DEVELOPMENT OF RISK MANAGEMENT FRAMEWORK FOR CONSTRUCTION PROJECTS IN PAKISTAN

by

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DEDICATED

TO

MY DECEASED FATHER AND MOTHER

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ABSTRACT

Managing risks in construction projects is documented as a very important management process to achieve the project objectives mainly time, quality, cost, safety and environmental sustainability. Present research seeks to identify and evaluate these risks along with the effective mitigation measures thus developing a risk management framework which the investors/ developers/ contractors can adopt while contracting construction works in Pakistan. Through literature review twenty seven risks were identified which were categorized into three hierarchical levels (country, market and project). The critical nature of these risks to construction projects was evaluated and ranked through a survey all over Pakistan. Practical mitigation measures were also proposed for each risk and included in the survey for getting the sequential priority while handling a risk. Face to face, electronic mail and postal questionnaire surveys were used to collect data. Analysis of the data showed that the risks at Country level are more critical than that at Market level and the latter are more critical than that in Project level. Survey revealed that top 11 critical risks in construction projects are: Cost Overrun, Corruption, Political Instability, Inflation and Interest rate, Government Influence on Disputes, Disputed sites, Human Resource, Market Demand, Change in Law, Justice Reinforcement, and Low Construction Productivity. All of the mitigation measures were perceived by the respondents of the survey at the minimum level of "effective". A Risk model, which shows the hierarchical levels of the risks and the influence relationship among the risks, is developed. Based on the findings of survey, a risk mitigation framework has finally been proposed which will make the risk management process for construction projects relatively simple.

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Chapter 1

INTRODUCTION

1.1 GENERAL

Risk and uncertainty are more wide spread in construction industry because of nature of construction activities, complexity of processes and organizations. Risk has multi-faceted conception. From construction industry point of view, it can be the possibility of happening of a specific event/factor or group of events/factors to the project which may take place during the entire process of construction (Faber, 1979). In Pakistan very less research work on risk management in construction projects has been carried out. The reason being, Pakistan is a growing construction industry due to developing country. Masood and Choudhry (2010) carried out a study taking into account the perception of contractors regarding risk factors. Another study "Identification of Risk Management System in Construction Industry in Pakistan." has been done by Choudhry, R. and Khurram Iqbal (2011). This research has incorporated the risk importance, application of management techniques along with barriers for applying risk management processes. In present research an endeavor has been made to identify and evaluate the potential risks which are faced by construction firms in a hierarchal level as per their importance and further analyzing the effectiveness of their proposed mitigation measures. Furthermore a risk management framework has been proposed which can help the investors/ developers/ contractors to comprehend risks when contracting construction projects in Pakistan.

For categorizing or classifying various risks, many ways are adopted thereby bracketing them for different purposes. Some researchers categorize risks of construction projects mainly in external risks and internal risks, on the other hand, some categorize it in more comprehensively by including political risk, economical risk, market risk, social risk and intellectual property risk, etc (Songer *et al*., 1997). A broad categorization has been done by Hastak and Shaked (2000) who classified risks pertaining to complete construction scenario in three prominent levels, which are; country (macro) level, construction market level and project level Country (macro) level risks are considered to be associated with the political and macroeconomic constancy. These risks become effective if establishment of the country confiscate property, brings in foreign currency exchange and impose limitations on trade etc. Partial linkage of Macroeconomic strength can be attributed to the stand of financial and monetary strategy, susceptibility of the country to economic shudders and questions on writ of the government .Construction market level risks include advantage in technology, construction resources availability, difficult regulating processes, and focus of government on the construction industry. Risks at project level are considered to be particular construction site related and may include defects in design , improper safety at project site, violation of environmental protection, inappropriate quality control and logistic constraints to object site, etc. (Thobani, 1999). This classification was considered appropriate for the research in order to represent the influence of one risk on the others thus prioritizing the mitigation actions for each of the risks.

We can describe risk management as a methodical way of analyzing the areas of risk and consciously determining treatment for these risks. This is a management tool which aims on identifying sources of uncertainty and risk, determinating their impact, and development of suitable management response, (Uher, 2003). Managing risks includes the identification, assessment and ranking of risks pursued by organized and economical application of available resources. Objective is to reduce, examine, and control the probability /impact of unfortunate events and enhance the realization of opportunities. In most industries Risk management has been accepted as a necessity due to its increasing value today, and to mitigate the impact brought by potential risks a number of techniques have been developed (Schuyler, 2001; Baker and Reid, 2005). More risks are encountered in Construction industry Compared with many other industries, due to the unique construction activities which includes; long duration, complex processes, abnormal environment, dynamic organization structures and financial intensity (Smith, 2003, Flanagan and Norman, 1993; Akintoye and MacLeod, 1997).

Broadly the risk management process has been divided by researchers in four major categories which are risk classification, identification of risk, analyzing the risk and risk response. Furthermore risk response being the gist of risk management has been divided into four steps mainly retention, reduction or mitigating risk, transfer and avoidance of risk (Flanagan and Norman, 1993; Berkeley et al. 1991). An appropriate way of treating risk must be adopted after having identified and analyzed the risks of a project. Within a risk management framework, each of the stakeholder mainly contractors should make a decision the way of handling, mitigating or treating each risk and thus devise appropriate risk handling strategies or mitigating measures. Generally these mitigating measures take in to account the nature and potential outcomes of the risk under view. The aim is eliminating all possible potential influences of risk and increasing the level of control on the arising risks. Having more control of mitigating measures on one risk will increase effectiveness of mitigating measures. The objective of risk management process is not to eliminate all risks from a project completely but to formulate a systematized framework which helps decision makers in managing the risks, more effectively and efficiently especially the critical risks (Perry and Haynes, 1985).

1.2 RELATED PAST RESEARCH AND RISK CLASSIFICATION

The concept of risk management is not new in construction industry. Substantive research work has been carried out in risk management regarding construction projects, which have resulted in the identification of a number of risks that may have influence on the construction project outcome. Chen et al. (2004) in their research suggested 15 risks related to project cost, distributing them in three groups: management factors, resources factors, and parent factors. Eight major risks were identified by Shen (1997) attributing to project delay and subsequently graded them basing on a questionnaire survey input from industry practitioners. Risk management actions were also proposed to cope with these risks and validated their effectiveness through individual interview surveys. Another research revealed that main issues having affect on safety performance in China included “top management’s poor safety understanding”, “lacking in training”, “very less safety consciousness of project managers”, “reluctance in providing resources for safety” and finally “careless operation” which was established through a survey by Tam et al. (2004). Diverse risks which have influence on project objectives according to time, cost, and safety have been studied in above researches whereas the other researchers have studied the risks or risk management with perspective to different phases of a project lifecycle. Uher and Toakley (1999) examined the conceptual phase of a project life cycle and deduced that though many of the industry practitioner's knowledge about risk management and its importance but its applicability in the conceptual phase was relatively less furthermore qualitative methods were adopted rather than quantitative analysis in general and acceptance of risk management was hampered due to less knowledge and skill base generating from a less commitment on professional and training progress. Chapman (2001) has translated the risks into the design risks which comprised mainly as "difficulty in assessing and specifying requirements of the user", "complexity of estimating time and resources needed for completing the design", "difficulty of measuring progress during the development of the design". In Chapman words, in-depth knowledge of the design team regarding the sources of risk can have a great influence on the risk identification during a project's design phase. Construction risks have been classified in three groups by Abdou (1996), which includes construction finance, design, and time. He has addressed these risks in length keeping in view the varying contractual relationships which existed between the functional entities being part of designing, development and constructing the project.

Risk classification has been placed by the researchers as very important footstep for undertaking the risk management process, because with this, diverse risks affecting a construction project are broken down in a structural and hierarchal form. Perry and Hayes (1985) developed a list of factors taken out from several sources classifying them according to risks retainable by contractors, consultants and by clients. Risk grouping done by Chapman (2001) includes four subsets: construction industry, prevailing environment, client related and project specific. Shen (2001) categorized 58 identified risks related to Sino-Foreign construction joint ventures, into six groups which included (1) management (2) financial (3) legal (4) market (5) policy and (6) political. Risks specific to whole construction circumstances has been classified by Hastak and Shaked (2000) in three broad levels which included country (macro) level, construction market and project related. The same is adopted in this research paper in order to get the influence of one category of risk on the other category and thus prioritizing mitigating actions for every risk.

1.3 RESEARCH OBJECTIVES

The main objective of this research is to develop a model and a risk management framework for the risks encountered on construction projects, so that any investor /contractor in the construction industry can have a fair idea of risks which they might encounter and get a framework for mitigating these risks. This study would particularly be suitable for the firms who cannot have /afford a dedicated risk management professional. Following have been focused:-

- To identify and evaluate the critical risks related with construction projects in Pakistan.
- To propose and evaluate the measures for mitigating these risks.
- Development of a model in order to categorize and represent the risks related with construction projects.
- To formulate a risk management framework.

1.4 SCOPE OF THESIS

The scope of this research is confined to the construction industry of Pakistan which mainly covers key stakeholder i.e. sponsors /clients, consultants and contractors. Main focus is given to sponsors and contractors as they are the one who gets the major toll for risks. An endeavor has been made to include every category of firms/contractors regardless of the projects undertaken by them.

1.5 THESIS ORGANIZATION

The research has been distributed in five chapters. First chapter covers an introduction to risk management; chapter 2 is about literature review. Methodology used in the research is covered in chapter 3 and results and analysis are given in chapter 4. The final (5th) chapter deals with conclusions and recommendations.

Chapter 2

LITERATURE REVIEW

2.1 INTRODUCTION

Construction industry is multifarious due to a variety of working parties, application of varying methodologies and activities executed; therefore, it is always prone to more risks. In other words, risk management is essential for construction projects as numerous uncertainties stem out during construction process which may relate to country, market or project itself and due to number of project stakeholders involved. Construction projects includes sometimes, thousands of interacting activities, each having cost, quality, time or sequence setback. As the construction projects take place in dynamic environment, therefore, project objectives are likely to change throughout the life cycle of the construction project. Risks within the project whether dynamic risks creating potential gains /losses, or static risks relating only to potential losses, have to be managed effectively for smooth project termination. Risk and uncertainty does not pertain to large projects however small projects also require an effective risk management plan as stated by Perry and Hayes (1985). Risk management is therefore a critical task, which requires a whole life cycle approach to be adopted for getting effective and meaningful results. In order to ensure project accomplishment risks have to be managed throughout the project lifecycle by all project members in existence of uncertainties related to macro-environmental aspects and construction-related aspects.

2.2 CONCEPTION OF RISK AND RISK MANAGEMENT

Risks present in construction projects can be numerous because of complex nature of construction process involving many interrelated activities performed by different parties on different timings. Risk is a vide term having different perceptions and meanings according to situation and type of scenario created or faced, therefore, it is foremost to understand the concept of risk and uncertainty in the backdrop of construction projects and comprehension of risk management within construction industry.

2.2.1 Risk and Uncertainty

Risk is related to the Probability of happening uncertain events in future. “A chance or threat of damage, loss, or some other harmful happening that is originated by external or internal expostres, and that might be avoided through anticipated action”(business dictionary.com). No regular or consistent definition of the word “risk” is present in the literature as concluded by Al-Bahar and Crandall (1990).They were of the view that most of the definitions cover the pessimistic side of risk, focusing on losses and damages, whereas the positive side and opportunities are generally overlooked. Therefore Al-Bahar and Crandall (1990) have defined the risk as “the exposure to the likelihood of events that adversely or favorably affect project objectives as a result of uncertainty”. In Royal Society journal (1991) the meaning of risk is given as “probability t hat an undesirable event take place during a declared period of time”.

Another definition of risk has been described by Burtonshaw-Gunn (2009) as “the threat or prospect that an action or incident will adversely or favourably have influence on an organization’s ability to realize its objectives”. In his research Wharton (1992) have concluded that word “risk” just describe any unplanned or unforeseen result which may be fine or dreadful, of a choice or manner of action. Risk is a multifaceted happening which may have physical, cultural, economical and communal aspects and can be defined as, having concern with the changing incidents which may take place in future, the exact probability and outcome of which is uncertain but may possibly have affects on the interests and aims of an organization by some means (Loosemore, Raftery, Reilly and Higgon ,2006) .

It is obvious that project risks are having influence on more than one project objectives. Cost, quality and time has been perceived by most of the authors as the affected project objectives, such as (Akintoye and McLeod, 1997; Smith, Merna and Jobling, 2006; Burtonshaw-Gunn, 2009). Performance and productivity has been added by Mills (2001) as subjected to risk and uncertainty while undertaking construction projects. Therefore uncertainty and risk terms can be used interchangeably with some apprehensions, which has been clarified by Al-Thani and Merna (2005) in the words that their meaning is different as risk is referred to statistically predictable events whereas uncertainty refers to an unfamiliar and unexpected changeability(table 2.1).

Table 2.1: Risk and Uncertainty Continuum

Risk		Uncertainty
Quantifiable	⟶	Non-quantifiable
Statistical Assessment	⟶	Subjective Probability
Hard Data	⟶	Informed Opinion

If the probability of a particular event occurring can be assessed either intuitively or realistically then that conclusion is prepared under risk but if decision-maker takes the decision in the absence of historic data or the past relevant to the situation under consideration, then uncertainty prevails, as concluded by Flanagan and Norman (1993).

The term risk is more pertinent in construction industry perspective than the term uncertainty, due to the reason that there is always a number of information which can be based which can be utilized by a company to convert the uncertainty to risk by using that information. Risk is made up of four essential parameters as per Allen (1995). These include probability of happening, severity of the impact caused, susceptibility to transform and amount of interdependency to other causes of risks. There are risk events which lead to the potential impacts and cost to be paid (Loosemore, *et al*. 2006). Similarly, “a risk can be ascertained by having a cause and if it happens, it leads to a consequence” as said by Kerzner (2005). The probability and consequence terminologies are used to convey and evaluate risks, as added by Loosemore, *et al*. (2006) which may be stated as:

Risk = Probability of occurrence x degree of loss/gain.

Risk changes between 1 and 0. 1 shows 100% risk and 0 shows 0% risk. If definition of risk is impossible by numbers, it can be defined by the words like; ‘high’, ‘low’, ‘acceptable’, ‘carelessness’ etc. In some conditions, risk can be determined but cannot be said that it is a zero risk. Risk management determines importance of risk of an activity not determines the safety of activity. The question “whose this risk?” is important as the question “what is the risk?” By this way acceptable risk concept becomes important. For example, the interruption on expenses to health problems can be an acceptable risk for you but can not be an unacceptable risk for a person who becomes alive by going to hospital ones a week. To show the alternatives when the risk is unacceptable is also important. Risk can change with the person, condition and opinion. For example;

- Unfamiliar risks are less acceptable than familiar risks
- Unwillingly taken risks are less acceptable than the willingly risks
- The risk controlled by others are less acceptable than the risk controlled by ourselves
- Known risks are acceptable than the unknown risks
- Definite risks are more acceptable than the indefinite risks.

2.2.2 Risk in Construction

"Risk and uncertainty are present in every construction projects, without consideration of the size" (Hayes, et al., 1986). In the same way, Chapman and Ward (1997)concludes that a non-risky project should not be taken up, just to state that all projects will involve some degree of risk. high risks in construction is due the character of construction activities, methods, organization and environment (Akintoye and MacLeod, 1997). "Risks can be transferred, managed, minimized or shared, but cannot be ignored." (Latham ,1994).

Risk in construction projects may be termed as the probability of a damaging event happening to the project as assimilated by Baloia and Andrew(2004). As major objectives for construction projects are the targets established for function, cost, time and quality, therefore, the foremost important risks in construction are failure to meet up these goals. Risk in construction has been the focus because of time and cost overruns correlated with construction projects.

A project may encounter numerous risks because of design, construction, contract or management practices. Each risk needs a separate investigation. Various types of risks have been analyzed by different researchers. Delay risks of Hong Kong construction industry were analyzed by shen. In this research a well thought off set of questions was prepared and opinion of professionals was sought. All these professionals were above management level in various construction companies. This research concluded that most severe risk due to which projects are delayed is insufficient or incorrect design information. The second most important risk was unforeseen ground conditions which affect the foundation construction hence the project runs out of schedule at the very offset.

Sometimes subcontractors are unable to arrange sufficient manpower at site and causes delays to the project. Theoretically many other causes of delay to projects can be discussed but those were not considered noteworthy by local industry. Construction risks of Kuwaiti construction industry and attitude of large Kuwaiti contractors was presented by Kartam and Kartam. They not only assessed various risks but also allocated a relative contribution to each factor. In order to prevent or mitigate losses they have investigated best contractual arrangement which will be helpful to avoid delay risks. This research concluded that most of the contractors are willing to accept those risks which are contractual or legal in nature as compared to other risks. The researchers highlighted that contractors of Kuwaiti construction industry are relying on experience and subjective judgment rather than applying some formal risk analysis techniques to averting and tackling construction related risks. A contractor's approach to identify any risk is very imperative. Bajaj *et al*. investigated this aspect for various construction firms of New South Wales, Australia. The first stage of any construction project is estimation and tendering. Bajaj et al. considers this as the first stage of risk management too. They suggested that contractors should identify various risks at tendering and estimating phase because it is easy to tackle them here by incorporating suitable clauses in the contract document.

2.2.3 Various likely Risks Involved on a Construction Project

Various risks summarized by Flanagan and Norman which a construction project can face are given below:-

- Inability to complete a project within given time schedule.
- In a given design program we are unable to obtain approval of outline plans, detailed plans or building code/ regulations related approval.
- Unexpected soil condition causes delay in design and construction of foundation.
- Unusual adverse weather like rain, fog etc delays the project.
- Strike by locals or labours.
- Price hike was much more than what already catered for in project.

- Inability to bring a tenant upon completion.
- An accident at work site.
- Poor workmanship leading to structural defects.
- Natural calamities like windstorm, flood, earthquake etc
- Delay in provision of design or certain design details from design team which may give rise to contractor’s claim.
- Budget overrun also delays projects substantially.

One must differentiate between causes of a risk and eventual affects of a risk. Risks faced by a project, are ultimately associated to any one or more of the following:-

- Budget overrun.
- Time schedule overrun.
- Inability to satisfy quality standards, environmental standards, safety standards etc.

