RISK MANAGEMENT PROCESS FOR POWER GENERATION PROJECTS IN SRI LANKA

BY

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Supervised By

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Abstract

Risk management helps potential obstacles to be identified and contained early through proper response strategies, thereby minimizing negative impacts on positive aspects on project cost, schedule, scope and quality. Managing potential risks also helps identify opportunities that may enhance the project and have a positive impact on project objectives.

The initial surveys carried out by the author revealed that neither the main power utility in Sri Lanka, the Ceylon Electricity Board nor any of the Independent Power Produces operating in the country either possess or practice any documented, structured Risk Management Process for power generation projects. Therefore, there is a great requirement to develop an appropriate Risk Management Process for Sri Lankan power generation projects.

The main scope of this research is to formulate a Risk Management Process for Power Generation Projects (RMPPGP), taking in to account the current risk management context of the country. In the thesis, the author has proposed an RMPPGP consisting of six sub-process i.e Establishment of the risk management context of the Power Project, Risk identification, Risk analysis , Risk response planning, Risk monitoring & control and Communicate &consult. Comprehensive flow charts for each of these sub-processes and also the required supporting material of the RMPPGP have also been presented for convenient practice.

DECLARATION

I certify that except due acknowledgement has been made, the work is that of the author alone, the work has not been submitted previously, in whole in part, to qualify for any other academic award in any institution.

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ACRONYMS

APM	Association for Project Management , UK
BOT	Built Operate and Transfer
C	Constructability
CPM	Critical Path Method
EIA	Environmental Impact Assessment
EPC	Engineering, Procurement and Construction
EIA	Environmental Impact Assessment
IRM	Institute of Risk Management , UK
M	Maintainability
NPV	Net Present Value
O	Operability
PMI	Project Management Institute
PERT	Programme Evaluation & Review Technique
PM	Project Manager
PMBOK	Project Management Body of Knowledge (published by PMI)
RO	Risk Owner
RBM	Risk Breakdown Matrix
RBS	Risk Breakdown Structure
REB	Risk Evaluation Board
RM	Risk Manager
RMP	Risk Management Process
RMPPGP	Risk Management Process for Power Generation Projects
SME	Subject Matter Expert
WBS	Work Breakdown Structure

1. Introduction

1.1. Background

In order to meet the 8% annual growth rate in electricity demand in Sri Lanka , it is required to add nearly 200MW of generation capacity to the national grid every year. According to the country's Long-Term Generation Expansion Plan(2005) published by the Ceylon Electricity Board, 11 Coal Power Projects of the capacity of 300 MW each are to be implemented , up to year 2020 . The investment required for these projects is around 4 billion US $. The possible economic loss to the country, when a proposed power plant is not connected to the national grid on the desired date could be very much higher than the investment. As a considerable amount of the country's limited financial resources are utilized in carrying out power projects and also as the consequence of a failure of any power project can bring catastrophic results to the economy, environment and safety, there is a strong need to practice Risk Management methodologies in power projects.

For Power Projects, risks can come in many forms such as, political risks, commercial risks, technical risks, management risks , environmental risk, legal risks and force majeure. Majority of the Sri Lankan power projects do not have a good history in coping up with these risks. Delays and/or cost overruns were reported in many power projects implemented so far. Ineffective Risk Management might be one of the contributory factors to this situation. There is a debate on the implementation of Samanalawewa Hydro Power Project overlooking the adverse geological complexities in the area. . According to an independent study, this project cannot be categorized as a failure as the expected energy as well as the peak demand from the plant has been delivered despite the technical complexities (Lakshman,1996). However, there would have been an opportunity to avoid at least the cost overrun of the project if properly adhered to a Risk Management system.

The concept of Risk Management has not yet become an integral part of Project Management in Sri Lanka. According to the Project Managers interviewed by the author, systematic Risk Management techniques are not widely practiced compared to other Project Management techniques like Work Breakdown Structure (WBS) and scheduling techniques based on critical path analysis. All projects in general tend to suffer unexpected outcomes, delays, cost overruns and disappointing results and this scenario is common in Power Generation Projects too. Power utilities must learn to expect these uncertainties and be ready to cope with them thereby reducing the adverse impact. This can not be done intuitively but by following a systematic approach, as per Risk Management methodologies. In other words, project Risk Management should become an essential and an integral part of every Power project.

In general, the advantages of Risk Management in a project can be summarized as follows.

- A more confident and rigorous basis for decision-making and planning
- Better identification of opportunities and threats
- Gaining value from uncertainty and variability
- Pro-active rather than re-active management
- More effective allocation and use of resources
- Improved stakeholder management and trust
- Improved compliance with relevant legislation

1.2. Research question

The extent of the use of prudent project management methodologies in Sri Lankan construction projects should be examined. The extent to which well documented, well structured Risk Management methodologies are practiced in Sri Lanka is not clear. The underlying reasons for this are not clear and require further research. This remains a poorly researched area in Sri Lanka.

In the above context, the research question of this thesis can be stated as *'How to develop a well structured Risk Management Process for Power Generation Projects in Sri Lanka ?'*

1.3. Objective

The objective of this research is to develop a Risk Management Process (RMP) for Power Generation projects in Sri Lanka.

1.4. Research justification

The use of properly structured RMP is of great importance to construction projects. As mentioned in the introduction, there are a number of Coal Power Projects planned in the country's power generation plan. Our experience, expertise and exposure in coal power technology / projects is limited. Also, the investment required for these earmarked projects is considerable. Under these circumstances, use of an appropriate Risk Management Process is essential. The findings of the research will be very useful in addressing the possible risks and implementing well managed Coal Power Projects.

1.5. Research methodology

- A detailed literature review has been carried out to analyze Risk Management tools and techniques used in infrastructure projects in the world.

- Information on Risk Management tools and techniques used in construction projects in Sri Lanka were examined. Interviews with Project Managers handling key construction projects were the main methodology in fulfilling this.

- A Risk Management Process suitable for future Sri Lankan Power Projects was formulated considering the information received in the above two steps.

1.6. Scope and limitations of the research

The scope of the Risk Management Process for Power Generation Projects (RMPPGP) proposed under this research is to initiate a comprehensive and structured but a simple process to address all the risks associated with the project.

The limitations of the research need to be acknowledged. The initial survey done on Risk Management practices in Sri Lankan construction projects were limited to unstructured interviews with Project Managers and engineers. The responses received from the internationally reputed contractors who are implementing power projects in Sri Lanka were limited and inadequate. Therefore, there is a possibility of having unaddressed areas in the research.

There are different ways of identifying, analyzing and evaluating risks in a project. In the Sri Lankan context, Risk Management is still not a well developed area. Therefore, an uncomplicated technique like probability-impact grid is preferred to risk analysis at the start, over complex scenarios like Monte Carlo simulation, Multi Criteria Decision Making (MCDM), Analytical Hierarchy Process (AHP), Fuzzy Set Approach (FSA), Neutral Network Approach (NNA). However, using a combination of techniques would have been more appropriate for the process of analyzing different kind of risks.

On the other hand, a considerable amount of reliable data on past projects is required to apply such advanced techniques. As we lack well practiced and well structured Risk Management systems , there is a shortage in the required data in Sri Lanka. Therefore, dependency on statistical analysis is avoided in this model. However, even for this model, lack of historical data is a limitation. When enough data is absent, determination of important parameters like probability of occurrence and impact of risk has to be done based on assumptions and professional judgment. This limitation might affect the accuracy and effectiveness of risk analysis process. However, the

main objective of the author is first to start with a straightforward model and allow it to evolve into a widespread RMP using advanced techniques in years to come.

1.7. Structure of the Dissertation

This dissertation has five chapters. Chapter 1 provides an overall view of the research. It addresses the background, research question and objective, research justification, research methodology and scope & limitations of the research.

Chapter 2 reviews the literature related to general Risk Management, importance of Risk Management in construction projects and also Risk Management tools and techniques used in infrastructure projects.

Chapter 3 describes the methodology used in this research. Starting with an analysis of Risk Management tools currently used Sri Lankan construction projects, literature on Risk Management Process and standards practices by various organizations in the world were referred.

Chapter 4 describes the proposed Risk Management Process for Power Generation Projects (RMPPGP). It consists of six interconnected sub-processes. Flowcharts as well as brief description of each element of the process have been formulated.

Chapter 5 summarizes research findings relating to research questions, and the contribution of this work to the profession of Project Management. It concludes with recommendations for future research and practice.

2. Literature Review

2.1. Introduction to Project Risk Management

Risk Management is defined as *'Within a project , risks are unplanned events or conditions that can have a positive or negative effects on its success'*. Risk Management is the process in which the project manager and project team identify project risks, analyze and rank them, and determine what actions, if any, need to be taken to avert these threats (Phillips, 2003).

The project risk can be identified as undesired events that may cause delays, excessive spending, unsatisfactory project results, safety or environmental hazards, and even total failure (Raz, Shenhar & Dvir, 2002). They further elaborated that while no one can avoid project risks, we can certainly prepare by adding Risk Management activities to project plans, and putting in place mechanisms, backups, and extra resources that will protect the organization when something goes wrong – 'just in case'. That is project Risk Management and it is defined as the added planning, identification, and preparation for project risk. Within the current view of project management as a life-cycle process, project Risk Management is seen as an encompassing process staring at project definition, continuing through planning , execution and control phases, up to completion and closure.

The concept of 'Uncertainty Management' could be considered as a emerging concept which is a broader concept than Risk Management (Chapman & Ward, 2003). They have quoted the definition of 'Risk' by the Project Management Institute (PMI) and the Association for Project Management in UK (APM) which are quite similar as follows.

> PMI – an uncertain event or condition that, if it occurs , has a positive or negative effect on a project objective.
>
> APM – an uncertain event or set of circumstances that, should it occur , will have an effect on the achievement of the project's objectives.

They endorse the PMI and APM definitions with respect to their breadth in terms of threats and opportunities but strongly resist the very restricted and limiting focus on 'events', 'conditions' or 'circumstances', which causes effects on the achievement of project objectives. Rather than a focus on the occurrence or not of an event, condition, or a set of circumstances, it is important to take uncertainty about anything that matters as the starting point of Risk Management processes, defining uncertainty in a simple 'lack of certainty' sense.

Risk identification is the starting point of Risk Management . It happens early on the project to allot time for risk response planning. Risk identification also happens throughout the project. The project manager, the project team , customers and other stakeholders are involved in this process. There are several methods to risk identification. According to Chapman and Ward (2003), the most common approaches of risk identification are reviewing project documents, interviews, brainstorming sessions, and the Delphi Technique.

After Risk Identification, the next step is risk analysis. Qualitative analysis qualifies the list of risks in a matrix based on impact of probability. This subjective approach uses rankings as 'very low, low, moderate, high and very high'. The risks can be prioritized based on their scores. After qualitative analysis, some risks may be sent through quantitative analysis. This approach attempts to quantify the risks with hard numbers, values and data. (Phillips, 2003)

There are four possible risk responses :

- Prevention : countermeasures are put in place to stop the threat or problem from arising or to prevent it from having any impact on the project.
- Mitigation or Reduction : actions either to reduce the likelihood of risk developing or reduce the impact to acceptable levels.
- Transference : the risk is assigned to a third party, usually for a fee, for example by adding on an insurance policy or a penalty clause and

- Contingency : Where actions are planned and organized to come into force as and when the risk occurs (Phillips, 2003)

2.2. Importance of Risk Management in Infrastructure Projects

Raz, Shenhar & Dvir (2002) focused on the relationship between the project types and the application of Risk Management practices, and how these practices contribute to project success. According to the research, the Risk Management techniques have not yet become part of the mainstream practices in project management like Work Breakdown Structure or scheduling techniques based on critical path analysis. It is further stated that organizations must realize that projects are risky undertakings that do not always end as planned, and that in fact, delay or failure may not be the exception. Projects are liable to suffer unexpected outcomes, i.e. delays, overruns and disappointing results. Hence organizations must learn to accept that as part of reality , and be ready to prepare for them and reduce them as much as possible. This should be done in a systematic way, according to Risk Management techniques. Project Risk Management should become part of the culture of project management activity and a routine component in any project plan and review activity.

There is a strong link between the amount of Risk Management undertaken in a project, and the level of success of the project. The better the project managers the risk, the more successful will it be. Also, the earlier the Risk Management is used in a project, the more successful it will be. There are often high levels of uncertainty in construction projects. Any feasibility study necessarily contains many assumptions about the future. Systematic Risk Management helps you quantify that uncertainty. Confidence comes from certainty, but in absence of such certainty, confidence can be increased by knowing where the risks are coming from, how extensive that uncertainty is, and what the potential consequences are. According to the research, systematic Risk Management is deemed to have the following advantages.

- Questioning of the assumptions that most affect the success of your project.
- Concentrates attention on actions best to control risks, and
- Assesses the cost benefit of such actions.

The application of Risk Management at the outset clarifies the objectives and helps refine the project brief. Risk Management helps to recognize the importance of any constraints that may be set and assess their impact on the project (Elkington & Smallman, 2002).

Mills(2001) concludes that Risk Management will not remove all risk from the project. It's principle aim is to ensure that the risks are managed in the most efficient manner. Risk Management is not intended to kill off worthwhile projects, nor to dampen levels of investment. It rather aims to ensure that only projects that are genuinely worthwhile are sanctioned.

A review of techniques that support risk management in product development projects using the concurrent engineering philosophy has been introduced by Ahmed and Amornsawadawatana (2007). This paper presents techniques that are commonly used in Project Management , outlining their usefulness to project Risk Management, especially in concurrent engineering projects.

Yu and Rardin (2006), in their research paper 'Lessons Leaned from the failed Risk Management for planning Natural Gas fired Power Plants' have stated that developers should have revisited the mistakes many had made in the gas power plants in the past and avoid similar mistake by adhering to a proper Risk Management Process.

2.3. Review of Risk Management tools and Techniques in Infrastructure Projects

Although there are plenty of Risk Management tools and techniques available, many managers are still reluctant to apply them in their projects. It seems Risk Management techniques have not become part of the mainstream practices in project management like Work Breakdown Structure or scheduling techniques based on critical path analysis. Also, they believe that part of the problem is lack of awareness and over-optimism (Raz, Shenhar & Dvir, 2002).

