How to Manage Risk and Uncertainty in Projects: A Comparative Multiple-Case Study

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ABSTRACT

Risk and uncertainty are very closely linked; they are recognized as threats arising from unclear causes and effects of the project. Risk and uncertainty management has always been acknowledged as a very important aspect of project management and is mostly used to accomplish project objectives. These objectives are; quality, cost, time, safety and environmental sustainability. A majority of researchers have focused on other characteristics of risks and uncertainty management rather than a comprehensive method which encompasses developing risk management plan, identify, and analyze the likelihood of its occurrence and consequence should it happen. The common challenges still experienced in project environment are; use of improper project management methodology, stake holder interference in the decision making process, complexity of the project, and changing requirements and management.

This study seeks to look at how risk and uncertainty can be successfully managed within project environment. Through case studies this research will also look at how does improper risk management plan affect the project, and the consequences of stakeholder interference in the decision making process.

The report presents project risk management approach of two projects carried out in the same organisation. The project A was executed by a project manager from the Project Management Office (PMO) in accordance with the project management methodology, while the execution of project B was highly influenced by a client/sponsor with no regard of the approved project management methodology. The selected projects both involved equipment replacement in which the main deliverables are supply and delivery of the final product.

A description of the project risk management approach and analysis of data collected for each case study are followed by a comparison of two project risk management processes applied in case studies. This study will finally draw the conclusion and make recommendations based on its findings.

ACKNOWLEDGEMENTS

I am thankful to God for giving me the power and courage to do this work, without Him this dissertation would not be possible.

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CHAPTER 1: INTRODUCTION

The manner in which risk and uncertainty are managed in the project management context is still a challenge. However the benefits of a proper risk management in projects are enormous. Project management practitioners can save their respective organizations lots of money and resources if they use proactive and decisive approach to handle risky or uncertain project events. The outcome of risk management will be a minimized impact of project threats and seizure of the potential opportunities. Proper risk management allows the project to be delivered on time, on budget and with the quality standard as expected by the project sponsor. The project team would also enjoy avoiding any possible “fire fighting” situation of the project which is usually considered necessary to repair project failures that could have been prevented.

The risk management is still a recognised tool and widely employed in projects with the intention of securing project success, regardless of all sorts of unanticipated events and circumstances that may take place during project execution. Some of the questions that relate to different perceptions on how to manage project risk include:

- what is the fundamental process of managing project risk?
- what happens when risk management process or one of its elements is executed?
- what effects will project risk management process or probably the individual process elements have on the project outcome?

The (PMBOK Guide, 2004) defines project as; "a temporary endeavour undertaken to create a unique product or service.”

- Temporary - meaning a clearly defined duration, with start and finish date.
- Unique - meaning the deliverable must be distinguishable from all similar deliverables.

The project also implies uncertainty and risk. A risk free project would not be worth pursuing, hence risks in projects should be managed to limit the exposure to the losses (Visser, 2012).

Any project management practitioner has to understand what a risk is in order to be able to manage it. Risk is basically resulting from the constraints and uncertainties (Hillson and Murray-Webster, 2005). Whoever that wants to carry out a project, will always face the constraints and uncertainty. A project risk can never be removed; however it can be lowered to a minimum acceptable level by reducing either uncertainty and constraints or both (Visser, 2012). Practically, only few people have managed to reduce constraint in a project, as a result most project managers opt for the reduction of uncertainty rather than the reduction of constraints. Therefore a project manager should seriously consider how to manage that remaining portion of risk in a most effective manner through the application of project risk management process.

1.1 Problem Statement

There is a rational consensus on what projects are and why are they executed. The history shows that humans have been undertaking ventures of project nature for thousands of years, even though were not always categorized as projects (Hillson, 2009). With such an extensive experience of undertaking mega projects, definitely humans should be very successful today, however the best long-term data on project success from the Standish Group in Figure 1 below suggests otherwise.

Standish Group CHAOS report continues to publish a very low project success rate and a high number of projects which are either challenged (meaning that they were delivered either late or over budget or with reduced scope) or fail completely. Figure 1; below shows the Standish Group CHAOS report since its establishment in 1994 up to 2006; (*Source*: CHAOS Database, www.standishgroup.com). This report gives a clear indication that there has been no significant improvement in project success rate over the past years.

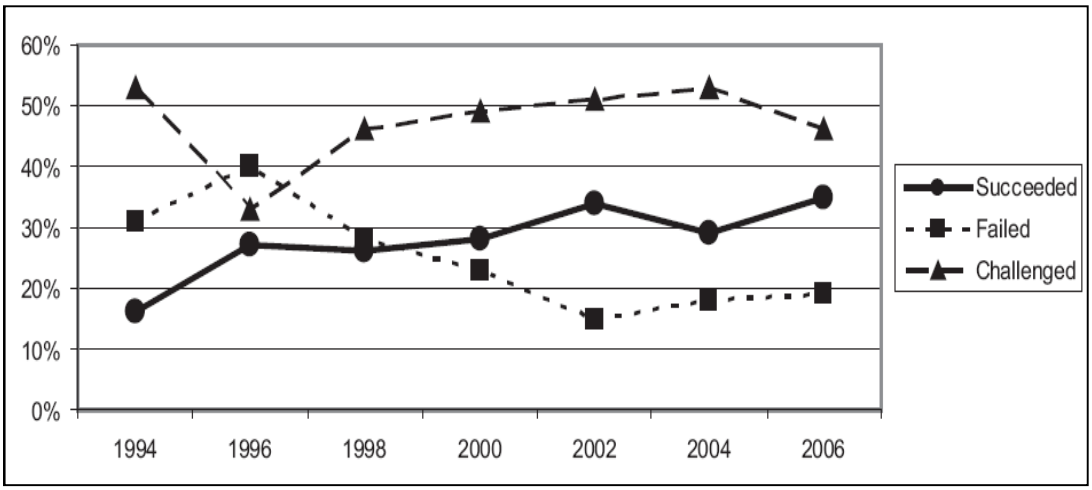

Figure 1: Standish Group CHAOS data on project success 1994–2006

Source: CHAOS Database, www.standishgroup.com

(a) Successful project

A successful project must deliver a final product of good quality, within cost, and on time. The benefits of the project delivered must be aligned to the business case presented. Some identified factors that project managers in organizations see as a key for the project success are listed in order of priority as shown below (Elbeik & Thomas, 1998):

- project objectives which are clearly defined
- excellent project planning and control technique
- good support from management
- enough time and resources
- stakeholders commitment
- high involvement of the user
- good communications
- proper organization of the project structure and culture
- ability to stop a project

(b) Failed project

A project that does not deliver the final product in line with expectations will be considered as a failure. Project that is declared a failure will generally cease to exist as time, effort and money sink. The hard decisions are made, and the team can move on. For the project to succeed the requirements must be clear and fixed; however it's not always easy because the second part of the project success definition states that the deliverable must be “in line with expectations."

For instance if key stakeholders approved that the initial budget of a project can exceed with a certain amount, the project could still be regarded as a success. Similarly, a project that didn't include fundamental elements needed by key stakeholders but delivers everything as specified in detailed project designs may still be considered as failure.

For most of the successful projects there will always be concerns that need attention during the project life-cycle. A project would succeed provided that the project manager stays on top of things and avoids the unpredicted circumstances completely.

It does happen that a project turns into a complete failure. The big question to ask is; what are the primary causes for a project failure? Eventually, projects failures could have a number of probably inter-related causes. Listed below are a number of causes that might contribute to project failure:

- lack of a project charter
- lack of user involvement
- poorly defined requirements
- scope creep
- poorly defined or unrealistic time scales
- inadequate or non-existent testing
- lack of resources

- use of new or unfamiliar tools
- political instability
- poor project management

Since anything can happen regarding project failure, it is important to know the factors that can lead to project failure that project manager may look for when managing projects. The abovementioned list gives the necessary indication to the project manager to take advantage of any problem that arises, thus reducing the possibility of project failure and increasing the possibility of success.

(c) Challenged project

Challenged projects are in enough trouble to not be considered a success; nevertheless they lack attention and support that would lead to reorganization or cancellation. The challenged project consists of at least one of the following features:

- it is behind schedule
- the team morale is low
- stress levels are high
- technical debt is piling up, while the technical quality is deteriorating
- project documentation is also deteriorating
- rising pressure to deliver, growing disconnect between the team and the rest of the organization
- lots of time spent in long meetings, where blame is assigned and passed around

1.2 Research objectives

The primary objective of the research presented in this report is to do a study about managing risks and uncertainty in projects which will also include identifying stakeholders influence in a project, particularly project sponsor and client. In order to comprehend the objective, the following secondary objectives must be met which are:

- to compare the conventional project management approach of the organization with the modern business approach to identify gaps and irregularities in the project management approach
- to ascertain if there is alignment between the business strategy and project goals within the company

1.3 Research questions

Major causes for project failure have always been arising from occurrences of external or internal risks. These occurrences might result into a severe project delay and/or over expenditure which leads to most projects being completed with poor project overall performance or a complete termination. In order to understand the phenomenon, a following research question will be investigated:

How to successfully manage risk and uncertainty in project?

Formulating and answering this primary question, possibly will define the overall purpose and also give direction to the research.

1.4 Research process

The (Olsson, 2006) paper describes research as a journey from a known situation to an unknown destination. For this journey there are basically two significant resolutions to be made:

- what are research questions that need to be answered, and
- how to get on with finding answers to those questions

There are practical steps through which a research journey must go by with the aim of finding answers to these questions. The required methods, procedures and models of research methodology must be chosen by the researcher from a wide range to help achieve objectives of the research process. The objectives of the research are met by following these steps of the process (Kothari, 1985); (Dawson, 2002) and (Kumar, 2005).

- Formulating the research problem
- Literature review
- Developing the objectives
- Preparing the research design
- Collecting the data
- Analysis of data and interpretation
- Presenting results and conclusion

1.4.1 Clarification of the research question

There are definite responsibilities assigned a project sponsor that can be linked with the project success or failure (Kloppenborg, Manolis and Tesch, 2009). To further clarify the question this study will explicitly investigate areas which are related to project leadership requirements, the project's essential aspects, and the leadership behaviours of sponsors during the initiation stage and throughout the project lifecycle.

Through case studies the sub sequential questions will be answered:

- how does inappropriate project risk management plan affect the project, and
- how can project sponsors and their decisions influence the project?

1.4.2 Research definition and design

A research is a survey planned to develop a satisfactory scientific methodology for solving problems and creating a new commonly applicable knowledge base (Kothari, 1985); (Dawson, 2002) and (Kumar, 2005).

The scientific methods attempts to systematically describe and provide information about the situation or phenomenon in the field of interest. It presents risk management process implemented by the organization during the replacement of equipment. The most significant of features of this process will be illustrated and also applied. The research includes how risks management planning is done, how the

possible impacts of risks are evaluated as a function of multiple assessment criteria, and how identified risks are rated to produce a high-to-low critical risk ranking.

In addition, methods are also illustrated for evaluation of risk mitigation process and visually display risk status for decision-making. The report further draws conclusion through a summarizing the best practice considerations and recommendations.

1.4.3 Review of literature

Reviewing of the literature can be a lengthy, discouraging and frustrating process, however it is also worthwhile. Its objectives are:

- to clarify the research problem to enhance perception within a discussion area in order for the researcher to conceptualise research problem clearly and accurately.
- to assist a researcher to improve research methodology by selecting procedures and methods that are well proven and able of presenting suitable response to the investigate question.
- to expand the researcher's knowledge about the subject in which the study is intended so as to understand how the research results assimilate into the already available literature.
- formulate study results and compare them with existing body of knowledge.

1.4.4 Collecting the data

Having defined and formulated design of research, a researcher then needs to do data collection from which conclusions about the study will be drawn (Dawson *et al.*, 2002).

1.4.5 Analysing the data

Processing and analysing of data involves various, functions that should be carried out to summarize and organize collected data in such that the research questions will answered (Dawson *et al.*, 2002).

1.4.6 Presentation of results and conclusion

Interpretation of the collected data, preparation of the report and documenting the findings is the final, and probably the challenging stage of conducting a research. The report provides information on what the researcher has done, research findings and the conclusion based on the findings.

This report is in a traditional rational format using formal language. The research process steps are covered across various chapters of this report. The research report outline section presents an overview of where each step is discussed.

1.5 Research report outline

The introduction in Chapter 1 comprises of problem statement, objectives and goals of the research. It further discusses research question, research process including the research definition and design, collecting, analysing and interpretating data, presentation of results and conclusion.

