management through a survey of the top 100 contractors. The study demonstrated that in the recent years contractors are intending to guess risks that go together with contractual and

legal problem in the form of risk sharing with the owner. The survey also revealed that contactors assume the risk associated with actual quantities toward the practice of protective engineering is determined. On the other hand **Shen L Y (1997)** identified the risk associated with the project time boundary and the effective response for managing these risks. Practitioners' risk management planning and their success have been investigated through a questionnaire survey. It identified that subjective judgement and practitioners' lesson learned are the most effective and significant risk management actions. The methods used for quantitative analysis have been rarely used due to limited knowledge about it. The findings also advocate a need to uphold the application and consciousness of a range of analytical techniques for risk management in a proper context in the Hong Kong construction industry. In **1999 Shou Qing Wang** carried out an international survey on risk management of BOT projects in China. The overall objectives of the survey are (1) to recognize the exclusive or significant risks associated with China's BOT projects; (2) to assess the effectiveness of course for mitigating these risks; (3) to look at the key contract clauses used in Laibin B's concession agreement; and (4) to present a risk management outline for investing in future BOT projects in China. The study explained the sufficiency of key contract clauses in Laibin B's concession agreement connected to the political and force majeure risks in China, from the perspective of foreign developers, lawyers, and lenders. The contract clauses explained include changes in law, corruption, delay in approval, expropriation, and force majeure. Resonance with above survey **Makarand Hastak and Aury Shake (2000)** established a risk assessment model for international construction projects named ICRAM-1. The paper argues some of the existing models for country risk assessment, presents prospective risk indicators at the macro, market, and project levels, and explains the ICRAM-1 methodology through an applied example. Four most important results are gained from the ICRAM-1 analysis: (1) High-risk indicators; (2) Environmental impact on a specific project; (3) Market value impact on a specific project; and (4) Total project risk. Besides these there were more research conducted which highlighted different risk. For example **Shen et al (2001),** according to their survey, formed a risk significance index to show the relative significance among the risks associated with the joint ventures in the Chinese construction procurement practice. Real cases were inspected to show the risk environment faced by joint ventures and **Tarek M. Zayed (2002)** established a BOT risk prototype evaluation model that

provides a rational, dependable, and steady procedure for assessing the BOT project risk. The proposed model set up the BOT risk index (F), which depends on the actual performance of eight main BOT risk areas. Two different approaches were used in constructing this index: a new developed and an modified Dias and Ioannou model. Considering risk perception analysis to assess the risk criticality, risk management capability, risk allocation/sharing preference, and factors influencing risk acceptance of major stakeholders **Thomas et al (2003)** of IIT Madras, surveyed various stakeholders associated with project participants.. Eight types of risks have been recognized as very critical in the Indian road sector under BOT set up with traffic revenue risk being the most critical. The study exposed that the factors and their relative influence on the risk acceptance of stakeholders are different. To identify the risk on Chinese construction procurement practice **Shen et al (2003) always** recognized the risks associated with the joint ventures. He also investigated applications of risk management in joint ventures. To support in the determination of the lower and upper activity duration values for schedule risk analysis **Daud Nasir et al (2003)** introduced program evaluation and review technique analysis or Monte Carlo simulation. Probabilities for various combinations of parents for each risk variable were acquired through an expert interview survey and included into the model. Finally, sensitivity analysis was performed that was tested using 17 case studies. For ranking the risk according to their criticality **Shou Qing et.al (2004)** recognized there are twenty-eight critical risks linked with donor funded construction projects in developing countries and considered them into three hierarchy levels (Country, Market and Project), of which 22 were appraised as Critical or Very Much Critical by a 7-degree rating system. The top ranking 11 critical risks are: Approval and Permit, Change in Law, Justice Reinforcement, Local Partner's Creditworthiness, Political volatility, project cost overrun, Corruption, Inflation and Interest Rates, Government Policies, Government Influence on Disputes and Termination of JV. The risks at Country level are more significant than that at Market level and the latter are more significant than that in Project level. For all identified risks, measures were provided and evaluated.

CHAPTER 5

METHODOLOGY

5.1 METHODOLOGY

The methodology adopted in this study is given below:

- Reviewed related journal articles, literature to identify the risk factor for preparation of Questionnaire.
- Major construction site visit
- Questionnaire survey and interviews with project manager/ engineer.
- Data collection from site.
- Analysis of survey result qualitatively.
- Analysis of survey result quantitatively
- Suggestion for remedial measure.
- Conclusions, recommendations and suggestions for future study

5.2 METHOD OF SURVEYING

The common methodology of this study depends largely on the survey questionnaire that is collected from the local building contractors of different sizes by personnel meeting. A comprehensive literature review was primarily carried out to identify the risk factors that affect the performance of construction industry as a whole. This study has adopted the more general and broad definition of risk as presented by Shen et al (2001) on China's construction joint ventures and more risk factors from other literature. Also some interviews with construction practitioners were conducted to create to check effectiveness of questionnaires.