2.2.4 Factors causing Risk

Sources of risk as identified by Ökmen and Öztas are shown in table 2.2.

Table 2.2: Main sources/types of risks (Ökmen and Öztas,2004)

Risk No	Risk Name
1	Late handing over of site by client.
2	Political unrest
3	Bureaucratic procedures for approval of design, cost and bill
4	Local laws and regulations are changed in mid of project.
5	Projects specs are either sketchy or does not meet site/ project requirement
6	Failure to assess bids on time and lack of procedures to evaluate bids
7	Prolonged disputes or lack of interest in resolving disputes.
8	Tax rate and regulations are changed in the mid of project.
9	Late payments to contractors/ subcontractors/ suppliers.
10	Difficulties in obtaining credits
11	Inflation
12	Changes in foreign currency rate.
13	Changes in interest rate of acquired loan.
14	An unusual financial model of the project may give rise to difficulties.
15	Shortage of labour because of disputes, strikes or lockout
16	Accidents
17	Lesser output either by machinery or manpower
18	Shortage of men , material and equipment
19	Delay caused by third party.
20	Corrective works because of poor quality.
21	Enhancement in quantum and scope of work

Risk No	Risk Name
22	Delays caused by client in getting approvals, slow payment etc
23	Unexpected soil conditions
24	Unusual and prolonged adverse weather condition
25	Natural calamities for example flood, windstorm, seismic / volcanic activity, mud slide, stone fall or outbreak of fire etc
26	Local festivals and social/ religious/ cultural events, or terrorism etc
27	Restrictions posed to safeguard against ecological contamination
28	Non availability of design
29	Design is available but has certain shortcomings and details are missing
30	Novice contractors or labour who are not acquaint with construction practices/ techniques

The effects of above causes are summarized by Ökmen and Öztas as follow:-

- Project runs out of budget.
- Project does not meet the completion time line.
- Project does not fulfill the quality standards.
- Project does not satisfy the operational requirement.
- Project does not meet the safety standards.
- Project suffers losses because of damages related to natural disaster.

2.3 CONCEPTUAL FRAMEWORKS AND PROCESS MODELS

A thorough review of studies carried out about construction risk management reveals that entire academic work pertaining to subject can be grouped as following (Dikmen et. al, 2004) :-

(1) Studies which develop a framework for systematic risk management at conceptual level and model for its processing.

(2) Studies which explore and analyse various risks, investigate trends to manage those risks and investigate common perceptions.

(3) Case studies to apply certain techniques to a given project for identification and management of risks.

(4) Studies which focus to develop certain Support Tools for risk management.

This grouping is generalized one and other researchers prefer a different set of headings to group the studies carried out on risk management.

2.3.1 Project Risk Analysis and Management Guide (PRAM)

In order to provide guidance to professionals of the Association of Project Managers, Champan drafted Project Risk Analysis and Management PRAM Guide in 1997. This guide provides a generalized guidance in formal risk management processes (RMP). Numerous organizations have been using RMP for quite some time and PRAM guide is based on practical experience of those organizations. Almost all methodologies of risk analysis emphasize that all project participants should apply risk management process to all stages of a project life and PRAM is no different. PRAM provides a flexible methodology where one can opt for short cuts or make a detailed process. In both cases one remains within the bounds of PRAM. Generic stages are found in some of the RMPs but PRAM describes detailed nine phases. It clarifies importance and role played by each stage in an RMP.

Nine phases of PRAM are :- define, focus, identification of risks, forming a structure, assigning ownership, estimate the cost and time, evaluate the estimate, plan risk mitigation and finally manage the execution of developed plan. All stages of PRAM run in parallel and have a start to start precedence. These stages / phases are interlinked with intermittent activities having their own iterative process. Each stage is assigned a well defined deliverable. The purposes of each deliverable are given. And associated task to be performed which will produce those results are also discussed in PRAM.

Define Phase: - This phase is about gathering and then consolidating all information about the project, especially those which are more relevant to RMP. This information may include objectives of the project, scope of the work, time schedule, work activity sequence, allocation of resources and details of resources etc. Each phase of PRAM aims at achieving a deliverable target and in this phase the analyst shall get a detailed, explicit and unambiguous understanding of the project in totality. This comprehension is achieved by doing few specific tasks. All gathered information is sifted and consolidated, properly documented, checked and verified, risk is evaluated and all this is reported at the end. Champan and Ward (1997) have elaborated on six approaches to perform these given tasks for achieving the deliverables of define phase. Like all other phases define phase is also a continuous to do work as all information is usually not available at the beginning of project. In certain projects objectives are not clearly defined at the offset and in others objectives keep on changing as per requirement of the client. One must focus on constantly achieving and updating key information because any loophole / inaccuracy in define phase will adversely affect the quality and usefulness of other phases too.

Focus Phase: - In PRAM the second phase is focus phase which is also termed as initiation phase in other risk management procedures. This phase is about setting parameters for RMP and plan RMP itself as a project which is separable from main construction project to which RMP is being applied. In define phase the target was clear comprehension of project and in focus phase the target deliverable will be clear and unambiguous comprehension of risk management process to be adopted. This means, for whom the analysis is being done? Who is responsible for this analysis? What could be the probable risks and their limits? Which is most appropriate application or suitable model for this project? In each phase of PRAM analyst has to perform few specific tasks to achieve the target deliverable. Such four tasks for focus phase are documentation, verification, evaluation and reporting. In fact these four tasks are common to all phases of PRAM. Focus phase is also an ongoing continuous work in which RMP plan is constantly updated and upgraded. It runs parallel to define phase.

Identify Phase: - Third phase of PRAM methodology is identify phase. In this phase all likely risks are discovered and categorized. Minimum one response is assigned to each risk and its results are evaluated. The best response is selected through an iterative process of check and correct. This is a very important phase and every single RMP lay due emphasis to identify all possible risks. Some methodologies also stress upon digging the root cause of all risks and other considers an appropriate response to be adequate thus deferring the issue of root cause. The target deliverable of this phase is a comprehensive log of all risks and our response to each one. Specific tasks to be performed to this end are ‘search’ and ‘categorise’. Searching applies to discovery of sources as well as discovery of responses. Some useful techniques for search task are to ponder upon / brainstorming, use a check list, and interview the stake holders.

Structure Phase: - Fourth phase of PRAM is structure phase. In some risk management procedures this phase is made part of analysis phase. In this phase categorization of risks already done is further polished, revisited and possible relation between a project activity, potent risk and suitable response is searched for. Here we also look for reasons as why they are interdependent. Sequence of various activities is already given in define phase however based on newly explored interdependencies of structure phase, now we may develop a new order for activities of a construction plan. Relationship between project activity, risk and response are based on assumptions and in this phase we also test those assumptions. Based on our testing certain assumptions are simplified and if need arise more elaborate structure is provided to safeguard against losing any opportunity. The key deliverable for this phase of PRAM are establishing and testing of assumptions which give a clear picture about the linkage between construction plan, posed risks and probable response. This is also a continuous ongoing phase where assumptions are constantly modified which means simplification or sophistication.

Ownership Phase: - The fifth phase of PRAM is ownership phase. In any risk management program every risk shall be responded by someone to neutralize or avert its effects. This 'someone' is decided here in ownership phase. PRAM gives due importance to assigning ownership to various risks so that they is no confusion in dealing those. Assigning a separate phase for this purpose is an effective project management by itself. There are certain risks which shall be responded by the owner and there are risks where other organizations come in to play their role. In ownership phase PRAM goes a step forward and client nominates individuals who shall own a particular risk. This phase also approves ownership management allocation where client wants that the contractor or third party shall own certain risks and associated response. The target deliverable of this phase is explicit definition of responsibilities to manage various risks. In order to achieve these deliverables scope has to be decided and ownership has to be planned. Certain specific questions once answered will make the job easy like, what do analyst want to achieve from ownership policy? Which all are the risks to be distributed among various owners? Who all are contenders for owning certain risks?

Estimate Phase: - The sixth phase of PRAM is estimate phase. Here probability of various risks and matters pertaining to cost and time are elaborated upon. The target deliverable for this phase is working out additional cost to be born and extra time to be spent in a particular risk response. This estimate is prepared for all explored risks; alongside probability of occurrence of a risk is also estimated. Apart from cost and time any other aspect/ specifications of the project as deemed necessary are also estimated against a given risk. This phase provides a baseline for clear understanding of all risks and enables the client to differentiate between more important and less important risks. Now it is easy to refine our initial estimate based on estimation of each risk. This phase requires lot of data collection and few decisions by client team. Due to its iterative nature where a reference plan is always refined, this is also a continuous ongoing phase.

Evaluation Phase: - Seventh phase of PRAM is evaluation phase which is undertaken after estimation phase. It is a separate phase in PRAM but other RMPs will combine estimation and evaluation phases to make it one broader phase. Results obtained from estimation phase are evaluated and amalgamated in this phase. Here client is enabled to make certain calculated decisions. Evaluate phase should be used to drive the distinction between two purposes of the estimate phase. The target deliverable of this phase can be a list of risks set in order of priority. As a special case we may evaluate a likely problem associated with given contingency plan and suggest certain improvements in the plan.

Plan Phase: - Eighth phase of PRAM is plan phase. Here the outcome of all preceding phases is consolidated and a deliverable project plan is produced which can be easily implemented. Project plan is duly modified in light of previous work. Alongside this project plan, a relevant risk management plan is also ready. Both these plans shall be complete with all details. Plan shall describe various activities, start and finish time for each activity and precedence of each activity. In case of risk management contingency plan the triggering mechanism for each activity along with ownership responsibility shall be described. Resources in terms of men, material etc are also allocated to each activity. Contractual terms where applicable are added. Various milestones to be achieved, starting payment, allocation of funds and likely expenditure for each contingency are also given. A complete base plan and a complete risk management plan are deliverable targets of this phase.

Manage Phase: - Manage is the ninth and last phase of PRAM**.** This is a project monitoring phase. In this phase planned activities and actual activities being done are constantly noted and entries are made. In case of any variations both project plan, as well as risk management plan are updated accordingly. Measures are suggested to keep the project on planned lines. A short term priority list is constantly updated to meet the immediate future requirement of the project. This list contains immediately posed threats / risks and our likely response. Issues requiring immediate attention of management are brought to lime light with the help of this priority list. This is also a continuously ongoing phase.

An overview of all nine phases of PRAM shows that this is a flexible and all encompassing risk management methodology. PRAM facilitates application of all risk management principles.

2.3.2 Risk Analysis and Management for Projects Methodology (RAMP)

RAMP stands for Risk Analysis and Management for project Methodology and it was developed by Institute of Civil Engineers in 1998.The complete outline comprises of nine phases for proper management of risks. Risks are futuristic and hidden by nature but a wholesome endeavour is made in RAMP framework to predict those with calculated certainty. The hidden future likelihood of risks is unveiled in RAMP process. It covers the complete duration of project from planning to start and from execution to winding up.

There are four activities which are performed in a RAMP process which includes Process Launch activity, Risk Review activity, Risk Management activity and Process Close down activity. These activities are performed at different phases of a project. Process launch and process close down are performed only once each in the entire duration of a project. However risk review and risk management are carried out as many times as needed. In fact at each critical stage of a project, risk review is carried out. Than risk management becomes mandatory to take the issue to its logical conclusion. Risk review is the core of this process and shall be invariably applied before any important decision. Risk review and its natural comrade risk management are continuously performed to safeguard the project from any loss.

The first activity is RAMP launch. Here ground is prepared to identify the objectives of project. The outline of the project, its purpose and time frame is also considered in launch activity of RAMP. A preliminary policy for reviewing risks and broad guide lines to manage those is described here in launch activity. A time table is decided for application of risk review activity. Occasionally instead of timings, certain stages or nodal points of the project are selected to apply the risk review activity. Sophistication level of risk analysis is also defined in the launch activity. This will help in defining the quantum of effort to be applied for a particular project. Now a budget can be established for conducting RAMP process. RAMP process as a whole emphasize on team work and communication. More is the awareness of risk management and risk review strategy more will be the effectiveness of RAMP process. Hence it is not a secret activity where analyst should work in isolation rather proper communication will increase its dividends. A well geared up team is decided in the launch phase that will be carrying our analysis in subsequent phases.

Identify, analyse, mitigate and monitor are four phases of RAMP risk management approach. The purpose is to identify all important kinds of risk, sources of risks and improbability of all risks. Root causes for all kinds of risks are searched out and depending upon their mutual relationship or common response grouping of these risks is carried out. This classification is helpful in evaluation of risks.

In first step we look into major objectives and key parameters of a project and try to hit the connected risks. This first attempt is done without any checklist ensuring that discovery process is original and our list is not mere reproduction of previous literature. We may upgrade and complete our risk list by going through various check lists so that nothing is missed out. All risks are entered in risk register so that these can be examined and investigated later on. Significance of each risk and mutual relationship of risks is also identified. Risk register is further extended by discussion and repeated thought bombardment sessions.

Now once all probable risks have been identified we can start with classification phase. All similar risks are grouped together. This grouping will help in evaluation. Next is the analysis phase where recurrence frequency of all risks, their probability of occurrences and potential penalties it can impose are assessed. Probable timings of given risks and timings of their consequences are also assessed for the life cycle of a project. Acceptance score is worked out for each risk using risk tables. Here likelihood is combined with aftermaths of a risk. Similarly grouped risks which have same root cause or same timings of occurrence etc are evaluated together. Outcome assessments entries will be recorded in risk register. Net effect of all risks over the duration of the project is also assessed. First round of appraisal will be made to establish whether something can be done to diminish the effects of main risks. Outcome will be entered in the risk register. At this stage purpose will be to hint towards a possible line of action rather than conclusive a response.

Alleviation of the risk is considered after identification and evaluation of all risks. This risk mitigation plan is the final outcome of any risk management strategy. The whole process was initiated to reach at this plan. Four ways suggested by RAMP for risk mitigation are briefly described here. Risk mitigation is done either by adopting certain techniques to avoid the risk. This can be done by changing the sequence of activities, reducing the time frame of an activity etc. If any risk is not avoidable than effort is made to divert the risk. Risk is usually diverted toward a faculty within the project which is already covered under some warranty / insurance or risk is diverted out of the scope of project etc. This is also termed as risk transfer in certain literature. Risk absorption or pooling of risk is also a very useful technique described by RAMP. Finally if a particular risk is unavoidable then measures shall be adopted to lessen the loss or damage to the project. Risk mitigation strategy should be well deliberated and all phases of projects shall be covered in it. While calculating the overall savings because of risk mitigation plan, the cost incurred on risk mitigation measures shall be taken into account. However financial returns can only be achieved once the mitigation plan is successfully implemented. The risk response plan is properly monitored and left over risks are also tackled as the process goes along.

2.3.3 Project Management Body of Knowledge (PMBoK)

Project Management Institute (PMI), which is the largest professional organization with over 100,000 professional members representing 125 countries, is dedicated to project management field. PMI proposed a risk management methodology to eliminate informality of risk management application by the sector participants which is called as Project Management Body of Knowledge (PMBoK) which is updated periodically. The Project Management Body of Knowledge (PMBoK) is an inclusive term that describes the sum of the knowledge within the profession of project management. This document is intended to provide a common lexicon within the profession for talking about project management.

The PMBoK (2004) describes the project management process as measures to be adopted for enhancing the prospects and positive impacts of favourable events on a project and lessening the likelihood and negative impacts of adverse events on a project. It covers the risk management process in six stages. The PMBoK process of risk management includes planning, identification of risks, risk analysis (Qualitative and Quantitative), risk response and finally monitor / control. In planning phase various activities to be performed for risk management are defined. Identify phase is about finding out various risks which can adversely affect the project. Peculiarities of each risk are also noted. Analysis of all found and probable risks is performed qualitatively and quantitatively. In qualitative analysis risks are prioritized based on need for further analysis or based on their likelihood of occurrence or based on their affects on the project. In quantitative analysis numerical values are allotted to the effects of explored risks on the project as a whole or on certain activities of the project. Based on these analyses responses are planned. While planning risk responses various options are considered to offset the negative impacts of a risk and best possible option is included in the plan. Last phase is to monitor the response and control the risk. All responses developed in last phase are put into action in this phase. Each response is unleashed when its counterpart risk come into play. All identified risks are tracked and those in hibernation are also kept under observation. New risks may also be discovered. Sometimes our planned responses may not prove to the task and in such cases response plan is also revised.

An overview of PMBoK process shows that all phases are linked to each other like a chain. End of one phase marks the start of next phase. The outcome of a phase is used as data for the subsequent phase. In each phase more than one individuals, syndicates or organizations are committed. It all depends upon the need and complexity of the project. PMBoK process focuses on marginalizing the negatives and endeavours to optimize the positives. Each process will be executed minimum once in the life cycle of a project. Certain processes are repeated twice and more. Like all other methodologies the PMBoK also gives detailed explanations for each phase like what is the precise input data for each phase? What techniques, procedures, tools etc are used to look for inputs? What outcome is expected at the end of each phase? This enables application of risk management process throughout the lifecycle of the project.

2.3.4 The Australian Standard

This Standard offers a common guide for establishing and implementing the risk management methods. The major elements described in this standard are summarized below.

2.3.4.1 Main Elements of Australian Standards for Risk Management

The main elements of the risk management process, as shown in Figure 2.1, are the following:

- **Establish the context.** It means ascertaining the planned, organizational and risk management framework in which the rest of the processes are going to occur.
- **Identify risks** will include what, why and how situations can arise from the sources for to be analyzed further.
- **Analyze risks.** Existing controls are required to be determined and risks should be analyzed in terms of consequence and likelihood in the backdrop of those controls.
- **Evaluate risks.** Estimated levels of risk are required to be compared aligned with the already recognized criteria. This facilitates risks ranking in order to spot management priorities. In case the levels of risk have been set up at low level, then risks may be placed in an tolerable category and action may not be needed.
- **Treat risks.** Low-priority risks are admitted and monitored a specific management plan has to be built up and implemented which take account of funding issue.

- **Monitor and review.** performance of the risk management system has to be monitored throughout and changes which might affect it should be taken into account
- **Communicate and consult**. It is very essential to communicate and consult by internal and external stakeholders as felt suitable at each stage of the risk management process and in relation to the process as a whole.