Chapter 2 presents the entire literature review on subject. The existing knowledge is a fundamental of project risk and uncertainty management which will be studied so as to understand the relevant information that has previously been published. The researcher will learn from previous theories and give own view on the available body of literature where applicable.

Chapter 3, a research methodology discusses and evaluates various research methods and gives a motivation for selecting case study as the most suitable research method to obtain answers to the research questions. It also explains data collection and analysis throughout the research.

In Chapter 4, the case study description provides background on the two projects selected as the case studies. It also gives a description of how the data of case study was collected and analysed during the systematic approach that was applied.

The result discussion in Chapter 5 shows a relationship between the project success and risk management starting with the relevant theory concerning them. It also compares data gathered from two cases so as to determine similarities or differences. To simplify the research, results are subsequently summarized and concluded.

The Chapter 6 summarizes and concludes the research based on the findings of the study.

1.6 Conclusion

This chapter of the report lays out risk management concept within a theoretically common area of project risk. The term risk management is broadly used, and its meaning varies when used in different context. An uncertainty is a most influential factor in the project implementation, however it is predictable, but with some degree of possibility.

In the next chapter, the body of literature relevant to the study is reviewed. The literature review is a critical preliminary task intended to providing the existing body of knowledge within the field of study.

CHAPTER 2: LITERATURE STUDY

2.1 Introduction

Literature study is essential part of whole research process as it formulates valuable input to every operational step. Literature review studies the relevant information that has previously been published. It assists the researcher to understand the area of study better, and consequently have a clear and precise conception of the research problem. Conducting literature review establishes the understanding of the connection between the studied problem and the body of knowledge.

2.2 Definition of risk and uncertainty

The (PMBoK, 2000) describes risk as uncertain occurrence which will have negative or positive outcome on achieving project objective if it occurs. This future event is not completely known but at least can be identified or modeled. With enough effort, the likelihood of it happening and the potential consequence on the project can be forecasted. This definition and treatment of risk are identical to those commonly used in project management environment.

There are three important aspects of the risk definition:

- *uncertain event:* refers to the possibility of emergent indeterminate events. Under conditions of low uncertainty, approximate forecasts can still be made. High uncertainty entails conditions of indeterminacy where future events are neither identifiable nor amenable to calculation. The strategies for managing risks and uncertainty are quite different.
- *positive or negative outcome*: project risk does not always have a negative effect; it can also have positive and valuable ouput.
- *project objectives:* the project objectives are threatened if a risk does happen. Occurrence of negative risks can lead to severe outcome or even termination of a project while minor risks may slightly extend the duration to project completion.

2.3 Interpretation of risk

Risk is a two dimensional abstract which consists of:

- Probability - can be defined as the possibility that the specific risk occurrence will take place, and
- Consequence – is the impact that occurrence will have on the project, should it happen.

The basic risk equation is usually expressed in mathematical terms (Visser, 2012) as:

Risk = Probability x Consequence

In project risk management, the loss can be expressed in a form of a quantifiable financial nature, a human loss (such as injury, illness or death) which may or may not be capable of having a monetary figure attached to it, or other financially indeterminable loss such as the impact on the value of a product brand or the company image.

A simple qualitative expression of the two dimensions of risk is shown as a 2X2 grid in Figure 2. If both probability and the consequence are low, risk will be classified as low risk. If both probability and consequence are high, risk will also be classified as high risk. But if the probability is low and the consequence is high or vice versa, the risk is typically assumed to be medium risk. However, if the consequence is very high while the probability of an event is low, the risk cannot always be considered as medium in all cases. Some unlikely events might have severe or catastrophic consequences, for example the methane gas explosion in Hlobane coal mine near Vryheid on 12 September 1983, where 68 workers were killed. In such cases a classification of high risk is more appropriate and indicates that further attention and action should be taken to mitigate the risk.

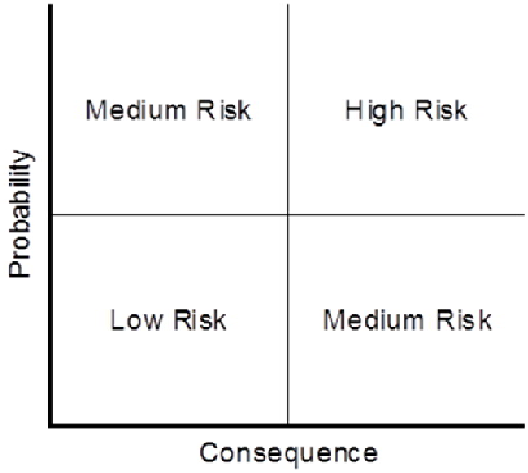

Figure 2: Two-dimensional grid for interpreting risk

2.4 Sources of project risks

There is almost no doubt that conducting a project is a risky exercise, whoever that has worked on a project will know. Project risk is composed of three distinctive causes which need to be understood in order to successfully manage project risks. These three causes are discussed below:

- project characteristics
- intentional design of the project, and
- project external environment

(a) Projects characteristics

Approximately every project has a number of attributes which may certainly introduce uncertainty into a project. The factors that are similar in most projects and that make them risky (Hillson, 2009) are:

- *Uniqueness of the project* – every project will consist of some few fundamentals that were never done before. This obviously results into uncertainty related to those specific fundamentals.

- *Project complexity* – the project complexity can exist in many different ways other than just a straightforward list of tasks to be performed. A range of complexities in projects include; economical, commercial and technical interfaces, each of these complexities brings its own risk into the project.
- *Project constraints and assumptions* – this is scoping of the project results into a variety of hypothesis about the future. It generally contains both the constraints and assumptions which can eventually be inappropriate, and it is also highly possible that some will remain hidden and unidentified; therefore it is due to this reason that they are regarded as a source of uncertainty in the majority of projects.
- *People* – every project is executed by the people, which might include management, project team members and other stakeholders. These individuals or groups can be unpredictable to some degree, which leaves projects they are involved in open to uncertainty.
- *Stakeholders* – project prospects, deliverables and objectives are imposed by these people. Their requirements from a project may possibly differ, overlap or even contradictory, which is a threat to project acceptance and execution.
- *Change* - a project involves change which is moving from the present and known situation into an unknown future, therefore there is uncertainty related to this kind of transformation.

The characteristics listed above cannot be removed as they are natural to projects, but can be controlled.

(b) Intentional design

According to (Hillson, 2009) projects are considered, initiated and carried out in order to accomplish certain objectives of the organization, most probable in line with the strategy. In many organizations projects are used as means to deliver the necessary competitive benefit. Obviously every organization desires to progress quickly, and

that involves taking risks as a result the businesses get exposed to a series of uncertainties that determine whether their desires will be achieved or not. (Hillson, 2009) further alludes to that change can be achieved in two ways:

- *Small steps* – this option gradually introduces evolutionary change to the existing products and services. This strategy seems to be less risky therefore will deliver smaller benefits at each increment, and the benefits will be dependent on a continuous supply of value-enhancing developments.
- *Giant leap* – this option is different, as it seeks a major advance and ground breaking change to get few steps ahead. This is the most risky strategy, but the possible benefits are as bigger as the risk and can be achieved more quickly.

Risk and reward are positively connected; therefore both the small steps and giant leap method reveals the significant connection between them. In projects, the possible gain is usually directly proportional to the risk; the higher the risk means a potentially higher reward. However there is also a better opportunity that a considerable failure can happen. Making a great progress in a short timeframe might result into the organization taking more risks in both negative and positive dimensions. This statement is graphically presented in Figure 3, for an example, an attempt to introduce a completely new product in a new market could possibly be very profitable and give first-mover a big advantage, or it could just be a disaster (position 'A'). On the other hand if the organization chooses to play safe and expose itself to a lower risk, the potential gains are also lower (position 'B').

The role of projects in project-based organizations is to bring business success therefore, conducting projects is a purposeful risk-taking undertaking. The project's definite principle is to keep risk as low as possible while aiming for the maximum reward for the business. The projects existence is coupled to the reward system; there is also an expectation that they are well linked with risk. Organizations are

familiar with this relationship so they purposely carry out projects to take risk in order to deliver good value.

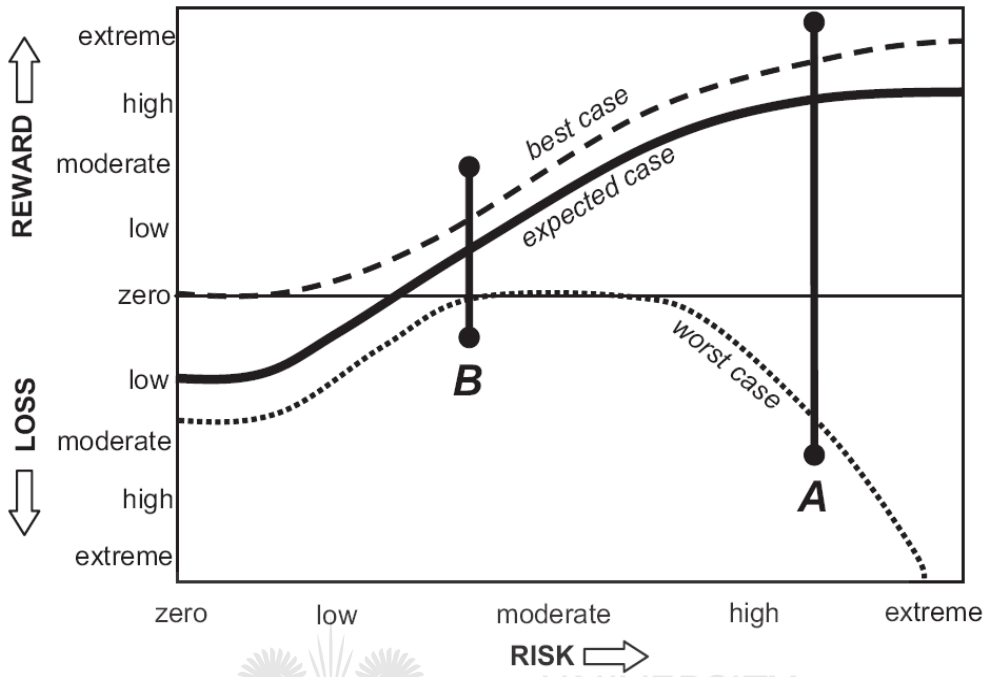

Figure 3: Relationship between Risk and Reward/Loss (Hillson, 2009)

(c) External environment

Projects cannot be undertaken in an isolated space, they are always undertaken in an environment considered as external to the project itself, and this external environment creates a variety of challenges and limitations. The external environment can be organization-wide beyond the project and the environment outside the organization. The PEST analysis matrix divides the global external business environment into 4 sub-sections (Hillson, 2009):

- political
- economical
- social, and
- technological

These external factors are each responsible for an increasing change we see in the world today. Projects basically have a fixed scope in which they are required to bring within a flexible environment; this obviously poses risk to projects. Projects cannot be isolated from their environment thus there is a common source of risk within the projects.

2.5 Sources of uncertainty

The main source of a variety of problems experienced during the execution of a project is uncertainty and risk. There are at least five different types of uncertainty sources (Migilinskas and Ustinovicius, 2008) namely:

- undefined project language and non standard communication
- inadequate skills and lack of proper training to employees
- unacceptable planning of the schedule and poor estimation of work amounts
- ineffective management tools and poor planning of works on site
- unclear definition of responsibilities and strict contractual obligations

Describing sources of uncertainty provides a good platform to realize the real influential factors in order to prepare methodology to manage those uncertainties.

2.6 Probability and uncertainty

Uncertainty is described as a number of different values that can be present for a quantity, and risk means the likelihood of either gain or loss due to uncertainty. Most of the variables that are prone to uncertainty and unpredictability could affect the outcomes of a project, such as:

- delivery lead times for purchased items
- duration of tasks and activities
- exchange rate fluctuations
- technical performance and reliability of subsystems, and
- material and labour costs

Uncertainty is expressed and modeled by means of probability. Probability theory is concerned with the outcomes of chance events that occur frequently in projects. Probability figures are also used to describe the likelihood of events such as failure of machinery or the occurrence of accidents. There is currently no universally accepted definition of probability that exists; it can be best described mathematically by the following equation which makes a relationship between the probability and the relative frequency of occurrence of an event (Visser 2012):

$$P(A) = \frac{y}{y+x}$$

Where, P (A) = probability of some event A

y = number of times that event A occurred

x = number of times that event A did not occur

In an uncertain situation, parameters are doubted, and furthermore there might be little known information about their probabilities. In a risk situation parameters are uncertain but are controlled using probability distributions known as the decision maker.