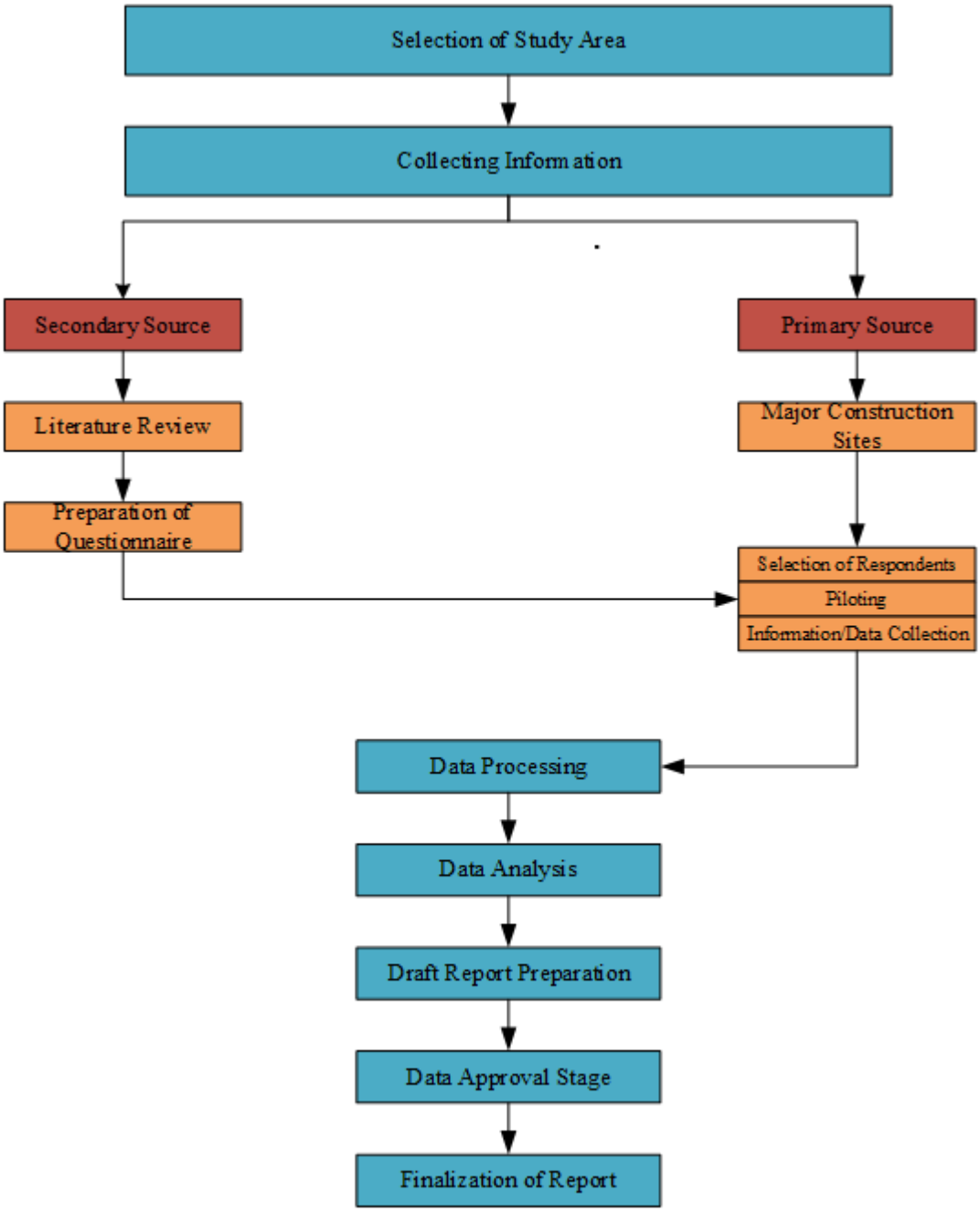

Fig 5.1: Flow Chart of Study Design

5.3 QUESTIONNAIRE STRUCTURE

The close end structured interview questionnaire is presented in Appendix A. The questionnaire was experienced with a pilot survey for clarity, ease of use, and value of the information that could be gathered. The questionnaire survey is divided into three

parts. The first part consists of quantitative survey, the second part consists of qualitative survey and the third part consists of general information like participant name, name of Company, value of their project e.t.c. and the third part consists of the construction risk factors for evaluation.

Risk factors for this thesis are classified into seven categories, namely:

1. Financial risk
2. Legal risk
3. Management risk
4. Political risk
5. Technical risk
6. Environmental risk
7. Social Risk

5.4 QUESTIONNAIRE DESIGN

The survey questionnaire is planned to probe the cross-sectional behavioural pattern of construction risks construction industry. The questionnaire was prepared by studying the relevant literatures in the area of construction risk. The interviewer gave freedom to ask supplementary questions that focused on issues arising during the course of the interview. The freedom to pursue the interviewee, to seek for clarifications, and to focus on specific projects, risk practices and knowledge, made the interviews insightful.

5.5 RISK RATING

A Likert scale of 1-5 was used in this questionnaire. A Likert scale is a psychometric scale used in questionnaires, and is the most widely used scale in survey research. When responding to a Likert questionnaire point, respondents state their level of declaration to a statement. Rensis Likert invented the scale and published a report recitation its use (Likert, 1932). The respondents were required to point out the relative criticality/ effectiveness of each of the probability of risk factors and their

impact to the management. (In Appendix-A details of evaluation made in the questionnaire survey are given)

5.6 DESIGN OF SURVEY

The respondents were appealed to judge the implication or ‘‘expected loss’’ of each risk. Respondents need to consider many criterions. One substitute approach adopted by previous researchers (Shen et.al 1998) is to consider two attributes for each risk: risk occurrence probability, denoted by α; and the impact of each risk is denoted by β. Such evaluation is used in this thesis. Thus, risk significance, denoted by RS, describe as the function of the two attributes $RS = f(\alpha, \beta)$. Through this approach, the respondents were asked to answer to the two attributes for each risk. For taking into account 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 taking into consideration 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.

5.7 ANALYSIS OF SURVEY RESULTS

To measure the relative significance among risks, earlier literatures study suggests establishing a risk significance index by calculating a significance score for each risk. To calculate the significance score one has to multiply the probability of occurrence by the degree of impact. Thus, the significance score for each risk measured 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; and β_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.

5.8 PILOT STUDY

A pilot survey with the questionnaire in the earlier phase and follow-up interviews with local contractors were conducted. The intention was to identify the factors out of the 44 factors that applied overseas could also apply to the local construction industry. For statistical analysis at pilot study it is required large number of interviews and the structure of the questionnaire. Interviewers response have been used to identify consistent themes, common practices, and insight provided by active and influential project participants that would provide additional guidance and assistance to the research team. The survey results shaped the basis of modifying the questionnaire for the subsequent full-scale survey. The pilot study tries to short-list locally relevant factors. The short listing on the basis that is fit in the local construction industry. As a result, only important and related factors were chosen for addition in the full-scale survey in the second phase of the research.

CHAPTER 6

RESULTS OF SURVEY

The study has been done qualitatively and quantitavly through close end questionnaire. There were twenty five companies in Dhaka city had been given the questionnaires, out of which fifteen had an effective reply, five did not reply and five were rejected due to inappropriate answering. Therefore the response rate is 60% that is considered as a good response in this type of survey. All responders are contractor of govt owned projects. Project manager of the project or project engineer, assistant project engineer of the corresponding site is the responders of my study. I made the survey to get contact physically though it was difficult to conduct survey one by one.