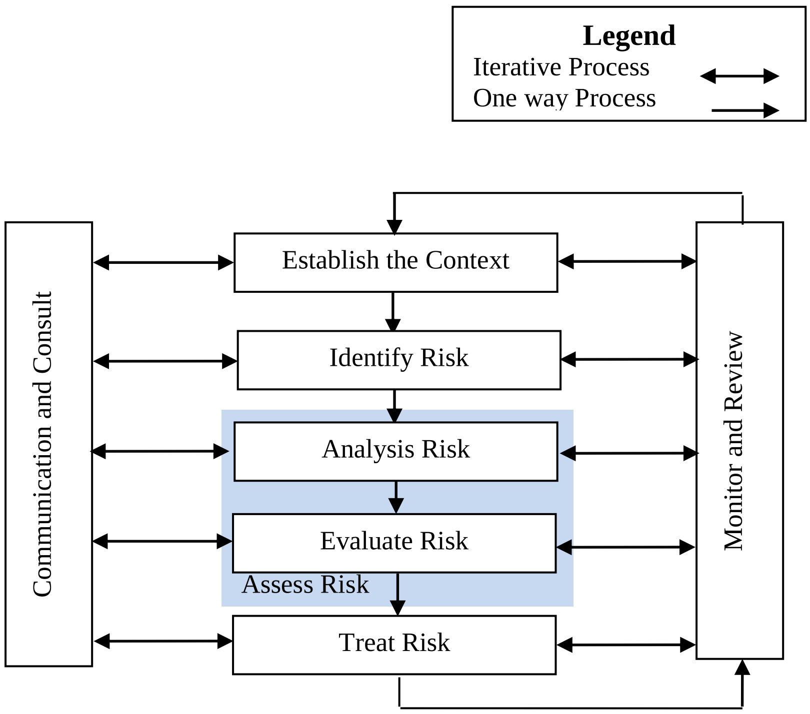

Fig 2.1: Elements of Australian Standards (1999) for Risk Management

2.4 APPLICATION OF ANALYSIS TECHNIQUES

A number of research studies are available to suggest how the Risk Management Plan should carried out in an organized and efficient manner with the help of different techniques. Few researchers such as Chapman (2001) concludes that risk identification can be taken as a part of risk analysis process. Meaning thereby, risk analysis should be evaluated in cooperation with qualitative risk analysis including knowledge attainment and identification of risk, and quantitative analysis which covers quantification and assessment of identified risks should be undertaken with the help of various risk analysis techniques. American National

Standard adopts the methodology of PMBOK while conducting risk management and same is widely adopted world wide as a standard.

2.5 RISK IDENTIFICATION - INPUTS

As a prelude to risk identification one must understand and identify his objectives. The risk and opportunity identification process should commence while a decision is being made, rather than after it has been made, as is too often the case (Loosemore et al. 2006). The decision objectives must be identified first before the identification of risks and opportunities because risks and opportunities are future events that can affect objectives either positively or negatively. Unfortunately, many decisions are made automatically without a proper understanding of objectives which is one of the main reasons why many potential risks and opportunities are overlooked which can be avoided by following these steps as suggested by Loosemore et al. (2006) and American National Standard (2004):-

- Obtain organizational commitment to risk and opportunity management.
- Conduct a stake holder analysis.
- Consult stakeholders.
- Identify objectives.
- Identify key performance indicators (KPIs).

2.6 PROACTIVE RISK IDENTIFICATION–TOOLS AND TECHNIQUES

Most of these techniques could possibly be divided with proactive and reactive to match the time of their employment. Ideally the danger identification process gets started when choosing one is becoming made using proactive chance identification tactics; however, it is not possible to distinguish all risks ahead of time regardless of the effort done to distinguish them. This particular entails that risk id should continue despite the decision continues to be made using reactive chance identification tactics. Loosemore et al. (2006) suggest following positive risk identification techniques: -

2.6.1 Employing and Using Creative People

The most apparent way to enhance an organization’s creative abilities is simply to employ more creative people or use creative employees more effectively.

To identify creative people is also not an easy task so a lot of effort has to be put on in this regard. Creative people excel at finding problems, at finding new perspectives in their solution and at producing order out of chaos. They are also enthusiastic to take risks, to get lesson from failure and are firm, exceptional, confident, tolerant of ambiguity and intrinsically rather than extrinsically motivated by things such as money, evaluations, prizes etc. For example, one of Albert Einstein's main motivations in life was to find simplicity and to disseminate his ideas without undue publicity. Indeed, when asked why he used hand soap for shaving instead of shaving cream, he replied that using one bar of soap was less complicated. It is worth noting that a number of psychological tests have been developed to identify creative individuals, some based upon personality measures, some on biographical experiences, some on intellect and others on cognitive skills such as divergent thinking. However, there is controversy surrounding these tests and only inconsistent evidence of their ability to predict real world creative achievement. Consequently, contemporary creativity tests focus upon people's outputs rather than upon their mental abilities. For example, in rating Frank Lloyd Wright as one of the most creative architects of his day, one would tend to cite as evidence, his buildings rather than his personality traits, although, admittedly, he often behaved and wrote eccentrically. Unfortunately, creative individuals like Einstein and Frank Lloyd Wright are rare and most managers need to elicit creative potential from specific combinations of relatively uncreative individuals. Nevertheless, it remains the case that most management teams are created in haste without proper regard to such issues.

2.6.2 Creativity Training

An alternative to recruiting creative people is to train an existing workforce to be more creative. Most creativity training programs are based upon the creative problem solving program developed by Sidney Parnes. This program teaches participants a range of techniques to help them find facts, problems, ideas and solutions to overcome resistance to their implementation. Unfortunately, while creativity training does seem to produce changes in creative ability, the effect is often short lived. Therefore, until there have been more long term studies of its effectiveness, its value to managers remains uncertain and it needs reinforcing with other approaches to learning which can open people's minds to potential risks and opportunities. One learning approach that could facilitate greater risk awareness in projects is project closure reviews. This simply involves spending some time at the end of a project reflecting upon the lessons learned and transferring them to people in future projects. For example, Ernst and Young use this technique by constructing a risk database using a standard set of questionnaires that are completed at the end of every project by different stakeholders. Future project managers can access this database to predict possible risks and develop effective management strategies, based on past company experience. In effect, this is a process of knowledge management. Similarly, British Petroleum has created a post project appraisal unit with the sole mission of helping the company learn from its mistakes and successes. The unit's objective is to improve company performance and help managers formulate investment decisions more accurately, appraise them more objectively and execute them more effectively.

2.6.3 Organizational Characteristics

For recruitment and training strategies to work, the structural and economical characteristics of an organization must also be favorable to creativity. Leadership, organizational structure, organizational culture, and environmental relationships are the main organizational characteristics which affect creativity are.

2.6.4 Idea Elicitation Techniques

These techniques help individuals structure their thinking so that they more fully understand the risks and opportunities associated with a decision. “It is not enough to have a good mind. The main thing is to use it well”. Following are few idea elicitation techniques as suggested by Loosemore et al. (2006).

2.6.4.1 Checklists

The simplest way to identify risks and opportunities is to use a checklist of them complied from experiences on previous projects. However, such checklists must be updated and reorganized to individual project requirements. It can be reorganized according to the level of decision making affected, the stage of project they arise in and the impact on organizational goals.

2.6.4.2 Decomposition

The simple task of planning a decision or project and breaking it down in to its component parts can help identify the potential risks and opportunities involved. This is a common method of risk identification used in construction projects where work break down statements or method statements are often used to divide an activity in to simple set of steps, operations or activities which can be analyzed in isolation. It is a valuable process that encourages a decision maker to think through a decision in a logical incremental and structured way and provides a useful audit trail for future risk management activities. In creating a work breakdown statement, stakeholders should be consulted. Working alone is always a mistake and will inevitably result in a narrow range of risks and opportunities being identified.

2.6.5 Forecasting

Forecasting is widely used to identify quantifiable risks and opportunities. It involves analyzing and evaluating past information and statistically using the results to predict future trends. A good example of forecasting is the life cycle costing of building components using discounted cash flow techniques. There are three main types of forecasting methods:-

- Extrapolative forecasts - based upon the belief that history repeats itself.
- Causal forecasts - based on using cause-and-effect relationships to predict the future.
- Normative forecasts - assume that people take an active role in shaping the future and try to take their goals and values into account when predicting it.

2.6.6 Brainstorming

Brainstorming is a group-based process which is valuable when making decisions about new, large, complex and non-standard business activities and relies upon group dynamics to elicit ideas. The success of brainstorming depends upon the breadth of experiences and perspectives within the brainstorming group and the skills of the facilitator in combining them effectively. It also requires careful planning because of the time and resources involved. A typical brainstorming group consists of between 10 and 15 stakeholders in a decision. Ideally, the group should draw from different disciplines, which are key members of a project team and involve any specialists who can bring additional expertise to the process. It is critical to have a range of interests represented to prevent polarization of views, and the inclusion of stakeholders encourages collective responsibility for the identification of risks and opportunities. In particular, when external stakeholders are involved, there are also numerous public relations benefits and the group will gain enormously from an outsider's perspective.

2.6.7 The Delphi Technique

It involves a coordinator carefully constructing a series of small multi disciplinary problem solving groups to discuss potential opportunities and problems which could influence the outcome of a decision. The difference between Delphi groups and brainstorming groups is that the former never physically meet but are usually coordinated through e-mail, the worldwide web or in writing. The Asch Effect and the Groupthink effect are therefore minimized due to the lack of interaction between respondents. The Delphi process starts with the coordinator asking group members on an individual basis for their opinions about a certain problem, usually in some form of questionnaire. After a pre specified period, ideas are returned and anonymously summarized by the coordinator and redistributed for further discussion. The important point about this initial session is that outlandish suggestions are encouraged and people are not restricted to their own knowledge domain. Furthermore, ideas are not associated with specific individuals. A second stage of opinions are then sought which are quite different from stage one in that they are more evaluative and based on the ideas generated from stage one. Once again the coordinator summarizes the ideas and after a number of further rounds of discussion when opinions have stabilized, a final consensus list is produced which is a team output rather than an individual one. While overcoming some of the problems associated with traditional brain storming, there are a number of weaknesses with the Delphi technique. For example, people tend to find out who is in the Delphi group and might exert pressure upon each other, beyond a manager's control. Furthermore, it is difficult to ensure the diligence of participants and to maintain their motivation to contribute. Finally, the process takes considerable preparation, is often slow and depends upon the respondents' abilities to express themselves clearly in writing.

2.6.8 Influence Diagrams

Influence diagrams (sometimes called "Ishikawa diagrams" or "tree diagrams") can be used to help you discover how a threat or opportunity might arise. It should be used only after you have used another technique to identify what threats and opportunities might occur and when they may occur. Such techniques include checklists, method statements, forecasting, soft systems analysis and brainstorming. Influence diagrams recognize that most threats and opportunities do not occur in isolation but arise from a chain of contributory events (or sub-risks). Most things have one thing wrong with them and, very often, it only takes a second fault to make it a problem. A threat or opportunity cannot be understood fully in isolation from this interdependency and the effective management of a potential threat or opportunity is only possible when you understand this whole process. To this end, influence diagrams are used as a graphical representation of the chain of contributory events which could lead to a risk or opportunity eventuating. An example is provided in Figure 2.2, which reveals the component events that could cause a cost overrun to arise (the horizontal arrow) and how they could combine to do so. The process of constructing an influence diagram is simple and involves dividing the main threat or opportunity into its components and subcomponents until the origins of a risk are identified. This process can be facilitated by working backwards from the eventual threat or opportunity, asking "what could cause?" questions.

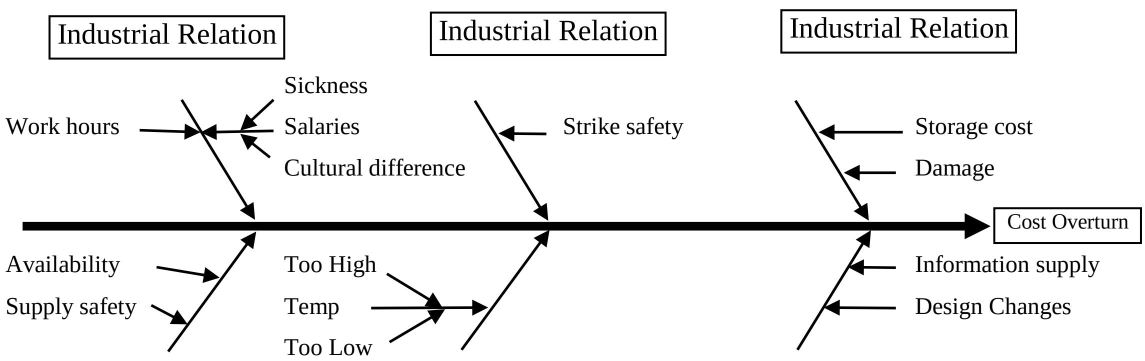

Figure 2.2: Influence Diagram (Loosemore et al. 2006)

2.6.9 Fault Tree Analysis

A sophisticated analytical technique which uses tree diagrams to predict risks is Fault Tree Analysis. This was originally developed in the US to prevent the accidental launching of missiles and has been used extensively in safety engineering ever since. Fault Tree analysis involves looking for potential faults in a system that might cause failure and mapping the connections between them. Fault trees can be used to help discover how a threat or opportunity might arise. It should be used only after another approach is used to identify what and when threats and opportunities might occur. A typical fault tree is shown in Figure 2.3.

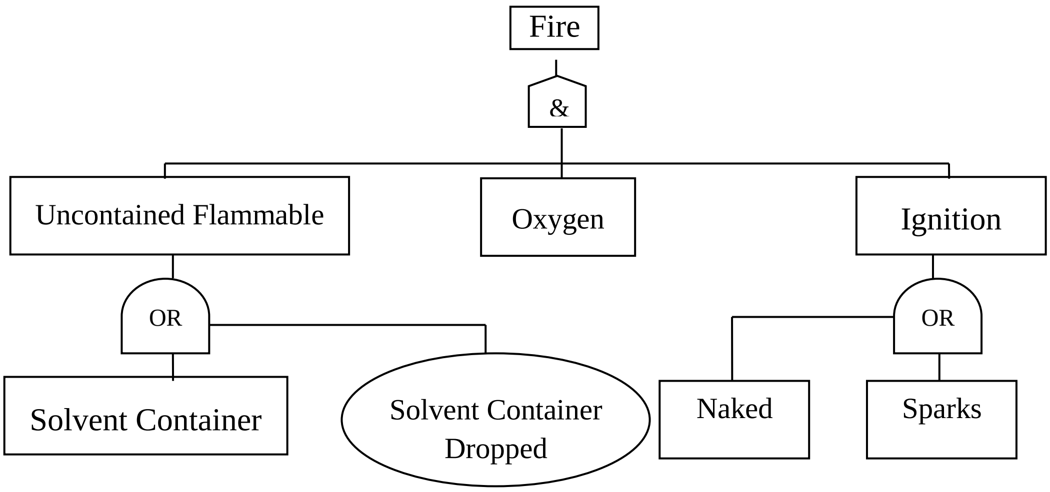

Figure 2.3: Fault Tree Analysis (Loosemore et al. 2006)

2.6.10 Simulation

Simulation uses mathematical modeling techniques to help managers artificially experience a situation and thereby identify the potential risks and opportunities associated with it. The advantage of simulation over the largely manual techniques is its ability to handle huge quantities of information and to take into account the interdependence between different risk variables. That is how one risk can create another and how a particular combination of circumstances can impact upon a project variable. Simulations also allow managers to experiment by altering project variables to see what the impact on various risk levels will be. Computers are essential to undertake this process where the computer acts as an experimental laboratory where the project can be "run" over-and-over again using different combinations of input assumptions. The business world has noted the potential value of simulating the business environment in much the same way as one can model an aircraft. The latest development in this field is to link real data from a company's accounts and records so that managers can ask "what if" questions about the future.

2.7 REACTIVE RISK IDENTIFICATION TECHNIQUES

No matter how rigorously a manager applies proactive risk identification techniques, it is inevitable that some risks and opportunities will arise after a decision has been made or after a project has moved forward and is progressing through its implementation stages. It is impossible to identify all potential risks and opportunities in advance and new risks and opportunities often arise as a result of completely unpredictable events. There is therefore a need to have the capacity to effectively and efficiently react to these risks and opportunities when they arise. This can be done by simply encouraging employees to notify their supervisor of potential hazards, when they become aware of them. However, there are also a number of formal techniques that can assist in this process. Loosemore et al. (2006) summarize these techniques as under:-

2.7.1 Risk Inspections

Risk inspections involve inspecting the workplace, employees and / or documents at regular intervals. The aim is to identify new potential threats and opportunities to a decision outcome that arise while it is being implemented. Regular inspections are particularly important when documents or the workplace is changing continuously.

2.7.2 Bug Listing

The idea behind bug listing is to list things that tend to bother people on a day-to-day basis, which could potentially interfere with decision outcomes. The problem with bugs is that they are so commonplace that they are hard to remember. People tend to miss them by focusing on the larger problems that might arise in their formal inspections. However, the cumulative effect of minor problems can be very important. Bug lists arc best made by carrying a notebook to record the bugs when they arise. These lists can form the basis of risk identification in regular risk review meetings.

2.7.3 Risk Review Meetings

Risk review meetings should be organized regularly with decision stakeholders, the purpose being to:-

- Discuss the results of regular risk inspections.
- Discuss the implementation of a decision with the aim of identifying potential new threats or opportunities.
- Maintain effective communications with decision stakeholders.
- Facilitate cooperation in instigating, developing and implementing measures to minimize threats and maximize opportunities.
- Formulate, review and disseminate standards, rules and procedures to ensure that the decision outcomes are achieved, ideally better than planned.

2.7.4 Industry Information

Ensuring that decision makers keep themselves up-to-date with the latest industry information relating to new research and practice is important in highlighting new threats and opportunities to decision outcomes. This can be done through regular training programs, email lists, websites, risk and opportunity newsletters, and bulletins etc.