Dey and Ogunlana (2004) have focused their study on 'Selection and application of Risk Management tools and techniques for build-operate-transfer projects'. This paper demonstrates the application of Risk Management in BOT projects. The studies focus on

- What types of risks have been identified
- How risks have been perceived by project participants and
- How risk response and allocation have been done in practice.

The knowledge on the magnitude of the possible impact that may be caused by the contingent factors, the parties can seek for better allocation of the risks through the agreement of suitable contract clauses, procurement of insurance or other risk response methods. They have summarized the following as Risk Analyze Tools and Techniques commonly used in BOT projects.

- Influence Diagram
- Monte Carlo simulation
- Programme Evaluation & Review Technique (PERT)
- Sensitivity Analysis
- Multi Criteria Decision Making (MCDM)
- Analytical Hierarchy Process (AHP)
- Fuzzy Set Approach (FSA)
- Decision Tree Analysis

- Neutral Network Approach (NNA)
- Risk check list
- Risk mapping
- Cause and effect diagram

The author referred two generic international standards; the Australian/New Zealand standard on Risk Management ; AS/NZS 4360: 2004 and Risk Management standard by the Institute of Risk Management (IRM); AIRMIC,ALARAM, IRM :2002. The RMP given the AS/NZS 4360: 2004 can be stated as one of the comprehensive model for managing risks.

Burchett,Tumala & Leung (1999) in their paper on 'The application of the risk management process in capital investment decisions for EHV transmission line projects', have formulated a RMP for selecting the best project out of several project proposals.

Burchett, Tumala & Leung (1999) have done a study to examine current world-wide practices of Risk Management within electrical supply projects in terms of the methods used and reasons for using them, including the application of Risk Management processes in project evaluation in the electricity supply industry. However, their main focus had been to explore financial risks of electrical supply projects.

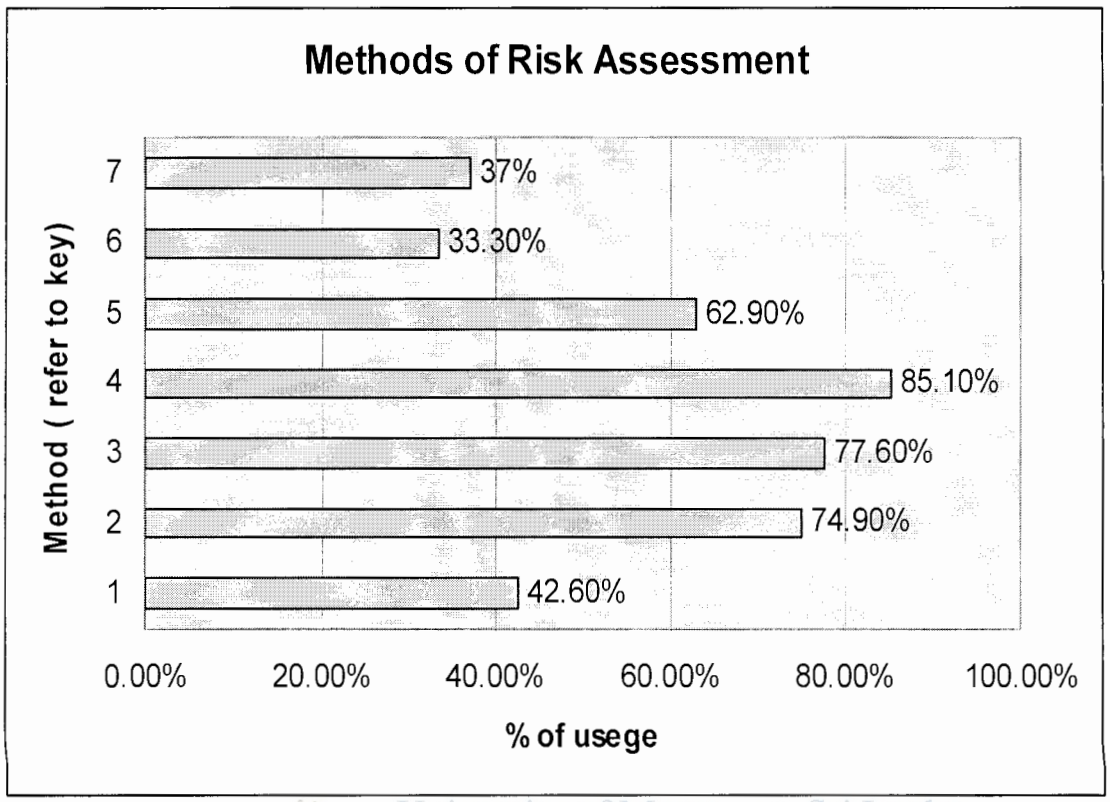
The trends in the use of Risk Management approaches and the barriers faced and benefits perceived have also been examined. Under this study, the practices of electric utilities world-wide have been compared with the latest viewpoints from the literature and other surveys in similar industry sectors. This study provides an insight on current risk handling practices within the electric power generation and distribution industry. The study also provides possible suggestions on how Risk Management approaches should be used to close the gap between theory and actual use.

They have identified two majour factors on Risk Management practices implementation barriers, namely 'interpretation' and 'justification'. Thus managers

with little quantitative background may find difficulty in understanding and using and interpreting concepts of probability distributions, expected values and variances which would also cause human and organizational resistance due to inadequate knowledge causing problems in operation. Although, some managers appreciate the potential benefits of Risk Management practices , they have to become familiar with RMP before these can become part of their capital budgeting system. According to the survey, formal Risk Management approaches are more likely to be applied to large, complex projects with a potential for cost overruns. However, the criteria for application are likely to depend more on overcoming managers' concerns and understanding of input estimates and probabilities.

According to the study by Burchett, Tumala & Leung (1999), project stakeholders desire a more thorough assessment of risks than demanded previously, and Risk Management practices are applied to check the relationship amoung the returns of different projects. Thus the drive is towards a more formal Risk Management process that will meet the expectations of business growth and project sponsors to ensure that all risks are actively managed throughout the life cycle of the project. Some respondents have indicated that their organization is not suitable for Risk Management application, as decision on capital budgets are made simply to meet a need (supply of electricity) without concern regarding returns. These electricity utilities are manly public owned corporations, with no shareholders or owners requiring a profit to be shown. This is certainly changing, and mainly recently privatized utilities have shown a very positive response to Risk Management, which demonstrate the need for the top management to provide authority to any new evaluation methods for capital investment proposals.

The methods used for risk measurement and assessment by electric utilities have also been analyzed by the study. Figure 2.1, Methods of Risk Assessment, given below is on extent of usage of various (financial) risk assessment methods of electric utilities. There are many approaches or tools for Risk Management ranging from doing nothing to a formal Risk Management process. Sensitivity analysis was found to be the most frequently used method and it is about 85 % of the respondents.



Key

1 - No explicit assessment

2 - Assumed subjectively/ intuitively as low, medium & high etc.

3 -Analyzed by assessing three point pessimistic, most likely and optimistic (3PE)

4 -What if analysis

5 -Analyzed by assigning probability distribution of net cash flow and expected value of NPV

6 -Analyzed by Capital Asset Pricing

7-By formal Risk Management Process(RMP)

* used a Likert scale – (Never, Rarely, Little, Sometimes, Often, Very Often)

Figure 2.1 Methods of Risk Assessment (Burchett,1999)

The concept of Risk Breakdown Structure (RBS) has been described by Hillson (1997) RBS is defined as ' *a source oriented grouping of risks that organizes and defines the total risk exposure of the project or business. Each descending level represents and increasing detailed definition of sources of risk'*

It is a hierarchal structure of potential risk sources which can be used for risk identification effectively. The main similarity in Work Breakdown Structure (WBS) and Risk Breakdown Structure (RBS) is their hierarchical structure and both can be used as tools of management process, WBS for project management and RBS for Risk Management. WBS forms the basis for many aspects of the project management process; similarly RBS can be used as the structure and guide the Risk Management process. According to Hillson (1997), benefits of RBS are

- Tool for risk identification and ensure complete identification
- Can be used to compare project risks
- Provide a framework for cross-project risk reporting
- Can be used as a check list

Hillson (1997) has also produced specific RBSs for clients in various industries with different project types, including defense software, energy supply, construction management, general engineering, and telecommunication.

Iranmanesh, Jalali & Pirmoradi (2007) have further developed the concept of RBS by introducing a Risk Breakdown Matrix (RBM). A combination of WBS and RBS is used to develop RBM. In this particular paper, a customized and modified RBM is introduced according to the nature and structure of engineering, procurement & construction (EPC) projects.

Hillson,Grimaldi and Rafele (2006) have introduced a WBS/RBS/RBM pyramid for risk analysis by linking the hierarchical levels of WBS and RBS into RBM with increased degree of detail, as a useful guide for determination & identification of the most vulnerable areas in a project.

3. Research Methodology

3.1. Analysis of risk management tools and techniques used in infrastructure Projects

The initial intention of the author was to gather information on risk management methodologies that are being practiced by power utilities and internationally reputed contractors who undertake large-scale power projects. However, the response received from them was far below the expectations and insufficient for the purpose of the research. Some of the companies were reluctant to reveal their internal Risk Management process as such information was restricted for internal use of the organization. On the other hand, initial surveys carried out revealed that neither the main power utility in Sri Lanka, the Ceylon Electricity Board nor any of the Independent Power Produces operating in the country either possess or practice any documented, structured Risk Management Process for power generation projects. Hence it is understood that the risk management is only a unstructured component of Project Management which applies intuitively in construction projects in Sri Lanka.

In order to obtain information on risk management practices used in the construction sector, unstructured interviews were held with a number of Project Managers who handle large scale power and construction projects, including the Project Director, Upper Kothmale Hydro Power Project, Senior Project Director Puttlam Coal Power Project and Project Director, Trincomalee Coal Power Project. These interviews revealed that the risk transfer through the 'Project Contract' is the main mode of risk management in the Sri Lankan power projects. The common transference tools used in construction projects were Performance Bonds, Warranties, Guarantees, Incentive/Disincentive clauses and Insurance.

It was revealed from the interviews that most of the Sri Lankan Project Managers who manage construction projects, commonly use software like MS Project and Primavera as Project Management tools. The Risk Management features are also incorporated into these tools. However, these software require the project

managers to quantify the risks of each and every activity independently. The author is of the view that , quantifying risk incorporated on each activity and planning for risk treatment for the same as specified by these software may not be effective most of the time , specially for construction projects. The author believes that the prudent way is to identify and analyze project risks in a holistic way rather than analyzing risk factors of each individual activity. On the other hand, analyzing risk factors for each and every activity for a large project, is a complex task. These may be some of the contributory factors for not using the risk management features incorporated in those software by Project Managers.

Generally, Critical Path Method (CPM) and Programme Evaluation and Review Technique (PERT) are used for identification and analysis of critical path as well as critical tasks of the project by Project Managers. Although these are considered in general as typical project management tools, they address the issue of 'risk of project delay' as well. Hence, use of these techniques automatically lead Project Managers to plan for risks associated with one important component of the triple constrains, 'time'.

The financial risks of Sri Lankan construction projects are analyzed to a certain extent by using standard project finance analysis tools like the NPV and the Payback periods. However, not much analysis is done on the risk due to interest rate fluctuations, exchange rate fluctuations and possible cash flow problems.

Although, a structured and documented Risk Management Process could not be found, the information provided by Project Managers interviewed by the author was very useful to develop such a process for power projects.

3.2. Risk Management Processes and Standards available

After obtaining available information on risk management tools and techniques in Sri Lankan power projects, Risk Management Processes and standards practices by various organizations in the world were referred to obtain a better understating.

Tumala, Rao and Leung (1995) have developed a Risk Management Model for assessing safety and reliability risks. According to them the majour aim of developing the risk management model to assess the safety and reliability risks is to make RMP a more practitioner- oriented approach by integrating it with system hazard analysis in identifying and assessing all potential hazards. The hazards are ranked based on their indices then action plans are developed and then the best course of actions are taken to control and manage risks. The six phases included for the model are

- Risk or hazard identification
- System hazard analysis
- Ranking of hazards
- Development of action plans
- Risk evaluation and
- Risk control and monitoring

The model is given in Figure 3.1, Risk Management Model for assessing safety and reliability risks.

The Department of Defense, USA(2002) defines Risk Management Process as a continuous process that is accomplished through out the life cycle of a system. It is an organized methodology for continuously identifying and measuring the unknowns ;developing mitigation options; selecting, planning and implementing appropriate risk mitigation, and tracking and implementation to ensure successful risk reduction. Effective risk management depends on risk management planning early identification and analysis of risks, early implementation of corrective actions, continuous monitoring and reassessment and communication,

documentation and coordination. The Risk Management Process of the Department of Defense , which is stated in the Risk Management Guide for Department of Defense acquisition, 6th Edition (2002) is given as Figure 3.2 , Risk Management Process – Department of Defense, USA.

The Institute of Risk Management , UK (2002) defines Risk Management Process as *'a process whereby organizations methodically address the risk attaching to their activities with the goal of achieving sustained benefit within each activity and across the portfolio of all activities.'* According to the standard published by IRM (2002), the focus of good risk management is the identification and treatment of risks. Its objective is to add maximum sustainable value to all the activities of the organization. It marshals the understanding and potential upside and downside of all those factors which can affect the organization. It increases the probability of success, and reduces both the probability of failure and the uncertainty of achieving the organization's overall objectives. The standard of the IRM is a generic RMP which is basically suitable for an organization. However, I assume the main framework of RMP for a Power Project can also be derived through this standard. The Risk Management Process stated in the Institute of Risks Management standard is given in Figure 3.3, Risk Management Standard by IRM (2002).

The RMP based risk management model as formulated in Figure 3.4, Risk Management Process for project selection which has been developed by Burchett (1994) in assessing Extra High Voltage transmission line project cost risks and developing the required response actions to contain and manage the identified risks. The main scope of this RMP is to select the best project in a portfolio of projects.

