A FRAMEWORK FOR INTEGRATING KNOWLEDGE MANAGEMENT WITH RISK MANAGEMENT FOR INFORMATION TECHNOLOGY PROJECTS

(RiskManIT)

By

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ABSTRACT

This research focused on the challenges experienced when executing risk management activities for information technology projects. The lack of adequate knowledge management support of risk management activities has caused many project failures in the past. The research objective was to propose a conceptual framework of the Knowledge-Based Risk Management (KBRM) process, which integrates KM and RM processes, and presents a methodology for applying the KBRM (RiskManIT) conceptual solution. The research strategy was qualitative and was supported by interviews with subject matter experts to validate the research. The key contribution is the development of a Framework, which integrates the Knowledge Management activities with Risk Management for Information Technology Projects (RiskManIT). The RiskManIT Framework provides the ability to develop remedial project management actions that address the problem of IT project failures by integrating KM and RM in a single framework.

DEDICATION

I would first offer my thanks and appreciation to my God and the Lord Jesus Christ for taking care of me and seeing me to the end of this long research process.

This work is dedicated to my wife, Rana, who always encouraged me to study and to my two children, Massa and Sanad. You made tremendous sacrifices during my master and doctorate studies, which made it possible for me to complete this difficult and long journey. The accomplishment of my Doctorate degree is a task that I would not be able to complete without your support and understanding. You provided the encouragement necessary for me to overcome the challenges and finish this project.

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CHAPTER 1 INTRODUCTION

In the past year, the world witnessed major turbulence in the global economy. Many companies restructured themselves, some merged with others, filed for bankruptcy, acquired another company, and some implemented drastic layoffs. This resulted in a decrease in the resources available to all departments and a subsequent increase in business risks. Additionally, the U.S. economy has shrunk sharply since last autumn, with a real gross domestic product (GDP) having dropped at an annual rate of more than 6 percent in the fourth quarter of 2008 and the first quarter of 2009. One of the enormous costs of this economic downturn is the loss of 6 million payroll jobs over the past 15 months (Bernanke, 2009).

Another issue facing companies is globalization. The globalization of companies introduces many challenges. To meet these challenges, companies are required to become more innovative and introduce new ideas. The need to change is forcing corporations to organize their projects and their systems. Many companies depend on their own resources or external resources to meet their objectives and be better prepared for changes in their surrounding environment.

Moreover, corporations are facing new and different types of risks every day because of the changes in the world environment. These changing environments might introduce new risk or raise existing risks to the corporations. The source of risks can be differentiated between those that are internal or external. This risky environment, if not managed appropriately, might negatively affect the existence and possible future conditions of corporations.

Companies often utilize Information Technology (IT) to develop innovative solutions in the hopes of having a competitive advantage. The IT systems attempt to streamline the business and reduce costs. IT enables businesses to integrate the operational, transactional, and financial information processing. This information processing and reporting allows management to identify business risks and resolve risk-related issues.

With recent headcount reductions, IT Projects are faced with many challenges and risks and new projects are conducted with fewer resources available. A 2009 report by CHAOS stated that there is an overall decrease in the IT project success rate. , As a result, managing risks properly in IT projects is extremely critical for project success and risk management (RM) might need renewal to improve project performance and have project management activities perform more effectively.

This researcher examined the relationships between KM processes and RM processes to improve the RM activities. The objective is to introduce the Knowledge-Based Risk Management (KBRM) process by employing and introducing some of the KM processes into RM. The purpose is to obtain the most comprehensive, complete and relevant information of risks, thereby enabling companies to respond rapidly to the changing, turbulent environment surrounding the organization. These environmental changes may introduce new risks and organizations must arm themselves with comprehensive knowledge to address the risks introduced by this unstable environment.

The remainder of this Introduction Chapter is divided into the following sections:

- Section 1.1 introduces KM and provides the substantiation of its role in risk mitigation in the organization..
- Section 1.2 gives an introduction to RM.
- Section 1.3 describes the scope of dissertation.
- Section 1.4 identifies the research focus.
- Section 1.5 covers the relevance of the research to industry.
- Section 1.6 addresses the research questions and hypothesis.
- Section 1.7 provides the research aim and objectives.
- Section 1.8 contains the research methodology.
- Section 1.9 gives the reader an overview of structure and the dissertation outline.

1.1 Introduction to Knowledge Management

Organizations are seeking improvement to their business processes due to strong competition, the prevailing economic crisis and hasty changes in the business environment. Organizations are attempting to introduce new business processes, with the overarching goals to reduce costs, improve efficiency and reduce the impact of the economic crisis on their functionality. In this regard, knowledge is becoming increasingly important to identify improvements to the business processes based on several studies and research. KM is also required to respond effectively to an increasingly competitive environment. Companies are scrutinizing how to leverage knowledge assets and create more value (Lin, Su, & Chien, 2006).

KM is described as a procedure, process or practice to accomplish the process about knowledge, process for knowledge, and process from knowledge, which leads to improve the internal and external operation (Alryalat & Alhawari, 2008).

Also, KM is defined as the disciplined means of administrating this precious resource called knowledge, by promoting an incorporated approach to identifying, capturing, structuring, organizing, retrieving, sharing and evaluating an enterprise's knowledge assets (Kim, Lim, & Mitchell, 2004).