6.1 GENERAL ANALYSIS

In qualitative survey responders were asked to give answer about their perception on risk management plan. Three questions had been asked them. 88.89% percent of responders told that there organization had no risk management plan where remaining has. They treated risk ad-hoc basis. About 73.33% had no idea about risk management plan. **Even though they did not know how to identify the risk and they have no risk response strategy.** In quantitative survey forty four question were asked and let them to mark 0 for not applicable, 1 for very small, 2 for small, 3 for normal, 4 for large & 5 for very large. Arithmetic analysis of the study revealed that Increase of materials cost, labour cost, improper verification of contract documents, bribery, unfairness in tendering sub-contractor related problems, time constraint, inflation were the major problems concerned with the contractor. The least risk rating are given by contactors are environmental risk, lack of knowledge in arbitration, problems due to adjacent projects. The pie chart and the full results are shown in the fig.6.1 & 6.2 and table 6.1 respectively.

Fig 6.1 Availability of risk management plan.

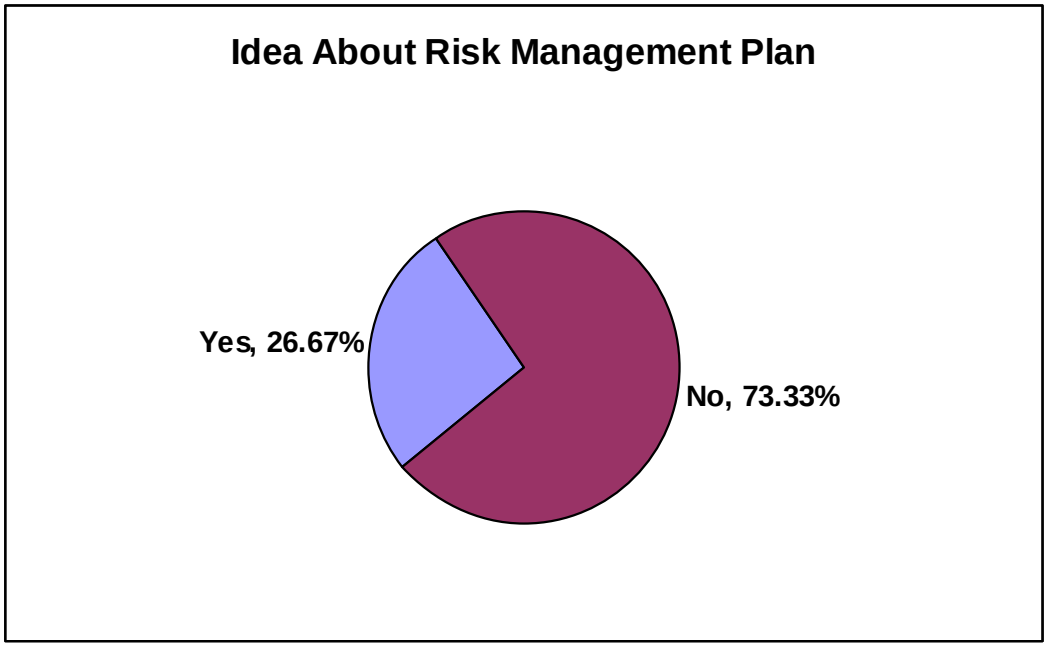

Fig 6.2 Idea about risk management plan.

Table 6.1 Overall ranking of risks

SL No	*Sub Risk*	*Mean*
01	*Increase in material cost.*	*22.11*
02	*Increase in labor cost.*	*19.33*
03	*Cost increase due to govt. policy*	*19.11*
04	*Unfairness in tendering*	*18.56*
05	*Loss due to corruption & Bribery*	*18.00*
06	*Loss due to political changes*	*15.50*
07	*Short tendering time*	*14.78*
08	*Project Time constraint*	*14.38*
09	*Project Delay*	*14.28*
10	*Loss due to bureaucracy for late approvals*	*14.00*
11	*No past experience in similar projects*	*13.78*
12	*In competency of sub-contractor*	*13.72*
13	*Breach of Contract by Project partner.*	*12.06*
14	*Poor communication between stakeholders*	*11.39*
15	*Internal management problem*	*9.61*
16	*Accidents on site*	*9.33*
17	*Rise in fuel prices.*	*8.72*
18	*Improper Project planning & budgeting*	*8.61*

SL No	Sub Risk	Mean
19	Incompetence of transportation facilities	8.44
20	Improper Verification of contract documents	8.45
21	Poor quality of Construction materials	8.0
22	Shortage of supply of water	7.5
23	Architect Vs Structural Engineer dispute.	7.35
24	Theft of materials at site	7.28
25	No/Improper Project feasibility Study	7.0
26	Fluctuation of interest rate.	6.83
27	Materials Shortage	6.67
28	Wastage of materials by workers	6.58
29	Design Changes	6.39
30	Shortage in supply Fuel	6.2
31	Fluctuation of inflation rate.	6.0
32	Unhealthy working environment for the workers	6.0
33	Bankruptcy of Project Partner	5.83
34	Change of Top Management	5.61
35	Stakeholders support of the projects	5.0
36	Shortage in supply of electricity	4.18
37	Site Distance from urban area	4.15
38	Equipments failure	4.0

SL No	*Sub Risk*	*Mean*
39	*Any adverse impact on project due to climate change*	*4.0*
40	*Errors in drawing*	*3.0*
41	*Resettlement & rehabilitation of affected people*	*3.0*
42	*Lack of knowledge of arbitration*	*2.67*
43	*Problems due to adjacent or nearby projects*	*2.5*
44	*Impact on environment due to the projects*	*2.0*

6.2 FINANCIAL RISK

According to CPD's state of the economy reports Bangladesh experienced the highest rate of inflation among the south Asian countries which causing the hike of construction materials price. Increasing fuel prices have also been lifting up inflation in Bangladesh. Domestic prices of petrol and diesel have been increased by 22.73% in Bangladesh last year (2017). The construction industries have suffered a major setback from Bangladesh Bank's money tightening policies. Their top-lines and bottom-lines have shown a much slower growth than their respective interest costs .Ranking of financial risks are given in the table 6.2 and the corresponding bar chart is shown in figure 6.3.