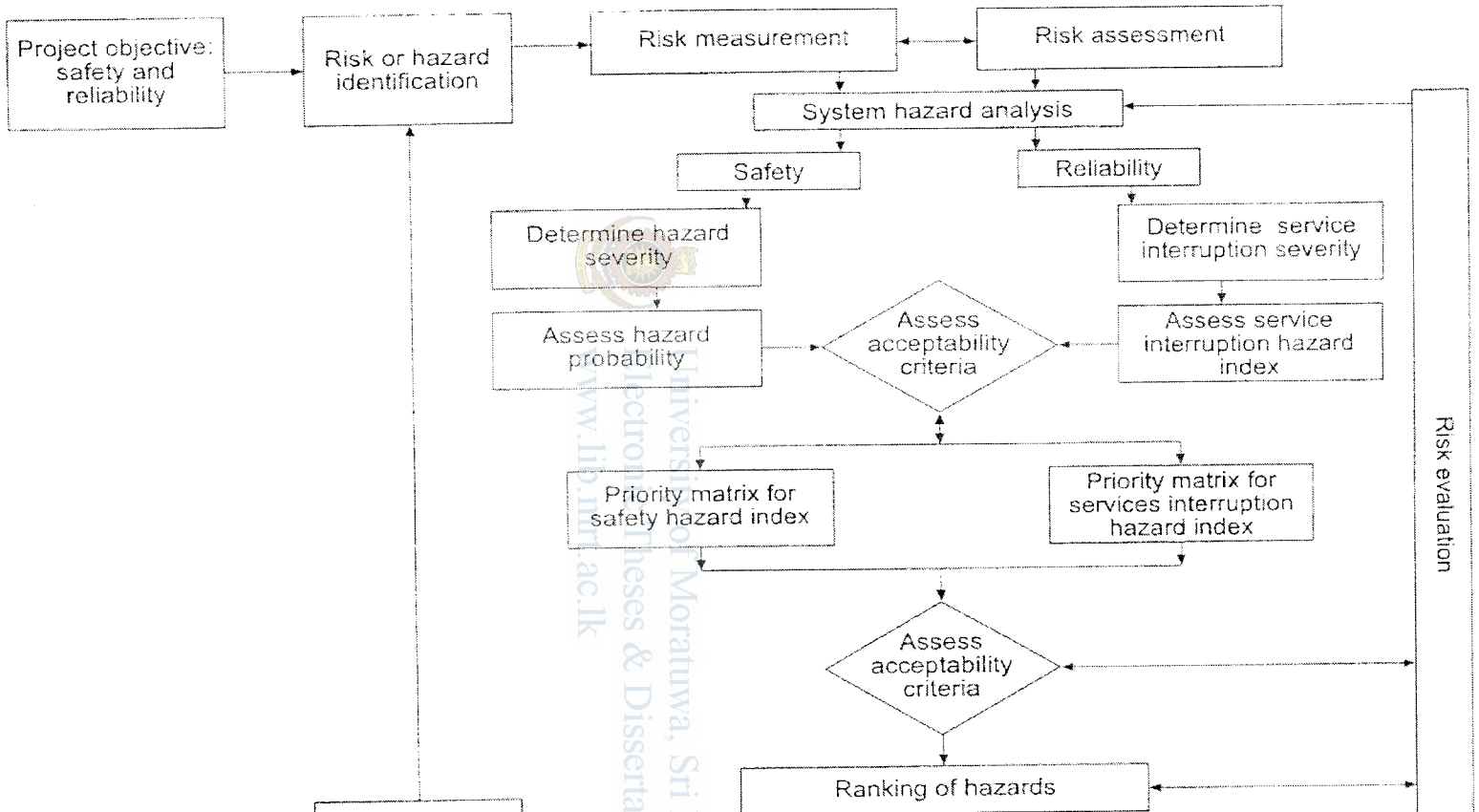


Figure 3.1 Risk Management Model for assessing safety and reliability risks (Tumala & Rao, 1995)

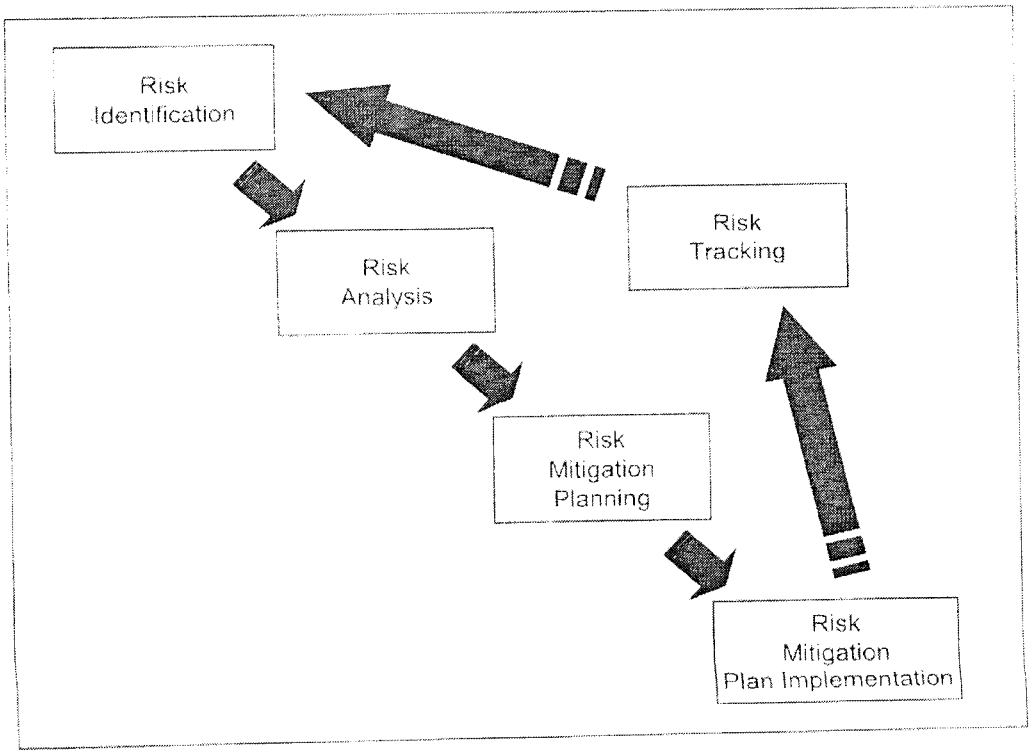
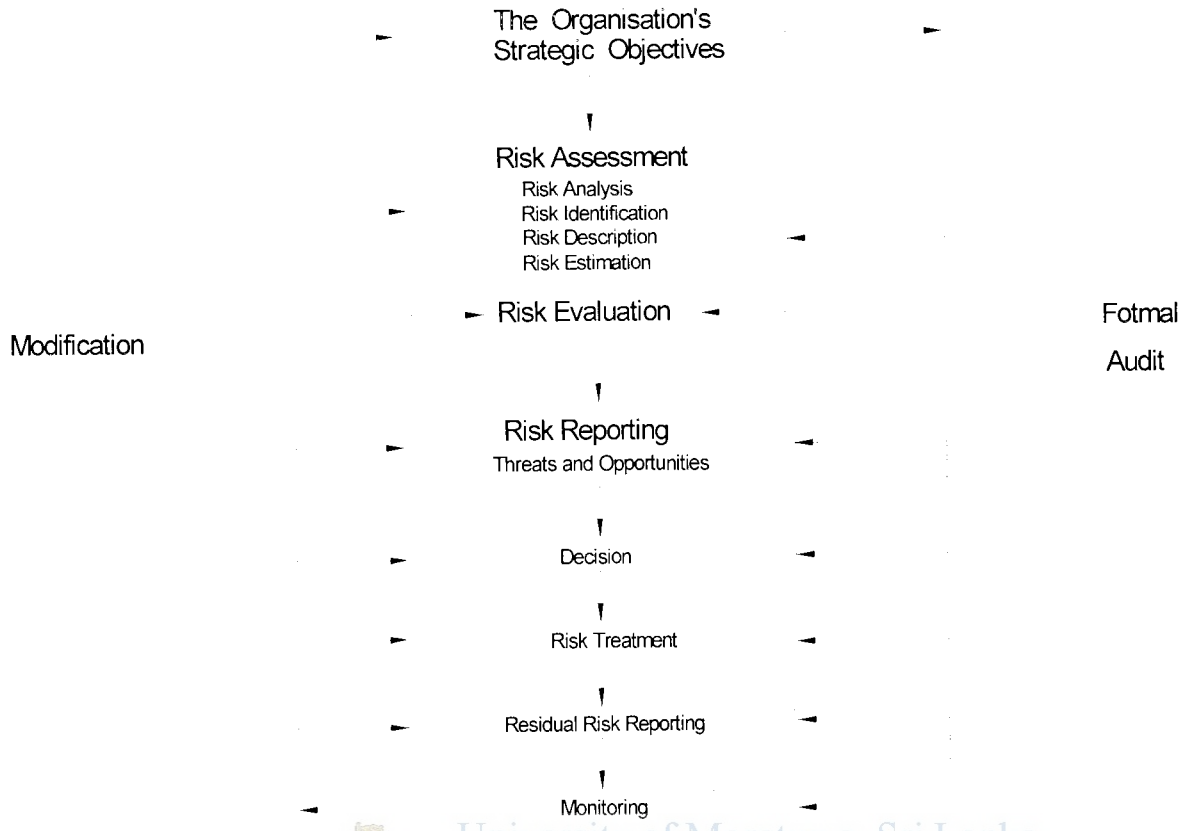


Figure 3.2 : Risk Management Process (Department of Defense, USA, 2002)

The Association of Project Managers (2000) has developed a nine- step procedure for Project Risk Analysis and Management (PRAM). i.e

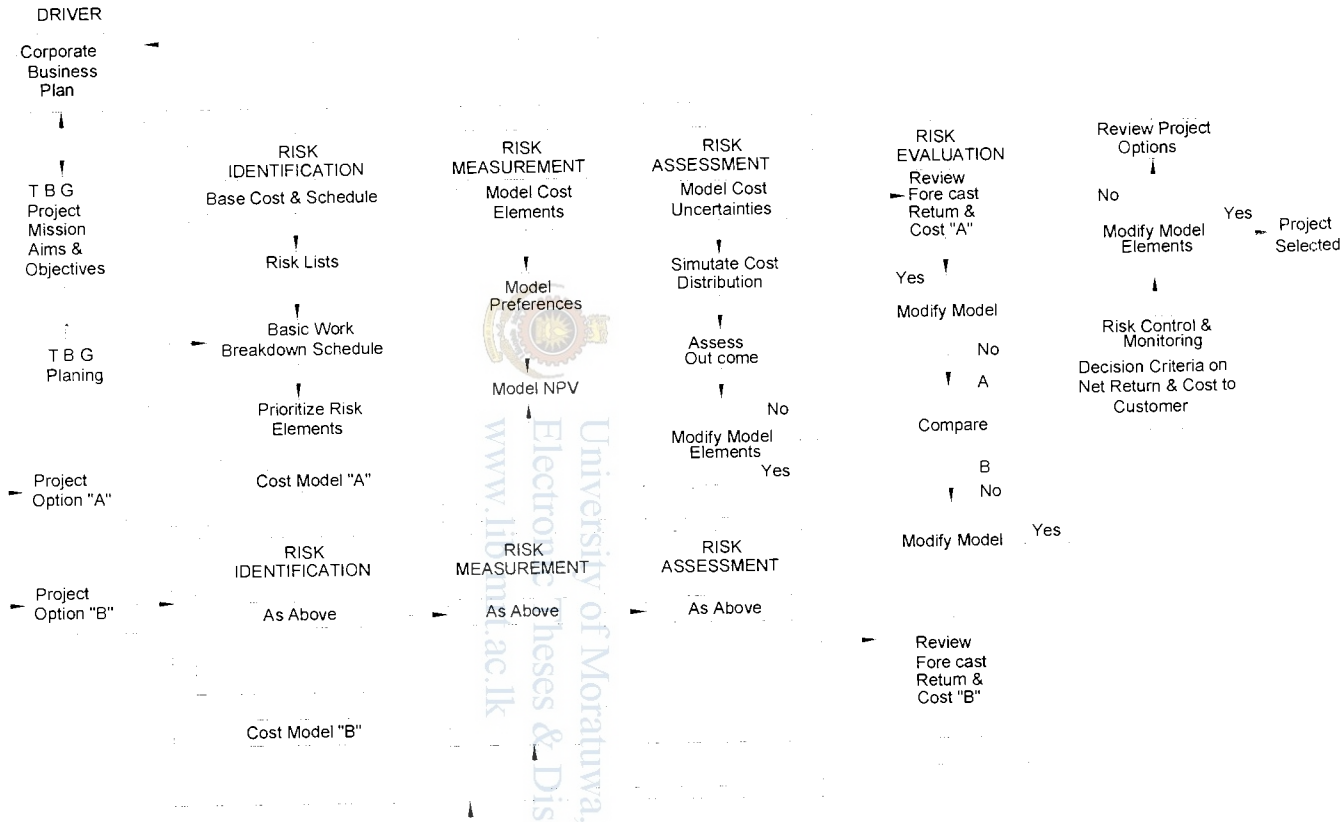
- Define
- Focus
- Identify
- Structure
- Ownership
- Estimate
- Evaluate
- Plane, and
- manage



The Risk Management Process by IRM (2002)

Figure 3.3

According to the Australian / New Zealand Standard on Risk Management, AS/NZS 4360 (2004), a Risk Management Process is defined as ' *a systematic application of management policies, procedures and practices to the task of communicating, establishing the context, identifying, analyzing, evaluating, treating, monitoring and reviewing risk*'. The risk management process defined by the Australian/ New Zealand Standard is given in Figure 3.5 , RMP, Australian / New Zealand Standard AS/NZS 4360(2004). It composed of seven iterative sub-processes of establishing the context of risks, risk identification, risk analysis, risk evaluation, risk treatment , communication and consultation across stakeholders and monitoring and control of above sub processes. It is also a generic Risk Management Process similar to standard of the IRM which can be applied for a product development process or for an organization.