KM is gaining significant attention in the organization and the research field. In fact, there are an increasing numbers of researchers and practitioners working in the area of KM and exploring different aspects of KM. Furthermore, organizations are integrating KM in their business processes to provide them with more efficiency and effectiveness, which results in reducing cost, becoming more agile to environment changes, and responding more dynamically to crises. KM will be explored in more detail in Chapter 2, section 2.1 in terms of theory and applications.

1.2 Introduction to Risk Management

Risk is an event that might cause obstruction to project progress and can have negative results on the deliverables. Risk is the possibility of something going wrong as a consequence of a threat or a vulnerability and can have a major impact on the operation (Mees, 2007). RM involves a number of managerial processes that companies utilize as a necessity in managing and controlling risks in a wide variety of projects. The purpose of RM is to identify all potential risks and opportunities, and construct a comprehensive Risk Response Plan to minimize the risks to an acceptable level. Additionally, RM consists of a series of iterative processes that assists a project team in the comprehension and management of risks (Bandyopadhyay, Myktyn, & Myktyn, 1999).

The term RM is used in a broad variety of disciplines, which combines concepts and techniques from different fields such as economics, statistics, decision theory and information technology (Mees, 2007). For example, RM provides control and documents practical decisions and actions based upon the monitoring of what is going wrong. RM identifies those factors and resources that are important or critical to project success and considers what the relevant risks are. RM also considers the approach to be taken to address and minimize these risks (Bruckner, List, & Schiefer, 2001). RM is described as a systematic and iterative process of identifying, analyzing, and responding to project risks in order to reduce the potential negative events and maximizing the positive events in terms of consequences and probabilities (Kasap D. & Kaymak, 2007).

Improvement to RM may be beneficial by allowing the organization to become more knowledgeable, and thereby facilitate faster response to changing environment risks. A RM system should be based on a secure platform for storing, processing and transmitting organization information. Moreover, a number of authors have found that RM needs to be changed to enhance the alignment of risk with the organization's strategy, improve risk response judgments and minimize process shocks and losses.

1.3 Scope of Dissertation

This section will outline the scope of the study in terms of the following aspects:

- Review the background literature on KM and the framework.
- Review the background of RM and applications.
- Analyze RM applied in IT projects.
- Identify the need for integrating KM with RM.
- Attempt to link certain KM processes with RM processes

The Dissertation Project had four phases of work with key milestones and deliverables as detailed below:

- Research publications on KM Framework.
- A research publication on the conceptual development and proposal of KBRM framework based on multiple perspectives and literature reviews.
- Conduct interviews with experts in the KM and RM field.
- Based on the analysis of the input of experts on KM and RM field, propose a conceptual solution in the form of a KBRM framework.

The research was limited to certain factors due to time, cost and human resources. The research was not able to investigate all KM processes concerning RM integration. The research also used a qualitative methodology which makes it impossible to generalize.

1.4 Identify Research Focus

The Standish Group's 2004 "CHAOS" study updated and incorporated data from several thousand software development projects and reveals that only 28 percent of IT projects were completed on time and on budget, down from a previous high of 34 percent. Another 18 percent (up from 15%) were canceled before completion of the development cycle and the remaining 51 percent were completed over-budget, behind schedule, and contained fewer functions than originally specified. Remarkably, CHAOS Summary 2009 results showed a marked decrease in the project success rates, with only 32% of all projects succeeding, which are delivered on time, on budget, with required features and functions.

Another survey revealed that investment managers lack sufficient knowledge to manage risk optimally ("A Long Road Ahead for Portfolio Construction:

Practitioners," 2009). This survey revealed more than half of the responding industry professionals saw the level of knowledge within their profession as the main barrier.

A company cannot manage its risks effectively if it cannot manage its knowledge. Therefore, Intel and ChevronTexaco are today integrating and coordinating their existing safety, supply chain and KM systems in a more coordinated way, as part of a broader RM program (Neef, 2005). In addition, many projects failed due to lack of knowledge among the team, or lack of knowledge sharing during project progress.

Based on research conducted by Rodriguez-Montes & Edwards (2008) an effective RM process model can't be achieved without the assistant of a well established KM process model. Therefore, a well-defined and designed integrated KM and RM framework is essential to improve decision-making in IT projects. In another study by Shaw (Shaw, 2005), KM as a discipline can add positively to RM implementation in reference to data and information management, risk-knowledge sharing and analysis consolidation and reporting.

Therefore, project failures can be the result of not capturing the appropriate knowledge at the right time, or discovering the knowledge needed. Inappropriate or lack of KM implementation or sharing will result in lack of understanding the goal and objective of projects, which translates into execution failure. In fact, without KM as a tool to communicate risks among members of a project team, RM might suffer from ineffectiveness and inefficiencies. Therefore, if companies are serious about both mitigating the effects of the threats their

operations encounter and seizing the opportunities that are passed their way, KM in turn must sit right at the heart of their RM strategy (Scott, 2002).

The integration of KM in support of RM processes has the potential of mitigating risks of IT projects. This integration is seen as an iterative process to mitigate the probability of risks, thereby raising the probability of successful project execution. It is important that the organization prioritize the knowledge infusion of RM. This prioritization would require the creation, capturing and sharing of knowledge related to the potential risks of key assets of stakeholders. Karadsheh et al. (2008) has conducted a research project with a goal of knowledge infusion with RM processes and found that it requires integrating KM processes such as knowledge discovery, knowledge capture and knowledge sharing to enhance risk identification, analysis, planning and execution by capturing the risks relevant to the organization's goals and objectives.