2.7 Project risk and uncertainty management

Every project has circumstances that should never come to existence in order for the project to prosper. The combination of these circumstances constitutes a risk. These circumstances are usually not predictable; therefore a project manager may have a very little control over them. In order to fully grasp the actuality of risk management in this perspective, a distinction needs to be made between two broad types of risks. There are risks that can be expected, and there are those that just emerge over time and cannot be simply expected. Risk management is a standard tool that is accustomed to identify project risk and uncertainty sources of the expected risks with the aim of determining their impact in a project in order to enable a development of the appropriate management plan (Uher, 2003). However, the definite dynamics of

projects require different and more precise methods for managing both ***emerging*** and ***anticipated*** risk.

The emergent risks can either be internal to the project or coming from the project environment. The significant exposure to emergent risk has many causes:

- duration and scope of projects
- large number of stakeholders with diverse and often conflicting interests
- their visibility
- the irreversibility of many decisions, and
- the systemic effects found in such large complex projects

The management of risk and uncertainty in the face of this dynamic unfolding has to go much further than risk management as it is conventionally conceptualized and practiced in the field of project management. The significant goal of risk management has always been to improve project performance, which simply means to supply the correct deliverables within budget and on time as agreed upon by the stakeholders. This study will further look at the concepts of uncertainty, probability, decision-making, risk modeling and risks simulation.

2.7.1 Management of emergent risks

An effective management of anticipated risks actually reduces the number of risks that will be perceived as being emergent events (Miller and Lessard, 2000) and (Miller and Hobbs, 2002). However, although putting best efforts can be helpful, but emergent risks are likely to exist, and the project organization must be intended to manage them. The plan to withstand and manage emergent risks must be done from a complex systems viewpoint. The objective is to formulate a plan that will increase the chances that responses or reactions will allow survival in the face of unforeseen events and situations. Control of emergent risks is usually indirect. In a nutshell, project design must consider the ability to imagine emergent risks early and to create

a steady and supportive project environment, as well as a project governance framework that can withstand and respond to emergent risk.

2.7.2 Management of anticipated risks

In project management the recommended approach to risk management involves identification of future possible events, analyzing those events to determine whether they will occur or not and their potential consequences on the project as well as the elaborating strategies. Therefore a good management of projects requires good risk management plan. The best project sponsors show an ability to manage risks more effectively, which in turn contributes to making projects more successful.

Anticipated risks are open to analysis, both qualitative and quantitative. The disciplines of management science and scenario building form the backbone of the analysis. Severity and discipline also are necessary to act on this information. Effective risk management is dependent on the identification of risks particularly in the early stage before the project concept can be elaborated. In the initial stages, thus it is more important to be aware of potential risks including their sources than to actually identify individual risk events.

Competent project sponsors are very helpful at identifying the issues that will need to be addressed, and putting the systems in place to resolve them. Project sponsors rely a great deal on their own experience for this, but they also know who to involve in the risk management process. A wider variety of viewpoints is likely to be better at identifying more areas of concern and will have more information and competency to draw on in all the steps of the risk management process. Having an efficient partnership of the project participants and a large network external to the project that the sponsor can draw on in the search for information and solutions are keys to effective identification and management of risks.

As project gets closer to the point where commitments will be undertaken, sponsors often organize risk management sessions where risk management strategies and the

allocation of risks are assessed for comprehensiveness and acceptability prior to commitment. Many viewpoints are brought to these sessions. Effective risk management requires the courage from sponsors and participants to withhold commitment until risks have been dealt with in a satisfactory manner. In the enthusiasm and drive to continue with projects, some sponsors and other participants tend to neglect downside risks, that is, risks with low probabilities but large impacts. People with a background in finance tend to be more sensitive to these types of risk and often will withhold their approval and commitment until those risks are resolved. The presence of people with financial background and attitude is often associated with project success. It is the sponsor's responsibility to identify the necessity for such scrutiny and to engage the relevant people.

In general, most of successful projects undertake more scrutiny than less successful projects. They are scrutinized from different viewpoints, in more detail, and more thoroughly than less successful projects. Scrutiny is applied during the project life cycle. The sponsor's tasks involve identifying the issues that need scrutiny and the viewpoints that are applicable to each issue and to put a project organization in place that will ensure that issues are dealt with entirely. Risk management is more than just applying a method to identify and analyze risks. Project organization is one of the most important risk management tools in large and complex projects. Effective risk management requires the project organization to include the right combination of participants and that it structures them to ensure that risks are identified and addressed effectively. Establishing an effective project structure means identifying the issues that need to be resolved, as well as the participants with the competence and means to deal with them, and setting up a structure that enforces resolution to the issues. Aligning of the participant roles with their particular competencies and interests in the project is a vital aspect of designing the project structure and of risk management. As can be seen from this description, the effective management of anticipated risks in projects goes much beyond the steps in the risk management methodology of traditional project management.

2.8 Project risk management process

The risk and uncertainty management is part of project management plan and usually begins as early as the appraisal stage of the project (Migilinskas and Ustinovichius, 2006). The project management plan involves implementing a number of actions to minimize the possibilities of risk occurrence and the impact of each risk in separate phases. Each phase is executed at least once towards planning phase of the project. Some project managers prefer to apply a rather superficial risk management process at the beginning of the planning phase and follow up with a more detailed.

An effective project risk management helps to understand not only the kinds of risks the project is facing, but also how they can be managed throughout different project lifecycle stages. Due to the significance of project risk management most organizations recognize it as a requirement, and have developed a set of management techniques to ensure that potential risks are controlled (Schuyler, 2001) and (Baker and Reid, 2005).

The proposed risk assessment model is generated by taking into consideration the previous researches. A proper project risk management process should address the following sub-elements and include a statement on how the specific requirements have been met for each sub-element. The PMBoK suggests the project manager to create a task list and perform those tasks in sequence:

- risk management plan
- risk identifying
- risk analyzing
- risk evaluating
- risk mitigating
- risk monitoring and controlling

The Figure 4 below is an illustration of risk management process to be followed to manage project risk in an effective manner.

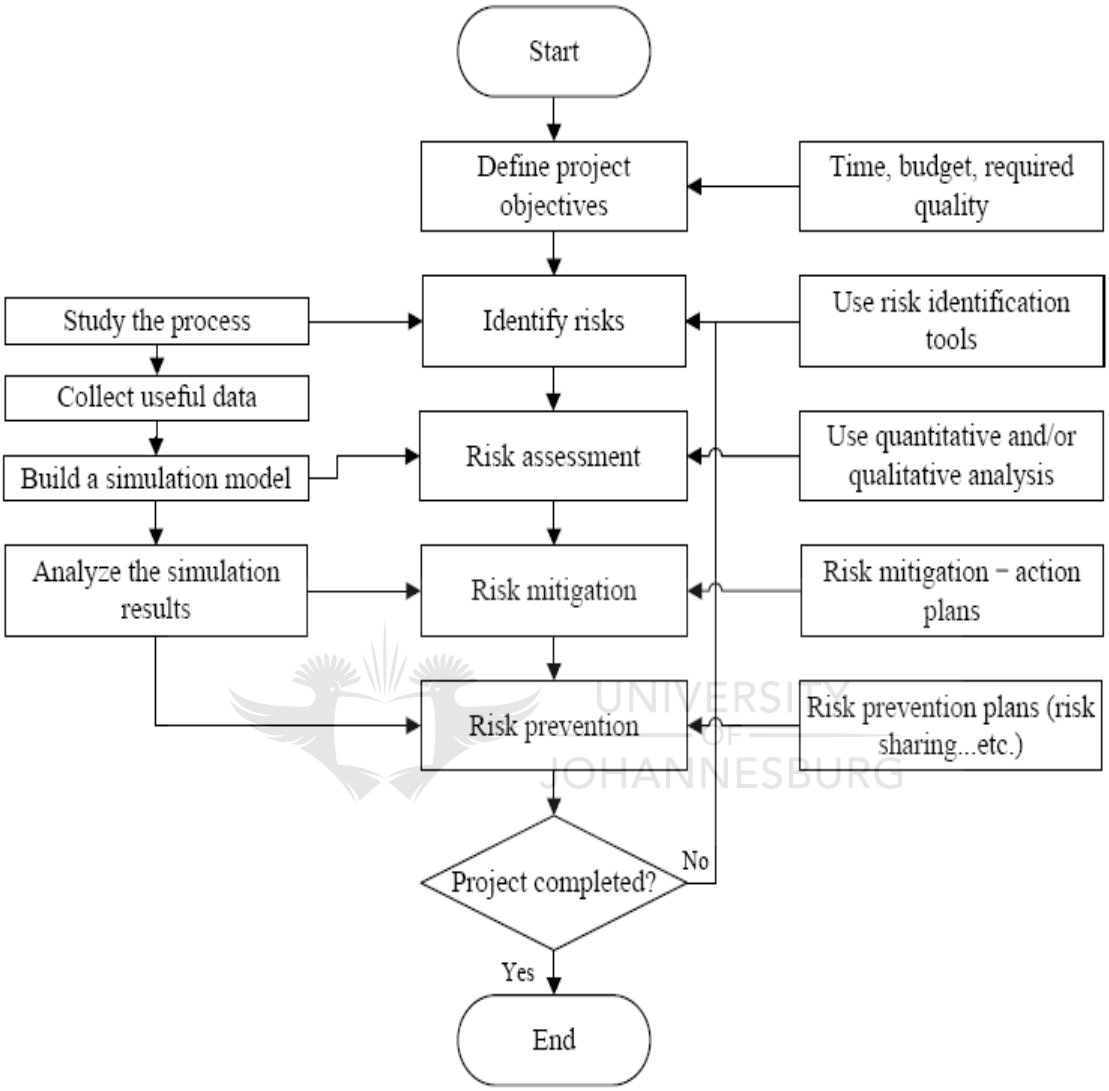

Figure 4: Project risk management process map (Chinbatbi and Takakuwa, 2009)

2.8.1 Risk management planning

In risk management process, planning is the initial step; this step involves application of project planning as sub-project of the overall risk management with its main input being the scope statement. The other risk management inputs are as follows:

- risk management policies that are used within the organisation
- templates that are already in use within the company, and
- preliminary project management plan

The primary goal of risk management planning is development of detailed plan based on the project plan for the overall project. Generally the risk management plan comprises of at least the following:

- scope statement for risk management element containing the deliverables cost, completion date including constrains and limitations
- work breakdown structure for risk management element
- cost break down structure for risk management element
- project schedule for risk management element

The final risk management plan should always be incorporated into the project plan. On large projects a risk manager is usually appointed to manage the risk element of the project. For small projects the project manager normally handles the role of a risk manager

2.8.2 Risk identification

The research done by (Chapman, 2001) states that the process of identifying risks must form part of risk analysis. However this study separates these two project risk management processes, in actual fact risk identification precedes risk analysis rather than being its part, taking into consideration its significance and effects on the results of risk analysis.

Risk identification involves recognizing risks that seem to threaten the outcomes of the project. During risk identification, the project manager must be supported by a team of experienced people from within or outside of the project to assist in identifying risk, sort the risk according to their effects to the project and document them. The following inputs are relevant in the identification of project risk.

- previous information from similar project and lessons learnt
- proper risk checklist used for different projects
- project management plan
- project schedule
- cost breakdown structure and project budget
- work breakdown structure
- technical performance goals for the project
- risk categories

There is a variety of tools and systems that readily available to assist in project risk identification process. The majority of these systems are well known in the field of project management. These systems discuss the following topics:

- the brainstorming sessions
- structured interviews
- Delphi technique
- the risk record reviews
- assumption analysis

The brainstorming method is the most widely used of the above mentioned techniques. In a brainstorming session the facilitator allows the participants to mention all possible projects risks freely. These risks are only documented with no effort of quantify them at this stage, except for considering the probability of occurrence, as well as the impact for every identified risk. All risks identified during brainstorming session should be documented in brief for more screening, structuring and analysis. The best approach is to document these risks in an electronic format immediately and later transfer it into database.

2.8.3 Project risk analysis

Risk analysis is process that entails an evaluation of the likelihood that a risk event will take place or not, and the impact should the event happen. Each risk event that

has been identified in the previous step is reviewed and an assessment is made of how likely the event is to occur. Results from the analysis are used to assess the likelihood of successfully achieving the objectives of the project, and to estimate the required contingency. Contingencies are generally for time and appropriate cost for the risks and the risk tolerance of project stakeholders. The consequence on the project result in case event occurs must also be assessed. Realistic estimates of probability and consequence are not easy and are best achieved through consensus by the project team. This exercise is inevitably time consuming. There are three distinguished methods of analyzing risk:

- qualitative assessment
- semi-quantitative assessment, and
- full quantitative assessment

The project size and its level of complexity are usually used to determine the choice of project risk analysis to be used and by also taking availability of quality data to assess the likelihood and consequence into consideration.