Risk Management Process For Project Selection By Burchett (1994)
Figure 3.4

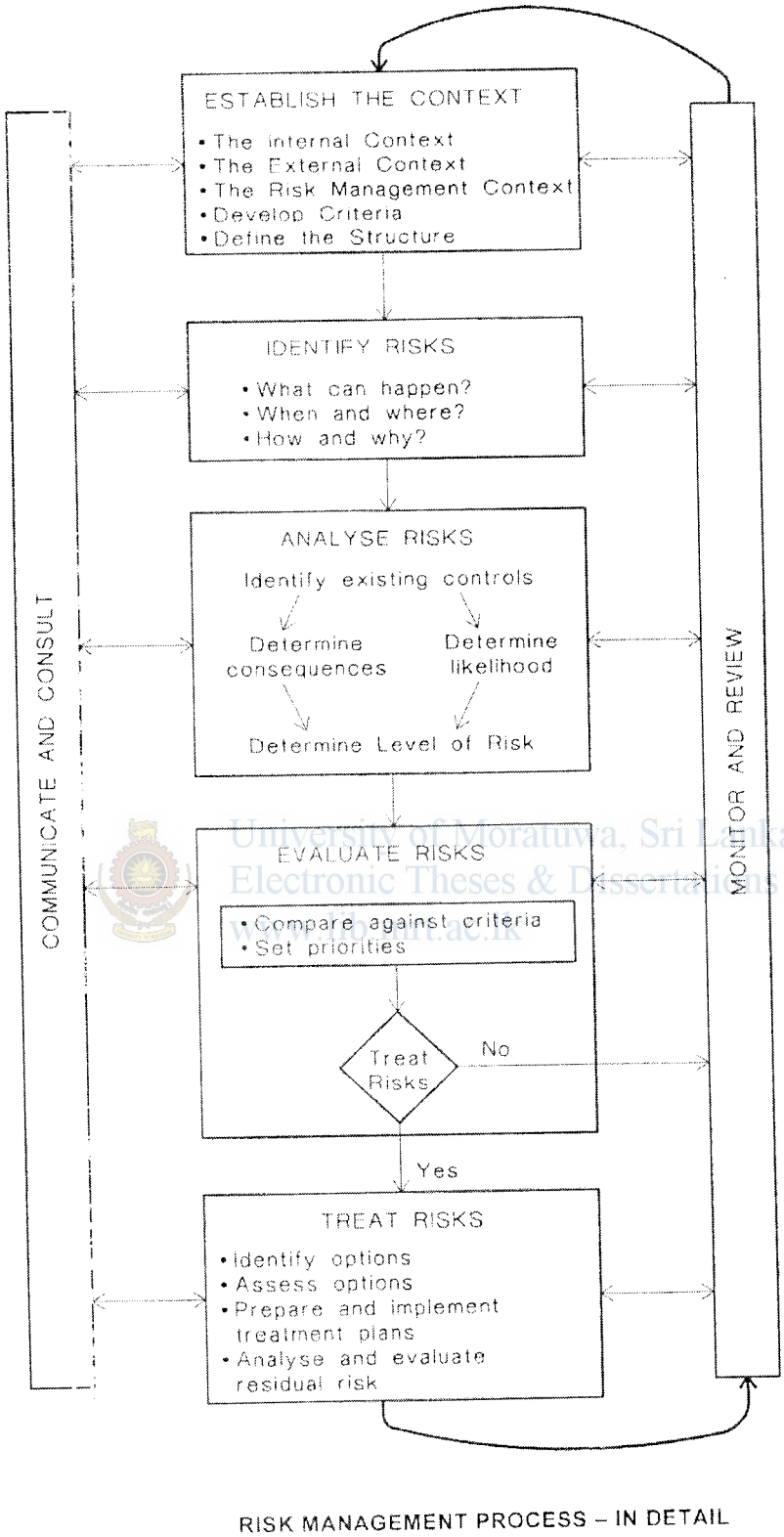


Figure 3.5 : RMP, Australian / New Zealand Standard (AS/NZS 4360, 2004)

3.3. Formulation of Risk Management Process for Power Generation Projects

The information gathered through the interviews and concepts given in the above few Risk Management Processes were very useful for the author to formulate the Risk Management Process for Power Generation Projects (RMPPGP). Specially, the Standard of the Australian/New Zealand Risk Management; AZ/NZS 4360 (2004) can be stated as the foundation for the RMPPGP. Although, AZ/NZS 4360 (2004) is only a generic standard recommended for an organization or a product development process, it can be configured and expanded for generation projects. However, there are two major deviations between AZ/NZS 4360 (2004) and the RMPPGP. i.e.

- The author considers the component 'Communicate & Consult' as a child process of the sub-process 'Monitor & Control' whereas AZ/NZS 4360 (2004) considers them as in an equal hierarchal level.
- The relationship between the organization and the project or the driver of the RMP is recognized in the RMPPGP. This is not a consideration for AZ/NZS 4360 (2004) as it is not specially for projects.

It was also noted that most of the RMP's, including AZ/NZS 4360 (2004), do not provide enough detailed information on its main sub-processes. The author believes that the process should be defined into finer elements so that the Project Team could practice the RMP conveniently and confidently. Also the RMP can be standardized within the organization when all the finer elements are uniformly defined. As stated in the introduction, risk management has not yet become a core process in Project Management in Sri Lanka. Therefore developing a detailed process is of utmost importance.

RMPPGP consisting of six sub-process i.e Establishment of the risk management context of the Power Project, Risk identification, Risk analysis, Risk response planning, Risk monitoring & control and Communicate & consult. The author has developed simple but comprehensive flow charts for each of these sub-processes.

4 Risk Management Process for Power Generation Projects

The purpose of this chapter is to describe the Risk Management Process formulated by the author for Power Generation Projects. RMP is a well structured system, whereby the project team address the risks attached to all activities of the project with the goal of achieving sustained benefits within each activity and across the portfolio of all activities.

The Risk Management Process for Power Generation Projects (RMPPGP) consists of six interconnected sub-processes as shown in the Figure 4.1. The sub-processes are

- Establish the risk management context of the Power Project
- Risk identification
- Risk analysis
- Risk response planning
- Risk monitoring & control
- Communicate & consult

The RMPPGP is driven by the corporate business plan of the organization and begins with identifying the strategic importance of a project together with the project mission, aims, and objectives as shown in the Figure 4.1, RMPPGP. The strategic business plan and project mission are not components of the RMP but only the drivers of the process. A comprehensive expansion of each of these sub-processes is given below.

4.1. Establish the Risk Management Context of the Power Project

Establishing the context defines the basic parameters within which risks must be managed and sets the scope for the rest of the risk management process of the Power Project. The context includes the project's external and internal environment and the purpose of the risk management activity. This also includes consideration of the interface between the external and internal environments. This is important to ensure that the objectives defined for the risk management process take into account the organizational and external environment. The sub-process consisting of three elements and their relationship is elaborated in Figure 4.2, Establish the Risk Management Context of the Power Project.

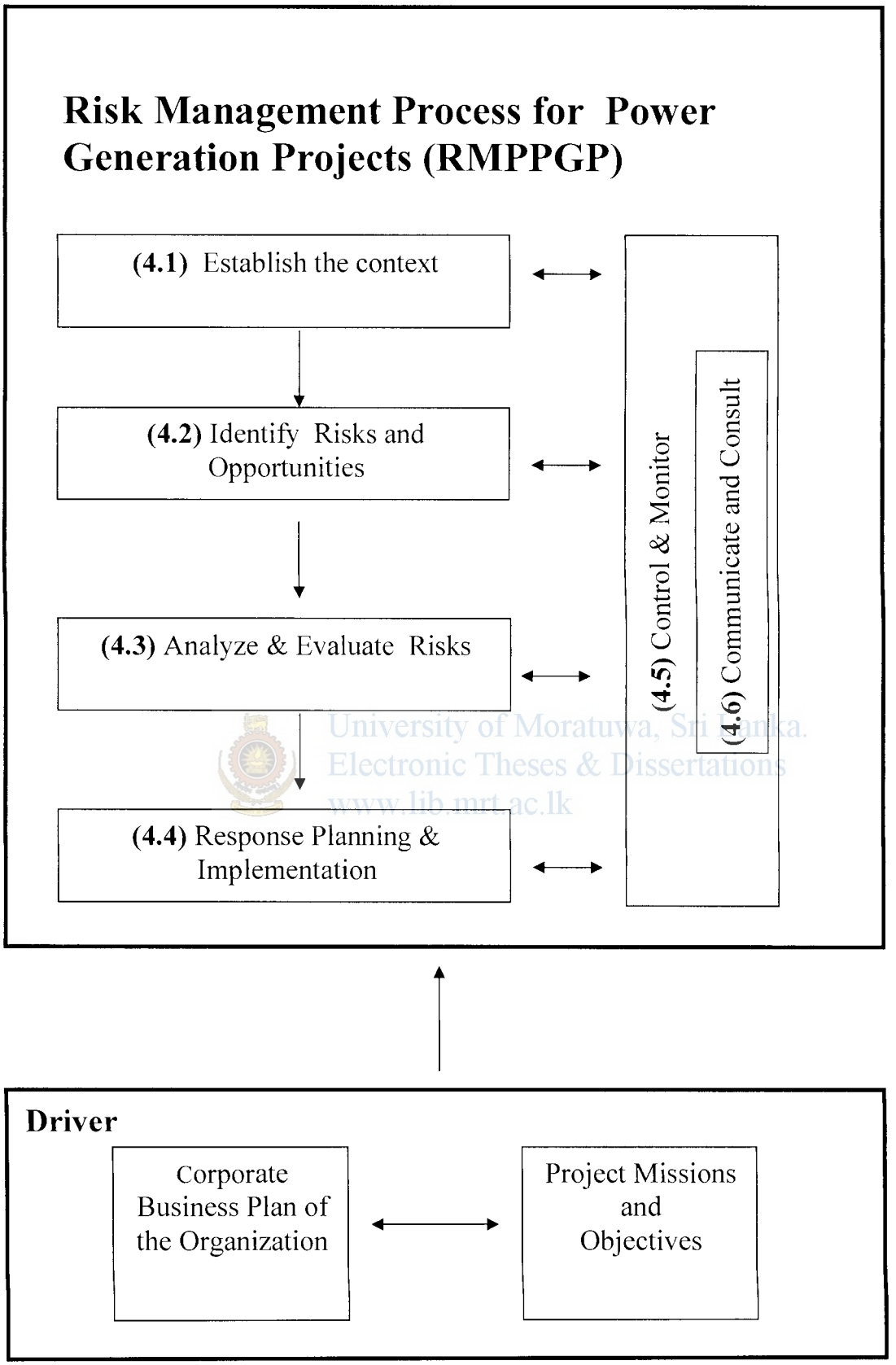


Figure 4.1: Risk Management Process for Power Generation Projects

4.1.1 Establish the external context

This step defines the external environment in which the organization operates. It also defines the relationship between the organization which implement the Power Project and its external environment. This may, for example, include:

- the business, social, regulatory, cultural, competitive, financial and political environment;
- external threats and opportunities
- external stakeholders; and
- key business drivers.

It is particularly important to take into account the perceptions and values of external stakeholders, and establish policies for communication with these parties. Establishing the external context is important to ensure that stakeholders and their objectives are considered when developing risk management criteria and that externally generated threats and opportunities are properly taken into account.

4.1.2 Establish the internal context

Before a risk management activity, at any level, is commenced, it is necessary to understand the organization.

Key areas included in this exercise are ;

- internal stakeholders
- structure
- culture
- capabilities in terms of resources such as people, systems, processes, capital; and
- goals and objectives and the strategies that are in place to achieve them.

Establishing the internal context is important because:

- risk management of the power project takes place in the context of the goals and objectives of the organization;
- the organizational policy and goals and interests help define the project's risk policy; and
- specific objectives and criteria of a project must be considered in the light of objectives of the organization as a whole.

[4.1] Establish the Risk Management Context of the Power Project

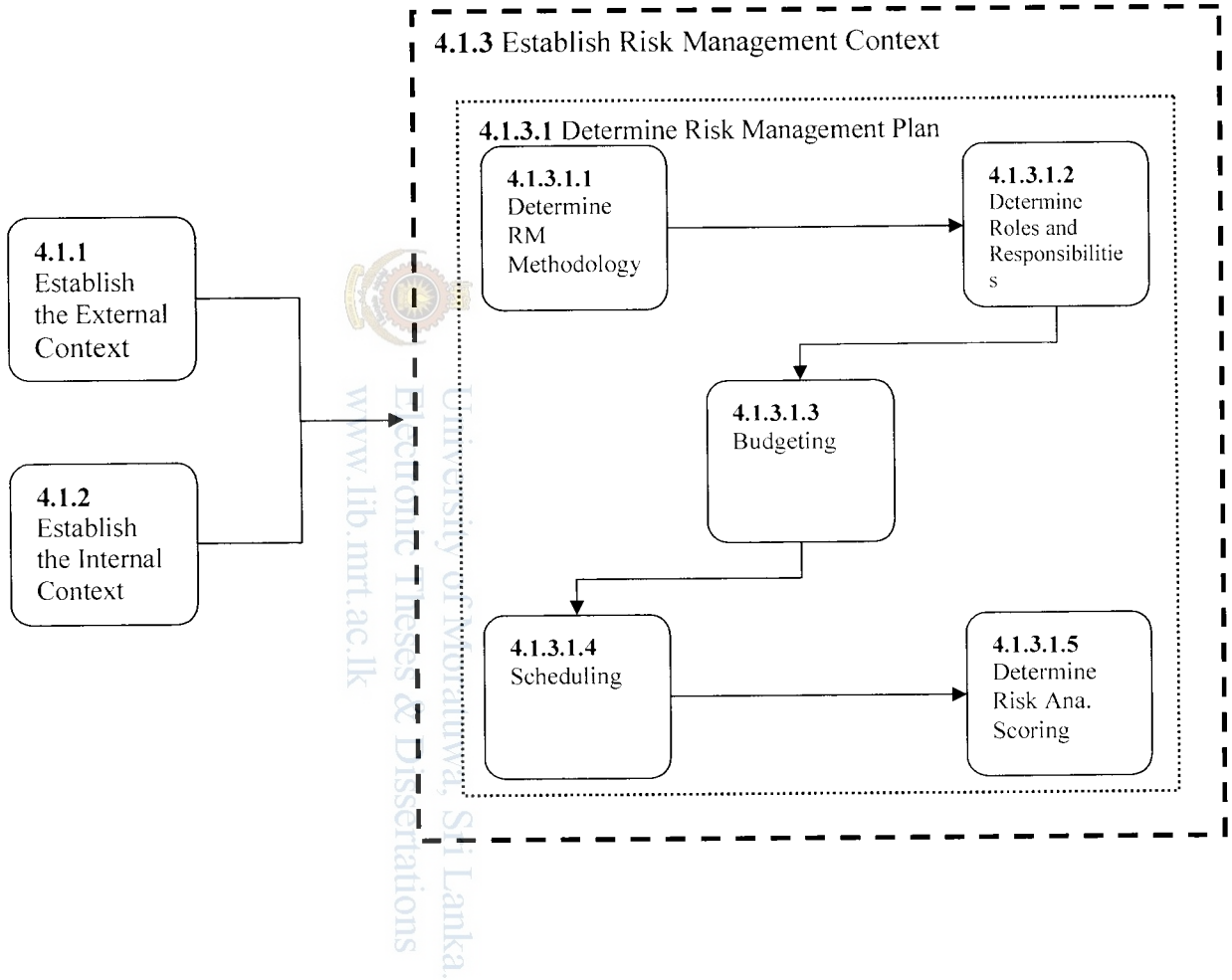


Figure 4.2 Establish the Risk Management Context of the Power Project

4.1.3 Establish the risk management context

The goals, objectives, strategies, scope and parameters of the Power Project which the risk management process is being applied to, should be established. The process should be undertaken with full consideration of the need to balance costs, benefits and opportunities. The resources required and the records to be kept should also be specified.