2.7.5 Automatic Sensors

It is important to use any technology available to monitor and detect potential physical risks that might arise in the workplace. Such risks include noise, dust, fire, fumes, vapors, gases, temperature, sun, radiation, security etc. Appropriate sensors should be installed which are connected to automatic controls or communication systems that can facilitate a response. Sensors might include, heat sensors, dosimeters, static area monitors etc and control devices might include alarms, sprinklers, ventilation fans etc. It is important that such equipment is inspected, tested, recalibrated and maintained regularly.

2.7.6 Incident Investigations

Incidents are defined as the occurrence of any event which causes actual loss or benefit to business objectives. Thorough investigations of any incidents after they have occurred are important since the lessons learnt can be very useful in preventing a repetition of events and in identifying further potential risks and opportunities to business activities.

2.7.7 Performance Appraisals

Regular performance appraisals should be conducted using the objectives and measurement criteria identified at the start of the risk identification process. Deviations from planned performance levels may indicate new risks or opportunities which will need investigation, analysis and response.

2.8 RISK IDENTIFICATION – OUTPUT

Risk register is used to maintain a record of outputs of risk identification process which becomes part of the project management plan. The risk register finally contains the outcomes of the other risk management processes also. The risk register contains list of identified risks, list of potential responses, root causes of risk and updated risk categories as per American National Standard (2004).

2.9 QUALITATIVE RISK ANALYSIS – INPUTS

The input to qualitative risk analysis include organizational process assets, project scope statement, risk management plan and risk register.

2.10 QUALITATIVE RISK ANALYSIS - TOOLS AND TECHNIQUES

The tools and techniques as described in American National Standard (2004) include:-

2.10.1 Risk Probability and Impact Assessment

Risk probability assessment investigates the likelihood that each specific risk will occur. Risk impact assessment assesses the negative and positive effects on a project objective. Probability and impact are assessed for each identified risk and rated according to the criteria given in the risk management plan. Sometimes low risk for probability or impact may not be rated but are included to see any future effects of them on project objectives.

2.10.2 Probability and Impact Matrix

Risks can be prioritized for further quantitative analysis and response, based on their risk rating for their specific probability and impact. Risks are then prioritized for their importance using a probability and impact matrix which depict rating of the risks as low, moderate, or high priority as explained by Loosemore et al. 2006 (Table 2.3). Numeric values can also be given for ratings as per the preference of organization which also specifies which rating of risk should be included in which category like high, risk, moderate risk and low risk. These conditions can be depicted by various color codes or gray shades (Table 2.4).

Table 2.3: Descriptive Qualitative Risk Estimation (Loosemore et al. 2006)

Probabilities	**Consequences**				
	Insignificant	**Minor**	**Moderate**	**Major**	**Extraordinary**
Almost certain	Low	Medium	High	High	High
Likely	Low	Medium	Medium	High	High
Possible	Low	Low	Medium	High	High
Unlikely	Low	Low	Low	Medium	Medium
Rare	Low	Low	Low	Medium	Medium

Table 2.4: Numeric Qualitative Risk Estimation (American National Standard 2004)

Probability and Impact Matrix

Probability	**Threats**					**Opportunities**				
0.90	0.05	0.09	0.18	0.36	0.72	0.72	0.36	0.18	0.09	0.05
0.70	0.04	0.07	0.14	0.28	0.56	0.56	0.28	0.14	0.07	0.04
0.50	0.03	0.05	0.10	0.20	0.40	0.40	0.20	0.10	0.05	0.03
0.30	0.02	0.03	0.06	0.12	0.24	0.24	0.12	0.06	0.03	0.02
0.10	0.01	0.01	0.02	0.04	0.08	0.08	0.04	0.02	0.01	0.01
	0.05	0.10	0.20	0.40	0.80	0.80	0.40	0.20	0.10	0.05

Impact (ratio scale) on an objective (e.g., cost, time, scope or quality)

Each risk is rated on its probability of occurring and impact on an objective if it does occur. The organization's thresholds for low, moderate or high risks are shown in the matrix and determine whether the risk is scored as high, moderate or low for that objective.

2.10.3 Risk Data Quality Assessment

A qualitative risk analysis requires accurate and unbiased data so that it should be useful for risk management. The data is examined for its degree of accuracy, quality, reliability, and integrity for the particular risks. The low quality data may lead to un-realistic and misleading conclusions which may be fatal for the project. So it is imperative to gain reliable data which may consume time and resources.

2.10.4 Risk Categorization

Risk categorization can be done by various criteria i.e. sources of risk, the area of the project affected or according to project phases to determine project area or phases which can be effected by uncertainty. One of the methods can be to categorize risk by common route cause so as to prepare effective risk responses.

2.10.5 Risk Urgency Assessment

Risks which need immediate actions and attention are identified through risk urgency assessment. Indicators of priority can include time to affect a risk response, symptoms and warning signs, and the risk ratings.

2.11 QUALITATIVE RISK ANALYSIS – OUTPUT

Updation of risk register for those risks identified in risk identification process is an output of qualitative risk analysis and the updated risk register is included in the project management plan. Risk register updates may include relative ranking or priority list of project risks, risks grouped by categories, list of risks requiring response in the near future, list of risks for additional analysis and response, watch lists of low priority risks and trends in qualitative risk analysis results.

2.12 QUANTITATIVE RISK ANALYSIS – INPUT

The input to quantitative risk analysis includes organizational process assets, project scope statement, risk management plan, risk register and project management plan.

2.13 QUANTITATIVE RISK ANALYSIS – TOOLS AND TECHNIQUES

Loosemore et al. (2006) suggests techniques for quantitative risk analysis which are described subsequently.

2.13.1 The Risk Premium

The risk premium is a rather is extensively used tool and known as the contingency fund. In construction it is a usual routine to have a contingency fund. In almost every industry, the contingency premium is added to the base estimate to account for for those risks which cannot accurately be ascertained at some early time frame. However, in practice, the way in which contingency allowances are calculated is often problematic. While giving contingency allowance, it can be a tendency to give greater allowance then required which may push project approval towards rejection during benefit-cost analysis. It may also be an effort to mask the poor project management. It is, therefore imperative to be extra cautious while giving such allowances. The risk premium is at best a rather blunt tool that is made less effective because it is also not used very effectively in practice.

2.13.2 Sensitivity Testing

Sensitivity tests identify the effect on a decision output, of certain specified changes in the value of input variables (risks). This will reveal what input variables (risks or opportunities) project cost is most sensitive to. If costs increase when a variable in changed then it is a risk, but if costs fall then the variable is an opportunity (assuming that the objective is to minimize costs). Sensitivity testing can portray an extremely useful picture of a project / investment decision under real conditions and scenarios. It is quick and easy to use, requires little information and can usually be carried out by hand. Furthermore, it fully recognizes uncertainty in the input variables and can show how the output will be influenced by changes in input variables either singly or in combination.

This will reveal what input variables (risks or opportunities) project cost is most sensitive to. For example, a 5 percent change in one variable may produce a 50 per cent increase in costs whereas a 5 percent change in another variable might produce no change in costs. Clearly, the bigger risk variable which merits special attention is the one which produces the 50 per cent change. Furthermore, if costs increase when a variable in changed then it is a risk, but if costs fall then the variable is an opportunity (assuming that the objective is to minimize costs). Nevertheless, sensitivity testing, when interpreted correctly and conducted realistically, can convey an extremely useful picture of a project / investment decision under dynamic real world conditions. There are several advantages to the use of sensitivity testing. It is quick and easy to use. It requires little information and it can usually be carried out by hand. Furthermore, it fully recognizes uncertainty in the input variables and can show how the output will be influenced by changes in input variables either singly or in combination. However, there are also several limitations with this method. For example, it takes no account the likelihood of the range of input and output variables. Therefore, does not give a probabilistic picture of risk exposure and there is no explicit method of allowing for risk attitude. For this reason, it has been argue that the results of sensitivity tests are at best ambiguous and at worst misleading. They are said to be ambiguous because they do not suggest how likely it is that the pessimistic or optimistic results will occur. They can also be misleading when some analysts unrealistically take a number of very low probability worst or best case values of input variables and calculate the effect on the output. Such combinations produce extremely low probabilities, are very unlikely in the real world and such a test would produce exaggerated results.

2.13.3 Expected Monetary Value (EMV)

A simple way of incorporating probability into risk analysis is the EMV method. It is often very useful for companies, in making decisions, to express their risks in dollars. Although this is not always possible with reliable accuracy the resultant value is commonly referred to as the expected monetary value (EMV) of a decision. When calculating EMV, it is important to appreciate that every event has a range of possible outcomes (consequences), each with a different probability of occurring. So far we have simplistically assumed that any event has only one possible outcome with an associated probability of occurring. This range of possible outcomes is called a probability distribution. For example, consider a lottery ticket which gives the owner a 0.75 chance of winning $5000 and a 0.25 chance of winning nothing. The expected monetary value (EMV) of the ticket is given as:

$$EMV=0.75 \times \$5000 + 0.25 \times \$0 = \$3750$$

This implies that over a large number of transactions, I can expect to make $3750 from purchasing such lottery tickets. The significance of this EMV calculation is that it tells us there is no risk in spending $3750. It also tells us that if we spend more than $3750 then we can expect to lose money and the more we spend over this amount, the more risk we incur. While valuable, it is important to appreciate that EMVs, when based on objectively derived probabilities, are only meaningful in the context of a large number of identical transactions. Unfortunately, it is sometimes used inappropriately to assess decisions of a more unique nature, which change over time. The advantage of the EMV method is that it considers all possible outcomes and avoids simply combining all the best and the worst cases to produce unrealistic extremes of possible outcomes. The EMV method is also suitable for a range of applications - budget figures, tender price forecasts, rates of project return or completion dates. It also overcomes some of the limitations of sensitivity testing by explicitly allowing for the probability of change in input values producing a risk-adjusted outcome. The limitation of EMV, when based on objective probabilities, is that it is best used consistently over many similar-sized projects. The guidance it provides is helpful, but strictly, only in the very long run.

2.13.4 EMV using a Delphi Peer Group

One of the issues in using any probabilistic technique is how to arrive at the probability values. The Delphi method is named after the oracle at Delphi in ancient Greece. It utilizes a formal Delphi group and is designed to pool the expertise of many professionals in order to gain access to their knowledge and technical skills while removing the influences of seniority, hierarchies and personalities on the derived forecast. It also eradicates the biases of overconfidence which may encroach on expert forecasts. Very first, a group of experts is discovered. The collection associates are stored individual to prevent any private relationship, as well as the planner questions every member to generate a predict along with a summary possibility estimation for that appropriate components of the actual challenge or perhaps selection under consideration. The planner receives and also summarizes these kinds of estimates as well as the synopsis is given back towards the associates without the brands affixed. The collection associates are then inquired to help modify the forecasts inside gentle on the synopsis data. The revolutionary forecasts are then revised and also conveyed to all associates. This technique of predict, synopsis, change and also opinions remains until finally there's a agreement or perhaps when the associates no more wish to modify the forecasts. The actual result would be the Delphi predict and also there's no doubt that will this is the effective means of coming up with crucial jobs at the funds and also feasibility point. In many jobs it may simply be carried out employing e-mail during one morning. The luxury of putting the actual Delphi collection towards the EMV process is it is a new well recognized method of getting the best out of a group of experts in the forecasting circumstance. The issue would be the added resources and also occasion it requires to undertake. Likewise, individuals may not have a similar window of your energy so that you can carry out the method together. Consequently risks and also dimensions of the challenge need to be satisfactory to help guarantee the time and effort required.

2.13.5 Expected Net Present Value (ENPV)

The ENPV approach is useful in investment and development appraisal and can be applied in a wide range of situations where future income or cost flows are known. For example, it is used by the Victorian Government in Australia to evaluate tenders for PPP projects covering periods of up to 30 years. ENPV is also the basis of life cycle costing technique. ENPV is based on the particular combined chance examination and the corporate fiscal technique of lower dollars flows (DCF) which includes also been designed to help transform future income or perhaps price flows back to net modern ideals. The particular DCF method is based on the particular premise the price regarding cash diminishes as time passes as a result of amount of components including inflation, taxation and also gaining prospective. These types of components signify a new greenback right now is worth more than a greenback later on. This is reflected inside ENPV data with a discount fee (a percentage number which echoes these kind of factors) to help transform future price or perhaps revenue channels back to present day (present) ideals, thus aiding solitary point reviews among different investment decision chances or perhaps risks. Basically, the ENPV number may be the amount that could be desired right now to buy the comparable level of merchandise or companies eventually later on. Therefore if a building portion costs $1000 to fix inside decade time period, the particular ENPV of the fix price may be the comparable amount the item costs right now to undertake of which precise fix. Considering that inflation will certainly almost always improve fix costs above the 10 12 months period, the particular ENPV number of comparable fix right now are invariably below $1000. So the discount rate can be based on a number of factors which determine how the value of money changes over time. These include future rates of inflation, taxation rates, affordability rates and investment rates that determine how a dollar invested now can grow in value over the period being considered. For example, the discount rate used by the UK government and Australian Victorian State Government for the economic appraisal of PF1 and PPP projects respectively has been 6 percent per annum - the average rate of return from government investments. In UK changed its PFI discount rate to 3.5 per cent to reflect society's time value of money (inflation). Coincidentally, Australia also changed its discount rate to a flexible one, based on the perceived level of risk on each project. The example given here is for investment appraisal but the same approach could be used for the development appraisal of a new building or an infrastructure project.

2.13.6 Risk Adjusted Discount Rate (RADR)

This can be a great instinctive and intensely uncomplicated technique of dealing with risk, that's popular within checking along with company intended for investments which produce an income mode in excess of some time. The method is not effectively grasped within construction although might be a handy means of dealing with each risk subjection along with risk frame of mind, for living cycle being choices along with profit / price streams within PFI along with PPP initiatives. Your RADR functions gradually transforming the actual discount price to take bill of the standard risk came across within a advancement. Each and every improvement from the discount price efficiently sets a higher problem for that venture, turning it into less suitable through reducing the actual computed net provide importance (NPV) of long term income.

2.13.7 Detailed Analysis and Simulation

Simulation is a sampling technique which draws randomly assessments from complete range of individual probability allocations developed for every decision on a project. Simulation provides the systematic assessment of alternative project strategies and explores the optimum one. The Monte Carlo technique is used as the statistical basis for such analysis in general. Although many managers have heard of this simulation technique, it conjures up images of a complex analytical tool that is difficult to use. Nevertheless, the Monte Carlo technique is very simple in principle and identifies individual variables into calculation as probability distributions instead of single numbers. Using a simulation program (probably built on the back of a spreadsheet such as Excel) a project is "built" many times, with random variations of the input variables defined in the input probability distributions in respect of each decision in a project. Result provided by simulation is in a statistical sample of unlike projects outcomes but having matching probabilistic characteristics.

2.14 QUANTITATIVE RISK ANALYSIS – OUTPUT

The main output is in the form of updating of risk register. Initiation of the risk register is carried out in the Risk Identification process and constantly updated throughout the processes sequentially in qualititative analysis. Further updation is done after quantitative risk analysis. Updates as suggested by American National Standard (2004) include probability of attaining cost and time goals, list prioritization of quantified risks and tendencies in quantitative risk analysis findings.

2.15 RISK RESPONSE – INPUT

American National Standard (2004) suggests risk management plan and risk register as inputs to this process.

2.16 RISK RESPONSE – TOOLS AND TECHNIQUES

2.16.1 Strategies for Negative Risks or Threats

The main strategies suggested by American National Standard (2004) to deal with threats or risks that may have negative effects on project objectives in case they are materialized. These are comprised of three components namely; avoid, transfer, or mitigate. Detail is given subsequently.

2.16.2 Avoid

Avoid the risk involves ,making changes in the project management plan to get rid of the threat created by an adverse risk, isolating the project objectives from the impacts of risk, or the objective that are under threat may be relaxed, e.g extension of the schedule or scope may be reduced.

2.16.3 Transfer

Risk transfer refers to allocating the undesired impacts of a hazard, in conjunction with the rights of the response, to a third party. Such an arrangement simply provides another party responsibility of managing these risks; it does not eradicate it. This is more effective when dealing with exposure of fiscal risks. Risk transfer almost entails payment of a risk premium to other stakeholder taking on the risk. Variety of risk transfer tools and techniques are available which are quite dissimilar and may include the use of insurance, performance bonds, warranties, guarantees, etc. One of the effective ways is the contracts which may be utilized to transfer liability for specified risks to other party. Use of a cost-type contract, in much of situations, may shift the cost risk to the buyer, whereas a fixed-price contract may transmit the risk to the seller, provided design of the project is stable.

2.16.4 Mitigate

Risk mitigation term refers to reducing the probability and / or influence of an undesirable risk event to a tolerable threshold. It is much desirable and advocated to take early actions in order to diminish the probability and / or impact of a risk going to happen on the project and it proves many times more effective instead of repairing the harm after the risk has taken place. Mitigation measures examples can be, to adopt simple processes, carryout more tests, or selection of a more assured supplier . Prototype development may be required for carrying out mitigation measures in order to reduce the chance of scaling up from a bench-scale replica of a procedure or result. In cases which do not allow reduction in probability, a mitigation response might tackle the risk influence by focusing on the linkages that decide the severity.