2.8.3.1 The benefits of analysing risk

Risk management activities consume resources that project sponsor or stakeholder could argue would be better invested in delivering a project's scope. Similarly, team members might question the benefits of participating in the periodic refreshing of the risk register or their involvement in risk response activities.

When dealing with risk management practices, it can be difficult to provide tangible evidence of their value. Therefore it is expected for projects to have predictability relative to committed baselines, for this reason the effort spent in meeting expectations will often be seen as "business as usual" as opposed to something to be recognized and encouraged.

Here are few methods of demonstrating tangible benefits to help reinforce project risk management perceived value with the decision makers;

- Include opportunities in the scope of the project risk management activities. While threat reduction focuses on meeting project expectations, exploiting opportunities could result in an increase in realized project benefits.
- Use risk register & issue log data to increase institutional knowledge. While there is often a rush on the part of resource managers to move project managers and team members to their next project, ensure there is sufficient time in the project closeout phase to analyze those issues that had not been identified as risks and incorporate the ones that have a likelihood of recurring into the knowledge bases. Of course, knowledge that is stored but not used is wasted, but overtime it should be possible to show a reduction in the number of "been there, done that" issues.
- Measure the overall effort spent on issue management (known as firefighting) activities when compared with overall effort spent on risk management. Over time, if risk response plans are appropriately executed, there should be a reduction in firefighting effort with roughly the same level of effort being spent on risk management. Not only will this reflect more "in scope" work productivity on the part of team members, but it's a great way to ensure that the risk management practices are not gold-plated.

With project resource constraints being unlikely to ease soon, project management practices will continue to be scrutinized – through opportunity management and effort measurement, you can reduce the odds of the project risk management "baby" being thrown out with the unnecessary process bath water.

2.8.3.2 Qualitative assessment

The qualitative assessment is done as part of initial screening of the risk. If there is very limited data and information available in the early phases of the project, the best approach is to use a 3-point scale (Low, Medium, and High) for classifying probability and consequence. This leads to a 3x3 risk matrix as indicated in Figure 5.

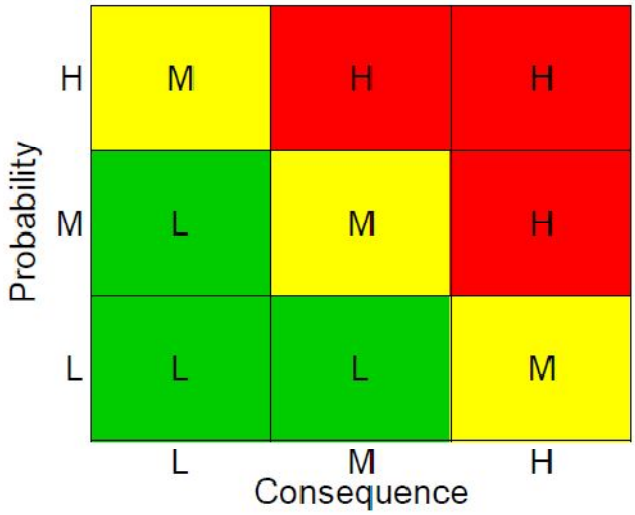

Figure 5: A 3x3 risk matrix

High risk – cannot be acceptable, a priority management decision is required.

Medium risk – this risk is moderate, therefore some attention may be required.

Low risk – usually this risk has a minimum impact therefore a minimum oversight may be required to ensure that risk remains as low as possible.

2.8.3.3 Semi-quantitative assessment

With the qualitative assessment, the risk value is obtained from the risk matrix. This could be cumbersome and the semi-quantitative assessment therefore uses numbers to express the value of probability and consequence. The risk is then calculated using basic risk equation (Visser, 2009);

$R = P \times C$

Where, R = Risk

P = Probability of occurrence (1-10)

C = Consequence if it occurs (1-10)

The semi-quantitative assessment is used when a more detailed list of prioritized risk events is required. Descriptors are usually defined for the probability and consequence scales to assist the risk team to allocate the values.

2.8.3.4 Fully quantitative assessment

This section quantifies the severity or impact of a loss event in terms of the magnitude of the potential loss. The loss can be of a quantifiable financial nature, a human loss (such as injury, illness or death), which may or may not be capable of having a monetary figure attached to it, or a financially indeterminable loss such as the impact on the value of a product brand or the company image.

Table 1: Probability/likelihood scoring criteria (from Matla Risk Scoring Guideline)

DESCRIPTION	GUIDELINES	SCALE
Certain	This is a significant threat that could occur at any time. Immediate remedial action is required to remove or reduce the risk.	10
Likely	The threat exists and it indicates high probability. Action is required to reduce this risk.	7
Moderate	The threat exists but the history or expectation of this type of situation indicates occurrence is moderately probable. Action could be taken to reduce this risk but it is unlikely to be cost beneficial.	4
Unlikely	A slight threat is perceived from this source but the situation is unlikely to occur. No action is required to reduce this risk, unless the business demands minimal risks.	2
Rare	No perceived threat exists from this source. No action is required to reduce the risk.	1

The potential loss that may result is calculated and includes not only material damage and business interruption losses but also direct costs such as legal action, and others such as the damage to image or reputation, impact on market share, impact on earnings per share, etc.

Table 2: Consequence/impact scoring criteria (from Matla Risk Scoring Guideline)

DESCRIPTION	GUIDELINES	SCALE
Catastrophic	Death, system loss, criminal guilt, loss of agency, reputational issue, material financial loss.	10
Critical / Major	Occupational threatening injury or illness, major damage, substantial damages, will exceed contingency, dividend at risk.	8
Serious / Moderate	Lost time, injury or illness, damage causing down time of plant, consumes contingency.	6
Marginal / Minor	Injury or illness requiring first aid at work only, minor damage that can await routine maintenance will only require an apology letter.	4
Negligible / Insignificant	So minor as to be regarded as having no consequence, accommodated as part of contingency or insurance excess.	2

A full quantitative assessment provides the most detailed quantification of the probability and the consequence of risk events as well as the risk value itself. At the later stage of the project when more data is available, a more accurate assessment of probability and consequence is performed using numerical values.

Numerical weightings are allocated in accordance with the significance of the exposure. A scale of 1 to 10 is usually used for the probability of the event. As a general guideline, a weighting of 1 is used for exposures for a lesser significance and weighting of 10 for a high potential loss. The units for the consequence of risk of a risk event is usually chosen as either monetary or delay in schedule. The risk value has the same unit as the consequence

2.8.4 Risk evaluation

This step of risk management process involves an evaluation of the significance of the risk events. The outputs from the previous phase are used to determine the most important risks.

2.8.4.1 Risk sorting

A first action in prioritizing the risk is to sort the risks in a table format from highest to lowest in terms of the risk value or expected loss. If the risk value of two risks is the same, a risk event with higher consequence receives more attention. After the risk sorting, the team can decide how many risk events can be nominated as critical risks that cannot just be accepted.

2.8.4.2 Risk map and threshold line

Sorting risks based on the risk value and selecting a specific number of risks as critical risks has the disadvantage that high consequence risks are often not given much attention if the probability is very low. The method of using risk map and threshold technique can overcome this problem.

2.8.5 Risk mitigation

The risk resolution phase in the risk management process entails developing action plans to eliminate either likelihood or impact of the critical risks. If positive risks or opportunities are identified, a response to the risk must be to set up the required actions to improve the probability or consequences of opportunities within the project.

This step also assigns ownership of individual risks to teams, individuals or other parties associated with the project.

The non-critical risks, typically those below the threshold line, are usually just accepted and dealt with if they should occur. A general contingency reserve for all such risks can be included in the budget. In all projects some risks have to be accepted, usually the risks classified as “low” or even “medium”. It is important to make a conscious decision to accept a particular risk. If the consequence of a risk is not severe, and the cost of avoiding, reducing or transferring the risk is too high, the project manager (or risk manager) might simply decide to allow the risk. Such a risk should still be monitored during project execution. If other events or triggers indicate that the probability of such a risk has increased, a different risk response would be necessary and the risk cannot be accepted any more.

A number of generic responses have been developed for dealing with the critical risk in a project and are discussed briefly:

- risk avoidance
- risk reduction
- risk transfer
- contingency planning
- establish a contingency reserve
- use redundancy

2.8.5.1 Avoidance

The basic risk equation is R = P x C by (Visser, 2009), therefore to avoid a risk completely, the risk value (R) should be zero. This can be achieved if either probability (P) or consequence (C) is zero. Regularly this is not possible, unless a totally different project strategy or technological concept for the end product is selected. Technologically advanced projects are inherently risky and many risks for

such projects cannot be avoided. It should also be noted that risk and reward should be balanced.

2.8.5.2 Reduction

Reduction of risk is often possible by reducing either the probability or consequence of risk events. The following methods are typically used for general reduction of the risk value.

- use standards, guidelines and processes that are well established in the company
- recruit and retain competent project managers and other technical personnel
- utilise modelling and simulation to predict system performance during design phase for development type projects
- test and evaluate prototypes or scale models thoroughly for system development
- use a phased development process, and
- reduce the complexity of a system for a system development project

2.8.5.3 Transfer risk

Transferring risk to another party is a popular method of dealing with certain types of risk. Transfer of risk means to make another party accountable for a risk; usually by means of some contract, incentives, penalties and warranties which are also part of contracts that are negotiated between customer and contractor on a project. In practice the sharing of risk between two or more parties normally appears to be better than transferring all risk. If a risk event occurs each party has to provide the necessary funding according to a negotiated risk sharing agreement.

2.8.5.4 Contingency planning

Another response to risk is to develop a contingency plan. The initial project plan is followed and risks are closely monitored. If a particular risk event that was identified during the identification occurs, the contingency plan is adopted. In practice a

contingency plan is drawn up in some level of detail and filed carefully so that the correct response could be implemented if required.

2.8.5.5 Establish a contingency reserve

Risks below the threshold line are generally just accepted and some of these risk events will occur during project execution resulting in some loss. There will always be risks that were not identified initially, no matter how much effort was taken by the risk team. Some contingency reserve should therefore be included in the project budget and schedule to be used when necessary.

2.8.5.6 Use redundancy

Redundancy can be used for technical equipment that is used on a project. This method obviously involves some cost and will only be used for critical risks.

Another method of using redundancy in a project is to appoint more than one contractor or developer in development type project.

2.8.6 Control and monitoring risk

The risk monitoring and control is an ongoing risk management process during which the risks are closely monitored as specific events and conditions occur during execution of the project. The effective method of monitoring project risk is to put together all those risks with the top scores to the project schedule and assign a risk manager to manage them. The risk monitoring must be continuous throughout the project lifecycle and it must include the recognition of the conditions that trigger each risk and comprehensive recording of the entire process.

Making use of project review meetings is essential to deal with changes in risk events and responses to critical events. The following are usual risk monitoring activities of a project.

- closely monitor intermediate project outcomes, typically at milestones on the schedule
- re-evaluate the probability, consequence and risk value of at least the critical risks
- develop action plan if the risk value is unacceptable
- identify any new risk events during the execution of the project
- quantify and evaluate new risk events

Close any risk events that are no longer applicable in the current project phase. The quantified monitoring is also used to track any trends in total risk exposure.

2.9 Decision making and risk simulation

The PMBoK mentions two quantitative risk analysis methods that can be applied for illustration of the overall project risk, namely:

- decision analysis, and
- risk simulation

2.9.1 Decision analysis

There are many situations in projects and project management where decisions have to be made, and inevitably there is uncertainty in data and future events. The taken decisions have a direct influence on outcomes of project, therefore should be considered cautiously. Many techniques for analyzing decisions have been developed and could be used effectively in a project environment. Decision analysis is a formalized process for making good decisions. The decision process comprises of the following elements:

- the decision maker
- possible outcomes of an uncertain event
- available countermeasures, and
- rewards as a function of the actions taken by the decision maker

A decision matrix is used to summarize the outcomes of all decisions and all possible outcomes of an uncertain event. A decision tree starts with a single decision node from which a number of alternatives spread out. Each option ends in a chance node. Several possible outcomes spread out from each chance node. Each of the possible outcomes has a certain probability of occurring as well as an outcome value.

2.9.2 Risk simulation

The complexity of modern physical and organizational systems increases the need to model the behavior of these systems. A variety of physical, analytical and simulation models can be used during project execution.