Setting the scope and boundaries of an application of risk management involves :

- defining the project and establishing its goals and objectives;
- specifying the nature of the decisions that have to be made;
- defining the extent of the project activity or function in terms of time and location;
- identifying any scoping or framing studies needed and their scope, objectives and the resources required; and
- defining the depth and breadth of the risk management activities to be carried out, including specific inclusions and exclusions.

Specific issues that may also be discussed include the following:

- The roles and responsibilities of various parts of the organization participating in the risk management process.
- Relationships between the project and other parts of the organization or other projects.
- Appointment of a Risk Manager for the process (depending on the cost or complexity or any other relevant factor to the power project)

4.1.3.1 Determine the Risk Management Plan

The risk management plan is to determine

- How risks will be identified
- How analysis will be completed
- How risk response planning will happen
- How risks will be monitored
- How ongoing risk management activities will be controlled throughout the project life cycle

Through planning meetings, the risk management criteria is formulated. Risk management plan templates, performing organization policies, and the risk

tolerance level of the stakeholders aid the creation of the risk management plan. The following personnel involve in determining the Risk Management Plan for the project.

- The Project Manager
- Risk Manager
- Project team leaders
- Consultants of the project (if any)
- Key stakeholders
- Any other persons with authority or needed input to the Risk Management Processes

4.1.3.1.1 Determine Risk Management Methodology

The methodology is concerned with how the risk management processes will take place. The methodology asks

- What tools are available to use for risk management?
- What approaches are acceptable within the performing organization?
- What data sources can be accessed and used for risk management?
- What approach is the best for the Power Project type, the phase of the project, and
- Which is the most appropriate given the conditions of the Power Project?
- How much flexibility is available for the project given the conditions, the timeframe, and the project budget?

4.1.3.1.2 Determine Roles and Responsibilities

The roles and responsibilities identify the groups and individuals that will participate in the leadership and support for each of the risk management activities within the project plan. In some instances, risk management teams outside of the project team may have a more realistic, unbiased approach to the risk identification, impact, and overall risk management needs than the actual project team.

4.1.3.1.3 Budgeting

Based on the size, impact, and priority of the project, a budget may need to be established for the project's risk management activities. A project with high priority and no budget allotment for risk management activities may face uncertain times ahead.

4.1.3.1.4 Scheduling

The risk management process needs a schedule to determine how often and when risk management activities should happen throughout the project. If risk management happens too late in the project, then the project could be delayed because of the time needed to identify, assess, and respond to the risks. A realistic schedule should be developed early in the project to accommodate risks, risk analysis, and risk response.

4.1.3.1.5 Determine Risk Analysis Scoring

Prior to beginning risk analysis, a clearly defined scoring system and interpretation of the scoring system must be in place. Altering the scoring process during risk analysis, or from analysis to analysis, can skew the seriousness of a risk, its impact, and the effect of the risk on the project. The project manager and the project team must have clearly defined scores that will be applied to the analysis to ensure consistency throughout the project.

4.2. Risk Identification

Risk identification is the process of determining those risks that might affect the project and its outcome. When a risk and its characteristics are identified and documented, then a response to the risk can be planned, and it can be monitored.

Risk identification is an iterative process because new risks may become known as the project progresses through its life cycle and previously-identified risks may drop off. The frequency of iteration and the question of who participates in each cycle will vary depending on the power project. However, if identification of risk is done effectively in the 'project initiation or conceptualization' stage, the Risk Management Process will be more productive as risks identified in these stage will have a bigger impact on the project. The project team should be involved in the process so that they can develop and maintain a sense of ownership of, and responsibility for, the risks and associated risk response actions. Stakeholders outside the project team may provide additional objective information.

The participants in risk identification activities can include the following, where appropriate : Risk Manager, Project Manager, project team members, subject matter experts both from the project and outside the project team, consultants, customers, contractors, end users, other project managers , and risk management experts. While these personnel are often key participants for risk identification, all personnel involved in the project should be encouraged to identify risks. The main elements of this sub-process is given below. Figure 4.3, Risk Identification describes the relationship of each element.

4.2.1 Formal Identification of Sources of Risks

The Risk Manager or/and Project manager is responsible for conducting formal risk identification activities. The Risk Manager stays apprised of the progress of the project, and communicates with project team members to specifically identify risks and sources of risks. The Project Status Meetings is the primary forum for the formal discussion of risk. The Risk Manager conducts risk management team meetings as necessary to formally identify and track project risk. The assigned team members identify the potential risks (threats and opportunities), using:

[4.2] Risk Identification

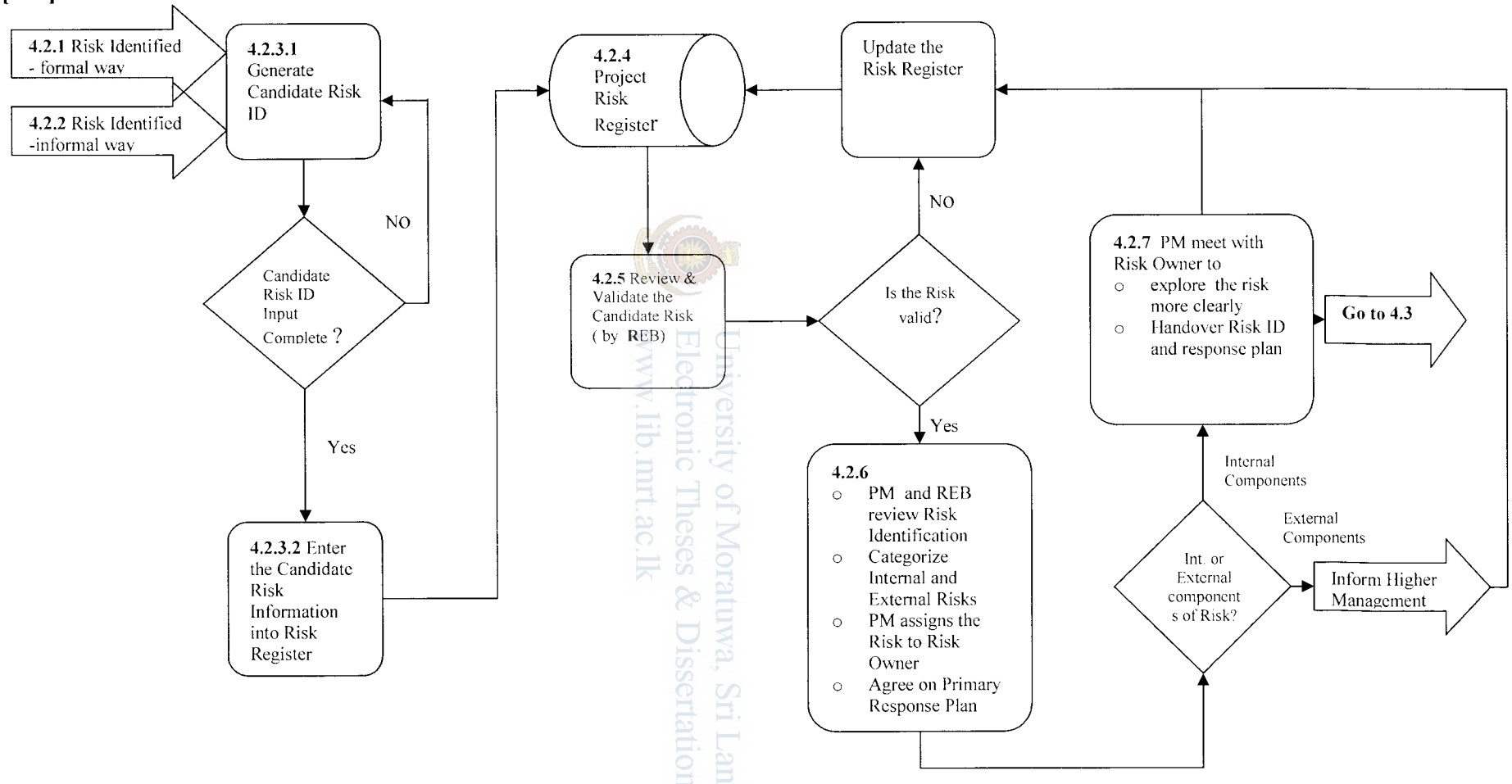


Figure 4.3 Risk Identification

- The risk breakdown structure (RBS), suitably tailored to the project. An example of a RBS for a coal power project is given in Annex 01.
- Their own knowledge of the project or similar projects.
- Consultation with others who have significant knowledge of the project or its environment.
- Consultation with others who have significant knowledge of similar projects.
- Other tools and techniques such as those provided in Chapter 11, PMBOK of the PMI.

It is important to specify the risk correctly. For instance, a risk has a cause and, if it occurs, an impact on a project objective. The risk statement structure that should be followed in specifying identified risks is: *Because of the (cause, condition that is true), (a risk) may occur, leading to an impact (at this stage unanalyzed) on XX objective where XX is cost, time, scope and or quality.*

4.2.2 Informal Risk Identification

Informal risk identification occurs as a result of normal project business. Any person associated with the project including prime contractor staff, sponsor representatives, stakeholders is expected to identify and document a candidate risk .

4.2.3 Initiating and Documenting of the Candidate Risk

The identification of risk is initiated by documenting what is known about the specific risk and the source. The PM/RM should prepare an appropriate form, 'Risk Identification & Response Plan form' for this purpose. An example of a such a form for a Power Project is given in Annex 02. The description of the risk clearly indicates the concern, likelihood (if known), and the possible consequences. The description may also include assumptions, constraints, and relationship to other project risks, issues or activities, and potential impacts on the project budget, schedule, quality, or stakeholders.

The initiator submits the form to the Project Manager or Risk Manager . The PM/ RM and the initiator ensure that the initiating information is complete. The Risk

Manager assigns a unique identifier and inputs the information into the Risk Register.

4.2.4 Risk Register

The process of Risk Identification produces a deliverable and, the Project Risk Register. The Risk Register contains vital information on identified risks including Risk ID, Category, Description, Root Source, Probability, Impact, Overall Risk Rating, Risk Owner and Response Plan etc. A sample Risk Register is given in Annex 03. For a complex project like a Coal Power Project, it is prudent to use a database driven by an appropriate software for the purpose.

4.2.5 Validating the Candidate Risk

The Risk Evaluation Board (REB) is responsible for coordinating the review and validation of the candidate risks. The Risk Manager relies on expert judgment of the REB, which is represented by subject matter experts, consultants and, project management team leaders. The REB assesses the candidate risk and determine if any concern or action is warranted.

The REB considers:

- **Threats** — a risk that will have a negative impact on a project objective if it occurs (what might happen to jeopardize the project's ability to achieve its objectives)
- **Opportunities** — a risk that will have a positive impact on a project objective if it occurs (what might happen to improve the project's ability to achieve its objectives)
- **Triggers** — symptoms and warning signs that indicate whether a risk is becoming a near-certain event and a contingency plan/response plan should be implemented.

If a candidate risk is determined to be invalid, the risk is retired. If a candidate risk is determined to be valid, PM / RM and REB jointly consolidate the risk (4.2.6).

4.2.6 Consolidation of Risks

Under consolidation process, the following will be carried out

- PM / RM and REB review identified risks of the power project
- Categorize Internal and External components of Risks
- PM assigns the Risk to Risk Owner
- Agree on Primary Response Plan

4.2.6.1 Separation of Internal and External Components of Risks

Under this, only the risks which can be managed within the risk management context of the Power Project, i.e internal components of risks will be routed to 4.2.7 for further actions. As external components of risks cannot be addressed within our framework of RMPPGP, those will be informed to the higher management and/or respective parties for appropriate actions.

4.2.7 Assignment of the Risk to a Risk Owner

When a risk is deemed valid, the Project Manager will assign the risk to a Risk Owner after exploring it further. The Risk Owner will normally be the WBS Task Manager for those WBS elements in which the project team can respond to the risk.

The Risk Manager will supply the previously initiated Risk Identification & Response Plan form (Annex 02) to the Risk Owner. The Risk Evaluation Board completes the remaining part of the form except the part filled by the initiator. The RM and the RO will ensure that the information in the form is complete and accurate.