2.17 TYPICAL RISKS IN CONSTRUCTION INDUSTRY

Physical Risks

- Accident on Site
- Damage to Equipment
- Damages to Machinery
- Human injuries
- Damages to Infrastructure
- Fire eruption
- Theft

Risks due to Act of God

- Floods
- Earthquake
- Landslide
- Fire
- Wind damage

Engineering Design Risks

- Incomplete design
- Inexperience Designer
- Defective design
- Poor Scope understanding
- Errors & omissions

- Inadequate specifications

Political Risks

- Disowner ship of Project
- Changes in laws and regulations
- Requirement for permits
- Law & order Situation
- New Legislation

Environmental Risks

- Pollution and Safety Rules
- Over activation of Environmental Agencies and NGOs
- Poor EIA report at design stage
- Local’s emotions hike due to damages to graveyards etc
- Climatic risks like rain, snow etc

Site Related Risks

- Labor disputes
- Stakeholder’s interventions
- Labor efficiency
- Extreme site conditions
- Design changes during currency of project
- Machinery, equipment failure
- Supply breakdown

Financial & Economical Risks

- Inflation
- Rise in Salaries
- Change in Interest Rates
- Escalation in Materials Costs
- Cash flows
- Exchange rate fluctuations

Stakeholders Risks

- Withdrawal of Acceptance
- Lobbying for Rejection
- Protests
- Strikes
- Denying access to site

Organizational Risks

- Demonization of Project Team
- Leaving of Team Member
- Organization's Ability to keep the project
- Financial health
- Policies

2.18 SOURCES OF RISKS (Standards Association of Australia)

- **Economic**
  - Inflation
  - Taxes
  - Price hike
  - Exchange rates
  - Market competition / demand change
- **Financial**
  - Interest rates
  - Cash flows
  - Capital supply
  - Pay demands / constraints
  - Delayed payments from client or customers
- **Political and social**
  - Changes in government and its policies
  - Permits
  - Law and order situation
  - Strikes
  - Civil war
  - Resistance from local population to the project
- **Commercial and legal relationships**
  - Contract conditions / requirements
  - Corruption / Fraud
  - Disputes and claims
  - Delay in possession of site
- **Technology, methods and procedures**
  - Stability of design / design changes
  - Availability of equipment / technology / material
  - Equipment reliability
  - Material quality
  - Sampling / testing
- **Human**
  - Effectiveness of communication
  - Skills and staffing issues
  - Racism / discrimination
- **Natural events**
  - Earth quake
  - Floods / heavy rain
  - Slides / avalanche
  - Tornado / hurricane

2.19 RISK IMPACT AREAS (Standards Association of Australia)

- Resources and assets of an organization including personnel
- Direct and indirect costs, budget and estimates
- Time and schedule of the project and activities
- Quality of the project
- Intangibles like goodwill and reputation
- Revenue and entitlement
- People
- Community
- Performance
- Natural environment
- Organizational behavior

2.20 STRUCTURE OF CONSTRUCTION INDUSTRY IN PAKISTAN

The construction industry in Pakistan is heterogeneous and enormously complex. There are several major classifications of construction that differ distinctly from one another: e.g.

- Housing
- Nonresidential / Commercial Building
- Airports
- Highways
- Utilities
- Industrial
- Dams & Canals
- Ports & Harbors etc

. Construction work is designed and supervised by Consulting firms / individual consultant. The Consultant may be (an) engineer (s) or (an) architecture (s).The PEC bylaws are considered binding legal framework for the construction works whereas international standards like ACI, ASTM, AASHTO etc. are used for construction activities. The construction work is carried out in the presence of "The Engineer" who has good authority over all the parties of the contract.

Usually following are the prime stakeholders of the construction project.

- The Client (The Employer, Customer, Buyer etc.)
- The Contractor
- The Engineer
- The Consultant (Designer etc.)
- The Supervision Consultant
- The Management Consultant (only on large projects)

- The Sub-Contractor
- The Suppliers

2.20.1 Risk Management Strategy in Construction

- It is of utmost importance to carry out or suggest actions which can eliminate the risks prior to their occurrence, or should decrease the consequences of risk or uncertainty.
- Make arrangements and strategy for risk mitigation, in case risk is ascertained.
- Root causes of risks need to be recognized, and risks should not be considered as events that can happen more or less randomly
- The client/contractor should have a complete strategy of risk management as part of the Contract Documents.

2.20.2 External Environment in Construction

Construction projects do not exist in isolation. These are heavily influenced by external factors and they also influence the world outside them. These external factors can be termed the project environment. Public sector projects are those undertaken by central and local government. whereas private sector projects are those undertaken by individual companies or consortia which are usually entirely privately owned The main aim of projects undertaken in the private sector is to make a profit, whereas for projects undertaken by the public sector is to provide a public service and also of benefit to the community in publicly funded projects, the government or local authorities have taken many of the risks. The Clients have generally sought to transfer more of the risk for the design and construction of their project to the consultants and contractors who design and construct them.

Chapter 3

METHODOLOGY

3.1 INTRODUCTION

The research was distributed in four parts/phases which were performed through literature review, discussions and interviews along with a questionnaire survey. Figure 3.1 illustrates the same graphically .A three level classification for risks: (country, market and project) was used in order to ascertain the criticality of each level and correlation of risks at different levels/groups. Study follows with little modifications methodology adopted by Wang et al. (2004). Each risk has been given an alphabetical ID for ease of reference. Mitigation measures have also been numbered as M1, M2,….. and so on for each risk. Afterwards the risks along with their proposed mitigation measures were filtered after discussion with industry experts and some experienced academicians. The list of shortlisted risks and mitigation measures are attached as Appendix I.

3.2 DEVELOPMENT OF QUESTIONNAIRE

A questionnaire was chosen as the principal survey method from literature review as first step then a pilot survey was carried out in order to confirm the applicability of the questionnaire in home environments. Seven experts from different organizations were selected and questionnaire was distributed among them: two from clients, two from consultants and three from contractors were chosen for this purpose. This was pursued by interview with every individual participant ensuring 100 percent response. Respondents were having more than ten years of construction related experience in their relevant field. The questionnaire was modified many times from the feedback of these experts and a final questionnaire was developed to suit local environments. The questionnaire covers all major risks which can be encountered in construction projects specifically in the backdrop of Pakistan. Practical mitigation measures for these risks were proposed for evaluation by the respondents.

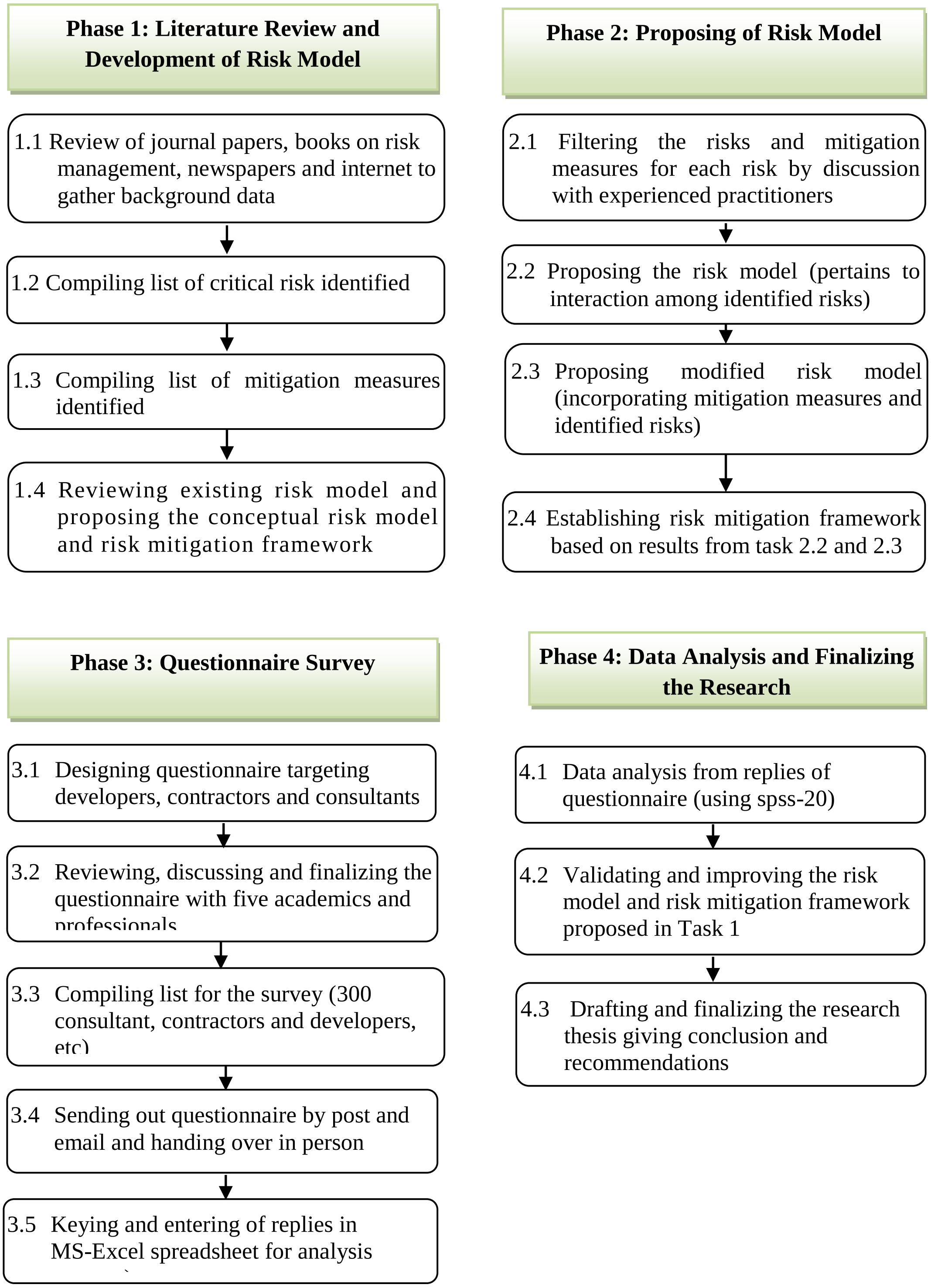

Figure 3.1: Research Tasks

Questionnaire in its final form (Appendix II) has an introduction of the respondents including their name, qualification, construction industry experience, appointment and organization, group i-e (Client, Consultant or Contractor).The questionnaire is divided in two parts: first; criticality of risks, second; mitigation measures to address these risks. In first part, 27 major risks have been identified, out of which 20 are taken from Wang et al. (2004), and rest were framed from input of experts of pilot survey. In second part, mitigation measures for these risks have been given taken from Wang et al. (2004) and from input of experts of pilot survey. After analyzing the survey results and responses, the risk model along with risk management framework was proposed.

3.3 SELECTION OF GEOGRAPHICAL AREAS AND FIRMS

To conduct the survey four most developed areas of Pakistan Lahore, Karachi, Islamabad and Rawalpindi were selected (Burki et al 2010). Karachi being the only sea route is main financial and construction hub of Pakistan with an estimated population of 14.7 millions. Whereas Lahore is capital of Punjab province which is a financial and construction centre of Punjab having second maximum population of almost 8.3 million. Islamabad and Rawalpindi are major cities with joint population of approximately 3.2 million and both constitute third highest concentration of population in Pakistan. Besides this Islamabad is a Federal Capital city also. Keeping in view the geographical location of these areas, their population, industrial concentration as well as development ranking, it can safely presumed that these areas have considerable contribution in the construction industry of Pakistan, representing most of the population of the country.

3.3.1 Sample Size

In order to get the sample for the research a population of construction enterprises were selected from Pakistan. PEC statistical data gives the registered number of consultancy and construction firms with PEC which have risen to 30000 until January 2013 but all of them are not practically taking on construction projects. This is quite a large population therefore the sample selection is going to represent varying construction experts such as clients, consultants and contractors with unlike categories and environments.

Acceptable sample sizes for various populations with different sampling errors for 95% confidence level are given in Table 3.1.It is assumed that the answers will be homogeneous and will set the p value to be 0.5meaning thereby that probability of occurrence is 50%.The use of 50/50 split maximizes the question variance, which requires the largest sample to control for the differences between response options. Keeping these factors in mind and consulting table 3.1, sample size comes to be 96 therefore any sample near 96 is quite acceptable. . Keeping in view the length of questionnaire and time required to complete it a response of 87 respondents is fairly large and is assumed to be representative of population.

Following-up have remarkable effects on the rate of response as established by Dillman (2000) . Adding on he is of the view that if no follow up is made; the response rates are going to be very less, inspite of an attractive and easy mail package or interesting the questionnaire. Researchers have to have a balance of the time and cost while undertaking the follow-up (McGuinness, 2008). In this survey, frequent follow ups were made via telephone after two weeks of the first mailing pursued by few visits after 8 weeks.

Table 3.1: True Sample Size *(Dillman, 2000)*

Completed sample sizes needed for various population sizes and characteristics at three levels of precision.

	Sample size for the 95% confidence level					
	±10% Sampling Error		±5% Sampling Error		±3% Sampling Error	
Population Size	50/50 split	80/20 split	50/50 split	80/20 split	50/50 split	80/20 split
100	49	38	80	71	92	87
200	65	47	132	111	169	155
400	78	53	196	153	291	253
600	83	56	234	175	384	320
800	86	57	260	188	458	369
1,000	88	58	278	198	517	406
2,000	92	60	322	219	696	509
4,000	94	61	351	232	843	584
6,000	95	61	361	236	906	613
8,000	95	61	367	239	942	629
10,000	95	61	370	240	965	640
20,000	96	61	377	243	1,013	661
40,000	96	61	381	244	1,040	672
100,000	96	61	383	245	1,056	679
1,000,000	96	61	384	246	1,066	683
1,000,000,000	96	61	384	246	1,067	683

A total of 300 questionnaires were sent through courier, electronic mail and delivered in person. As contractors bear major toll for risks so more input was solicited from them, therefore, 210 (70%) questionnaires were distributed to contractors and 45 each to clients and consultants. Total valid responses received were 87 (29 percent). The category wise distribution is: 16 (Consultant), 17 (Client) and 54 (Contractors). Sixty (60) percent of all the respondents were having more than ten years of experience and the rest were having 3-10 years of experience of working in their respective fields in construction industry.

Risk evaluation is a complex process which is veiled in uncertainty and vagueness; it could have been difficult for respondents to opine in true manner, however, project/construction managers can access risks in qualitative terms easily. Therefore to develop the reliability and preciseness of the survey, a five-degree ordinal rating for the criticality of risks and mitigation measure's effectiveness was adopted, where 1 represents lowest and 5 highest critical nature of risk for project.

3.4 UNDERSTANDING STATISTICAL TERMINOLOGIES

Statistical terminologies applied in the research have been taken from Choudhry and Kamal (2008) and are described below:-

3.4.1 Statistical Hypothesis and Testing

It has been considered as very important element of statistical inference. This is a procedure which facilitates to choose based upon the information acquired from selected sample data either to accept or reject an assumption regarding the importance of a population parameter. A statistical hypothesis is described as an assumption or statement which may be true on one occasion and may not be on the .other occasion. When the hypothesis is supported by the sample data it is accepted as being true, however, when it is not supported by the sample data, it is rejected.

3.4.2 Null and Alternative Hypothesis

Null hypothesis can be described as the hypothesis which is to be tested for possible rejection on the assumption that it seems to be true, it is symbolized by Ho. Alternative hypothesis is the one which is accepted when the null hypothesis is rejected and is denoted by H1,H2,…Hn.

3.4.3 Type I and Type II Errors

Type I error is described as rejecting null hypothesis when it is in fact true and type II error is the accepting of null hypothesis when it is false. The possibility of having type I error is denoted by α and that of having a type II error is denoted by β.

3.4.4 Testing of Significance and Significance Levels

Significance level can be defined as "the probability taken as a standard for rejecting Ho, a null hypothesis, when Ho is supposed to be true" and test of Significance can be described as a "rule or procedure with the help of which sample results are used to ascertain whether null hypothesis will be accepted or rejected".

3.5 DATA ANALYSIS TECHNIQUES

In order to analyze the data Statistical Package for Social Sciences (SPSS-20) has been utilized. The research follows the usual significance level i.e. 0.05. To analyze the data statistical tools/ techniques used are described subsequently.

3.5.1 Test for Normality

The test for normality is essential in deciding the form of statistics to be implemented, as normal data distribution is an underlying assumption in many statistical testing. Normality can be assessed graphically or numerically. Experience is required to use graphical methods, the numerical methods like, Shapiro-Wilk and Kolmogorov-Smirnov tests are objective in nature and are used in this research. Taking in to account the statistical procedures the null hypothesis (Ho) for testing data is that the data follows the normal distribution and for significant results it may be rejected. The results are tested at significance level of 0.05 with 0.01 depicting highly significant. The data has to be rendered normal by mathematical transformation for parametric testing or nonparametric testing is to be adopted in case it fails the test for normality. The mathematical transformation can create doubts about the realism of data unless proper judgment is applied. Therefore, nonparametric testing was adopted in the analysis accepting their major limitations i.e. less flexible and less powerful hence can draw fewer conclusions.

3.5.2 Sample Population Mean / Relative Index (RI) and Ranking

Ranking can be based on Relative Index (RI) or population mean. It is summarized by Holt (1997) that, when analyzing likert scale data to get ordinal sorting of the variables determined, mean response will produce the same results as RI. However, RI will also simultaneously generate relative indices where the maximum RI = 1.0, in contrast to maximum mean = N. In this research the ranking is based on sample population mean as it can produce similar results as Relative Index.

3.5.3 Kruskal-Wallis Test

A Kruskal-Wallis is known as nonparametric measure for comparing results for more than three groups. It is basically an extension of Mann-Whitney test. It is quite less sensitive to outliers hence was used for comparing the means of variables for testing the perceptions of each group i-e (Contractor, Client, and Consultant) regarding criticality of risks. In case of significant results obtained, the null hypothesis (Ho) for the test i-e “the means of variables are equal” will be rejected. The results were tested against the significance level of 0.05 with 0.01 being highly significant.

3.5.4 Spearman Rank Correlation Test

It is used when data does not follow normal distribution and is a nonparametric statistical test which is used to determine the strength and direction of association which exist among two variables. It is calculated through at least one ordinal scale and symbol rs (Rho) is used to denote this which is known as spearman’s Rho. This test was performed to check the consensus between different groups (Contractor, Client, and Consultant) for the given ranking of the criticality of risks. In case of significant results, null hypothesis (Ho)) for the test i-e“no correlation exists between variables” is rejected. The results are tested against significance level of 0.05 with 0.01 is taken to be highly significant. The assumptions on which test is based on are:-

- An interval, ratio or ordinal scale is used for measurement of variables.
- Data may not be normally distributed.
- Two variables have monotonic relationship i.e. either they increase in value simultaneously or as one decreases the value of other variable increases.
- Outliers do not have an effect on the correlation.

3.5.5 Quartiles

Quartiles are often used to know the dispersion of data. Third quartile value is of significant importance or important meaning as it represents the 75% of the collected sample and reliable inference can be drawn while comparing the results about the perception of correspondents about a certain category. Third quartile value has been used to draw the conclusion about the critical ranking given to risks distributed in three levels.