Neef (2005) claimed that the key to proactive RM processes lies in the company's ability to mobilize the knowledge and expertise of its employees regarding risk mitigation. This enables the key decision makers in the organization to receive accurate and timely information about potential harmful incidents, as an example. The rationale for applying KM techniques to risk programs is stated in the following:

- Sensing and responding to risks in an organization is directly dependent on the knowledge and judgment of employees at all levels.
- Key decision makers need to mobilize this employee knowledge and the large amount of information available concerning potentially threatening situations in a way that will allow them to respond quickly and appropriately to threatening risks.
- Utilizing KM techniques through opening communication channels to provide a system of incentives for managers and to encourage employees to uncover potentially dangerous issues could be beneficial to the organization.

- Finally, capturing lessons learned, applying proven RM techniques and creating decision support systems to assist in developing preventive RM policies can avoid costly repetition of errors.

Jones (2005) analyzed how the Hobart City Council, in Tasmania, Australia conducted a pilot information audit to establish the current state of information management in the Council, as part of its KM strategy. This resulted in an audit report of RM activities containing audit tables as a KM reference capability. This pilot audit has improved the understanding and application of information and KM in the Council. Moreover, the audit identified gaps and duplications as well as examples of best practice in information and KM across the organization.

Caldwell (2008) noted three core KM principles related to RM, namely business focus, accountability and operational support. The purpose of this research is to demonstrate how KM principles can be applied to information RM to create risk intelligence. This requires the KM principles to be adapted in the organization and the knowledge must be applied effectively to RM information. The result is maximizing the return on value from information RM investments.

Business focus includes five steps: (1) start with key business risks, (2) prioritize the business risks based on their importance to the business strategy, (3) identify information sources for the high-business risk areas, (4) identify at-risk information sources through establishing what information is critical to the business process, and (5) establish risk-mitigation strategies. He also stated that KM accountability requires that domain experts be assigned to work with knowledge managers to maintain various information sources. Finally, operational support is required to obtain the value.

Moreover, KM can be used in training and motivation for participants to aid in recognizing the appropriated stakeholders (Kontio, Getto, & Landes, 1998). In addition, an effective RM is built on effective KM which necessitates open, obvious and enduring communication within the team involved (Perera & Holsomback, 2005).

Kim, et al.(2004) defined KM as the methodical means of administrating this valuable resource, by promoting an incorporated approach to identifying, capturing, structuring, organizing, retrieving, sharing, and evaluating an enterprise's knowledge assets. While, RM refers to strategies, methods and supporting tools to identify and control risks to an acceptable level (Bruckner, et al., 2001).

1.5 Research Relevance

The importance of the research project is to investigate the feasibility of utilizing KM processes with RM processes and recommend an integrated knowledge and risk framework. The utilization of KM processes in relation to obtaining the most comprehensive, consistent and relevant information on risks was examined. This approach attempts to enable companies to respond effectively and efficiently to potential risks in the organization environment. In the ever changing environment, organizations must arm themselves with comprehensive knowledge to handle risks (Karadsheh, et al., 2008).

This research improved the RM process model by utilizing a well design KM process model. The researcher examined the processes in KM and integrated some of the KM processes with RM processes. The establishment of a KM framework will have a major impact on RM performance. A better RM process

could result in reducing risks in IT projects. Furthermore, the research contributed to the body of knowledge related to RM in IT projects by enhancing the RM processes.

1.6 Research Questions and Hypothesis

This study aims at building a conceptual framework to provide answers to the following research questions arising from the stated research problem:

1. How does the integration of KM and RM processes improve the organization's ability to manage and mitigate risks in IT projects?
2. What is the impact of knowledge capture on Scope Establishment and Risk Identification?
3. What is the impact of knowledge discovery on Scope Establishment and Risk Identification?
4. What is the impact of knowledge examination on RM processes?
5. What is the impact of knowledge sharing on risk analysis and planning?
6. What is the impact of knowledge evaluation on risk execution and monitoring?
7. What is the impact of having a live and dynamic knowledge and risk repository?
8. What is the impact of knowledge education on RM processes?
9. To what extend do KM tools, techniques, technologies and culture have an impact on KM processes?

The hypothesis for this research project is:

H0: The integration of KM principles in support of RM processes, when applied to IT projects, may improve the organization's ability to manage risks response planning by enhancing risk identification, analysis and mitigation.

1.7 Research Aim and Objectives

This research develops a conceptual framework that attempts to reduce the problem of IT project failures rates by integrating KM and RM in a single

framework. The research also examined the role of KM in the conceptual framework and the impact on RM processes. The following objectives guided this research:

- Improvement to the Risk Response Planning (RRP) process of risk identification, analysis, and execution by capturing the appropriate and relevant risks to the organization goals and objectives.
- Alignment and integration of the KM and RM processes.
- Analysis of KM and RM to find elements that will enhance both.
- Provided taxonomies of definitions for Data, Information, Knowledge and Wisdom, KM, KM processes and RM processes to enhance the comparison and analysis to the reader.

1.8 Research Methodology

A vigorous research strategy and methodology was utilized for this dissertation. The research strategy was based a well-defined criteria through interviewing experts in IT, KM, and RM using open-ended and closed-ended questionnaires. In addition, a research process model is included to describe the research methods and phases used during the dissertation process. This research methodology guided the research based on the research problem and research questions. Chapter 4 presents the research design for this project, in terms of research methods, data collection technique, sample selection method, research strategy using interview questions, analysis of data and research criteria.