If the system behaviour cannot be presented in mathematical equations the use of simulation models is always preferred option. The Monte Carlo simulation technique is one of the simulation models usually used to model risk. This simulation model presents the uncertainty in different variables through probability distribution. A random sample of each variable will then be taken and added together to produce a total output. The sampling is replicated in a large number of times to generate an output distribution. The outputs of a risk simulation are a histogram or probability density function (DPF), cumulative distribution function (CDF), as well as other statistics of the output distribution function e.g. minimum, mean and maximum.

2.9.3 Simulating cost risk

Even small projects could comprise hundreds of individual costs items, of which might be prone to uncertainty with only exception where orders have already been placed at fixed contract prices. Costs have impact on a bottom line of the project as well as on the bottom line of the company. Cost risk is simple to model since it could simply be added to calculate the total.

The total cost of the project is influenced by variability in cost values including cost of equipment, material, labour as well as uncertain events. Uncertainty in cost can be expressed by means of an event with discrete states.

A systematic process needed to develop a cost risk simulation model for a project is outlined in Figure 6.

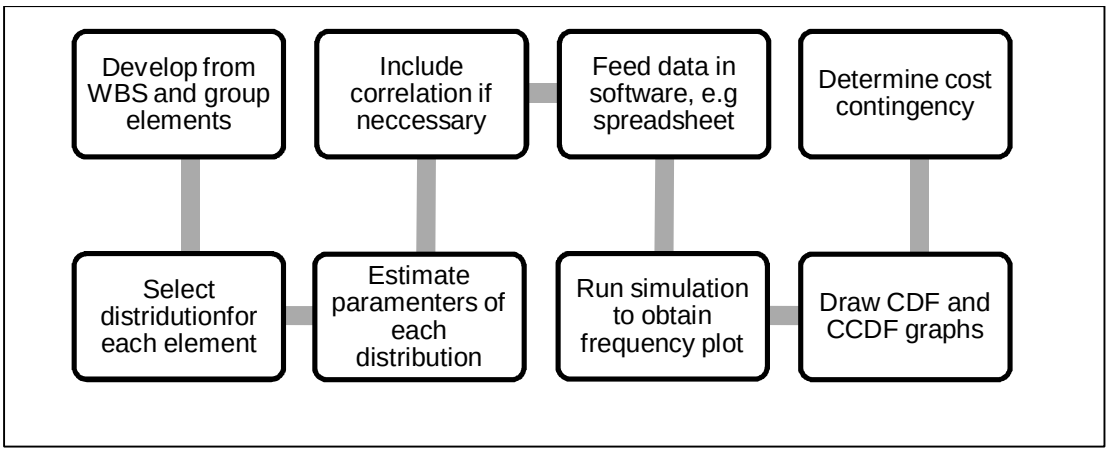

Figure 6: Process for cost risk simulation

The starting point of a cost risk simulation is the work breakdown structure from which a cost breakdown structure is derived. The next step is to select a suitable distribution for each cost element and the parameters of the distribution. The data of the distribution and parameter values are then fed into a suitable spreadsheet; therefore suitable software can then be used to run simulation. The output is then interpreted and the simulation might have to be run again a number of times. Once the satisfactory results of the simulation are obtained the cumulative distribution function can be used to determine the cost of contingency for different risk exposures in percentage.

A group of cost items could often depend on one underlying cause of uncertainty like exchange rate. Such cost items are then said to be correlated. An increase in this underlying cause will lead to an increase in all the costs that are correlated to it. Some simulation software packages have built-in functions that take care of the correlation between variables.

2.9.4 Simulating schedule risk

In some projects the total duration is more important than cost. One of the projects used in case studies is one of those projects where a schedule slippage impacts heavily on the loss of revenue through non-availability of the production equipment. It is therefore crucial to manage the project schedule carefully. In such cases the simulation technique can be used to obtain an overview of the uncertainty and risk of not meeting the due date. The PERT technique was a first attempt to model uncertainty of task duration and to obtain an estimate of total project time.

The application of risk simulation for project schedules is more difficult than for cost, since task durations cannot be simply added to calculate the total, the logic of the project network has to be considered in the simulation.

2.10 Conclusion

The literature review reveals that there is too much knowledge available within project risk management. The risk management concept as addressed in various studies has presented a valuable insight into the risk aspects and its implication on project's success. The company related aspect of risk such as management participation and support, and technical risk factors are also highly influential. The awareness of all the risks associated with the project does not necessarily mean that the acquired knowledge will be useful to managing those risks (Kutsch & Hall, 2005). The next chapter will describe the research methodology which was applied to further address the study problem.

CHAPTER 3: RESEARCH METHOD AND PROTOCOL

3.1 Introduction

This chapter focuses on the research method employed to find answers to a research question. The report presents project risk management approach of two projects carried out in the same organisation. The selected projects both involved equipment replacement in which the main deliverables are to supply and deliver the final product. A research method will compare project risk management approach of the two projects. One project was executed by a project manager from the Project Management Office (PMO) in accordance with project management methodology, while the execution of the other project was highly influenced by a client/sponsor with no consideration of proper project management methodology.

According to (Kothari, 1985; Dawson, 2002 and Kumar, 2005); research is a structured survey where a reasonable systematic methodology can be developed to produce new knowledge that is commonly relevant and solve existing problems. These systematic approaches comprises of methodical study, categorization and data interpretation. Undertaking a study to respond to the question implies that:

- the procedure is carried out within the specified guidelines approaches
- the process applies valid and reliable procedures, methods and techniques
- the process is planned to be objective and unprejudiced

Various research methods section are evaluated in this study to provide a motivation for selecting a case study as the most suitable research method to obtain answers to the research questions. It also involves collecting, analyzing and interpreting data to answer a research question. In order for the process to be considered as research, it should be: controlled, accurate, methodical, legitimate, confirmable, practical and decisive. Consequently a process that adheres to all the above mentioned criteria qualifies to be a research.

3.2 Case study defined

A case study is becoming increasingly accepted as a scientific tool in management research (Gummesson, 2000). For every risk factor identified, the risk effects are quantified by determining their likelihood and consequence, and a variety of suitable responses are established and cost implications for mitigating risk are also quantified.

A case study research method seeks to determine the processes existing in single situation (Eisenhardt, 1989). According to (Pervan and Maimbo, 2005) definition, case study protocol means a set of complete guiding principles comprising of fundamental element about case study procedures for performing a study and analyzing data.

In their study (Haanappel, Drost, Harmsen, Brinkkemper and Versendaal, 2011) mentioned the importance of setting-up a case study protocol before performing a case study research. Developing a protocol enhance dependability of case study research and directs the researcher to collect data from a case (Eisenhardt, 1989); (Maimbo & Pervan, 2005) and (Yin, 2009). The case study protocol is used for a number of reasons (Brinkkemper and Jansen, 2008):

- firstly, it describes case study objective with the purpose of avoiding divergence and misunderstanding at some point
- secondly, the case study is used as a tool to influence stakeholders about the research effectiveness
- lastly, the case study protocol is convenient for guiding researchers and providing the research results

3.3 Case study research

The research enables an in-depth understanding of particular circumstances, in which a number of sources of data are used (Noor, 2008). If a research involves more than one case then a multiple-case study must be considered.

A multiple-case study differs from holistic case study only by the perspective for each of the cases and by also allowing the researcher to analyse every single situation or multiple situations, whereas a holistic case study only allows the researcher to take in single distinctive case. The multiple case study, examines quite a few cases to comprehend the differences and the similarities amongst the cases. A multiple-case study according to (Yin, 2003) must either be used:

- predict similar results or
- forecast different results, but with known reasons

Generally, data generated through the study of this nature is considered as powerful and reliable, however the study can also be enormously lengthy and costly to perform.

3.4 Research method

The preference research method to be applied is dependent on the existing research problem (Darke, 1998), (Noor, 2008) and (Yin, 2009). Case study approach is the most common method that can be applied to study the difference in which the projects risk was managed. Once the case and its limitations are determined; the other elements needed for creating and performing comprehensive study must be considered. Yin (2003) describes the conditions under which a case study research method has to be considered:

- when the study is focusing on to answering “why” and “how” type of questions
- if the behaviour of those participating in the research cannot be influenced
- if the researcher needs to cover the appropriate setting that is believed to be relevant to the theme under study, or
- if the restrictions between the theme and its context cannot be drawn

Table 3: Various research approaches and methods, according to (Yin, 2009)

Method	Form of research question	Requires control of behavioural events?	Focuses on contemporary events?
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival Analysis	Who, what, where, how many, how much?	No	Yes/No
History	How, why?	No	No
Case Study	How, why?	No	Yes

Upon evaluating various applicable study approaches from Table 3, the case study was selected considering its descriptive nature which permits further expansion of hypothesis from the research findings. In addition, the case study approach combines both qualitative and quantitative data collection techniques; therefore it appears to be appropriate to be used in this study (Yin, 1994); (Kaplan and Duchon, 1998); (Darke et al., 1998); (Yin, 2009) and (Eisenhardt, 1989).

3.5 Case study method

The researcher can choose between a single or multiple-case approach when undertaking case study, depending on subject at hand. The single-case approach can still be used in situations where there is a lack of existing similar cases for comparison. Nonetheless, there are also shortcomings in utilising a single-case approach which are attributed to its lack of ability to deliver simplifying conclusion,

particularly if dealing with unusual events. The recommended technique to respond to this shortcoming is by applying triangulating method which evaluates the study against other methods with the intention of confirming its validity.

In contrast to the single-case, a multiple-case approach can be adopted in the situations where there are various sources of data on hand. The generalisation of results from each of the case methods comes from the theory than the population (Yin, 1994). The multiple-case approach will enhance and support the previous results by repeating the case through pattern-matching which assists to increase the level of confidence about the credibility of the method to a high level (Campbell, 1975). According to (Zainal, 2007), the case study design should be capable of demonstrating that:

- it is the most appropriate and feasible method to draw out implicit and precise evidence from the subject
- it is appropriate for the use to address research question
- it goes with set of guidelines with the appropriate application
- a series of collected data, are systematically documented and filed, mostly if interviews and inspection are considered as major basis of the evidence
- it is connected to the hypothetical structure (Tellis, 1997)

3.6 Case study research process

This section looks at the proposed case study process for use in this research and also the case study protocol from which it has been developed.

3.6.1 Background

There are many researches previously done on project risk and uncertainty management, some of which were discussed in the literature review. This section presents approaches which are derived from (Eisenhardt, 1989), (Maimbo & Pervan, 2005), (Brereton et al., 2008) and (Yin, 2009). The case study protocols were selected on basis that they are commonly used by most researchers. The (Brereton

et al., 2008) approach further presents clearly defined steps from which the research approach was developed while (Maimbo & Pervan, 2005) approach uses the study by (Eisenhardt, 1989) as the base in developing the case study protocols. The (Brereton et al., 2008) case study protocol identified 11 steps, as demonstrated below:

Table 4: Case study protocol by (Brereton et al., 2008)

Activity	Sub activity
1. Background	1.1 Identify previous research 1.2 Identify main research question (RQ) 1.3 Identify additional research questions (ARQ)
2. Design	2.1 Identify use of single-case/multiple-case/embedded/holistic design and show link with 1.2 and 1.3
3. Case Selection	3.1 Criteria for case selection
4. Case Study Procedures and Roles	4.1 Procedures governing field procedures 4.2 Roles of case study research team members
5. Data Collection	5.1 Identify data to be collected 5.2 Define a data collection plan 5.3 Define how data will be stored
6. Analysis	6.1 Identify criteria for interpreting findings 6.2 Identify data elements to answer RQ/SRQ and how to combine elements into an answer 6.3 Consider range of outcomes and id alternative outcomes 6.4 Analysis should take place as the case study task progresses
7. Plan Validity	7.1 Check again Höst and Runesons (2007) checklist 7.2 Check construct validity 7.3 Check internal validity 7.4 Check external validity
8. Study Limitations	8.1 (none)
9. Reporting	9.1 (none)
10. Appendices	10.1 Validation 10.2 Divergences

3.6.2 Proposed case study approach

The research procedure is derived from approach developed by (Brereton et al., 2008), which was also based on well know approaches by (Eisenhardt, 1989), (Maimbo & Pervan, 2005), (Brereton et al., 2008) and (Yin, 2009). The researcher added some activities (study population and limitations) to the original approach, while some activities assumed to be not applicable were removed. The activities included in this approach are intended to simplify identification of the process and the decisions made.