Table 6.2 Ranking Of Financial Risks

SL NO	SUB RISK	MEAN
01	Increase in material cost.	22.11
02	Increase in labor cost.	19.33
03	Rise in fuel prices.	8.72
04	Fluctuation of interest rate.	6.83
05	Fluctuation of inflation rate.	6.0
06	Bankruptcy of Project Partner	5.83

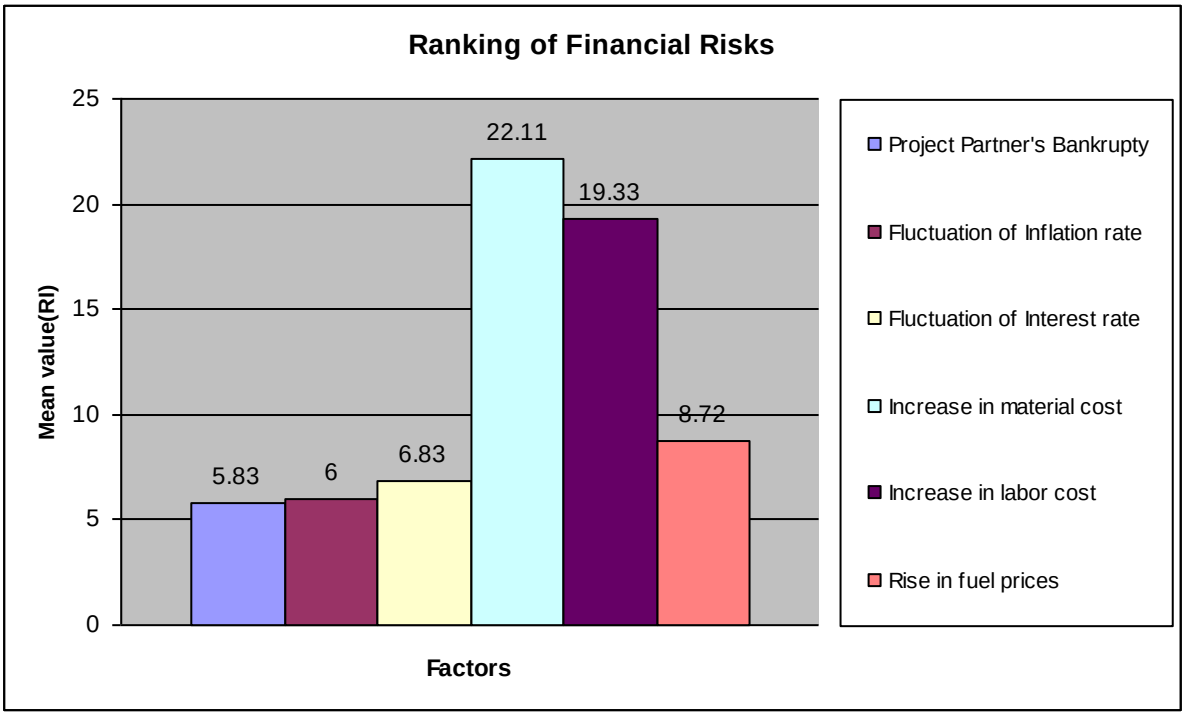

Fig. 6.3 Bar Chart For Financial Risks

6.3 LEGAL RISK

Legal risk in Bangladesh is not much, but if the contract legal problem arises then resolution dispute takes time & money. Nowadays arbitration clause has made in most of the projects. Ranking of legal risks are given in the table. 6.3 and the corresponding bar chart is shown in figure 6.4.

Table 6.3 Ranking Of Legal Risks

Sl No	***Sub Risk***	***Mean***
01	Breach of Contract by Project partner.	**12.06**
02	Improper Verification of contract documents	**8.45**
03	**Lack of knowledge of arbitration**	**2.67**

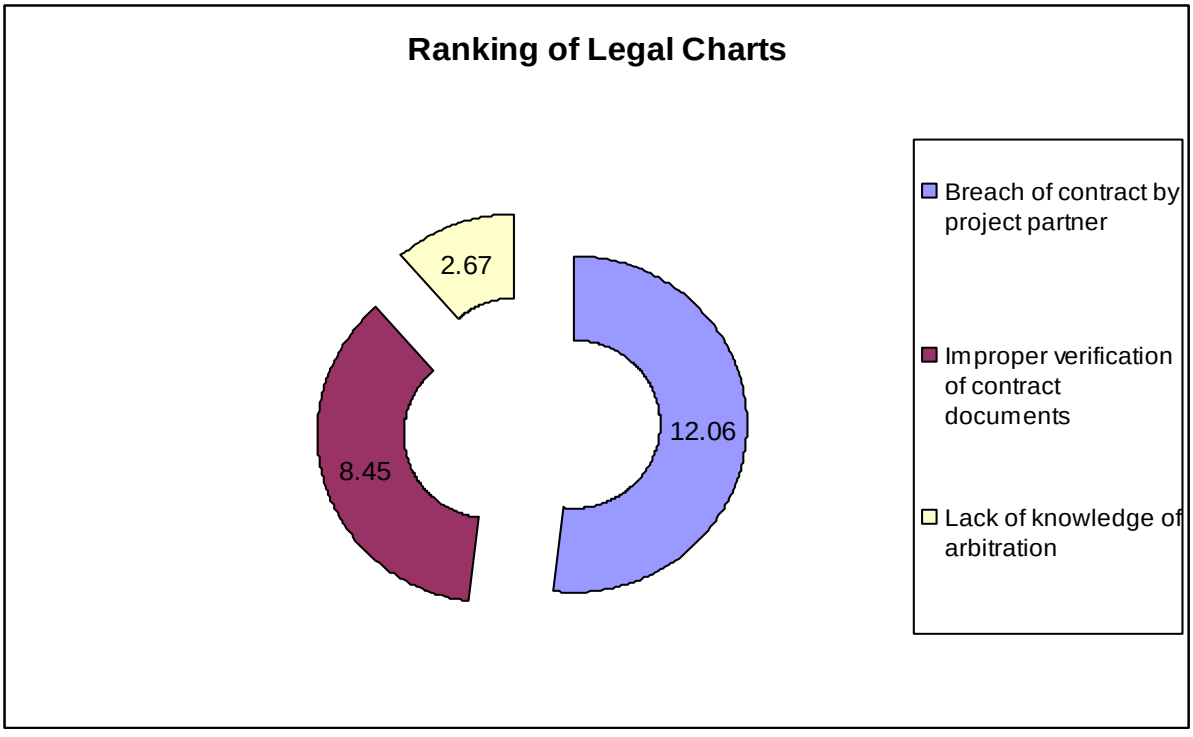

Fig. 6.4 Pie Chart For Legal Risks

6.4 MANAGEMENT RISKS

Ranking of management risks are shown in figure 6.4 which revealed that Unfairness in tendering was the most severe factor perspective of contractor side. Besides, short time of tendering, lack of experience, project delay, project time constraint, improper planning and communication were the main risks factor for delivering the project with success and appropriate practice of construction management system can resolve the problem easily. However, there is a lack of professional construction management experts in Bangladeshi construction industry. Finally, this study revealed that over all managerial weakness is one of the most important factor need to pay notice for minimizing project risk. Ranking of management risks are given in the table 6.4 and the corresponding bar chart is shown in figure 6.5