The research utilizes a qualitative approach in gathering data from experts in the field of RM and KM, and analyzes their input and viewpoints based on their industry experiences. This research will concentrate on how the organizations comprehend and view the significance of the integration of KB and RM processes.

1.9 Dissertation Outline

The structure of the dissertation provides a clear outline of the content of the study. The dissertation is composed of eight chapters. Each chapter provides an understanding of various issues that are critical to this research. The structure of the dissertation is illustrated in Figure 1:

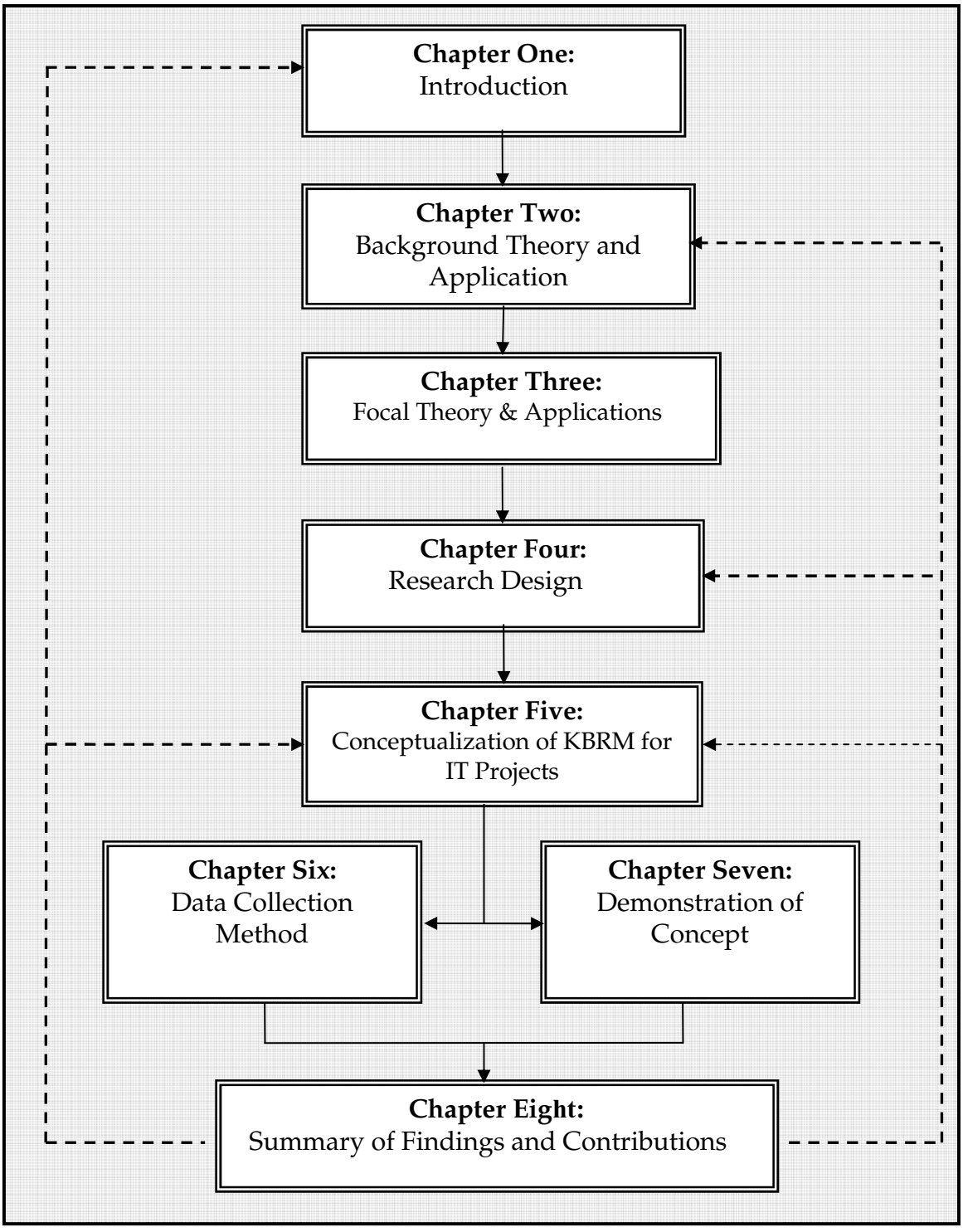

Figure 1 Dissertation Outline

- Chapter 1 contains the introduction and overview of the dissertation.

- Chapter 2 provides background theory and applications for both KM and RM.
- Chapter 3 presents the focal theory and applications on RM in IT projects.
- Chapter 4 offers the research design and describes the strategy, approach, overview of research methodology and research quality standards.
- Chapter 5 provides the conceptualization of KBRM for IT projects by identifying the role of KM in RM for IT projects and the proposed KBRM framework.
- Chapter 6 provides the data collection method, which contains the interviews of experts and processing of collected data.
- Chapter 7 provides the demonstration of concept.
- Chapter 8 provides the key findings of research, contributions made by the research, limitations of the research (based on design considerations), and recommended direction for possible future research.