4.3. Risk Analysis and Evaluation

Analysis of the risk is necessary so that a proper response to the risk can be planned and implemented. The risk description and primary risk areas as identified by the initiator on the Risk Identification & Response Plan form indicate to the Risk Owner the WBS elements in which the project team can take steps to respond to the risk. The Risk Owner can enlist other team members and REB to assist in identifying those WBS elements in which avoidance, mitigation, or transfer of the risk can take place. Additionally, the characteristics of the risk will also help place it in the time frame of the project lifecycle. Using the tools provided in the Risk Probability Ranking Tables given below, identified risks are assigned a prioritized ranking based on the probability, impact and exposure as outlined in this section. The results are recorded on the Risk Identification & Response Plan form in the appropriate boxes by the Risk Evaluation Board, and entered and updated in the project Risk Register by the Risk Manager. The sub-process, Risk Analysis, consists of seven elements and their relationships are elaborated in Figure 4.4, Risk Analysis & Evaluation.

4.3.1 Risk Probability Ranking

A current estimate will be performed based on professional judgment and past experience for the probability that the risk will occur over the impact time frame given. This value can change over time as the risk is actively managed. Ranking is done by the REB of the power project.

Set up a matrix to match a percentage (probability of risk) to a ranking number. It is assumed that the ranking given below is appropriate for a power project. However, a different ranking can be determined if it suits the particular power project better.

Table 4.1 : Risk Probability Ranking

Risk Probability Ranking	
Ranking	**Probability of risk event**
5	60- 99 %
4	40 – 59%
3	20 – 39 %
2	10 – 19 %
1	1- 9%

[4.3] Risk Analysis and Evaluation

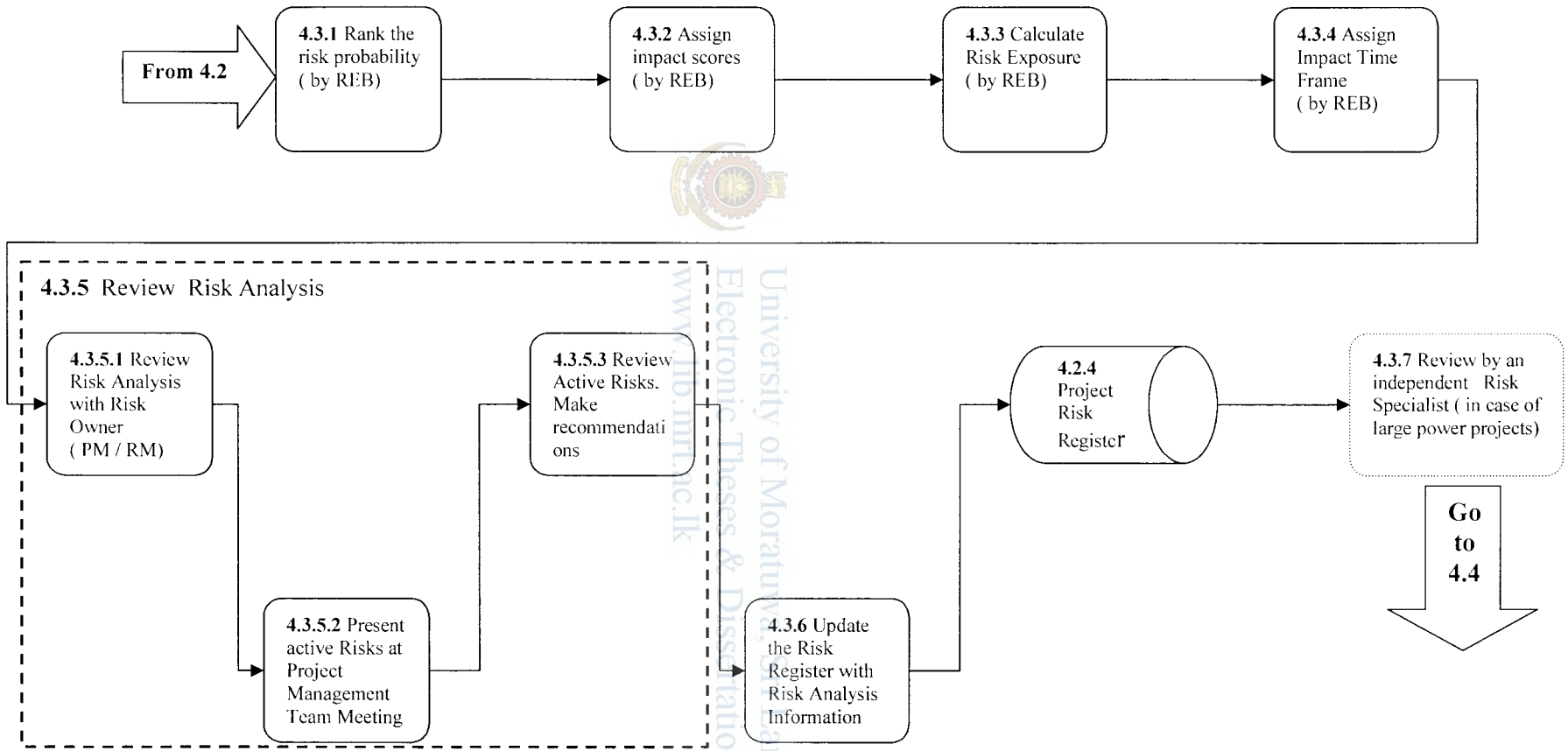


Figure 4.4 Risk Analysis and Evaluation

4.3.2 Impact Analysis

Set up a matrix to match the objective (time, cost, scope, quality) to a defined impact. Project Managers may use the impact ratings shown in the Table 4.2, Impact Ratings for risks, but they can choose values other than those shown below if the RM/ PM think it would better suit the project.

Table 4.2 : Impact Ratings

Evaluating Impact of a Threat on Major Project Objectives						
OBJECTIVE	**Impact**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
	Ranking	1	2	4	8	16
	Time	Insignificant schedule slippage	Delivery Plan milestone delay within quarter	Delivery Plan milestone delay of 1 quarter	Delivery Plan milestone delay more than 1 quarter	Delivery Plan milestone delay more than 2 quarters
	Cost	Insignificant Cost increase	< 5% cost increase	5-10% cost increase	10-20% cost increase	20% cost increase
	Scope	Scope decrease is barely noticeable	Change in project limit or features with < 5% cost increase	Changes in project limits or features with 5-10% cost increase	Sponsor does not agree that the purpose and need	Scope does not meet purpose and need
	Quality	Quality degradation barely noticeable	No safety issues, C,O,M, deficiencies approved by project team	No safety issues, C, O, M deficiencies require higher management approval	Quality may be made acceptable through mitigation or agreement	Quality does not meet one or all of the following Safety, C, O, & M
Evaluating Impact of an Opportunity on Major Project Objectives						
OBJECTIVE	**Impact**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
	Ranking	1	2	4	8	16
	Time	Insignificant schedule improvement	Delivery Plan milestone does not improve but float is added	Delivery Plan milestone improves but still with in quarter	Delivery Plan milestone improve by 1 quarter	Delivery Plan milestone improves by more than 1 quarter
	Cost	Insignificant Cost reduction	< 1% cost decrease	1-3 % cost decrease	3-5% cost decrease	> 5% cost decrease
	Scope	Scope effect is not noticeable	Improves chances to achieve project limits or features with cost increase of 10% or more	Improves chances to achieve project limits or features with cost increase 5-10%	Improves chances to achieve project limits or feature with cost increases of 2- 5%.	Improves chances to achieve project limits or features with cost increase of < 2%.
	Quality	No quality improvement noticeable	C,O,M improvement noticeable by project team	C,O,M improvement can be seen and measured.	Quality improvement can be claimed for the project	Quality improvement is " best in class"

Legend: C – Constructability, O – Operability, M – Maintainability

The impact value may change over time as the risk is actively managed. The primary purpose of the probability and impact numbers are to help rank risks relative to one another.

4.3.3 Risk Exposure

The risk exposure is a calculated value of the probability multiplied by the impact. Risk exposure is a standard quantitative measure of risk and will be used to compare risks with one another.

Table 4.3 : Matrix of Risk Exposure

Risk Exposure					
Probability	**Threats / Opportunities**				
5	5	10	20	40	80
4	4	8	16	32	64
3	3	6	12	24	48
2	2	4	8	16	32
1	1	2	4	8	16
	1	2	4	8	16
	Impact on Selected Objectives				

When above diagram is translated to Risk Ranks, it can be formulated as follows

Table 4.4 : Table of Risk Ranks

Score	**Risk / Opportunity**
1-6	Low
7- 19	Moderate
20 +	High

4.3.4 Impact Time Frame

The earliest and latest WBS elements that the risk could impact will be recorded on the Risk Identification and Response Plan form to assign an impact horizon category. These will be used to define a risk as short term (< 60 days), mid term (< 365 days) and long term (> 365 days). However the number of days given here depends on the size of the power project.

4.3.5 Review Risk Analysis and Ranking

The Risk Manager presents the risk analysis for discussion at the project management team meetings on a monthly basis. At this time, the impacts and possible mitigation/contingency options are discussed, and the risk's exposure is assessed. The project team then reviews the risk for its relative rank among existing risks and reviews the risk in combination with other risks (for example, with other risks in a similar functional area or risks with similar impacts). The team may recommend to the Risk Owner or Project Manager to adjust the action plans or other project priorities to ensure the risk is adequately addressed.

4.3.6 Update Risk Register with Team / Management Comments

After the review, the Risk Manager updates the Risk Register with any comments, and documents the next steps for the risk (if any). If the management team changed the ranking of the risks, the Risk Manager updates the Risk Register to reflect current priorities and concerns.

4.3.7 Review by an independent Risk Specialist

In case of a large scale power project, it may be prudent to review all the steps and the outcomes (detailed risk analysis) by an independent risk specialist who was not directly involved in the RMPPGP so far. However, this should be treated as an option to be decided by the PM.

4.4. Risk Response Planning

Risk Response Planning is the process of developing options, and determining actions to enhance opportunities and reduce threats to the project's objectives. It focuses on the high-risk items evaluated in the risk analysis. In Risk Response Planning, parties are identified and assigned to take responsibility for each risk response. This process ensures that each risk requiring a response has an owner monitoring the responses, although a different party may be responsible for implementing the risk handling action itself.

Those risks with an exposure rating greater than 7.0 (Moderate and High Risks), will have a Risk Response Plan prepared to reduce the threat (or to enhance the opportunity) to project objectives.

The project manager and the Project Team, with the help of experts, identify which strategy is best for each risk, and then design specific action(s) to implement that strategy.

The sub-process, Risk Response Planning is elaborated in Figure 4.5, Risk Response Planning.

4.4.1 Verify Risk Information

The following information is verified and documented in the Power Project Risk Response Plan form by the Risk Owner, and then entered into the project Risk Register by the Risk Manager.

- Verify the Risk Description as described by the Initiator of the risk; clarify if necessary
- Verify the primary risk area (time/cost/scope/quality) as described by the Initiator and recommended by REB; clarify if necessary
- The WBS element(s) associated with risk
- A probability, impact, and exposure rating.
- Impact time frame in which the risk may occur.
- The current status of the risk
- The impact on the Critical Path

[4.4] Risk Response Planning & Implementation

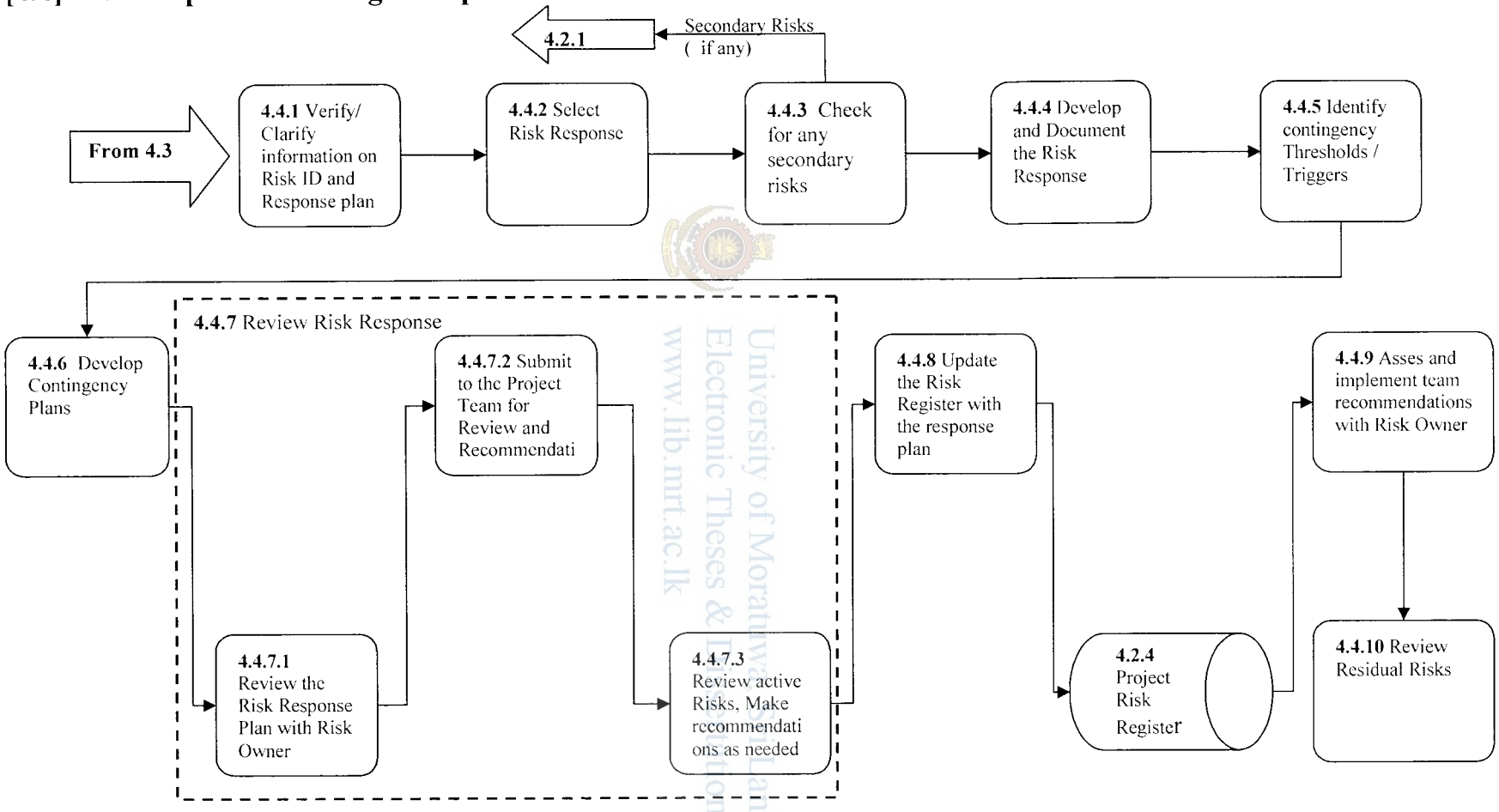


Figure 4.5 Risk Response Planning & Implementation

4.4.2 Selection of Tools & Techniques for Risk Response

A central reason for employing formal risk management is the pursuit of ' risk efficiency'. Therefore, the project team is expected to select the most risk efficient response for each risk identified under 4.2.