Table 6.4 Ranking of Management Risks

Sl No	Sub Risk	Mean
01	Unfairness in tendering	18.56
02	Short tendering time	14.78
03	Project Time constraint	14.38
04	Project Delay	14.28
05	No past experience in similar projects	13.78
06	In competency of sub-contractor	13.72
07	Poor communication between stakeholders	11.39
08	Internal management problem	9.61
09	Improper Project planning & budgeting	8.61
10	No/Improper Project feasibility Study	7.0
11	Change of Top Management	5.61

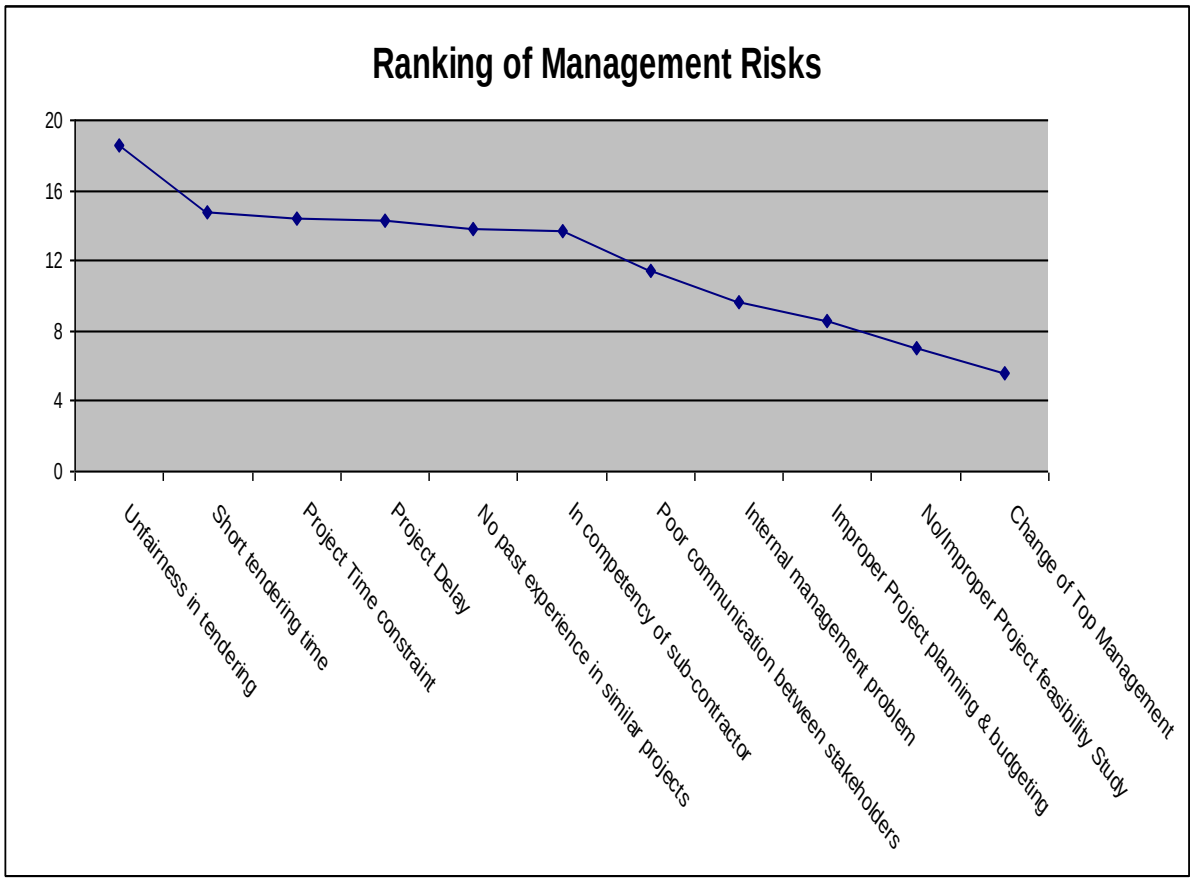

Fig. 6.5 Line Chart For Management Risks

6.5 POLITICAL RISK

The risks included in this section are highly rated by the responders. This is due to absent of good governance in all government sectors. Increase in materials cost due to govt. policy and bribery & corruption have the huge impact. When the party of the government changes the policy of the government has been changed which will also impact on construction industry. Approval for the new projects is present that will causes delays and even financial loss for the companies. Ranking of political risks are given in the table. 6.5 and the bar chart is shown in figure 6.6.

Table 6.5 Ranking of Political Risks

SL NO	SUB RISK	MEAN
01	Cost increase due to govt. policy	19.11
02	Loss due to corruption & Bribery	18.00
03	Loss due to political changes	15.50
04	Loss due to bureaucracy for late approvals	14.00