CHAPTER 2 BACKGROUND THEORY AND APPLICATION

This chapter examines the theories in the areas of KM and RM in two sections. Section 2.1 addresses the topic of Knowledge Management and reviews the background theory of KM, KM processes and applications. The second section reviews the background theory of risk, RM, RM processes and applications.

2.1 Introduction to Knowledge Management

A recent research article by Louay Karadsheh, Ebrahim Mansour, Samer Alhawari, Ghassan Azar and Naser El-Bathy, titled "A Theoretical Framework for Knowledge Management Process: Towards Improving Knowledge Performance was published in the Journal of Communications of IBIMA (2009) Volume 7, ISSN:1943-7765,. This article was based upon this research and developed based upon the content of sections 2.1 and 2.2.

The concepts of KM are reviewed first. A number of definitions of KM are presented and several descriptions of KM systems are illustrated. The next section explains the role of KM in organizations. Additionally, various KM theories are reviewed and the applications of KM are discussed.

KM has become a strategic resource to organizations due to the extent in which KM is currently viewed as the basis to achieve a competitive advantage for the organization. KM also has surfaced as a major subject issue for managers to deal with if they want to maintain their technical advantages. Additionally, KM has become an important subject since knowledge is considered as a competitive element for individuals, firms and nations (Dyer & McDonough, 2001).

Knowledge about competitors, customers, products, processes and past successes and failures are considered as an asset for the organization in the twenty-first century. Furthermore, KM evolves from a distinct responsibility to a strategic component of a business solution (Dyer & McDonough, 2001).

In fact, KM allows organizations to start thinking about how to improve their performance and processes. In this regard, knowledge has become a key source for organizations to enhance the competitive advantage and that has a direct contribution and significance for the organization's performance. In addition, KM has become embedded in the policy, strategy and implementation processes of worldwide corporations, governments, and institutions (Y. Malhotra, 2000). All organizations today are putting much emphasis on the adoption of KM. The objective of KM is not to manage all knowledge, but to manage the knowledge, which is most essential to the development and improvement of organizations. As a result, KM can help grow to such a stage where it can improve and expand the innovation process (Parikh, 2001).

2.1.1 Relation among Data, Information, Knowledge and Wisdom

Data, information, knowledge and wisdom are often represented as having a hierarchy, which provides a way to distinguish the meaning and portray the relationship between them. Figure 2 displays the progress from data to information, to knowledge, and then to wisdom (Humbug, 1997).

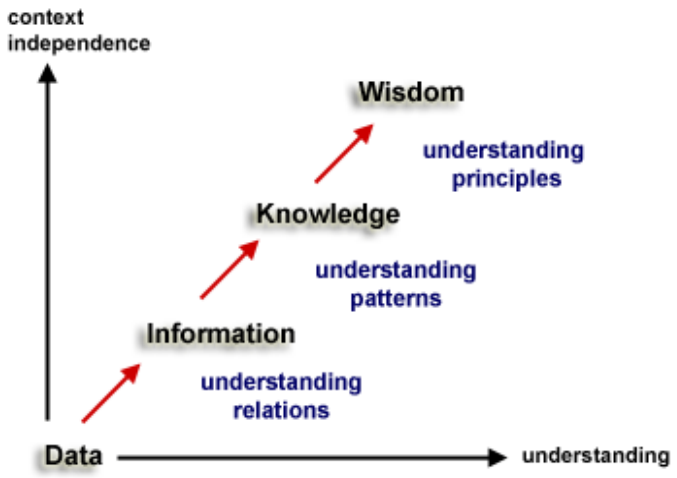

Figure 2 Data vs. Information vs. Knowledge vs. Wisdom (Humbug, 1997)

Figure 3 represents the relations between data, information, knowledge and wisdom (Leibowitz, 1999) .

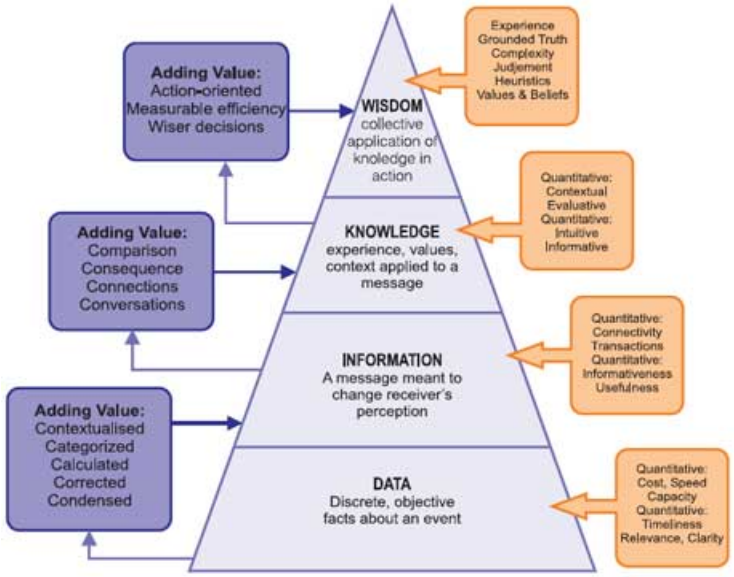

Figure 3 The Relation between Data, Information, Knowledge and Wisdom (Leibowitz,1999)

Figure 4 illustrates the relationship among data, information, knowledge and wisdom, with emphasis on the definitions created by several authors.