Table 5: The proposed case study protocol

Activity	Sub activity
1: Background	1.1 Identify previous research 1.2 Identify main research question (RQ) 1.3 Identify additional research questions (ARQ)
2: Case study design	2.1 Identify use of single-case/multiple case/embedded/holistic design and show link with 1.2 and 1.3
3: Case selection	3.1 Criteria for case selection
4: Study population	4.1 Criteria for case selection
5: Data collection protocol	5.1 Identify data to be collected 5.2 Define a data collection plan
6: Data analysis methods	6.1 Identify criteria for interpreting findings 6.2 How triangulation of perspectives from multiple participants will be achieved 6.3 Description of "cross sectoral" analysis
7: Reporting	7.1 (none)
8: Study limitations	8.1 (none)

3.6.3 Case selection

The researcher should consider the type of case study to perform once it has been established that qualitative case study will answer the research question and when the case together with its boundaries have also been established. The overall purpose of the study will normally guide the choice of a particular case study method. In their respective researches (Yin, 2003) and (Stake, 1995) described case studies in different ways. Yin classifies case studies as explanatory, exploratory, or descriptive; and further makes distinction between multiple-case and single case studies, whereas Stake categorizes them as intrinsic, instrumental, or collective. The Table 6 below presents different types of case studies and their descriptions.

Table 6: Case studies definitions (Baxter and Jack, 2008)

Case Study Type	Definition
Explanatory	This type of case study would be used if you were seeking to answer a question that sought to explain the presumed causal links in real-life interventions that are too complex for the survey or experimental strategies. In evaluation language, the explanations would link program implementation with program effects (Yin, 2003).
Exploratory	This type of case study is used to explore those situations in which the intervention being evaluated has no clear, single set of outcomes (Yin, 2003).
Descriptive	This type of case study is used to describe an intervention or phenomenon and the real-life context in which it occurred (Yin, 2003).
Multiple-case studies	A multiple case study enables the researcher to explore differences within and between cases. The goal is to replicate findings across cases. Because comparisons will be drawn, it is imperative that the cases are chosen carefully so that the researcher can predict similar results across cases, or predict contrasting results based on a theory (Yin, 2003).

Intrinsic	Stake (1995) uses the term intrinsic and suggests that researchers who have a genuine interest in the case should use this approach when the intent is to better understand the case. It is not undertaken primarily because the case represents other cases or because it illustrates a particular trait or problem, but because in all its particularity and ordinariness, the case itself is of interest. The purpose is NOT to come to understand some abstract construct or generic phenomenon. The purpose is NOT to build theory (although that is an option; Stake, 1995).
Instrumental	Is used to accomplish something other than understanding a particular situation. It provides insight into an issue or helps to refine a theory. The case is of secondary interest; it plays a supportive role, facilitating our understanding of something else. The case is often looked at in depth, its contexts scrutinized, its ordinary activities detailed, and because it helps the researcher pursue the external interest. The case may or may not be seen as typical of other cases (Stake, 1995).
Collective	Collective case studies are similar in nature and description to multiple case studies (Yin, 2003).

For comparative study design the material to be studied would be multiple cases. The cases are somehow similar although they vary in some respects, otherwise it would be irrelevant comparing them. Their variation then becomes the focal point of investigation with the aim of realizing why they are different, and also to reveal the common primary structure which causes or allows such a variation.

The comparative method is flexible to be used in detail study as complementary to other methods, or the whole research project structure can consist of the comparison of only few cases. In a comparative study, the researcher examines two or more cases. Based on the objective of the study, the researcher decides on the important characteristics or features to be noted and recorded for every case studied.

3.6.4 Study population

At least eight (8) personnel participated in this study. The participants comprised of the PMO manager, project managers, senior management and other individuals who

were involved in the mining equipment replacement decision making process. The senior management personnel are normally people who have reasonable experience within the company and are knowledgeable to provide the reliable information.

According to (Henry, 1990) recommendations; when studied population consists of less than fifty, data must be collected from the total population. The researcher made an effort to obtain the critical information on the process that was followed during the execution of Project X.

The researcher had a great opportunity to complete another project in line with the approved company processes, therefore interviewing the participants was a simple task to accomplish. There are a total of eight people that were interviewed.

3.6.5 Data collection protocol

The participants involved in the research were interviewed personally while some just referred the researcher to the formal communication documents already saved on the system. However it is in the interest of the researcher and the organization to keep the information strictly confidential.

3.6.6 Data analysis methods

Data analysis aims to depict trustworthy patterns in the data so the results can be studied and interpreted in a concise and consequential manner (Zikmund, 2003). Data analysis consists of the activities of categorising, rearranging, summarising, ordering, manipulating and separating out relevant data from the whole data set. The research by (Leedy & Ormrod, 2001) mentioned that qualitative evidence can not only be analysed in a single distinct method. They described data analysis as a process of breaking down a large body of information into a small set of fundamental subjects through “inductive reasoning, sorting and categorising”.

3.6.7 Reporting of case study

Case study reporting is challenging for many researchers as a result of complexity of its nature. There is difficulty in reporting the results concisely; however the researcher is responsible to transform the complexity into a simple and easily understood format. The reporting should depict the study in such a comprehensive approach that whoever reads it feels as if they have actively participated in it, and are able to establish if the results of the study are suitable for application in their individual situation. For the reporting purpose the researcher must describe phenomenon and perspective where the phenomenon is taking place. According to (Baxter and Jack, 2008), there is no one ideal method of reporting a case study; nonetheless some recommended methods are by giving a chronological report, by telling the reader a story, or by dealing with each proposition. Dealing with the propositions guarantees that the report keeps on determined to addressing a research question. The negative aspect of reporting that affects most inexperienced researchers is being distracted by excessive amount of interesting and redundant data about the research subject. A researcher can avoid this pitfall by always adhering to the propositions. The results must be evaluated and compared against the available literature with the purpose of positioning the new data into pre-existing evidence. Yin (2003) recommended six methods to be used for case study reporting which include; chronological, linear, comparative, suspense, theory building, and unsequenced. The comparative method is identified as the most suitable in this case due to the nature of this study.

3.6.8 Limitations of the research

This study has several limitations:

- one of the challenges of these case studies was to get permission to study what the researcher's need and to gain access to the people needed for the study.

- the information supplied by the participants can be biased to protect certain individuals within an organisation and some of the decisions made could not be supported by any evidence.

3.7 Conclusion

Case study approach is able to deal with “how” and “why” types questions and to consider how this phenomenon is influenced by the situation from which it is found (Baxter and Jack, 2008). Case study research method has a prospective of successfully handling a study throughout difficult circumstances. For novitiate research, a case study is seen as a tremendous and favourable chance to get an accurate and deep intuitive understanding into a case. It also allows the researcher to put together evidence on various sources with the purpose of clarifying the case.

Case study is a substitute qualitative or quantitative research and a real solution in cases where it is not possible to get a large sample population (Zainal, 2007). Although case studies have a range of advantages due to the manner in which they provide evidence in practical circumstances and an understanding of the behaviours of the studied subjects, on the other hand they are criticised for being unable to simplify the findings. Case studies presented in the literature are generally from selected fields. The acknowledgment and the use of case study research method resulted from researcher’s concern of the quantitative methods limitations to provide holistic and detailed description about situation at hand (Zainal, 2007).

The next chapter will provide background on the two cases selected, and also describe how the case study data was collected and analysed through a methodical approach to ensure a concrete research approach.

CHAPTER 4: CASE STUDY DESCRIPTION

4.1 Introduction

This chapter discusses the data derived from two projects undertaken in the same organisation and also following the same project management methodology. The studied projects both involve equipment replacement in which main deliverables would be supply and delivery of the final product. The Project Y was managed by a project manager in accordance with the project management methodology, while project X was managed by the client/sponsor without following a recognised project management methodology.

The Company B did not have Project Management Office (PMO) in the past; it was only established in January 2009. After the establishment of PMO, the old project management process where clients/project sponsors would run and manage project within their respective shafts was phased out. All the current and future projects would be managed through PMO which was assigned with different tasks associated with project management within a Business Unit. During the execution of Project X, the PMO was still small and under resourced to handle all the listed projects.

4.2 Research objectives

The goal of the research is to study; how project risks and uncertainty can be managed and to identify the influence of the stakeholders throughout the entire project life cycle. One of these two projects delivered good results while the other project delivered poor results. The study is about providing answers to the research questions mentioned in the Chapter1. The intention of the researcher is to obtain data from both projects to substantiate the theory and compare the two case studies.

4.3 Cases studies - the projects

This section provides background of the research and the situation where the case study research was carried out. The two similar projects were undertaken within a

business unit, however one project delivered good results, while the other project delivered poor results.

The case studies are two equipment replacement projects carried out by Company B between 2010 and 2013, one valued at R16.6 million and the other one valued at R40 million. The Project Management Office is responsible for managing projects on behalf of the business unit, which has all responsibility for the projects.

In both case studies the research was performed in the same company. The researcher has been working for the company since 2008 and started conducting a study from 2011. The company involved in the study is a captive underground coal mine. Captive means that all the assets and the coal reserves belong to another company, the Company A which is major power producer. The Company B is only responsible for the management of the people, assets and the mine operations. Company A provides capital for all projects taking place at the Company B; therefore Company B has to adhere to all the procedures prescribed by Company A in order to obtain funds approved for their projects. Company A would not approve any capital expenditure until they are satisfied that Company B followed the required approval process.

Shaft No 2 of the company B makes use of the shortwall mining method, utilising a system known as armoured face conveyor (AFC) to cut and haul coal out of the coal face. The system consists of; shearer haulage system, conveyor drives, non-driven return end (NDRE), and chain conveyor. Each of these components has to optimally work together with the other parts of the system in order for the system to operate. Both equipments were approaching the end their useful and economic life. Their replacement was determined by amount of tonnes of coal they had already produced. These two projects were run separately; Line Pans replacement (Project X) and non-driven return end – NDRE replacement (Project Y).

- Project X was executed by the project client/sponsor without following a recognised project management methodology.
- Project Y was executed by a project manager from the Project Management Office (PMO) in accordance with the project management methodology.

A background summary for each project and the project approval process will be provided in the following two sections, and the drivers which led to these two projects being handled differently.

4.3.1 Background of Project X

Project X is an equipment replacement project with its value estimated at R 40 Million. During the drafting of the 2011/12 budget in 2010, the OEM of the Line Pans indicated that the lead time for Project X would be 12 months which was seen as the risk. The Company B then realised that with such a long delivery lead time and the capital approval delay they would definitely never meet target date of project execution. The Company B made a provision of R40m in the capital budget of 2011/12 for the implementation of Project X. The capital budget confirming the inclusion of the R40m was forwarded to Company A in March 2011.

The Company B decided to place an order prior to project approval by the Investment Committees from both companies; therefore the equipment was purchased on the operating cost in July 2010 to ensure delivery on time. The equipment and its accessories were delivered by the OEM in June 2011. The purchase of this equipment was never treated as a project. The project manager was later appointed to facilitate the project management and get all the necessary documentation approved.

4.3.2 Background of Project Y

Project Y also involved equipment replacement with its value estimated at R16.5 Million. This project took place in the same environment as for Project X. The Company B made a provision of R16m in the capital budget of 2011/12 for the

implementation of Project Y. The PMO was formally mandated to execute the project. The PMO manager then appointed a project manager (the researcher) to execute and facilitate project throughout the life cycle. Project Y was initiated in September 2011 and its closure was expected to be in end of February 2013.

4.4 Identifying data to be collected

The data was collected through personal interviews and from the existing project management and communications documents. All documentation sources such as presentations, memos, emails and meeting minutes completed during the project execution for both projects were studied.

4.5 Defining data collection plan

Statistical researches seek to gather a population's quality by depicting conclusion on the basis of evidence obtained from the sample characteristics (Cooper *et al.*, 2001). In this study, a survey was conducted from the entire population; therefore it was not necessary to imply inference from the sample data. The interviews were conducted with the entire population of project manager, PMO manager and senior management who were familiar with the project in discussion. The researcher was partially involved towards the final stages of Project X after being appointed to manage the project and get all the necessary approvals. As for Project Y, the researcher was appointed as Project manager and actively involved from the start of the project. During the period of the study the researcher was employed by Company B as a Project Manager at the PMO from which both projects were run. The survey was carried out to determine the findings during interviews, personal involvement, participation, documentation review and observation.

4.6 Research data analysis

Data analysis would start upon completion of the survey, and the researcher would then analyse survey results. The results will be compared and validated to determine

whether they were significant. All relevant questions asked during interviews will be in line with the study objectives.

4.6.1 Identify criteria for interpreting findings

Interpreting results from the research requires a set of questions to be developed, which are then used to classify findings and allow for a comparison.

4.6.2 Triangulation of perspectives

The triangulation involves compiling more than one research perspective during the same study. The researchers could expect to succeed in dealing with the limitations and inherent biases or problems originating from single research perspective by combining multiple theories and methods.