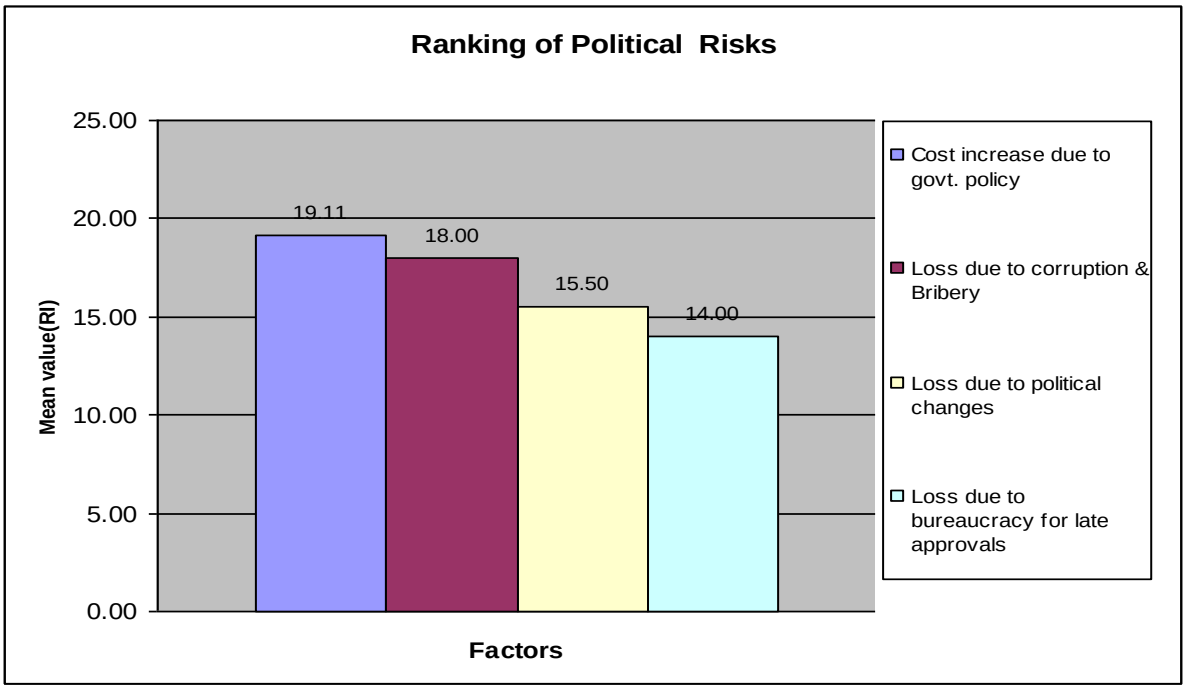

Fig. 6.6 Bar Chart for Political Risks

6.6 TECHNICAL RISK

Few technical factors are creating project risk where poor quality of material, shortage power, on site accident etc. marked as priorities by all the respondents. In addition, material shortage, wastage of materials by worker frequently happened during construction but proper management at site can solve these problems. Ranking of technical risks are given in the table. 6.6 and the corresponding bar chart is shown in figure 6.7.

Table 6.6 Ranking of Technical Risks

SL NO	SUB RISK	MEAN
01	Accidents on site	9.33
02	Incompetence of transportation facilities	8.44
03	Poor quality of Construction materials	8.0
04	Shortage of supply of water	7.5
05	Architect Vs Structural Engineer dispute.	7.35
06	Theft of materials at site	7.28
07	Materials Shortage	6.67
08	Wastage of materials by workers	6.58
09	Design Changes	6.39
10	Shortage in supply Fuel	6.2
11	Shortage in supply of electricity	4.18
12	Site Distance from urban area	4.15
13	Equipments failure	4.0
14	Errors in drawing	3.0

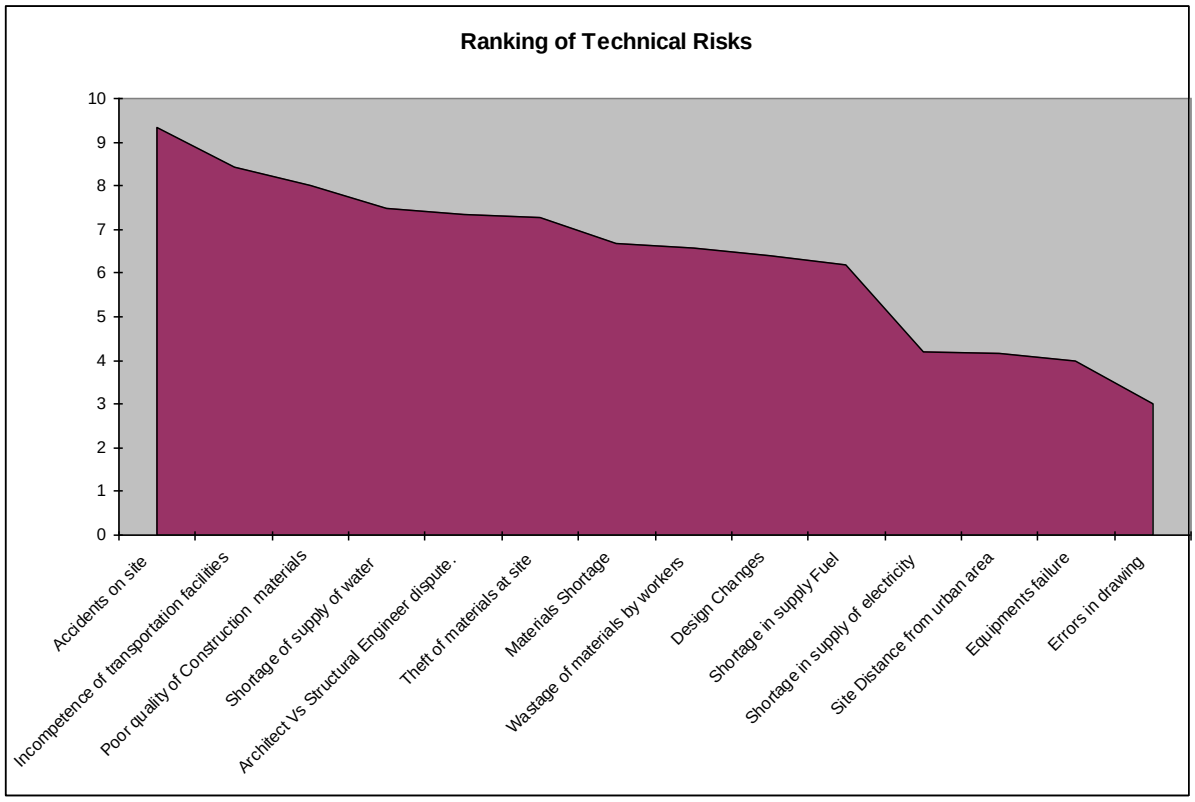

Fig. 6.7 Surface Chart For Technical Risks

6.7 ENVIRONMENTAL RISK

By inspecting construction sites, it is revealed that construction workers were doing their job at high risk conditions. They are living at the construction sites with very unhealthy environment. Though few construction companies ensured safety at site but they are leading to many accidents, even death and increase the project duration with subsequent risk. For the workers working under the direct sunlight is difficult, so safety helmets are provided in some companies. Though climate change is a big issue in the perspective of global weather responders ranked its at very low grade. Ranking of environmental risks are given in the table. 6.7 and the bar chart for the same is shown in figure 6.8.