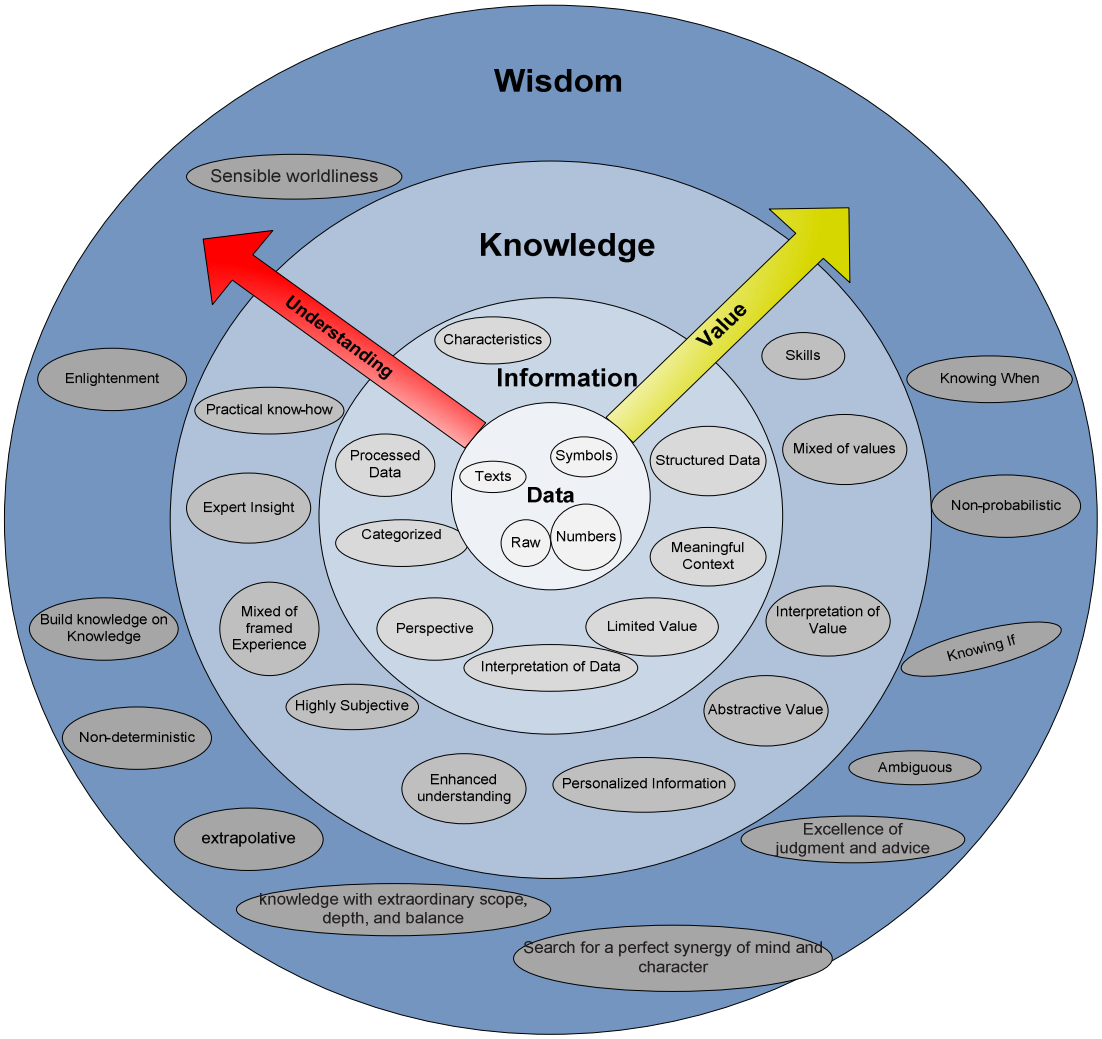

Figure 4 Data vs. Information vs. Knowledge vs. Wisdom (Karadsheh, 2009)

2.1.1.1 Data

T. H. Davenport & Prusak (T. H. Davenport & Prusak, 1998) define data as a set of discrete, objective facts about events. It is raw text, numbers, images or

sounds. In an organizational situation, data is described as structured records of transactions. Data by itself has little significance or essential meaning and is usually stored in some sort of technology system. All organizations need data and some are heavily dependent on it to function. Examples of data: account balances, demographic statistics or names and addresses of customers.

2.1.1.2 Information

T. H. Davenport & Prusak (1998) describe information as data put into perspective and meaningful context. Information has relevance and organization based on some purpose. When data has been processed and presented in such a way as to be meaningful in specific decision-making or learning contexts, we have information. Examples of information: a list of names and addresses of an organization's customers. To turn this into information it must have a particular use and structure, for example, identifying particular customers according to demographics that have a particular buying pattern.

2.1.1.3 Knowledge

T. H. Davenport & Prusak (1998) portray knowledge as a mix of framed experience, values, contextual information and expert insight that provides a structure for evaluating and integrating new experiences and information. It originates and is applied in the minds of the knowledge workers. In organizations, it often becomes embedded not only in documents or repositories, but also in organizational routines, processes, practices and standards (T. H. Davenport & Prusak, 1998).

2.1.1.4 Wisdom

Bellinger, Castro, & Mills (2004) explain wisdom as an extrapolative, non-deterministic and non-probabilistic process. It calls upon all the previous levels of consciousness, and specifically upon special types of human programming (moral, ethical codes, etc.). It indicates to give us understanding about which there has previously been no understanding, and in doing so, goes far beyond understanding itself. It is the essence of philosophical probing. It asks questions to which there is no easy answer, and in some cases, to which there can be no humanly known answers period. Wisdom is therefore, the process by which we also discern, or judge, between right and wrong, good and bad.