Chapter 4

RESULTS AND ANALYSIS

4.1 INTRODUCTION

Statistical Package for Social Science (SPSS-20) is quite flexible and quite comprehensive statistical tool which can get and process data from different type of files and uses them to perform complicated statistical analysis which includes charts, trends, and tabulated reports. SPSS helps in calculations and to produce results, the subsequent part i.e. drawing quality inferences from these results depends upon the degree of knowledge and expertise of the researcher about statistics as a subject. The data was entered in Microsoft excel sheets progressively as and when questionnaires reply were received and checked for correctness and completeness and further analyzed through SPSS-20.

Statistical analysis and key findings of the survey are summarized subsequently.

4.2 STATISTICAL ANALYSIS

4.2.1 Normality Test

'Shapiro Wilk normality test' was selected to check the normality of the collected data. We can find out, if the data is normally distributed or not, with the help of this test. It may also give the conclusion that further analysis should be parametric or non-parametric. The significance value comes to be 0.000 for all risks which are less than 0.05. This dictates that data is not normally distributed and further analysis should be based on non parametric tests. Table 4.1 shows the results of Shapiro Wilk test.

Table 4.1: Shapiro-Wilk Normality Test for Criticality of Risks

Risk ID	Description	Significance
C3	Cost overrun	0.000
A5	Corruption	0.000
A8	Political instability	0.000
C2	Inflation and interest rates	0.000
A4	Government influence on disputes	0.000
E3	Disputed sites	0.000
B2	Human resource	0.000
A1	Approval and permit	0.000
A2	Change in law	0.000
A3	Justice reinforcement	0.000
D2	Low construction productivity	0.000

Risk ID	Description	Significance
D3	Site safety	0.000
H1	Market demand	0.000
H2	Competition	0.000
D1	Improper design	0.000
D5	Improper project management	0.000
E2	Public Image	0.000
D6	Tight project schedule	0.000
G1	Force majeure	0.000
D4	Improper quality control	0.000
E1	Environment protection	0.000
A7	Quota allocation	0.000
B4	Corporate fraud	0.000
F2	Lack of coordination	0.000
J1	Artificial Shortage of materials	0.000
F3	Inadequate site information	0.000
A6	Expropriation	0.000

4.2.2 Mean/Critical Index

Responses on the criticality of 27 risks having effects on the construction industry were solicited through likert scale 1-5, so that 1 represent "not critical" and 5 represent "exceptionally critical"(Table 4.2). Total Criticality Index is obtained by adding up all rated indexes (1 to 5). The Mean Criticality Index is obtained by averaging rated indexes for every risk and is calculated as under:-

$$\textbf{Mean Index} = \frac{\sum \textbf{C1, C2, C3 \ldots\ldots Cn}}{\textbf{n}}$$

Where C1, C2, C3 ……. Cn is the critical level perceived by the respondent of survey in numbers and

n = no of respondents (87)

The critical level of the identified risks along with the mean and standard deviation (SD), placed in rank sequence is as shown in Table 4.3. The ranking has been done basing on the Mean Critical Index. Detail study of the result reveal that 21 from 27 identified risks have mean critical index in the range of 3 i.e. (Critical) and 5 i.e. (Exceptionally Critical). This means that respondents perceive about 75% of the risks identified critical or above in their grading. Top 11 critical risks include Cost Overrun, Corruption, Political Instability, Inflation and Interest rate, Government Influence on Disputes, Disputed sites, Human Resource, Market Demand, Change in Law, Justice Reinforcement, and Low Construction Productivity.

In depth study of risk ranking (Table 4.3) shows that within eleven top critical risks, we find seven risks from country level(A1, A2, A3, A8, A4, A5 and E3) which indicate Country Level group as most critical risk level.

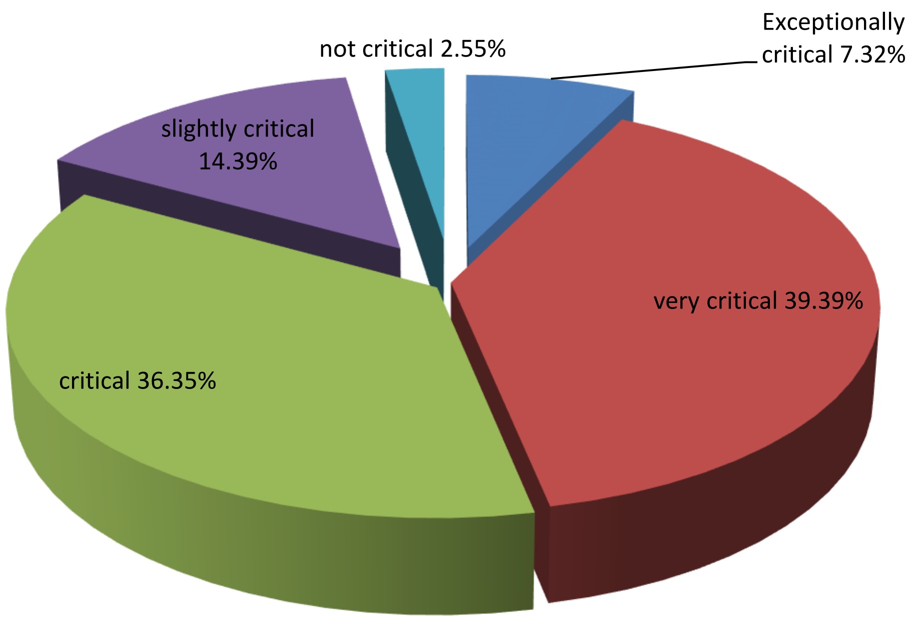

Table 4.2: Rating System Adopted for Risks and Mitigation Measures

Rating	Risk criticality	Mitigation Measure Effectiveness
1	Not critical at all	Not effective at all
2	Slightly critical	Slightly effective
3	Critical	Effective
4	Very critical	Very effective
5	Exceptionally critical	Exceptionally effective

Table 4.3: Risk Ranking Based on Mean Index

ID	Description	Total Index	Mean Index	Risk Ranking	Standard Deviation
C3	Cost overrun	375	4.31	1	0.736
A5	Corruption	358	4.11	2	0.784
A8	Political instability	352	4.05	3	0.901
C2	Inflation and interest rates	338	3.89	4	0.855
A4	Govt influence on disputes	327	3.76	5	0.715
E3	Disputed sites	322	3.70	6	0.823
B2	Human resource	318	3.66	7	1.032
A1	Approval and permit	313	3.60	8	0.739
A2	Change in law	305	3.51	9	0.791
A3	Justice reinforcement	294	3.38	10	0.825
D2	Low construction productivity	287	3.30	11	0.864
D3	Site safety	284	3.26	12	0.769
H1	Market demand	283	3.25	13	0.810
H2	Competition	281	3.23	14	0.694
D1	Improper design	274	3.15	15	0.755
D5	Improper project management	273	3.14	16	0.750
E2	Public Image	272	3.13	17	0.962
D6	Tight project schedule	270	3.10	18	0.850
G1	Force majeure	268	3.08	19	0.892
D4	Improper quality control	263	3.02	20	0.835
E1	Environment protection	242	2.99	21	0.769
A7	Quota allocation	239	2.75	22	0.918
B4	Corporate fraud	232	2.67	23	0.742
F2	Lack of coordination	228	2.62	24	0.633
J1	Artificial Shortage of materials	225	2.59	25	0.708
F3	Inadequate site information	220	2.53	26	0.745
A6	Expropriation	203	2.33	27	0.831

4.2.3 Kruskal Wallis Test for All Identified Risks

Kruskal Wallis test is a non parametric test and is performed to check whether all stakeholders i-e clients, consultants and contractors, have related perception regarding the critical level of each risk or otherwise. It is shown in table 4.4 that all stakeholders have similar view about critical ranking of all risks except cost overrun, human resource and improper design.

Table 4.4: Kruskal Wallis Test for Identified Risks

TYPE OF RISK	Chi-Square	Df	Significance
Approval and permit	3.163	2	.206
Change in law	1.865	2	.394
Justice reinforcement	2.774	2	.250
Government influence on disputes	1.367	2	.505
Corruption	5.975	2	.050
Expropriation	3.354	2	.187
Quota allocation	.883	2	.643
Political instability	.569	2	.753
Environment protection	1.849	2	.397
Lack of coordination	2.955	2	.228
Disputed sites	1.184	2	.553
Force majeure	2.772	2	.250
Human resource	9.794	2	.007
Corporate fraud	1.404	2	.496
Inflation and interest rates	.410	2	.815
Market demand	5.433	2	.066
Competition	3.688	2	.158
Low construction productivity	1.207	2	.547
Cost overrun	.130	2	.937
Improper design	7.282	2	.026
Artificial Shortage of materials	2.825	2	.243
Site safety	1.993	2	.369
Improper quality control	2.681	2	.262
Improper project management	1.102	2	.576
Public Image	1.603	2	.449
Inadequate site information	1.379	2	.502
Tight project schedule	2.758	2	.252

If we observe the criticality value given by different groups as is shown at table 4.5 we come to few conclusions as established from Kruskal Wallis test also. Cost overrun has been placed by the contractor as the top risk which is quite obvious where as corruption is placed at third number indicating that contractors have accepted the corruption to a certain level. Placing of disputed sites at four by the client shows the concern about the criticality of this risk where as consultants and contractors are less bothered on this account. Human resource graded at five by the contractor showing the criticality of this risk and concern of this group, however the other parties are not much concerned about this factor. Similarly for competition and improper design the client group has shown more concern due to obvious interests.

Table 4.5: Grading Based on Mean Index by Different Groups

Risk ID	Description	Overall	Client	Consultant	Contractor
C3	Cost overrun	1	2	2	1
A5	Corruption	2	1	1	3
A8	Political instability	3	3	3	2
C2	Inflation and interest rates	4	6	5	4
A4	Govt influence on disputes	5	7	4	6
E3	Disputed sites	6	4	10	7
B2	Human resource	7	15	11	5
A1	Approval and permit	8	5	8	8
A2	Change in law	9	8	7	9
A3	Justice reinforcement	10	12	6	11
D2	Low construction productivity	11	16	13	10
D3	Site safety	12	11	14	12
H1	Market demand	13	13	9	20
H2	Competition	14	9	15	16
D1	Improper design	15	10	21	17
D5	Improper project management	16	17	16	14
E2	Public Image	17	14	19	15
D6	Tight project schedule	18	22	12	18
G1	Force majeure	19	21	17	13
D4	Improper quality control	20	19	20	19
E1	Environment protection	21	18	22	21
A7	Quota allocation	22	20	18	25
B4	Corporate fraud	23	24	23	22
F2	Lack of coordination	24	25	24	23
J1	Artificial Shortage of materials	25	26	25	24
F3	Inadequate site information	26	23	26	26
A6	Expropriation	27	27	27	27

4.2.4 Spearman Rank Correlation

The result of Spearman rank correlation test shows that a positive correlation among the risk ranking of contractors, clients, and consultants exists due to significant statistical results obtained, as shown in table 4.6.

It can be deduced from the Kruskal-Wallis as well as Spearman rank correlation test results that though groups have difference of opinion on the perceptions of three individual risks out of twenty seven, but they all have the same opinion on risk ranking given by each other.

Table 4.6: Spearman Rank Correlation for Importance of Risks

CORRELATIONS					
			CLIENT	CONSULTANT	CONTRACTOR
Spearman's rho	CLIENT	Correlation Coefficient	1.000	.865**	.930**
		Sig. (2-tailed)	.	.000	.000
		N	27	27	27
	CONSULTANT	Correlation Coefficient	.865**	1.000	.951**
		Sig. (2-tailed)	.000	.	.000
		N	27	27	27
	CONTRACTOR	Correlation Coefficient	.930**	.951**	1.000
		Sig. (2-tailed)	.000	.000	.
		N	27	27	27
**. Correlation is significant at the 0.01 level (2-tailed).					

4.2.5 Third Quartile Value and Criticality of Group/ Levels

The identified risks have been divided in three groups to include (1) country level (2) market level and (3) project level. Moreover quartiles usually divide population in four groups (Fig 4.1), where the third Quartile value is considered the most reliable and of important meaning in statistical testing Third Quartile value of the means of each risk according to the level in which they fall are given in Table 4.7. The obtained value for third Quartile regarding Country Level is 3.70, which is the highest from other levels. It confirms already established fact that the Country Level has been rated as the top critical group. Market Level is the next group on the list of criticality with the 3rd Quartile value of 3.45. Project Level has the least third Quartile total of 3.26 which make it the lowest group in hierarchal level.

Table 4.7: Third Quartile Value of Risk Level Criticality

ID	Level	Criticality Index (1,2,..5)	Risk Rank	Level of Criticality (3rd Quartile)
	Level I : Country Level			3.7
A5	Corruption	4.11	2	
A8	Political instability	4.05	3	
A4	Govt influence on disputes	3.76	5	
E3	Disputed sites	3.70	6	
A1	Approval and permit	3.60	8	
A2	Change in law	3.51	9	
A3	Justice reinforcement	3.38	10	
E2	Public Image	3.13	17	
G1	Force majeure	3.08	19	
E1	Environment protection	2.78	21	
A7	Quota allocation	2.75	22	
A6	Expropriation	2.33	27	
	Level II : Market Level			3.45
C2	Inflation and interest rates	3.89	4	
B2	Human resource	3.66	7	
H1	Market demand	3.25	13	
H2	Competition	3.23	14	
B4	Corporate fraud	2.67	23	
J1	Artificial Shortage of materials	2.59	25	
	Level III : Project Level			3.26
C3	Cost overrun	4.31	1	
D2	Low construction productivity	3.30	11	
D3	Site safety	3.26	12	
D1	Improper design	3.15	15	
D5	Improper project management	3.14	16	
D6	Tight project schedule	3.10	18	
D4	Improper quality control	3.02	20	
F2	Lack of coordination	2.62	24	
F3	Inadequate site information	2.53	26	

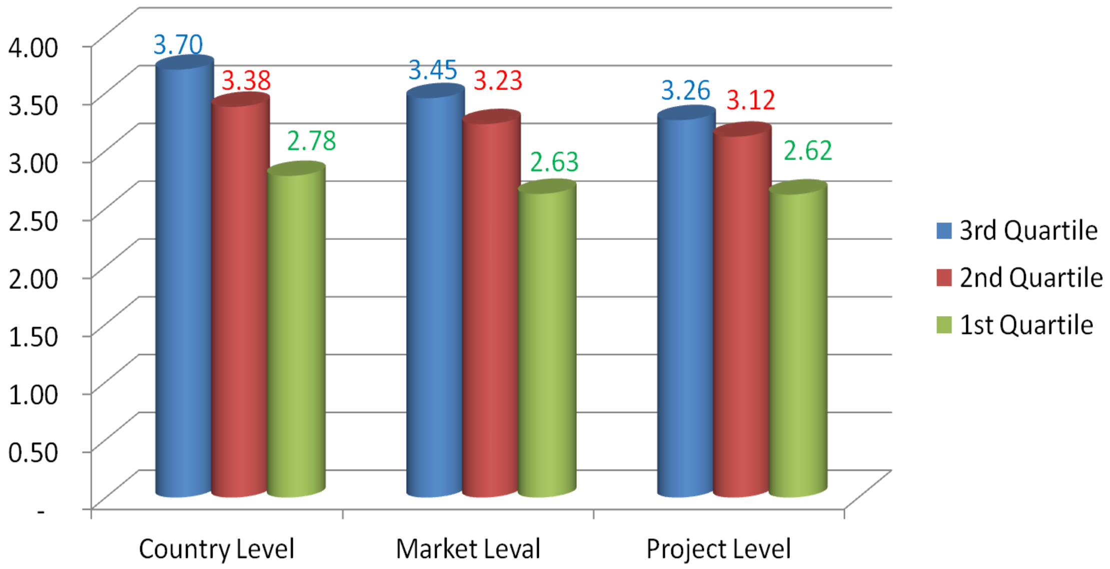

Fig 4.1: Quartile Value of Risk Criticalities

4.3 RISK INFLUENCE MATRIX

It has been drawn from above results, literature review, general wisdom, discussions and logical deduction, that there exists influence relationship among risks at different levels/groups. The country level risks being more dominant and at top level are influencing market and project levels risks, whereas the market level risks are influencing the project level risks (Flanagan and Norman, 1993; Thobani, 1999; Hastak and Shaked, 2000). Table 4.8 presents this influence graphically.

Table 4.8: Risk Influence Synopsis

	Risks at Country level	Risks at Market level
Market level	<	
Project level	◄	←

Note:

< Shows the Influence of Country Level at Market Level

◄ Shows the Influence of Country Level at Project Level

← Shows the Influence of Market Level at Project Level

The comprehensive influence of risks at a higher level on the risks at one lower level, which may be called as the dormant risks are presented in table 4.9. It is therefore concluded that the risk mitigation plan should prioritize the risks according to supremacy, i.e. the dominant risks are required to be mitigated with top priority or in first step first over the dormant risks. The objective is to mitigate the effects of the dominant risks thereby reducing their influence on succeeding dormant risks, which will eventually diminish the effects of dormant risks automatically.

Table 4.9: Risk Influence Matrix

		Country Level Risks										Market Level Risks					
		A1	A2/A3	A4	A5	A6	A7	A8	G1	E1	E2	B2	B4	J1	C2	H1	H2
Market Level Risks	B2		<								<						
	B4		<	<	<			<									
	J1		<					<	<								
	C2				<		<	<	<								
	H1								<								
	H2								<								
Project Level Risks	C3	◄	◄	◄		◄	◄	◄	◄			←	←	←	←		
	D1		◄						<			←				←	←
	D2	◄									◄	←					
	D3		◄		◄					◄		←					
	D4		◄		◄					◄		←					
	D5		◄	◄	◄							←					
	D6					◄					◄	←	←				
	F2													←			
	F3			◄	◄											←	

Note:

< Influence of Country Level Risks on Market Level Risks

◄ Influence of Country Level Risks on Project Level Risks

←Influence of Market Level Risks on Project Level Risks

Consider the influence which human resources risk B2 (Market Level) is having over the cost overrun risk C3, (Project Level) represented by 'B2 ➔ C3'.It will give us the deduction that a skilled, experienced and competent employee will guarantee the availability of exact measurements, pricing of the Bill of Quantities (BOQ), correct contract schedule and timely work done which is quite true thus reducing the chances of cost overrun C3. Take the other example 'J1, C2 ➔ C3', which shows that both Risk J1 (artificial shortage of material) and Risk C2 (inflation and interest rates) are having influence on Risk C3 (cost overrun). It is also correct statement because artificial shortage of material will give rise to cost overrun. Similarly sudden change in inflation and interest rates by government will reduce the availability of required cash flow and delay in payments by the client etc. which in turn will cause cost overrun.