By triangulation, the researcher compares multiple sources of evidence, to determine a variety of aspects to base the research on (Yin, 2004). Frequently, the intention of triangulation in particular perspective is to get confirmation of results through combination of different perspectives. The situation upon which the perspectives collaborate is seemed to signify actuality.

4.6.3 Description of cross-sectoral analysis

The analysis seeks to make a comparison between the two similar cases based on the emphasis of the evidence and results summaries. Through cross-sectoral analysis, potential results are supported or new outline is established that can add significance to the study. The cross-sectoral analysis results will be discussed in the following chapter.

4.7 Conclusion

The case study definition and design for this study were explained in Chapter 3. The case study research process, case selection, study population, collection of data protocol, methods of analysis of data and the research limitations were also explained. A systematic approach was applied to collect and analyse the evidence in

order to ensure a research design that is solid as prescribed by the case study method. This research employed a comparative multi-case study method where at least eight (8) individuals comprising of the PMO manager, project managers, senior management and other stakeholders were involved in the study. The Chapter 5 will present the actual results from each of the case studies as well as a cross-sectoral analysis which are structured around the research objectives to determine whether any generalisations can be made.

CHAPTER 5: RESEARCH RESULTS AND DISCUSSIONS

5.1 Introduction

The study was done by means interviews which were conducted with eight (8) employees within the organisation. This chapter will summarise and present the observations and findings of the study. The interview questions revolved around the research question as discussed in Chapter 1.

5.2 Project X - Data results

The interviews were performed about the replacement of Line Pans Project X at Company B and the results emerged as follows:

- In February 2010 the meeting was held between Company B and OEM to discuss equipment requirement for Company B and shortwall for financial year 2010 & 2011.
- The Company B was represented by a Resident Engineer, Mine 2 Manager, Operations/Mining Manager, Section Engineer, Senior Foreman and Technical Specialist from the Head Office. The OEM was represented by 5 management personnel. During this meeting a need to replace Line Pans was recognized, and therefore communicated with the OEM.
- After consultation with the Original Equipment Manufacturer (OEM), Company B was informed that the lead time delivery of a new Line Pans is 12 months after placement of an order.
- Both the OEM and Company B identified a long lead time as a risk to the project, however the sponsor not give a mandate to PMO to manage and execute the project, instead an early order placement was recommended by both parties as the best solution.
- During January to February 2010 budget planning cycle, Company B decided to transfer the Line Pans budget from the operating expenditure costs centre to capital expenditure cost centre.

- The transfer was informed by misalignment between Company A and Company B capital definitions.
- Company B has always purchased Line Pans under the working cost centre in line with the Coal Supply Agreement.
- By the end of February 2010 the Company B decided to revert the Line Pans to the working costs centre in order to meet the lead time, therefore an order was placed on working cost in July 2010, with the delivery expected to take place in July 2011.
- The equipment was delivered in June 2011; however the monthly capital to cover operational expenses paid by Company A to Company B was underpaid by R32m.
- Upon inquiry the Company B was verbally advised that short payment relates to the Project X that was paid for on working cost instead of Capex.

Some of this information could also be confirmed from the different documentation sources such as presentations, memos, emails and minutes of the meeting completed at different stages of the project life.

5.3 Project X - Factors contributing to failure of risk management process

The Company B decided to place an order on the operating budget in July 2010 in order to ensure delivery on time. The equipment and its accessories were delivered by the OEM in June 2011. During this process, the Company B violated almost all the processes and procedures of acquiring new equipment.

- there was no structured project risk management approach used.
- the project sponsor being influential took advantage and decided to fund the project on working capital.
- at the point when a decision was made to purchase equipment on working cost, the company a was not informed.
- the process of transferring these costs from working to capital expenditure (ratification) was then followed

5.4 Project X - Factors affected project success

The research data was collected through comprehensive interviews of the project stakeholders, inspection of the existing project management documentation, and through participation and observation. The objective of the interviews was to look at the equipment replacement methodologies that are employed, factors that may have influenced the bypassing of the equipment replacement and capital approval procedure. Data procedures in the data collection process are explained below. Both documentation and the information given by the interviewees, shows that these are basically the factors that affected project success:

- Failure to do a proper risk management plan.
- Poor project governance
- Poor decision making by the project sponsor
- The OEM involvement in decision making

5.4.1 Inappropriate risk management plan

The execution of Project A was highly influenced by a client/sponsor with no consideration of the appropriate project risk management methodology. The steering committee successfully identified the risk, but did not take it through a proper risk management process to develop risk mitigation plan. The reason for this was project sponsor's interest in a project as well as the authority to make financial decisions on the project.

5.4.2 Poor project governance

Project governance extends the principles of corporate governance into the management of individual capital projects through governance structures and the management of projects at a business level. The project sponsor normally gets support from the project's governance body, or steering committee. These governance roles give direction, guidance, and critically review the project and its progress.

Project sponsor identifies the need for change or improvement within a business, and commits to making that change to take place and succeeds. A good project sponsor would make an ordinary project incredible, while a bad project sponsor would discourage an incredible project team.

5.4.3 Poor decision making by the sponsor

Decision making is one of the most significant aspects in project environment. Making decisions ranges from the simple to the complex. Every situation would require decision making that can affect the outcome in an inconsequential or more profound ways. Regardless of the nature of decision making, organizations have to make decision making a best practice to support the organization strategy. In general, decision making is for whomever and the methodology that goes about to derive the final decision is often disorganized and ambiguous. The project stakeholders, especially the sponsor may also be required to act as decision makers in certain situations. It is important that these individuals are identified early in the project. Upon identifying main decision makers, it is very important to characterize what decisions should be made by whom. Project scope changes may be carried out by committee while budgetary approvals may be done by the sponsor. Assigning the primary decision makers for particular project aspects will simplify things as the project progress.

By definition, the sponsor implies the financial accountability for the entire project; therefore a project cannot be executed without the sponsor. In fact, PMBoK (2004) describes sponsor as "the person or group that provides the financial resources, in cash or in kind, for the project". However there is not much emphasis about the responsibilities of sponsor in project risk management literature. Some of the roles of the Project sponsor are present follows:

- it is to provide the financial resources for the project.
- it is to steer the project during the engagement or selection process until it is formally approved.

- project sponsors would form part of the project team on some projects; therefore they may take a leading role on the project team from time to time.
- they may also play a key role in critical activities such as approving scope changes, reviews of phase-closure and make go/no-go ruling when project is faced with a risky situation.

The sponsors are the ultimate owners of the end product delivered by the project. Their interest is critical as they set the requirements, they know the strategic intent of the project, and they also provide the financial support for the project to move forward. Anything in the project that will affect delivery of the product requires engagement with the sponsor. The project sponsors will definitely be involved in the planning stage to assist in the determination of high-level or organizational risks. There could be others but more frequently, and/or due to the nature of project and the organization, sponsors wouldn't have much time to sit down with the project manager and discuss low-level risks. Due to this reason the researcher sees a greater involvement of sponsors in risk management is when there is a probability of a risk event. This is the time when a project manager seeks advice through an escalation process to obtain sponsor insights, either the project manager providing a recommendation, or the sponsor providing direction. The bottom line is that, the sponsors own the end product of the project and they have all the rights to know and be involved in situations where there is a threat of a failing project.

5.4.4 The role of OEM in decision making

The supplier who recommended replacing the equipment was also the original equipment manufacturer (OEM), which is a company that manufactures equipment or main components of equipment that are sold to customers as new. The reason for this is that components and other items could work better if they come from the same OEM and meet the original standards. However, through this case study it was found that using OEM has both advantages and disadvantages, which also exposed a project to some degree of risk.

Advantages:

There are many advantages that can be realized through using OEM products like the ones that are listed below.

- high quality products is one of the reasons why the majority of companies prefer OEM products,
- sound and professional advice to the customer which can in fact minimize some of the unforeseen risks that the supplier learnt from other clients, and
- OEM can provide reasonable cost estimate including total cost ownership.

Disadvantages:

The main disadvantage of using OEM suppliers is that they tend to influence decisions towards their own interest. This can happen during technical evaluation of the existing equipment, (in case of replacement) conducted in order to make recommendations with regards to its current status.

The OEM decisions can possible result in the following:

- price escalation of material prices, and
- overlapping on project management

5.5 Project X - Data findings summary

During analysis of the findings it emerged that the difference between these two projects is the manner in which the identified project risks were mitigated. The obvious risk mitigation in the similar situation would be to speed up the business case approval or project funds approval. This can be done either proper planning or getting stakeholders buy-in during planning of the project risk management. Funding of capital projects with working capital has its own consequence, which includes bad financial and reflecting operating expenses as very high.

5.6 Project Y - Data results

The equipment replacement involved risks; therefore a comprehensive project risk management process was required. A proper risk management plan was developed and the risks were managed in accordance with the plan. For each and every identified risk, there is also a mitigating measure in place to minimise impact should the risk occur. The project risks were monitored throughout the project life cycle in the following sequence adopted from the PMBoK:

- risk management planning
- risk identifying
- risk analyzing
- risk evaluating
- risk mitigating
- risk monitoring and controlling

All identified risks in Project Y are realistic and any other project in a similar environment can be exposed to such risks refer to Table 7. The goal of risk identification exercise was not only to identify risks and list them, but to determine the most critical risks that can considerably affect the project delivery. Consequently, the risks ranked in top six (6) after the rearrangement were only selected as critical risks. The results of the replacement of NDRE project at Company B came out as follows:

- The project manager created a task list and performed the tasks in sequence according to PMBoK.
- A proper project risk management procedure was used during the project lifecycle which delivered the results as presented in Table 7 below.

Table 7: Risk register for Project Y

RISK NO.	RISK EVENT/CONDITION DESCRIPTION	P	C	R
		1 - 10	1 - 10	1 - 10
	BUSINESS RISKS			
1	Late approval of business case	0.35	0.8	0.28
2	IRC approval delay	0.1	0.85	0.09
3	Project management plan approval delay	0.1	0.65	0.07
4	Production losses	0.2	1	0.20
	FINANCIAL RISKS			
5	Exchange rate variations	0.15	0.3	0.05
6	Approval of business case	0.2	0.3	0.06
	PROJECT MANAGEMENT RISKS			
7	Schedule risk, flimsy scope statement	0.15	0.4	0.06
8	Design risk, design inadequate	0.1	0.25	0.03
9	Technical risks	0.25	0.15	0.04
	SYSTEM SAFETY RISKS			
10	Sprocket wear-out replace	0.15	0.6	0.09
11	Flight chain snaps	0.35	0.5	0.18
12	Lifting and transporting of heavy equipment	0.45	0.1	0.05
	PROCUREMENT RISKS			
13	Scope inadequate	0.1	0.25	0.03
14	Delivery time	0.35	0.3	0.11

By ignoring the class, risks are prioritised according to their scores, to measure each risk implication with regards to cost, time, quality, environment and safety. A first action when prioritizing the risk is to sort the risks in a table format from highest to lowest in terms of the risk value or expected loss. If the risk value of two risks is the same, a risk event with higher consequence receives more attention. Sorting risk events from Table 7 results in a new arrangement as presented in Table 8.

Table 8: Sorted risk for Project Y

RISK NO.	Probability (P)	Consequence (C)	Risk (R)
	1 - 10	1 - 10	1 - 10
1	0.35	0.8	0.28
4	0.2	1	0.20
11	0.35	0.5	0.18
14	0.35	0.3	0.11
2	0.1	0.85	0.09
10	0.15	0.6	0.09
3	0.1	0.65	0.07
7	0.15	0.4	0.06
6	0.2	0.3	0.06
12	0.45	0.1	0.05
5	0.15	0.3	0.05
9	0.25	0.15	0.04
8	0.1	0.25	0.03
13	0.1	0.25	0.03

Three (3) risks were chosen from Table 8, risk number 1; 4 and 11 were identified as critical risks. Critical risks selected would typically be between 10% and 20% of the total number of risks identified.

Risk events are plotted on a probability/consequence graph. The purpose of threshold line on the map is to separate regions with the risk events which cannot be accepted from those that can be accepted. It is recommended to always select the threshold value in such that about 20% of the total number of risks is above the threshold line and 80 % of the risks are well below (Visser, 2012). A threshold line value of 0.18 (18%) is also illustrated in Figure 7.