Various researchers have thought carefully about varying definitions of these four terms and produced their own analysis of the four terms. This section examines the difference between data, information, knowledge and wisdom based on several sources as seen on Table 1.

Definition	Description of Definition	References

(Data , Information , Knowledge, and Wisdom			
Sales Forecasting	Data	Data viewed as a set of facts	Kahn and Adams (2000)
	Information	Represented as categorized, reviewed and scrutinized data.	
	Knowledge	Knowledge is the result of merging information with practice, perspective and expression.	
Information Systems (IS)	Data	Does not include a value	Spiegler (2000)
	Information	Limited value	
	Knowledge	Append insight, abstractive value, enhanced understanding	
	Wisdom	Knowledge widens to wisdom through actions such as unearthing, value, skill and more	
Research and Development/ IT Company	Data	Raw facts gathered from business transactions and activities	Parikh (2001)
	Information	Structured data	
	Knowledge	Interpretation of information	
KM Platform/ Development in High Tech Sight Project	Data	Data as un-interpret signals without application.	(Stollberg, Zhdanova, & Fensel, 2004)
	Information	Information is data in an application scenario, so it is already equipped with meaning on the semantic level.	
	Knowledge	Knowledge is information used for solving specific problems, thus representing the pragmatic level.	
KM Process	Data	Unprocessed facts, with no concern of any value and purpose	Alryalat and Alhawari (2008)
	Information	Processed data - added value to determine purpose	
	Knowledge	Interpretation of information- improves the understanding of purpose, used for solving problem	
	Wisdom	Includes the new activity to achieve purpose	

Table 1 Taxonomy of Definitions of Data, Information, Knowledge and Wisdom

Stollberg, et al., (2004) claima that data is understood as un-interpreted signals without application, i.e. the syntactic level; information is data in an application scenario, so it is already equipped with meaning on the semantic level; and knowledge is information used for solving specific problems, thus representing the pragmatic level.

Kahn & Adams (2000) provide a distinction among these terms: data, information and knowledge. Data viewed as a set of facts. Information is represented as categorized, reviewed and scrutinized data. Knowledge is the result of merging information with practice, perspective and expression, resulting in insinuation and presents approaches and plans on which decision is based on.

Additionally, Spiegler (2000) argues that as data developed into information more value is added, which in turn convert information to knowledge by appending insight and enhanced understanding. As a result, knowledge widens to wisdom through actions such as an unearthing, value, skill and more.

Parikh (2001) indicates that data are raw facts gathered from business transactions and activities. Information is defined as a structured data. Data is also processed and viewed through a specific filter or from information while Knowledge is defined as an interpretation of information. When information is placed in a context, internalized, and assessed based on a mental model or view of the world, knowledge is generated.

Alryalat & Alhawari (2008) define data as unprocessed facts and raw numbers collected from business operations and applications, with no concern of any value and purpose. Information is processed data and has benefit to determine the purpose. Knowledge is also an interpretation of information to improve the understanding of purpose and can be used for solving problems and wisdom includes the new activity to achieve the purpose.

As illustrated in Table 1, the classification of definitions of data, information, knowledge and wisdom allows researchers to compare and better analyze the

definitions that deal with KM. These definitions allow the researcher to conclude there is a relationship between the definition of data, information, knowledge and wisdom. The author defines:

- "Data" as a raw collection of details without explicit contextual definition.
- "Information" is data in a context that can be classified, structured and organized for use.
- "Knowledge" is defined as understanding and thoughtful information, which can be to solve problems.
- "Wisdom" is a broadened knowledge through value and cleverness joined with more actions and activities.

2.1.2 Knowledge Management

This section describes various definitions of KM. More descriptions of the definitions of KM have been published as illustrated in Table 2.

KM Definitions	Description	References
Role of IT	Organized and systemic process for acquiring, organizing and exchanging knowledge among employees in order to effectively utilizing knowledge.	Alavi and Leidner (1999)
Research and Development/ IT company	Needs to view all organization activities as a process of producing knowledge to transport the firm into learning organization.	Parikh (2001)
KM Technology in Law Firms	A technique to enhance and abridge the process of implementing sharing, distributing, creating and comprehending knowledge of the organization.	Gottschalk (2002)
KM Learning	A structure based on experience and builds new mechanisms for exchanging and generating new knowledge.	(Miltiadis & Pouloudi, 2003)
Innovation Process	A process that contains creation, acquisition, incorporation, allocation, and application of knowledge to advance the operation efficiency and competitive advantage of an organization.	Albers and Brewer (2003)
Knowledge Architecture	A methodical means of administrating this valuable resource, by promoting an incorporated approach to identifying, capturing, structuring, organizing, retrieving, sharing, and evaluating an enterprise's knowledge assets.	Kim et al., (2004)
CRM Adoption	A methodical leveraging of data, information, proficiency and different structures of assets and resources to enhance organizational innovation, reaction, efficiency and capability.	Goh (2005)
KM Process	A Procedure, process or practice to achieve process about knowledge, process for knowledge, and process from knowledge which leads to improve the internal and external operation.	Alryalat and ALHawari (2008)
Align the KM process architecture with the business strategy	The KM process model is designed to address this problem by means of a knowledge enrichment cycle, which continuously seeks to align the KM process architecture with the strategic business objectives.	Konda (2008)

Table 2 Taxonomy of Definitions of KM

Alavi & Leidner (1999) describe KM as an organized and systemic process for acquiring, organizing and exchanging knowledge among employees to effectively utilize knowledge. Additionally, Parikh (2001) clarifies that KM needs to view all organization activities as a process of producing knowledge to

transport the firm into a learning organization. According to Gottschalk (2002), KM can be described as a technique to enhance and shorten the process of implementing sharing, distributing, creating and comprehending the knowledge of the organization.