Table 6.7 Ranking of Environmental Risks

SL NO	SUB RISK	MEAN
01	Unhealthy working environment for the workers	6.0
02	Any adverse impact on project due to climate change	4.0
03	Impact on environment due to the projects	2.0

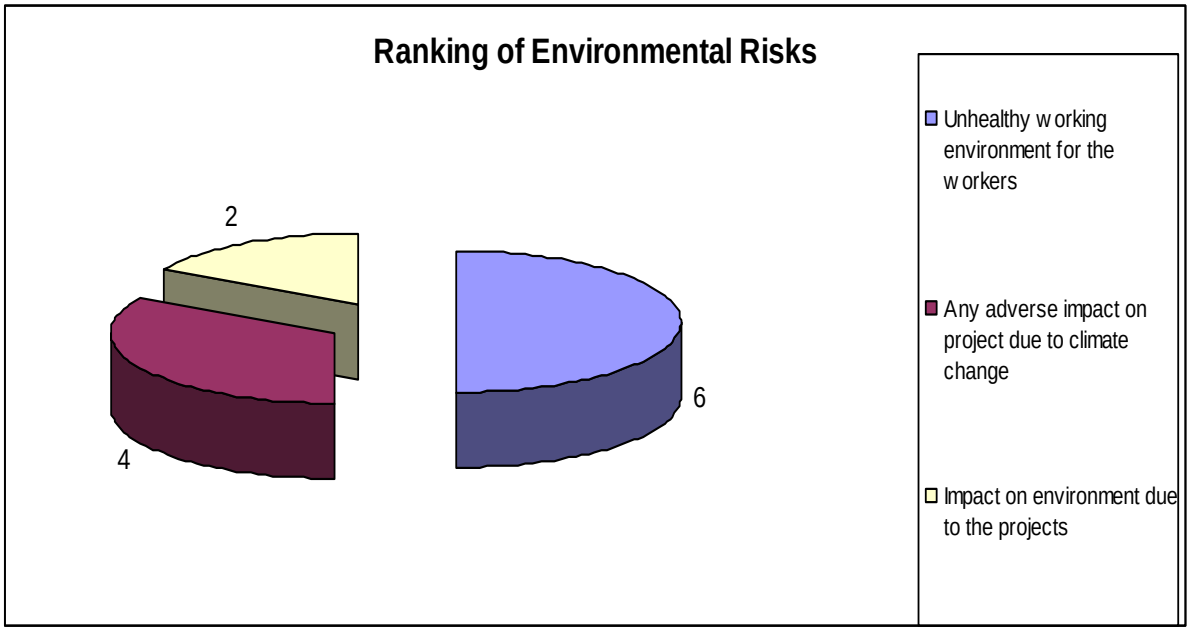

Fig. 6.8 Pie Chart For Environmental Risks

6.8 SOCIAL RISK

As the resettlement and rehabilitation of affected people is the pre construction activity by owner, responders are ranked it at very low grade. Though stakeholder support is very Important for a project, responders are ranked it also at very low grade. Ranking of environmental risks are given in the table. 6.8 and the bar chart for the same is shown in Figure 6.9.

Table 6.8 Ranking of Social Risks

SL NO	SUB RISK	MEAN
01	Stakeholders support of the projects	5.0
02	Resettlement & rehabilitation of affected people	3.0
03	Problems due to adjacent or nearby projects	2.5