Strategies for Negative Risks or Threats :

Avoid. Risk avoidance involves changing the project plan to eliminate the risk or to protect the project objectives (time, cost, scope, quality) from its impact. The team might achieve this by changing scope, adding time, or adding resources (thus relaxing the so-called 'triple constraint'). These changes may require a Project Change Request (PCR) which considered under change management. Some negative risks (threats) that arise early in the project can be avoided by clarifying requirements, obtaining information, improving communication, or acquiring expertise.

Transfer. Risk transference requires shifting the negative impact of a threat, along with ownership of the response, to a third party. An example would be the team transfers the financial impact of risk by contracting out some aspect of the work. Transference reduces the risk only if the contractor is more capable of taking steps to reduce the risk and does so. Risk transference nearly always involves payment of a risk premium to the party taking on the risk. Transference tools can be quite diverse and include, but are not limited to the use of: insurance, performance bonds, warranties, guarantees, incentive/disincentive clauses, etc. In Sri Lankan power projects, Risk Transfer through the Project Contract plays a majour role in risk management. But it should be verified whether it is the most risk efficient strategy for the respective risk.

Mitigate. Risk mitigation implies a reduction in the probability and/or impact of an adverse risk event to an acceptable threshold. Taking early action to reduce the probability and/or impact of a risk is often more effective than trying to repair the damage after the risk has occurred. Risk mitigation may take resources or time and hence may represent a tradeoff of one objective for

another. However, it may still be preferable to going forward with an unmitigated risk. Monitoring the deliverables closely, increasing the number of parallel activities in the schedule, early involvement of regulatory agencies in the project, early and continuous outreach to communities/advocacy groups, implementing value engineering, performing corridor studies, adopting less complex processes, conducting more tests, or choosing a more stable supplier are examples of mitigation actions.

Strategies for Positive Risks or Opportunities :

Exploit. The organization wishes to ensure that the opportunity is realized. This strategy seeks to eliminate the uncertainty associated with a particular upside risk by making the opportunity definitely happen. Examples include securing talented resources that may become available for the project.

Share. Allocating ownership to a third party who is best able to capture the opportunity for the benefit of the project. Examples include: forming risk-sharing partnerships, teams, special-purpose companies, and joint ventures, etc.

Enhance. This strategy modifies the size of an opportunity by increasing probability and/or positive impacts, and by identifying and maximizing key drivers of these positive-impact risks. Seeking to facilitate or strengthen the cause of the opportunity, and proactively targeting and reinforcing its trigger conditions, might increase probability. Impact drivers can also be targeted, seeking to increase the project's susceptibility to the opportunity.

Strategy for both Threats and Opportunities:

Acceptance. A strategy that is adopted because it is either not possible to eliminate that risk from a project or the cost in time or money of the response is not warranted by the importance of the risk. When the

project manager and the project team decide to accept a certain risk(s), they do not need to change the project plan to deal with that certain risk, or identify any response strategy other than agreeing to address the risk if and when it occurs. A workaround plan may be developed for that eventuality.

There are two types of acceptance strategy:

1- Active acceptance. The most common active acceptance strategy is to establish a contingency reserve, including amounts of time, money, or resources to handle the threat or opportunity.

> **Contingency Plan**: Some responses are designed for use only if certain events occur. In this case, a response plan, also known as "Contingency Plan", is developed by the project team that will only be executed under certain predefined conditions commonly called triggers."

2- Passive acceptance. Requires no action leaving the project team to deal with the threats or opportunities as they occur.

> **Workaround**: Workaround is distinguished from contingency plan in that a workaround is a recovery plan that is implemented if the event occurs, whereas a contingency plan is to be implemented if a trigger event indicates that the risk is very likely to occur. As with risk identification process, the team should also consider residual risks, secondary risks, and risk interaction in the risk response planning process.

4.4.3 Identification of Secondary Risks Generated due to the selected response

The response plan determined in 4.4.2 may be a source for another risk, which is termed as secondary risk. The identified secondary risk should be routed back to the formal risk identification process (4.2.1)

4.4.4 Develop and Document the Risk Response

If the response is not to accept the risk, then the conditions that will reduce or eliminate the effects of the risk are developed by the Risk Evaluation Board (REB) and documented on the Power Project Risk Identification & Response Plan .This response may be preventive, or may lessen the probability or impact of the risk should it occur. The REB may require the assistance of the team, or of Subject Matter Experts (SMEs) to develop an appropriate Risk Response Description.

4.4.5 Contingency Thresholds/Triggers

A contingency threshold or trigger is an indication that a change in the risk exposure has occurred (a change in the probability and/or the impact) and that the risk event has a greater potential to adversely affect the project. The trigger should be specific and defined well enough to be tracked and to remove the uncertainty that the risk event is occurring or is imminent. The REB documents the defining criteria of the trigger on the Risk Identification and Response Plan. When this defined criteria is reached, a contingency plan is implemented to respond to the risk.

4.4.6 Develop Contingency Plans

A contingency plan will be applied to risks that are imminent or are occurring. The contingency plan describes what actions are to be taken by whom and in what order to effectively respond to the negative circumstances or events. The contingency plan also gives the initial recommended actions to be taken by the Project Manager when a risk event occurs and the risk becomes an issue. Implementation of contingency plan may longer belongs to the RMPPGP and considered as a general project management function.

4.4.7 Review Risk Response Planning and Implementation

The Risk Owner and the Risk Manager will review the risk action plans at their discretion and significant developments will be discussed at the monthly status meetings. A risk team will periodically review the plans, trigger events, and measurements for tracking effectiveness to ensure they are feasible and appropriate

for the severity and ranking of the risk. The team may propose additional actions or changes to the response plans before their implementation.

4.4.8 Update Risk Register with Risk Response Status

The RO provides status updates to the RM who updates the Risk Register to reflect the actions being taken. In some cases, the actions may also be tracked in the project work plan to ensure appropriate visibility. Response plan activities and their effectiveness are reported in the monthly status meetings.

4.4.9 Implementation of Risk Response

The members of the project team implement the Risk Response Plan and coordinate with PM and RM on the progress. The Risk Owner and/or WBS Task Manager is the key person for the phase of implementation the Response Plan and give feedback information required for Control and Monitoring function.

4.4.10 Review Residual Risks

Residual risk is a risk that remains after Risk Management options have been identified and action plans have been implemented. It also includes all initially unidentified risks as well as all risks previously identified and evaluated but not designated for treatment at that time. (Those risks with an exposure rating less than 7.0 under 4.4.3)

It is important for the Risk Owner and all other decision makers to be well informed about the nature and extent of the residual risk. For this purpose, residual risks should always be documented and subjected to regular monitor and review procedures.

4.5. Risk Monitoring and Control

Risk monitoring and control keeps track of the identified risks, residual risks, and new risks. It also monitors the execution of planned strategies on the identified risks and evaluates their effectiveness. Risk monitoring and control continues for the life of the project. The list of project risks changes as the project matures, new risks develop, or anticipated risks disappear.

Typically during project execution there should be regularly held risk meetings during which all or a part of the Risk Register is reviewed for the effectiveness of their handling and new risks are discussed and owners are assigned. Periodic project risk reviews repeat the process of identification, analysis, and response planning. The project manager ensures that project risk is an agenda item at all progress meetings. Risk ratings and prioritization commonly change during the project lifecycle.

If an unanticipated risk emerges, or a risk's impact is greater than expected, the planned response may not be adequate. The project manager and the team must perform additional response planning to control the risk.

Risk control involves:

- Choosing alternative response strategies
- Implementing a contingency plan
- Taking corrective actions
- Re-planning the project, as applicable

The individual or a group assigned to each risk (risk owner) reports periodically to the project manager and the risk team leader on the status of the risk and the effectiveness of the response plan. The risk owner also reports on any unanticipated effects, and any mid-course correction that the project team must consider in order to mitigate the risk. Figure 4.6, Risk Monitoring and Control elaborates the sub-process and their relationships which consisting of nine elements.

[4.5] Risk Monitoring and Control

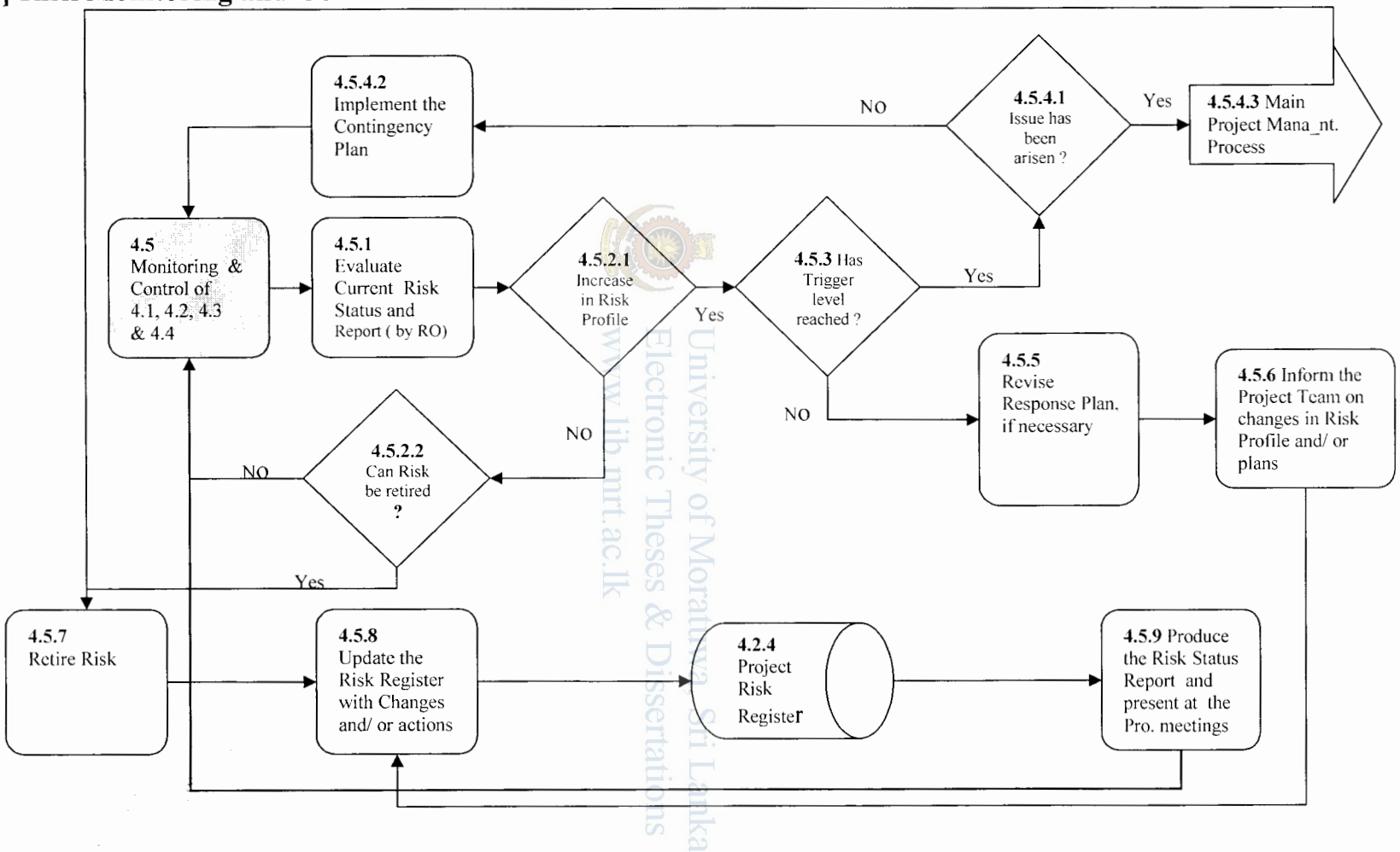


Figure 4.6 Risk Monitoring and Control

4.5.1 Evaluate Current Risk Status and Report

The Risk Owner monitors the assigned risk, notifies the Risk Manager whenever there is a significant change to the risk's profile, and makes recommendations to address the changes in the response plans. Recommendations to improve the effectiveness of the plans are also discussed.

The Risk Owner is required to report significant developments to the project team at the monthly status meetings. The Risk Manager reviews the status of risk activities periodically (at least monthly) with the Project Manager and the project management team and discusses the effectiveness of the current response plans. The Risk Manager updates the Risk Register to reflect the current risk state. At the discretion of the Risk Manager, or by the request of the Project Manager, risk management team meetings may be called in the interim between monthly status meetings.

4.5.2 Check for change in Risk Profiles

The deficiencies and proposed changes are discussed with the management team and changes are approved or sent back for further analysis/development, as needed. Changes to risk profiles also are discussed, both individually and across all risks. Risk ranking and project priorities may be changed as a result. If a risk's profile changes such that its probability and/or impact drops below the project risk tolerances, the risk may be a candidate for retirement or closure.