The threshold line = $\frac{0.18}{\text{Probability}}$

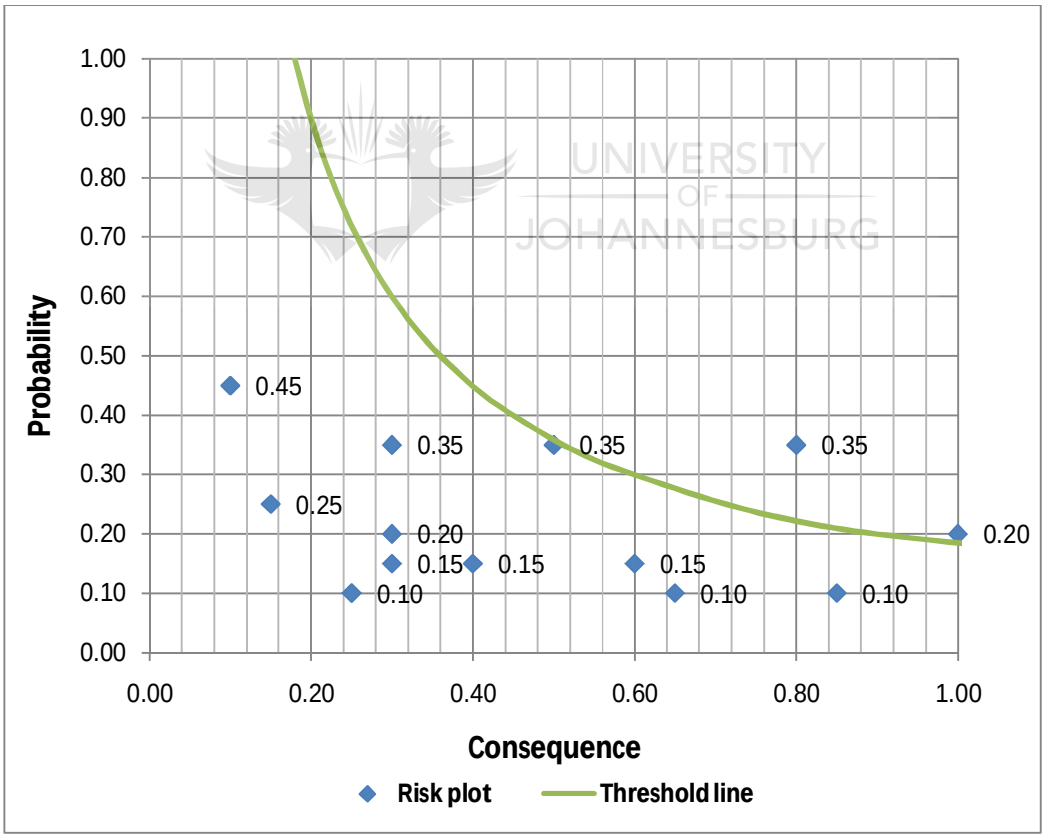

Figure 7: Risk plot with threshold line

The risk plot in Figure 7 shows that the critical risks are number 1; 4 and 11. Risk number 2 is also problematic due to its highly rated consequence should the risk occur, and for this reason it should be added to the list of critical risks. Non linear scales are sometimes used to distinguish the relative differences in probability or consequence more clearly if there are few very high-risk events with a very high consequence or probability.

5.7 Project Y - Factors contributing to risk management success

The Project Y demonstrates the efficiency of risk management methodology in project management. This systematic method enables the management team to ensure that risks are identified, assessed and managed, thereby maximizing opportunities and mitigating threats. The quantified monitoring was used to track trends in total risk exposure as indicated in Table 9.

Table 9: Risk response plan for Project Y

RISK NO.	Risk description	Risk response	Mitigated risk
1	Late approval of business case	Submit business case in as early as possible	0.12
4	Production losses	Replace the equipment on time	0.11
11	Flight chain snaps	Replace equipment to extend chain life	0.08
14	Delivery time	Ensure order is placed 6 months ahead of time	0.05
2	IRC approval delay	Present 100% sound business case	0.05
10	Sprocket wear-out replace	Replace equipment to get better chain control	0.04

The initial overall risk for Project Y was 0.09, with the highest risk event of 0.28 before any risk treatment was instigated. However the risk decreased after some risks responses were implemented. During the execution, the risk decreased further, with few exceptions where new risks were identified. Nonetheless, the general trend of the risk showed a continuous decrease towards project closure until there was no project risk remaining.

5.8 Project Y - Factors contributed to the project success

Both the interviewees and documentation proved that this project was managed successful. This success was achieved by always maintaining a mutual communication with the stakeholders and giving timely and accurate information regarding the progress on the project. The successful implementation of risk management plan and the good project sponsor behavior was a significant and made positive contribution to the risk management.

5.9 Project Y - Data findings summary

A successful project must deliver a final product within cost, to quality, and on time. The project should also present the benefits as promised during business case presentation. Some identified factors that project managers in organizations see as crucial for the project success are listed in order of priority as shown below (Elbeik & Thomas, 1998):

- project goals must be clearly defined
- proper planning and control methods
- proper support from management
- sufficient time and resources
- stakeholders involvement and commitment
- high involvement of user
- maintain proper communication
- proper project organization structure and culture

– ability to cease a unsuccessful project

5.10 Cross-case analysis

The analysis of evidence was done across both cases in order to discover similarities and dissimilarities. Cross-case analysis involves identifying similarities and differences comparing data from both projects seek to provide further insight into issues concerning the project risk management by analytically generalizing the case study results.

Table 10: Cross-case analysis summary

	Project X	**Project Y**
Project governance	– Governance structures were never followed	– Adherence to governance is one of the factors which brought success to this project
Risk and uncertainty management process	– No consideration of proper project management methodology – The risk was mitigated without any proper risk management and the consideration of other risks involved	– The projected adhered to the approved risk management plan. – The similar risk was well managed and kept under control
Stakeholders relations and involvement	– The observations did not indicate any use of techniques prior to purchasing the equipment – The role of PMO was ignored during the initial stage of the project	– The project was successful in managing relations with the stakeholders
Good communication	– Prior to the project execution the communication was maintained at a top management level	– Good communication enabled the project to bring information / viewpoints to the stakeholders

5.11 Conclusion

This chapter analysed and presented the summary of observations and results of the study. The study was done by means interviews which were conducted with eight (8) individuals comprising of the PMO manager, project managers, senior management and other stakeholders within the organisation. The interview questions revolved around the research question which was discussed in Chapter 1. The case studies were conducted to validate the fundamental structure of project risk management plan. The Chapter 6 will provide an overall wrap-up of the study and areas to be regarded for future study, which can be built upon the results of this report.

CHAPTER 6: CONCLUSION

6.1 Introduction

This section provides a brief summary from the previous chapters. The answers from the interviewees were reviewed and analysed to find out how sponsor involvement and poor decisions made impacted the project. The results from the interviews were used to determine differences and similarities between the two cases. The conclusions were drawn on both literature review and the case studies. Based on the findings, the recommendations will be made on how to improve risk management with the intention of increasing chances of project success.

It should be understood that project risk management cannot forecast at what time would the next project failure occur, but it can only assist project management team to make good and informed decisions, and that decisions are made at a right time. The outcome of project risk management is to avert project failure thus increasing the chances of project success.

The need to do project risk management and its level of intensity is normally decided on merits for every project. The hard work and effort spent in performing project risk management will be well rewarded if it is applied cautiously and correctly.

6.2 Research objectives

The primary objective of the research presented in this report was to accomplish a study about managing risks and uncertainty related to projects as well as determining the influence of the stakeholders in a project, particularly project sponsor and client. During interviews, the project managers and senior management described their own observation regarding the inappropriate project risk management plan and project sponsor influence in a project. In order to comprehend the research objective, the following secondary objectives were to be met:

- to compare the conventional project management approach of the organization with the modern business approach to identify gaps and irregularities in the project management approach
- to ascertain if there was alignment between the business strategy and project goals within the company

Both projects were able to deliver the final product despite all the complications experienced during the project approval and execution stages. The fundamental objective was to look at risk management and how it relates to project success in both projects studied.

6.3 Research questions

Major causes for project failure have always been arising from occurrences of external or internal risks. These occurrences might result into a severe project delay and/or over expenditure which leads to most projects being completed with poor project overall performance or a complete termination. The following research question was used to guide the study:

How to successfully manage risk and uncertainty in project? Through the comparative case studies the research also attempted to answer the following sub sequential questions:

- How does inappropriate project risk management plan influence the project, and
- What are the consequences of stakeholder interference in the decision making process?

The study results gave some answers to the research question, “How to manage risk and uncertainty in projects”? The answer to this question is presented through comparative case studies with the application of a complete risk management methodology on one of the cases. The results indicate that avoiding uncertainty

surrounding long lead-time had been a project sponsor's main source of concern in one of the two (2) cases studied.

6.4 How was the project success determined

Project success is conventionally measured through the set timeframe, allocated budget and the quality parameters. Although these project success measuring parameters are presently facing a criticism, but they are commonly used in a lot of journals to evaluate project success. Their criticism is pointing at three factors which are linked to the assumptions that the definition is based on:

- the timeframe, allocated budget and the quality is determined during the project initiation phase,
- the project success should be equal in a view of each stakeholder, and
- the project success is measured through progress of the project.

The time-budget-quality concept of project success is exclusively aimed at the interests of the supplier and does not emphasize the importance of including various stakeholders' perspectives. Setting of timeframe and allocating a budget and being aware of the quality expectations always takes place at the commencement of the project. During this time the uncertainty is at its highest level, and it's almost impossible to lay down reasonable limits and goals.

6.5 Decision making key factors

Decisions making is one of the most significant aspects in project environment. Making decisions ranges from the simple to the complex. Every situation would require decision making that can affect the outcome in an inconsequential or more profound ways. Regardless of the nature of decision making, organizations have to make decision making a best practice to support the organization strategy. In general, decision making is for whomever and the methodology that goes about to derive the final decision is often disorganized and ambiguous. The project stakeholders, especially the sponsor may also be required to act as decision makers

in certain situations. It is important that these individuals are identified during the project initiation phase. Upon identifying the main decision makers, it is very important to characterize what decisions should be made by whom. Project scope changes in may be carried out by committee while budgetary approvals may be done by the sponsor. Assigning the primary decision makers for particular project aspects will simplify things as the project progress.

Project sponsors should generate a project system that will efficiently and effectively be able to identify and manage risks by applying excellent risk management as it is conceived and practiced in the project management environment to a very wide collection of risks. However, the hesitant nature of the projects requires that the project organization is also designed to face emergent risk effectively. Incorporating the project organization with the properties of cohesion and resilience requires an approach that goes beyond the risk management approach currently practiced within the project management environment. To overcome uncertainty, project sponsors should use much greater resources on imagining and creating the future than a traditional model would suggest.

Effective project sponsors must clearly acknowledge that projects are not once-and-for-all decisions but rather journeys characterized by multiple decision episodes. During the project start, the role of the sponsor is first to promote multiple perspectives by enlarging the boundaries of groups participating in the project and shaping moves to break indeterminate situations. As uncertainty reveals itself, leverage can be applied to make desired futures happen. Reasoned commitments thus are made in the face of uncertainty.

6.6 Conclusion

In concluding this study, uncertainty management methodology was proposed as general steps and "what if" solutions. The two studied cases have:

- defined stakeholder responsibilities limits and their involvement in early problem identification.
- presented the active planning and virtual project simulation;
- highlighted the importance of communication amongst project team members and standardized methodology;
- presented the importance of accurate estimation of the amount work;

Risks are first acknowledged, analyzed and then monitored. Risk depends on the size and time and can also be associated with level of uncertainty. A strategy for managing project risks should be developed and implemented. The risk mitigation plan and the strategy entail the measures to be taken to respond to risks. The real risk consequences are usually measured against the forecasted risk consequences and therefore the effectiveness of the risk analysis and mitigation process would be assessed. There are various risks with potential of affecting equipment replacement projects. In case of Project X, an improper risk management plan, poor project governance, poor decision making and OEM interference with the decision making were major risks identified. For risks associated with inappropriate risk management plan, the risk mitigation would be to adhere to a proper risk management process from which a proper risk mitigation plan can be developed. The reason for this might be the fact that the project sponsor had a high interest on a project with also an authority to make decisions about the project. There was also a noticeable lack of good governance and best practices during project execution, resulting in misalignment of corporate governance with the management of individual capital projects at a business level.

Lastly, the uncertainty in project X was mostly concerned about risks, and fairly little attention was paid towards opportunity management. It must be noted that risk management could prospectively comprise of additional aspects than focusing only on threats associated with the project point of view.

6.7 Future research

In view of the fact that this study is based on the outcome from two small projects within an organization, it may be beneficial to do it for large project in other organization. As every developed method comprises of different structures of activities, processes, responsibilities, tasks and objectives, therefore it is possible that outcome of the study might be appropriate to other organizations. It would be particularly remarkable in organizations which have similar fundamentals.

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