4.4 EFFECTIVENESS OF MITIGATION MEASURES

The mean effectiveness, of the mitigation measures for every rated risk by the respondents using the likert scale is as shown in table 4.10. It is logical that mitigation measures which are graded to be of more effectiveness should be executed giving more priority on those with reduced effectiveness. In other words effectiveness states the implementation sequence to be adopted for mitigation measures. All the mitigation measures are rated between 3 and 5(table 4.10) which means that all respondents agree on effectiveness of proposed measures.

Table 4.10: Mitigation Measures Effectiveness for Each Risk

Risk ID	Effectiveness of Mitigation Measure (Mean Value)				
	M1	**M2**	**M3**	**M4**	**M5**
A1	3.45	3.52	3.68	3.59	
A2/A3	3.36	3.67	3.45	4.25	
A4	3.72	3.59	3.38		
A5	3.45	3.36	3.60	3.79	
A6	3.49	3.56	3.79		
A7	3.59	3.67	3.43		
A8	3.80	3.72	3.78	3.44	
B2	3.72	3.52	3.79		
B4	3.49	3.80	3.67		
C2	3.69	3.49	3.10	3.79	
C3	3.48	4.08	3.70	3.91	3.78
D1	3.55	3.64	4.13	3.97	3.76
D2	3.49	3.52	3.57	3.48	3.66
D3	3.49	3.57			
D4	3.70	3.43	3.49		
D5	3.92	3.56	3.66	4.01	3.76
E1	3.43	3.29	3.36		
E2	3.57	3.71	3.49		
G1	3.46	3.54	3.72		
H1	3.64	3.51			
H2	3.41	3.71	3.24		

4.5 PRIORITIZING MITIGATION MEASURES

It has already been described that measures adopted for mitigation of any risk must be prioritized according to effectiveness when implementing them to mitigate certain risk. Also, under three hierarchy levels, there is correlation among the risks therefore; priority of “mitigation measures” must consider the risk hierarchy levels also. This can be demonstrated further with the following example.

Suppose Mitigation Measure 1 of Risk A is A1M, Mitigation Measure 1 of Risk B is B1M and suppose that association between Risk A and Risk B has been established as 'A→B' i.e. (Risk A is having influence on Risk B). Therefore, 'A1M→B1M' will mean that Risk A's Mitigating Measure 1 is required to be applied before Risk B Mitigation Measure 1. Since risk A is having influence on risk B, thus prioritizing the mitigating measure 1 used for Risk A is going to help in reducing the possibility of happening of Risk B. Keeping above in view, for the example discussed earlier, since Risk J1 (artificial shortage of material) and C2 i-e (inflation and interest rates) in Market Level which are having influence on the Project Level Risk C3 i-e (cost overrun) , mitigating measures for Risk J1 and Risk C2 should be adopted first and measures for Risk C3 must be the descendant mitigating actions. (Table 2 may be referred for detail of mitigating measures regarding risks J1, C2 and C3 i-e M1, M2,. ..M5. Table 4.11 gives a summary of the prioritized outcome of the mitigating measures for risks as recognized by the respondents of survey at different levels of risk according to their corresponding effectiveness.

It can therefore be summarized that project level risks are dominated by country level and market level both and in order to mitigate the effects the dominating risks should be tackled first. For example if project level risk is influenced by two country level and one market level risk then the priority to be adopted would be to exercise all the mitigation measures in the order as given in table 4.11 for both the country level and market level risks which are having influence on the project level risk and then the mitigation measures for the particular project level risk should be undertaken as per the priority established through the survey. Similarly if market level risk is influenced by three country level risks then mitigation measures for those country level risks should be taken on in the prioritized sequence established through survey before the mitigating measures adopted for the market level risk faced.

Table 4.11: Priority of Mitigation Measures for Risks

Risk Group	Risk Code	Implementation Sequence of Mitigation Measures					
		I	II	III	IV	V	VI
Country Level Risks (Mitigation measure group L)	A1	M3	M4	M2	M1		
	A2/A3	M4	M2	M3	M1		
	A4	M1	M2	M3			
	A5	M4	M3	M1	M2		
	A6	M3	M2	M1			
	A7	M2	M1	M3			
	A8	M1	M3	M2	M4		
	E1	M1	M3	M2			
	E2	M2	M1	M3			
	G1	M3	M2	M1			
Market Level Risks (Mitigation measure group M)	B2	M3	M1	M2			
	B4	M2	M3	M1			
	C2	M4	M1	M3	M3		
	H1	M1	M2				
	H2	M2	M1	M3			
Project Level Risks (Mitigation measure group N)	C3	M2	M4	M5	M3	M1	
	D1	M3	M4	M5	M2	M1	
	D2	M5	M3	M2	M1	M4	
	D3	M2	M1				
	D4	M1	M3	M2			
	D5	M4	M1	M5	M3	M2	

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

Managing risks in construction projects saves time, effort and above all cost of the project. In developing countries like Pakistan where literacy rate is quite low; understanding of difficult terminologies, cumbersome techniques and long and hectic way of documenting the risks by contractors/project managers seems next to impossible. The cost of employing risk management professionals is too high. Due to this reason contractors/firms are scared of incorporating risk management systems in their corporations. The survey questionnaire has given an easy approach to risk management and has been well responded and appreciated by many firms and practitioners. It proved useful for getting the people involved in the mechanism of risk management by not only asking something but by giving them practical mitigation measures to comment or add upon. Many suggestions were received to take up this type of work in much more details incorporating more risks and increasing the number of mitigation measures which certainly is possible but much beyond the capability of MS student. This study is a first step and gradually building on this would certainly enable us to a have a comprehensive document like risk management code for Pakistan.

5.2 CONCLUSIONS

5.2.1 Criticality of Risks

- Twenty-seven critical risks were identified for construction projects out of which 21 were perceived as Critical or Very Much Critical.
- The top 11 risks included: Cost Overrun, Corruption, Political Instability, Inflation and Interest rate, Government Influence on Disputes, Disputed sites, Human Resource, Market Demand, Change in Law, Justice Reinforcement, and Low Construction Productivity in the order of priority.
- Country level risks have been ascertained as critical group than market level and sequentially the Market level proved to be more critical than Project level risk group.

5.2.2 Effectiveness of Mitigation Measures

- Proposed mitigation measures were graded at the minimum level of “effective” by the respondents of the survey.
- In order to mitigate a specific risk, higher priority should be given to the measures with higher effectiveness.
- The mitigation measures are required to be given priority from the higher risk group with their corresponding prioritized mitigation measures.

5.2.3 Risk Influence Matrix

- The country level risks being most governing and on the top hierarchical level whereas project level risks are relatively dormant and are in the lowest hierarchical level therefore a Risk influence matrix have been established (Table 4.9) where detailed influence relationship of risks have been shown.
- Risk mitigation plan should prioritize the risks according to dominance; therefore, the governing risk groups should be mitigated before or with higher priority over the lower group.
- The aim of risk mitigation plan should be to mitigate the dominant risks along with their influence on successive dormant risks, which will subsequently diminish the inactive risks as well.

5.2.4 Prioritizing Mitigation Measures

Measures adopted to mitigate a certain risk must be prioritized according to their impact, which results in minimizing the effects of risk. Also, levels of risk hierarchy must be considered for prioritizing of measures adopted to mitigate risk. Country level mitigation measures are grouped as ‘L’, followed by ‘M’ and ‘N’ for market and project level respectively.

5.3 RECOMMENDATIONS

- In order to reduce the adverse impacts of the critical risks identified, systematic study may be carried out for formulation of steps at national level adopt mitigation measures affecting construction projects, individually and collectively.

- Project level risks are dominated by country level and market level both and in order to mitigate the effects the dominating risks should be tackled first with their particular more effective mitigating measures.
- Risk model is proposed for better assimilation of risk influences of one level over the other.

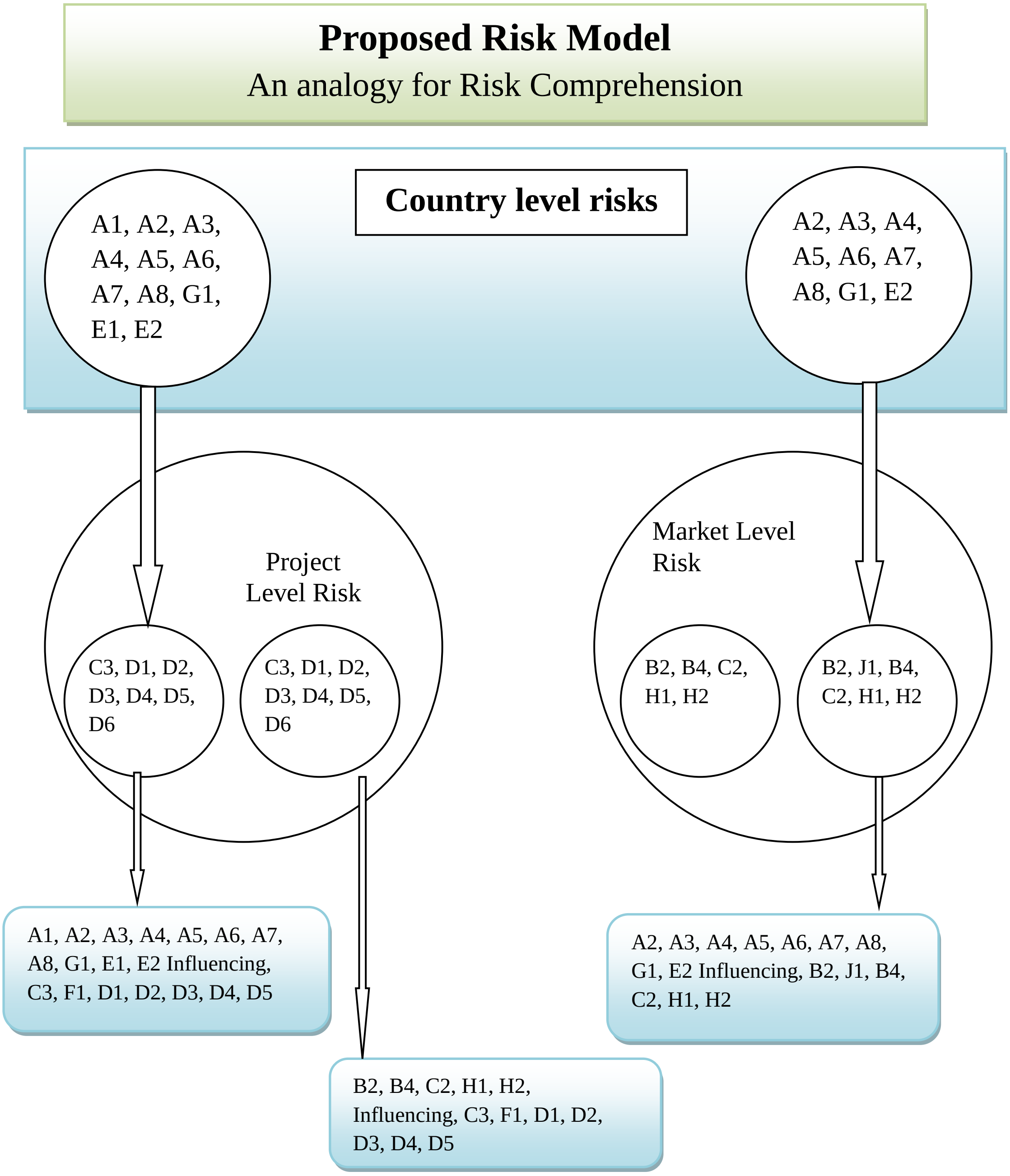

Figure 5.1: Risk Model

- Risk mitigation framework is proposed to be adopted by clients/consultants and construction firms.

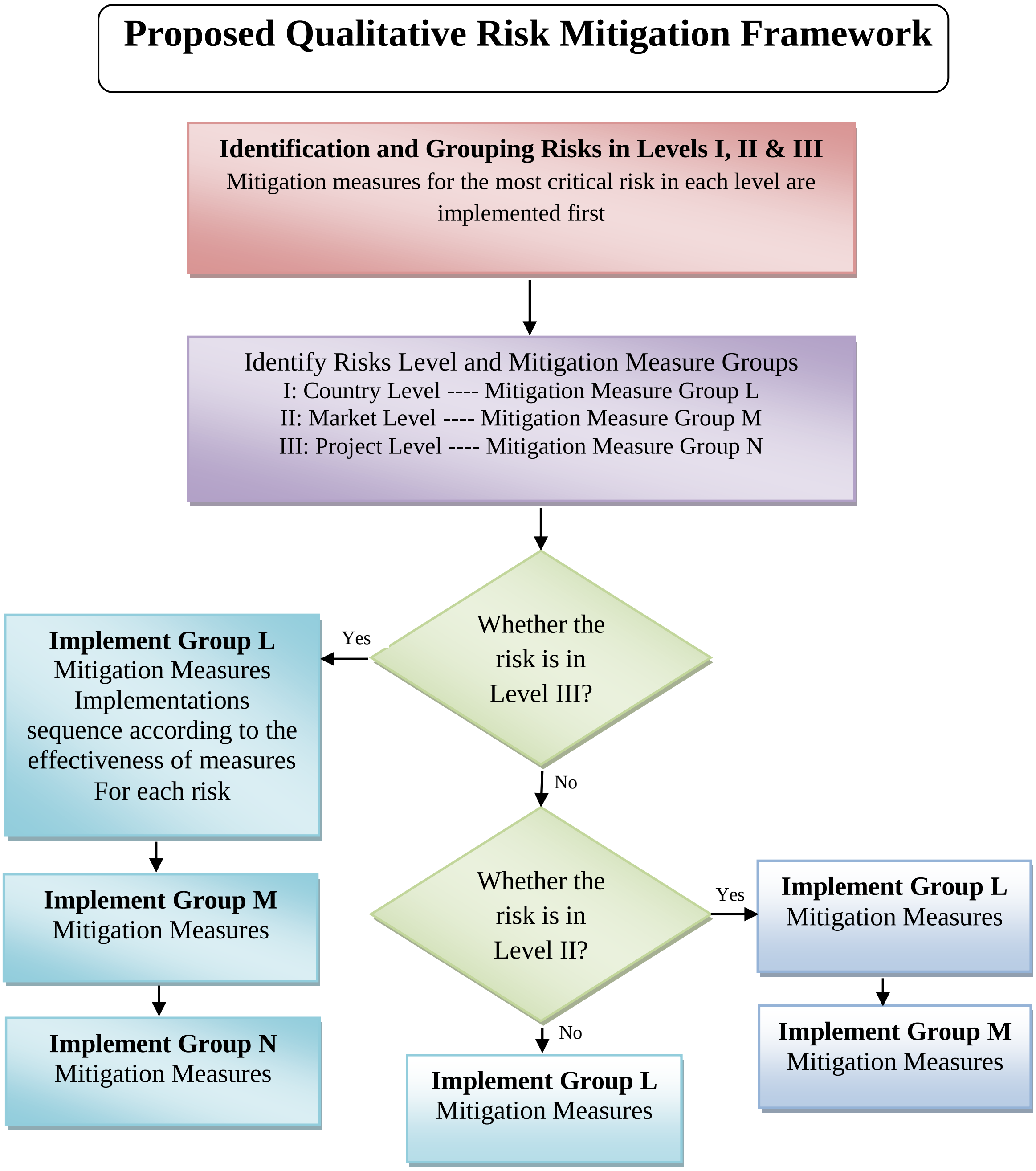

Figure 5.2 Risk Mitigation Framework

- Steps required to be followed for adopting risk mitigation framework.
  - **Step 1** Identification and Grouping Risks in Levels I, II & III. Mitigation measures for the most critical risk in each level should be implemented first
  - **Step 2** Identify risks level and respective mitigation measure groups as under:-

    I: Country Level ---- Mitigation Measure Group L (according to established priority)

    II: Market Level ---- Mitigation Measure Group M (according to established priority)

    III: Project Level ---- Mitigation Measure Group N (according to established priority)

  - **Step 3** If the risk pertains to country level(Level I), the mitigation measures of group L particular to this risk are required to be implemented as per prioritized effectiveness of mitigation measures.
  - **Step 4** If the risk pertains to market level(Level II), then Group L measures are implemented at first phase followed by Group M mitigation measures, particular to this level of risk, in the order of priority if applicable due to influence relationship.
  - **Step 5** If the risk belongs to project level (Level III) then mitigation measures should be implemented from Group L, then Group M and finally Group N, keeping in view the priority established and influence relationship of higher risk group.
- Risk model and proposed mitigation measures should be implemented on a national level project and their effectiveness be then analyzed as a separate case study.
- The Pakistan risk management standards for construction industry may be developed in line to international standards.

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Appendix I

LIST OF MAJOR RISKS ENCOUNTERED IN CONSTRUCTION PROJECTS ALONG WITH IDs

RISK ID	TYPE OF RISK
	Level I : Country Level
A1	Approval and permit: Delay or refusal of project approval and permit by local government
A2	Change in law: Government's inconsistent application of new regulations and laws
A3	Justice reinforcement: Lack of legal judgment reinforcement
A4	Government influence on disputes: Unnecessary and unjust influence by government on court proceedings regarding project disputes
A5	Corruption: Corrupt local government officials demand bribes or unjust rewards
A6	Expropriation: Due to political, social or economic pressures, government takes over the facility run by firm without giving reasonable compensation
A7	Quota allocation: Unfair quota for employing the unqualified locals imposed by local governments.
A8	Political instability: Frequent changes in government; agitation for change of government or disputes between political parties or different organs of the state.
E1	Environmental protection: Stringent regulation which will have an impact on construction firms' poor attention to environmental issues
E2	Public image: Victim of prejudice from public due to different local living standards, values, culture, social system, etc
E3	Disputed sites: disputed or problematic site possession given documentarily without the consent of locals/claimants.
G1	Force majeure: The circumstances that are out of the control of firm, such as flood, fires, storms, epidemic diseases, war, hostilities and embargo.
	Level II : Market Level
B2	Human resource: Unavailability of sufficient professionals, managers and skilled labor.
B4	Corporate fraud: Unexpected increases in turnover, unexpected resignation of financial adviser, letter of credits with 'unreasonably round figures', intentional or unintentional negligence either by auditors, bankers or creditors
C2	Inflation and interest rates: Unanticipated price inflation and interest rates due to immature local economic and banking system.
H1	Market demand: Inadequate forecast about market demand
H2	Competition: Competition from other investors / developers / contractors.
J1	Artificial Shortage of materials: Monopoly of material suppliers and transporters creating artificial shortage of material so as to cash it during financial closing period.