4.5.3 Monitor Trigger Events

The Risk Owner has the primary responsibility for monitoring the trigger events associated with mitigation/contingency actions. The Risk Manager assists with tracking triggers and includes any significant development in the regular risk status review in the monthly status meetings

4.5.4 Execute Contingency Plan(s) or Create an Issue

. When a trigger event occurs the Risk Owner:

- Implements the response plan and notifies the Risk/Project Manager of the plan execution.

- Notifies all parties identified in the response plan and ensures all activities are coordinated.
- Takes the specific measurements to determine the effectiveness of the activities.
- If the activities are not producing the desired effect he/she notifies the Risk Manager immediately and proposes changes to address the deficiencies.
- The Risk Manager will work with the Risk Owner to enhance or change the response plan including taking the matter to the project team and SME(s).

If the risk event occurs (or its probability becomes 100%), risk becomes an issue and it will be treated within the main project management process of the power project. PM is responsible to take appropriate actions on the issue and inform the issue to the higher management ,if required, depending on its gravity.

4.5.5 Revise Response Plan

Depending on the change in the Risk Profile, i.e if the Risk Profile has been increased, the Response Plans are modified to meet the latest context.

4.5.6 Inform the Project Team of changes in Risk Profile and/ or plans

The Project Team members are informed of the changes in the Risk Profiles and the Response Plan.

4.5.7 Retire Risks

Risks are closed when the risk event actually occurs or when the likelihood of the risk is reduced such that it is not worth expending resources to track it. Response Plans are halted and closed. If the risk could possibly arise again, the risk may be reduced to a "Watch" status and evaluated as agreed upon by the Risk/Project Manager and the Risk Owner. Any stakeholder may recommend a risk for retirement.

The Project Manager makes the final decision to retire a risk. If there is any disagreement, the REB and/or Sponsor should be involved in the decision to retire a risk.

4.6. Communicate and Consult

Communication and consultation are important considerations at each step of the RMPPGP. The Project Team should involve a dialogue with stakeholders with efforts focused on consultation rather than a one way flow of information from the decision maker to other stakeholders. It is a vital tool for controlling and monitoring of the risk management activities and be considered as a sub-process of the process 4.5, Risk Control and Monitoring. Figure 4. 7, Communicate and Consult elaborates the sub-process and relationships of it components.

4.6.1 Develop a communication Plan

It is important to develop a communication plan for both internal and external stakeholders at the earliest stage of the process. This plan should address issues relating to both the risk itself and the process to manage it.

Effective internal and external communication is important to ensure that those responsible for implementing risk management, and those with a vested interest, understand the basis on which decisions are made and why particular actions are required. Stakeholders are likely to make judgments about risk based on their perceptions. These can vary due to differences in values, needs, assumptions, concepts and concerns as they relate to the risks or the issues under discussion. Since the views of stakeholders can have a significant impact on the decisions made, it is important that their perceptions of risk be identified and recorded and integrated into the decision making process.

A consultative team approach is useful to help define the context appropriately, to help ensure risks are identified effectively, for bringing different areas of expertise together in analyzing risks, for ensuring different views are appropriately considered in evaluating risks and for appropriate change management during risk treatment. Involvement also allows the 'ownership' of risk by managers and the engagement of stakeholders. It allows them to appreciate the benefits of particular controls and the need to endorse and support a treatment plan. Records of communication and consultation will depend on factors such as the scale and the sensitivity of the activity. Communications regarding risks are continuous throughout the project's life cycle both through verbal and written reports.

[4.6] Communicate and Consult

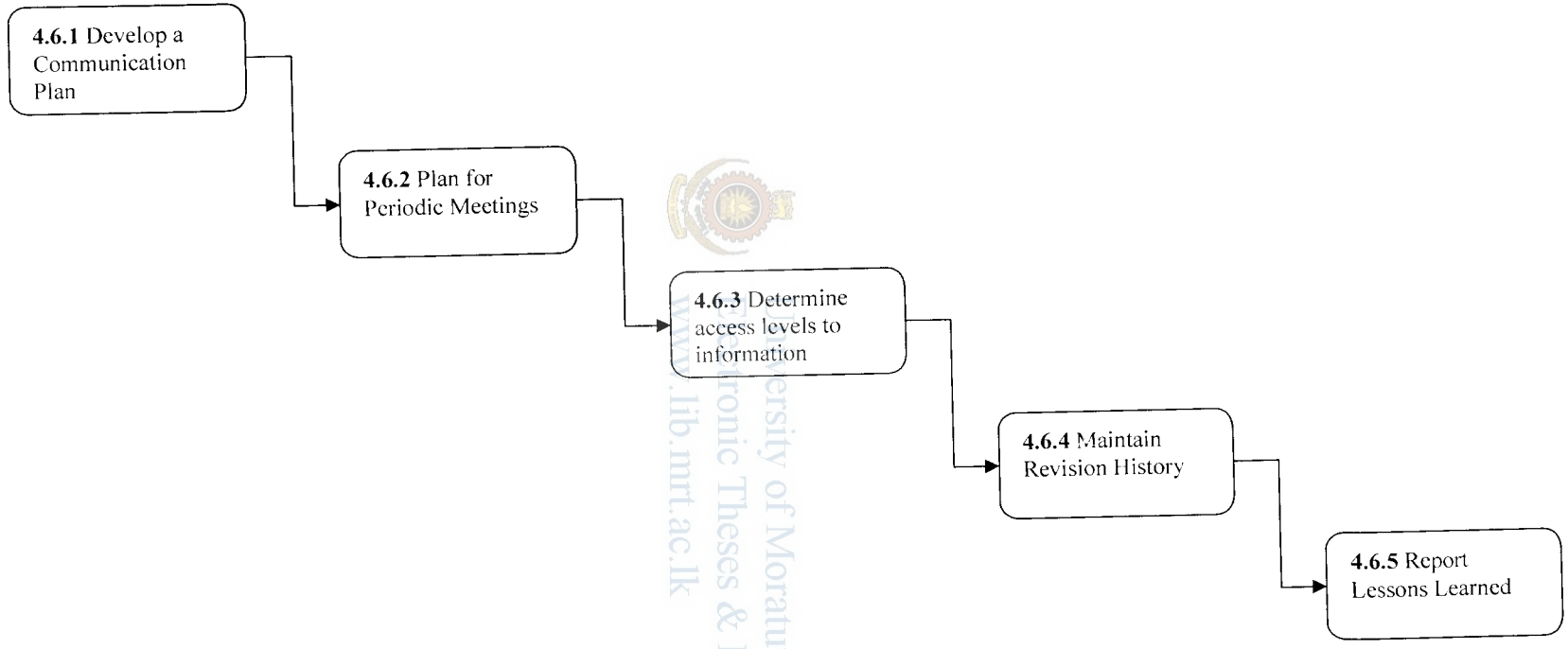


Figure 4.7 Communicate and Consult

4.6.2 Periodic Status and other Meetings

On a periodic basis, the Risk Manager solicits updates from the risk owners and updates the Risk Register. Risk management activities and the current log of active risks are discussed at project team status meetings. This includes formal and informal identification and status of individual risk activities and assignments. Current risk status and the results and effectiveness of mitigation/contingency actions are reviewed, along with the status of risk trigger events and risk profiles.

An example of plan for meetings can be given as follows. Also the PM should document the Communication Plan in line with the project communication plan.

Table 4.5 Plan for Risk Management Meetings

Meeting Type	Frequency	Members	Inputs	Deliverables
Team Status / Progress	Monthly / As required	Functional Team Leaders	Risks associated with WBS elements that will be worked on in the upcoming month. Progress	New risk identification. Changes required in Response plan, trigger levels etc.
REB meetings	Monthly/ As required	Members of the REB	Candidate Risks identified	Categorize Internal/ External risks. Assign Risk Owner Primary Response Plan
Any other				

4.6.3 Determine Access to Information

It is a vital requirement to share appropriate information with relevant members of the project team in order to maintain proper communication. One option is to use a suitable IT solution which can manage the access to the Project Risk Register.

4.6.4 Revision History

Any action taken on a specific risk will be logged in the Revision History field on the Power Project Risk Identification & Response Plan form, and will be logged in the Risk Register by the Risk Manager. This will serve as the repository of the life cycle documentation of the risk activities. This will also serve for justifying specific actions that were taken along with completing the lessons learned. The pertinent dates, events

or decisions made, the person(s) most knowledgeable about the event and a short description of the event will be captured.

4.6.5 Report Lessons Learned on Risks

The Risk Manager documents the result of risk actions (whether successful or unsuccessful) and lessons learned in the Risk Register. At the end of the phase, the Risk Manager discusses the results of the lessons learned sessions with the PM and with others as appropriate. The Risk Manager leads a final risk review to document the final status and results of mitigation and/or contingency actions to identify lessons learned during the project.

5 Conclusions and Recommendations

5.1. Conclusions

'Project risk' is an uncertain event or condition that, if it occurs, has a positive or a negative effect on at least one project objective. A risk may have one or more causes and, if it occurs, one or more impacts. Successful and effective risk management requires a clear understanding of the risks faced by a project. This involves more than simply listing identified risks and categorizing them by their probability of occurrence and impact on the objectives. Appropriate RMP is an effective tool to address risks in a project. However, there a deficit in practicing a RMP or other kind of Risk Management techniques, in Sri Lankan power project.

The scope of this research it to develop a RMP suitable for Sri Lankan Power Generation Projects. A RMP consists of a series of steps that, when undertaken in sequence, enable continual improvement in decision making. The Risk Management Process which has been introduced by the author in this dissertation, RMPPGP, gives a framework for systematic application of management policies, procedures and practices to the tasks of identifying, analyzing, evaluating, treating risks and also to the tasks of monitoring and reviewing risks.

RMPPGP consists of six interconnected sub-processes. They are as follows.

- **Establish the risk management context of the Power Project**

  When considering risk management within a project, it is important to first establish some boundaries within which the risk management process will apply.

- **Risk identification**

  Risk cannot be managed unless it is first identified. Once the context of the project has been defined, the next step is to utilize the information to identify as many risks as possible. The aim of risk identification is to identify possible risks that may affect, either negatively or positively, the

objectives of the project under analysis. The author concludes RBS as the most effective method of identifying risk for a power generation project. The REB is responsible for validating identified risks.

- **Risk analysis**

  During the Risk Identification step, project staff may identify many risks. However, it is often not possible to try and address all of them. The risk analysis step will assist in determining which risks have a greater consequence or impact than the others. This will assist in providing a better understanding of the possible impact of a risk or the likelihood of its occurrence, in order to make a decision about committing resources to control the risk.

  The Risk Exposure is a calculated value of the probability of occurrence multiplied by the impact. Risk exposure is a standard quantitative measure of risk and will be used to compare risks with one another. RMPPGP categorizes the risk exposure into three ranks of importance i.e Low, Moderate and High.

- **Risk response planning**

  Risk response planning involves identifying options for treating or controlling risk, in order to either reduce or eliminate the negative consequences or to reduce the likelihood of an adverse occurrence. Risk treatment should also aim at enhancing positive outcomes. It is often either not possible or cost-effective to implement all treatment strategies. The PM should aim to choose, prioritize and implement the most appropriate combination of risk response. Under RMPPGP, risks having a exposure of more than 7, i.e Moderate and High ranking risks, will have an appropriate risk response.

- **Risk monitoring and control**

  Monitor and review is an essential and integral step in the risk management process. The PM must monitor risks and review the effectiveness of the response plan, strategies and management system that have been set up to effectively manage risk. Risks need to be monitored periodically to ensure that changing circumstances do not alter the risk priorities. Very few risks will remain static. Therefore, the risk management process needs to be regularly repeated, so that new risks are captured in the process and effectively managed.

- **Communicate and consult**

  There are two main aspects that should be identified in order to establish the requirements of the process. These are communication and consultation aimed at:

  - eliciting risk information
  - managing stakeholder perceptions for management of risk.

  Communication and Consultation are important considerations at each sub-process of the RMPPGP. The Project Team should involve a dialogue with stakeholders with efforts focused on consultation rather than a one way flow of information from the decision maker to other stakeholders. It is a vital tool for controlling and monitoring the risk management activities and is considered as a sub-process of the process , Risk Control and Monitoring.

RMPPGP defines all its' components into finer elements so that the project managers could practice the RMP conveniently and confidently. The other advantage is that, when all the finer elements of the process are defined, the RMP can be standardized within the organization. Although the RBS (Annex 01) and the Sample Risk Register (Annex 03) is focused on Coal Power Projects, they could be easily tailored to suit any kind of power project.

The majour aim of developing this practitioner-oriented RMPPGP is to encourage Project Managers in the Sri Lankan power sector to use a RMP more conveniently to achive greater delivrables in the projects they are managing. The approach outlined in this research guides Sri Lankan Project Managers to anticipate the problems and utilizes the best minimizing amount of fire fighting and preventing a disaster, which could lead to sever financial crunch.

5.2. Recommendations for future research

The initial plan of the author was to test the model RMPPGP for an ongoing power project like Puttlam Coal Power Project or Trincomalee Coal Power Project. But due to time restrictions, the model could not be tested in a real environment. However, in the process of developing the model, several discussions were held with key staff members of the two projects. The sample Risk Breakdown Structure (Annex 01), which is recommended to be used for a Coal Power Project has been developed as a team effort during these discussions. Although RBS was developed focusing a Coal Power project, many issues are common to construction projects. Hence, RBS can be configured or improved according to the project under consideration.

For the rating for risk impacts under 4.3.2, Impact Analysis, the author has used a non-linear scale from 1 to 16 for the impacts on the main project objectives. It is recommended to carry-out further research on suitability of the values given on deviations in main objectives and also the rankings.

The issue of project risk management is valid to a greater extent to many organizations, other than the power utilities in Sri Lanka. Thus, moving the practice of project risk management forward is of utmost importance. Therefore, the application of the RMPPGP for future power generation projects in the country is recommended. The process can be developed further by researchers, practitioners or the project staff by modifying the weak areas of the process if any and strengthening process by adding any missing components.

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