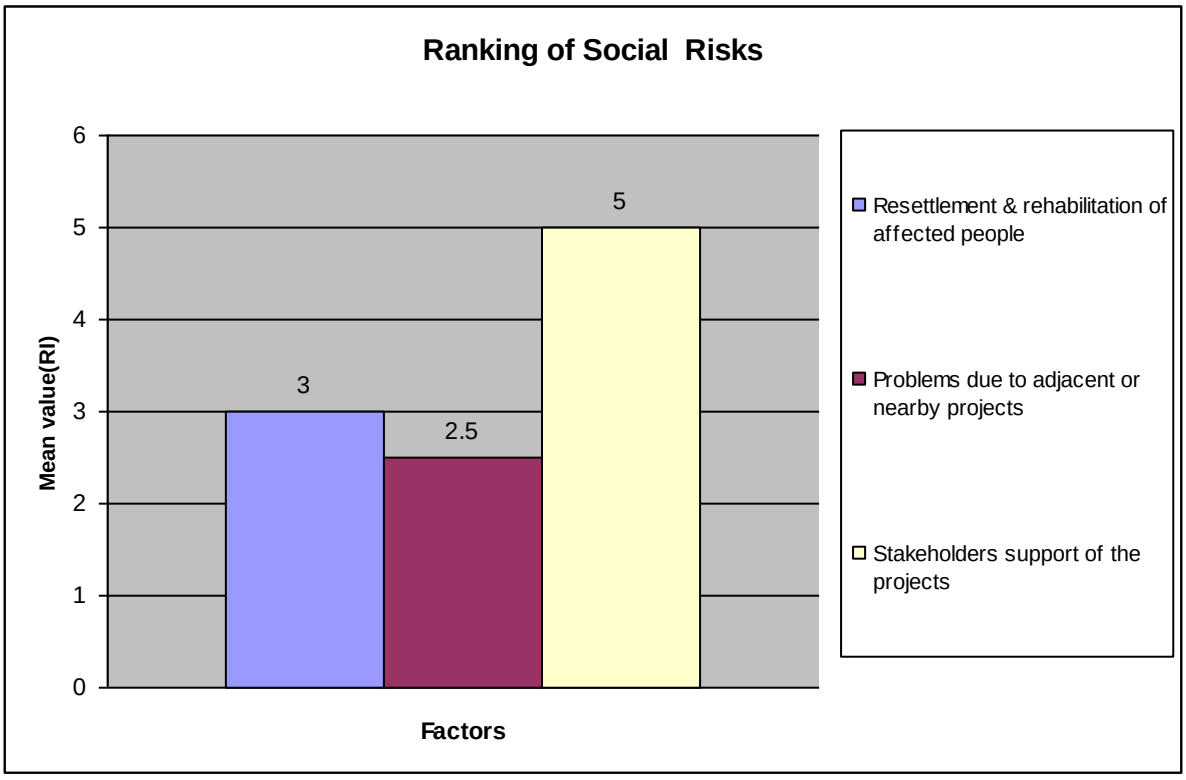

Fig. 6.9 Bar Chart For Social Risks

CHAPTER 7

CONCLUSION & RECOMMENDATION

7.1 CONCLUSION

Construction projects involve many lots of stakeholders & activities and that is why risk connected in this arena is a common and global phenomenon. In Bangladesh (BD) uneven inflation and fluctuation in currency rate is a serious issue which directly and negatively impact on the material prices and labor market. Besides, a good percentage of people and many supporting industry is involved with construction industry. But, this sector is encountered several problems to finish the project successfully. Lack of competent technical expertise, management experts and no research has been done to solve the problem, number of unsuccessful project increase day by day. So many public and private construction projects are dumped due to mismanagement and failure to response the associated risk. To assess the risk associated with construction industry in Bangladesh and to provide a guideline how to address the risk this study was conducted. From questionnaire survey, 44 risk factors were found mostly associated with BD construction industry. Then, these factors were categorized into seven groups. Research found that political factors are the most severe followed by Financial, managerial, technical, legal and environmental group factors. Regarding individual risk, increase material cost was the top most factors and its risk index (RI) value almost nearest of the second highest risk factor e.g. increase of labor rate. Other important risk factors were cost increase due to govt policy, unfairness in tendering, corruption & bribery, project delay, short time of tendering or bidding, lack of experience, loss due to fluctuation of the cost of construction materials, & inflation, improper planning and budgeting etc.

The following are the conclusions from this thesis work

1. Inflation rate is very high in Bangladesh and rising proportionately with time, that is why materials like cement, steel, stone increases which in turn causes financial risk to the construction firms. Though government order to the banks to retain bank interest at single digit banks don’t bother about it. They have continuously raising their interest rates for the loan given by them, this have

exaggerated the construction market vastly. For that reason the financial risk is very high than any other risk.

2. Absences of good governance in all govt. sector lead to unfairness in tendering, corruption & bribery. In Bangladesh due to political changes sometimes past government strategy will be altered which also cause of price hiking in all sector lead to loss of contractor.

3. Delay in the project is one of the main risks factor, this delay is spiralled with various others factors and risk directly and indirectly.

4. Incompetence of subcontractors is also a major risk since most of the sub contractors are unable to go along with the main contractor and the client due their size of work. Besides this short tendering time, no past experience in similar projects, poor communication between stakeholders leads the management risk to be the critical risk from this survey.

5. Political risk is significantly very high for the large firms when compared to other risk.

6. Legal risk is also very high, also for absence of good governance.

7. Study revealed that companies are not very much aware of health & safety of workers, they accept it as normal phenomenon

8. Overall Political, management, and the financial risks are high when compared to other risks.

7.2 RECOMMENDATIONS TO THE CONSTRUCTION COMPANIES

1. Risk management should be considered as a primary tool to assess the risk of a project. It is a iterative process should be done from inception to completion of the project. Risk should be identifying carefully through the guideline of PMBOK and will

treat as well them. There must exist a contingency reserve for unknown risks for minimizing loss.

2. During the planning stage there must be a risk management plan as a sub plan of project management plan.

3. Financial part of the risk is a comprehensive phenomenon and this risk should be handled carefully using subject matter experts (financial consultant) since this cannot be handled by project manger/engineers alone.

4. It is preferable to recruit a project manager/engineer in a project with a PMP certification holder.

7.3 RECOMMENDATIONS FOR FUTURE WORK

- Thesis is conducted in Dhaka city only with a limited sample; it is advisable to increase in sample size with coverage all over the country that can produce more realistic scenario for risk assessment in construction industry in Bangladesh.
- It is advisable for interviews to arrange a pre-survey meeting with the responders so that they can understand the risk factors and their impacts.
- Primary data should be analyzed effectively.
- It is advisable to engage all concern stakeholders as respondent for data collection to get comprehensive result.

REFERENCES

1. A Guide to the Project Management Body of Knowledge, 6th edition (2017), PMI, Project Management Institute.

2. Deviprasadh A. (2007), Risk assessment in Construction Projects, *MS thesis, Anna University, Chenni.*

3. Daud Nasir, Brenda McCabe and Loesie Hartono "Evaluating Risk in Construction-Schedule Model (ERIC-S) Construction Schedule Risk Model" Journal of Construction Engineering and Management, ASCE, Vol. 129, No. 5, October, 2003, 518-527

4. Likert R. "A Technique for the Measurement of Attitudes" Archives of Psychology 140, 1932, 55.

5. Makarand Hastak and Aury Shaked "ICRAM-1:Model for international construction risk assessment" Journal of Management in Engineering, Vol. 16, No. 1,January/February, 2000, ASCE, 59-69

6. Nabil A.Kartam and SaiedA.Kartam "Risk and its management in the Kuwaiti construction industry a contractor's perspective" International journal of project management 19, 2001, 325-335

7. Roozbeh kangari "Risk management perceptions and trends of U.S construction", Journal of Construction Engineering and Management, Vol. 121, No. 4, December, 1995, 422-429.

8. Shen L Y "Project risk management in Hong Kong" International Journal of Project Management Vol. 15, No. 2,1997, 101-105

9. Shen L Y, George.W. C. Wu, and Catherine S. K.Ng "Risk Assessment for Construction joint ventures in China" Journal of Construction Engineering and Management, ASCE, Vol. 127, No. 1, January/February, 2001, 76-81

10. Shou Qing Wang, Mohammad F. Dulami and Muhammad Y Aguria "Risk management framework for construction projects in developing countries" Construction Management and Economics , March 2004, 22, 237-252

11. Shou Qing Wang, Robert L. K. Tiong,S. K. Ting and D. Ashley," Evaluation and management of political risks in China's BOT projects" Journal of Construction Engineering and Management, Vol. 126, No. 3, May/June, 2000, 242-250

12. Shou Qing Wang, Robert L. K. Tiong, Seng Kiong Ting, and David Ashley, "Political risks: Analysis of key contract clauses in china's BOT project", Journal of construction engineering and management, ASCE, June 1999,190-197

13. Tarek M. Zayed, and Luh-Maan Chang Journal of Management in Engineering, Vol. 18, No. 1, January 2002, 1, 7-16

14. Thomas E Uher and A Ray Toakley "Risk management in the conceptual phase of a project" International Journal of Project Management Vol. 17, No. 3, 161-169, 1999