	Level III: Project Level
C3	Cost overrun: Unavailability of sufficient cash flow, improper measurement and pricing of Bill of Quantities (BOQ), ill planned schedule and client's delay in payment.
D1	Improper design: Unanticipated design changes and errors in design/drawings.
D2	Low construction productivity: Obsolete technology and practices or low labour productivity of workforce owing to poor skills or inadequate supervision.
D3	Site safety: High rate of accidents during construction or operation phases.
D4	Improper quality control: tolerance of defects and inferior quality.
D5	Improper project management: Improper project planning, budgeting; inadequate project organization structure; and incompetence of project team.
F2	Lack of coordination; Poor coordination, cooperation and relationship among key stakeholders.
F3	Inadequate or insufficient site information(soil test and survey report)
D6	Tight project schedule

ID	MITIGATION MEASURES
	Mitigation measures for risk #A1: Approval and permit
M1	Ensure the project is complying with local planning commission's development plan.
M2	Ensure the feasibility study report and contract depict local government, party's actual intentions (like anticipated profits, risk sharing)
M3	Prepare and submit all necessary documents and feasibility study report in a timely manner to government departments.
M4	Pre-package all approvals when signing contract with project client.
	Mitigation measures for risk #A2: change in law, and for risk #A3: justice reinforcement
M1	Obtain government guarantee to adjust tariff or extend concession period (for Build-Operate-Transfer (BOT) projects)
M2	Maintain good relationship with local government and higher officials
M3	Obtain insurance for political risks
M4	Include clauses for delays and additional payments in contract, which occur due to new rules or change in law
	Mitigation measures for risk #A4: government influence on disputes
M1	Provide dispute settlement clauses in the contract
M2	Ensure the approval is sought at the right local government departments
M3	Maintain good relations with concerned local government officials and concerned authorities
	Mitigation measures for risk #A5: corruption
M1	Try to work directly with the business connections, i.e. do not hire broker or middleman.

ID	MITIGATION MEASURES
M2	Set aside a budget for unavoidable spending.
M3	Commercial awareness training to management and key personal who may have to deal with corrupt officials.
M4	Obtain all necessary approvals in timely manner to minimize chance for corrupt individual to obstruct work.
	Mitigation measures for risk #A6: expropriation
M1	Be informed of political developments by making use of information sources like international security and risk assessment companies.
M2	Develop contingency plans and obtain insurance for expropriation possibility.
M3	Maintain good relations with concerned local government officials and concerned authorities.
	Mitigation measures for risk #A7: quota allocation
M1	Schedule training programme for imposed unqualified persons and unskilled labour
M2	Ensure inclusion of clause in the contract for bearing extra finances due to employment of locals(for their training/less productivity) due to quota enforcement
M3	Maintain good relations with administrative authorities of local area.
	Mitigation measures for risk #A8: political instability
M1	Keep your bills and payments abreast with the progress and schedule
M2	Seek incorporation of termination or delay clauses in contract.
M3	Include a clause in the contract for demobilization or force evacuation compensation.
M4	Maintain good relationship and connections with higher local government officials, local power sources like opulent persons and politicians.
	Mitigation measures for risk #B2: human resource
M1	Maintain good working relations with employees and care about their necessities.
M2	Arrange the staff/skilled labour from other parts of country where easily available, employ them on a contract and sign formal employment contract with every staff.
M3	Decide on recruitment and selection criteria and Offer better remuneration/incentive packages to staff/skilled labour.
	Mitigation measures for risk #B4: corporate fraud
M1	Get information about partner's credibility from its present and past business partners.
M2	Insist on having trustworthy people on key places within the JV
M3	All parties should agree on one accounting standard and hire one independent accountant.
	Mitigation measures for risk #C2: inflation and interest rates
M1	Client to secure standby financing (i.e. more than 100% financing commitments when needed)
M2	Obtain payment and performance bonds from local and international banks

ID	MITIGATION MEASURES
M3	Adopt alternatives to contract payment, e.g. land development rights, resource swap
M4	Specify extension or compensation clauses in contract for payment
	Mitigation measures for risk #C3: cost overrun
M1	Secure standby cash flow in advance
M2	Measure and price Bills of Quantities properly during bidding stage
M3	Develop a clear and appropriate plan and control schedule and cost
M4	Incorporate escalation clauses for interest, inflation rates and delays in contract
M5	Adopt as much as possible local product/labour to reduce cost and sign fixed or pre-determined prices with material and accessory facilities suppliers
	Mitigation measures for risk #D1: improper design
M1	Undertake pre-project planning to minimize design errors.
M2	Adopt Design & Build option which enables contractor to design in harmony with site conditions thus minimizing design/drawing disputes.
M3	Introduce adjustment clauses in contract to review plan and constructability
M4	Arrange and undertake comprehensive site investigation before construction phase.
M5	Organize for appraisal/vetting of drawings and design criteria by at least one independent engineering/architect consultant.
	Mitigation measures for risk #D2: low construction productivity
M1	Adopt proper quality control procedures.
M2	Organize site properly for maximum productivity.
M3	Incorporate weather impacts into project schedule.
M4	Apply innovative production concepts/philosophies like Lean Construction, Just In Time and Total Quality
M5	Management, to decrease variability and rework during construction.
	Mitigation measures for risk #D3: site safety
M1	Ensure that construction and operation are as per examination and concerned approving authority’s expectation
M2	Adopt proper safety control programme, management system, supervision, incentives and preventive measures
	Mitigation measures for risk #D4: improper quality control
M1	Adopt proper quality control procedures, supervision and incentives
M2	Review plans jointly with client to determine changes
M3	Implement ISO9000 and get certification
	Mitigation measures for risk #D5: improper project management
M1	Hire/select competent project management team
M2	Clear definition of each staff’s scope of work
M3	Conflict resolution clause in contract and specify construction extension clause in contract if client causes the delay
M4	Provide notice provision and notice period in contract
M5	Provide clauses on schedule delay and additional payment if caused by client

ID	MITIGATION MEASURES
	Mitigation measures for risk #E1: environmental protection
M1	Adopt strict pollution control measures
M2	Comply with international and/or local environmental laws, standards and regulations
M3	Include disclaimer in contract for present pollution level (conduct survey to see clear picture)
	Mitigation measures for risk #E2: public image
M1	Maintain good reputation and image to the public.
M2	Give donations to renowned non-governmental organizations, which are involved in elevating the living conditions of poor.
M3	Participate actively in public relation activates and charity
	Mitigation measures for risk #G1: force majeure
M1	A party which fails to meet his contractual obligation due to force majeure must notify the other one within a reasonable time.
M2	Insure all of the insurable force majeure risks.
M3	Include delay clauses for contingency plan in contract.
	Mitigation measures for risk #H1: market demand
M1	Employ reputable third party consultant to forecast market demand.
M2	Maintain good relationship and connections with higher government officials, local power sources like opulent persons and politicians.
	Mitigation measures for risk #H2: competition
M1	Conduct market study and obtain exact information of competitive projects
M2	Adopt as much as possible domestic product/labour to reduce cost
M3	Maintain good relationship and connections with higher local government officials, local power sources like opulent persons and politicians.

Appendix II

QUESTIONNAIRE

General Information (Will Not be Published)	
Name	
Qualification	
Experience In Construction Industry(Years)	
Organization/Department/Company	
Appointment/Designation	
Position	Client/Contractor/Consultant

ID	TYPE OF RISK	RISK CRITICALITY 1=Not Critical, 2=Slightly critical, 3=Critical, 4=Very critical, 5=Exceptionally critical				
		1	2	3	4	5
Level I : Country Level						
A1	Approval and permit: Delay or refusal of project approval and permit by local government					
A2	Change in law: Government's inconsistent application of new regulations and laws					
A3	Justice reinforcement: Lack of legal judgment reinforcement					
A4	Government influence on disputes: Unnecessary and unjust influence by government on court proceedings regarding project disputes					
A5	Corruption: Corrupt local government officials demand bribes or unjust rewards					
A6	Expropriation: Due to political, social or economic pressures, government takes over the facility run by firm without giving reasonable compensation					
A7	Quota allocation: Unfair quota for employing the unqualified locals imposed by local governments.					
A8	Political instability: Frequent changes in government; agitation for change of government or disputes between political parties or different organs of the state.					
E1	Environmental protection: Stringent regulation which will have an impact on construction firms' poor attention to environmental issues					
E2	Public image: Victim of prejudice from public due to different local living standards, values, culture, social system, etc					

General Information (Will Not be Published)						
E3	Disputed sites: disputed or problematic site possession given documentarily without the consent of locals/claimants.					
G1	Force majeure: The circumstances that are out of the control of firm, such as flood, fires, storms, epidemic diseases, war, hostilities and embargo.					
Level II : Market Level						
B2	Human resource: Unavailability of sufficient professionals, managers and skilled labor.					
B4	Corporate fraud: Unexpected increases in turnover, unexpected resignation of financial adviser, letter of credits with ‘unreasonably round figures’, intentional or unintentional negligence either by auditors, bankers or creditors					
C2	Inflation and interest rates: Unanticipated price inflation and interest rates due to immature local economic and banking system.					
H1	Market demand: Inadequate forecast about market demand					
H2	Competition: Competition from other investors/developers/contractors.					
J1	Artificial Shortage of materials: Monopoly of material suppliers and transporters creating artificial shortage of material so as to cash it during financial closing period.					
Level III: Project Level						
C3	Cost overrun: Unavailability of sufficient cash flow, improper measurement and pricing of Bill of Quantities (BOQ), ill planned schedule and client’s delay in payment.					
D1	Improper design: Unanticipated design changes and errors in design/drawings.					
D2	Low construction productivity: Obsolete technology and practices or low labour productivity of workforce owing to poor skills or inadequate supervision.					
D3	Site safety: High rate of accidents during construction or operation phases.					
D4	Improper quality control: tolerance of defects and inferior quality.					
D5	Improper project management: Improper project planning, budgeting; inadequate project organization structure; and incompetence of project team.					
F2	Lack of coordination; Poor coordination, cooperation and relationship among key stakeholders.					
F3	Inadequate or insufficient site information(soil test and survey report)					
D6	Tight project schedule					

ID	MITIGATION MEASURES	**<u>EFFECTIVENESS</u>** **1=Not Effective, 2=Slightly effective, 3=Effective, 4=Very effective, 5=Exceptionally effective**				
		1	**2**	**3**	**4**	**5**
Mitigation measures for risk #A1: approval and permit						
M1	Ensure the project is complying with local planning commission's development plan.					
M2	Ensure the feasibility study report and contract depict local government, party's actual intentions (like anticipated profits, risk sharing)					
M3	Prepare and submit all necessary documents and feasibility study report in a timely manner to government departments.					
M4	Pre-package all approvals when signing contract with project client.					
Mitigation measures for risk #A2: change in law, and for risk #A3: justice reinforcement						
M1	Obtain government guarantee to adjust tariff or extend concession period (for Build-Operate-Transfer (BOT) projects)					
M2	Maintain good relationship with local government and higher officials					
M3	Obtain insurance for political risks					
M4	Include clauses for delays and additional payments in contract, which occur due to new rules or change in law					
Mitigation measures for risk #A4: government influence on disputes						
M1	Provide dispute settlement clauses in the contract					
M2	Ensure the approval is sought at the right local government departments					
M3	Maintain good relations with concerned local government officials and concerned authorities					
Mitigation measures for risk #A5: corruption						
M1	Try to work directly with the business connections, i.e. do not hire broker or middleman.					
M2	Set aside a budget for unavoidable spending.					
M3	Commercial awareness training to management and key personal that may have to deal with corrupt officials.					
M4	Obtain all necessary approvals in timely manner to minimize chance for corrupt individual to obstruct work.					
Mitigation measures for risk #A6: expropriation						
M1	Be informed of political developments by making use of					

ID	MITIGATION MEASURES	**EFFECTIVENESS** **1=Not Effective, 2=Slightly effective, 3=Effective, 4=Very effective, 5=Exceptionally effective**				
		1	**2**	**3**	**4**	**5**
	information sources like international security and risk assessment companies.					
M2	Develop contingency plans and obtain insurance for expropriation possibility.					
M3	Maintain good relations with concerned local government officials and concerned authorities.					
Mitigation measures for risk #A7: quota allocation						
M1	Schedule training programme for imposed unqualified persons and unskilled labour					
M2	Ensure inclusion of clause in the contract for bearing extra finances due to employment of locals(for their training/less productivity) due to quota enforcement					
M3	Maintain good relations with administrative authorities of local area.					
Mitigation measures for risk #A8: political instability						
M1	Keep your bills and payments abreast with the progress and schedule					
M2	Seek incorporation of termination or delay clauses in contract.					
M3	Include a clause in the contract for demobilization or force evacuation compensation.					
M4	Maintain good relationship and connections with higher local government officials, local power sources like opulent persons and politicians.					
Mitigation measures for risk #B2: human resource						
M1	Maintain good working relations with employees and care about their necessities.					
M2	Arrange the staff/skilled labour from other parts of country where easily available, employ them on a contract and sign formal employment contract with every staff.					
M3	Decide on recruitment and selection criteria and Offer better remuneration/incentive packages to staff/skilled labour.					
Mitigation measures for risk #B4: corporate fraud						
M1	Get information about partner’s credibility from its present and past business partners.					
M2	Insist on having trustworthy people on key places within the JV					

ID	MITIGATION MEASURES	**EFFECTIVENESS** 1=Not Effective, 2=Slightly effective, 3=Effective, 4=Very effective, 5=Exceptionally effective				
		1	**2**	**3**	**4**	**5**
M3	All parties should agree on one accounting standard and hire one independent accountant.					
Mitigation measures for risk #C2: inflation and interest rates						
M1	Client to secure standby financing (i.e. more than 100% financing commitments when needed)					
M2	Obtain payment and performance bonds from local and international banks					
M3	Adopt alternatives to contract payment, e.g. land development rights, resource swap					
M4	Specify extension or compensation clauses in contract for payment					
Mitigation measures for risk #C3: cost overrun						
M1	Secure standby cash flow in advance					
M2	Measure and price Bills of Quantities properly during bidding stage					
M3	Develop a clear and appropriate plan and control schedule and cost					
M4	Incorporate escalation clauses for interest, inflation rates and delays in contract					
M5	Adopt as much as possible local product/labour to reduce cost and sign fixed or pre-determined prices with material and accessory facilities suppliers					
Mitigation measures for risk #D1: improper design						
M1	Undertake pre-project planning to minimize design errors.					
M2	Adopt Design & Build option which enables contractor to design in harmony with site conditions thus minimizing design/drawing disputes.					
M3	Introduce adjustment clauses in contract to review plan and constructability					
M4	Arrange and undertake comprehensive site investigation before construction phase.					
M5	Organize for appraisal/vetting of drawings and design criteria by at least one independent engineering/architect consultant.					
Mitigation measures for risk #D2: low construction productivity						
M1	Adopt proper quality control procedures.					
M2	Organize site properly for maximum productivity.					

ID	MITIGATION MEASURES	**EFFECTIVENESS** **1=Not Effective, 2=Slightly effective, 3=Effective, 4=Very effective, 5=Exceptionally effective**				
		1	**2**	**3**	**4**	**5**
M3	Incorporate weather impacts into project schedule.					
M4	Apply innovative production concepts/philosophies like Lean Construction, Just In Time and Total Quality					
M5	Management, to decrease variability and rework during construction.					
Mitigation measures for risk #D3: site safety						
M1	Ensure that construction and operation are as per examination and concerned approving authority's expectation					
M2	Adopt proper safety control programme, management system, supervision, incentives and preventive measures					
Mitigation measures for risk #D4: improper quality control						
M1	Adopt proper quality control procedures, supervision and incentives					
M2	Review plans jointly with client to determine changes					
M3	Implement ISO9000 and get certification					
Mitigation measures for risk #D5: improper project management						
M1	Hire/select competent project management team					
M2	Clear definition of each staff's scope of work					
M3	Conflict resolution clause in contract and specify construction extension clause in contract if client causes the delay					
M4	Provide notice provision and notice period in contract					
M5	Provide clauses on schedule delay and additional payment if caused by client					
Mitigation measures for risk #E1: environmental protection						
M1	Adopt strict pollution control measures					
M2	Comply with international and/or local environmental laws, standards and regulations					
M3	Include disclaimer in contract for present pollution level (conduct survey to see clear picture)					
Mitigation measures for risk #E2: public image						
M1	Maintain good reputation and image to the public.					
M2	Give donations to renowned non-governmental organizations, which are involved in elevating the living conditions of poor.					
M3	Participate actively in public relation activates and charity					
Mitigation measures for risk #G1: force majeure						

ID	MITIGATION MEASURES	**EFFECTIVENESS** **1=Not Effective, 2=Slightly effective, 3=Effective, 4=Very effective, 5=Exceptionally effective**				
		1	**2**	**3**	**4**	**5**
M1	A party which fails to meet his contractual obligation due to force majeure must notify the other one within a reasonable time.					
M2	Insure all of the insurable force majeure risks.					
M3	Include delay clauses for contingency plan in contract.					
Mitigation measures for risk #H1: market demand						
M1	Employ reputable third party consultant to forecast market demand.					
M2	Maintain good relationship and connections with higher government officials, local power sources like opulent persons and politicians.					
Mitigation measures for risk #H2: competition						
M1	Conduct market study and obtain exact information of competitive projects					
M2	Adopt as much as possible domestic product/labour to reduce cost					
M3	Maintain good relationship and connections with higher local government officials, local power sources like opulent persons and politicians.					