Also, L. Miltiadis, A. Pouloudi, & A Poulymenakou (2002) depict KM as a structure based on past experience and build a new mechanisms for exchanging and generating new knowledge. Moreover, Albers & Brewer (2003) portray KM as a process which contains creation, acquisition, incorporation, allocation, and application of knowledge to advance the operation efficiency and competitive advantage of an organization. KM presents the precise information to the exact group at the correct time.

Kim, et al.(2004) define KM as the methodical means of administrating this valuable resource, by promoting an incorporated approach to identifying, capturing, structuring, organizing, retrieving, sharing, and evaluating an enterprise's knowledge assets. Also, Goh (2005) describes KM as a methodical leveraging of data, information, proficiency and different structures of assets and resources to enhance organizational innovation, reaction, efficiency and capability. It represents the significant issues of organizational procedures, through the exercise of suitable technologies to connect dissimilar kinds of knowledge assets.

Alryalat & Alhawari (2008) define KM as a procedure, process or practice to accomplish a process about knowledge, process for knowledge and process from knowledge, which leads to improvements in the internal and external operation.

Konda (2008) proposes a KM process model which structures the KM life cycle process into three interacting KM classes. Each KM class involves a set of processes that interact synergistically with other KM classes in the process model. The KM classes are defined in such a way that they are closely aligned with the changing business objectives. The purpose is to address this problem by means of a knowledge enrichment cycle, which continuously seeks to align the KM process architecture with the strategic business objectives. The result enhances the ability of the organization to respond with agility to changing business needs and the external environment. Figure 3 illustrates the KM process model by Konda (2008).

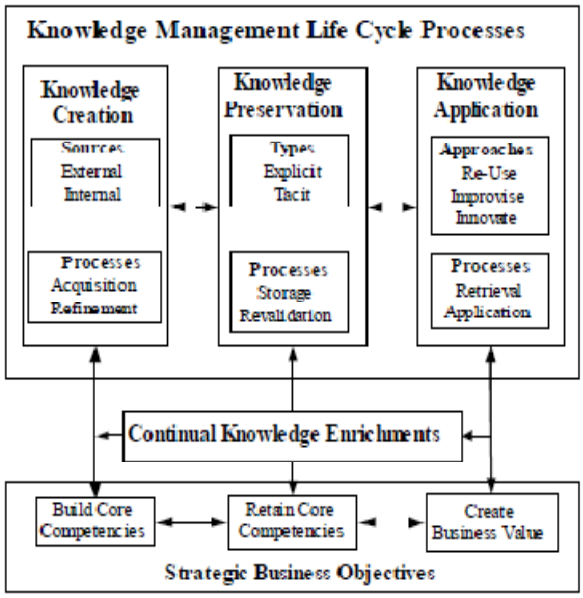

Figure 5 KM Process Model (Konda, 2008)

As illustrated in Table 2, the classification of definitions of KM allows researchers to compare and better analyze the definitions when dealing with KM. Therefore, at this point, the researcher defines KM as a structured process with activities to capture, discover, create, filter, evaluate, store, share and apply knowledge from

individuals to advance business processes and meet organization 's objectives and goals.

2.1.3 Knowledge Management System (KMS)

KMS refer to a class of information systems applied to manage organizational knowledge and are IT-based systems developed to support and enhance the organizational processes of knowledge creation, storage/retrieval, transfer and application (Alavi & Leidner, 2001). According to Steenkamp & Konda (2003) KMS is an administration system that incorporates technologies and knowledge resources to facilitate organizational ability to generate, conserve and employ existing knowledge supplies and to create business importance to the organization. A KM system should also include the following functions:

1. Locate the significant knowledge sources.
2. Capture and purify knowledge assets.
3. Accumulate and re-authenticate knowledge assets in the repository.
4. Retrieve and employ knowledge assets (A. Steenkamp & Konda, 2003).

KMS is an application resulting from the interaction between technology and social/structure meant to support KM processes (Becerra-Fernandez, Gonzalez, & Sabherwal, 2004). Moreover, KMS is called an Information and Communication Technology (ICT) system, which supports the functionality of KM such as creation, building, identification, capturing, acquisition, selection, valuation, organization, linking, structuring, formalization, visualization, allocation, retention, maintenance, refinement, development, accessing, searching and application (Maier, 2002). Furthermore, KMS allows both tacit and explicit knowledge to be created, stored and shared by utilizing technology (Harlow & Imam, 2006). Furthermore, KMS can be classified as a knowledge

discovery system, knowledge capture system, knowledge sharing system and knowledge application system (Becerra-Fernandez, et al., 2004).

The significance of KMS is in its ability to support the organization's strategic objectives by means of the tasks of knowledge workers and the execution of business functions to add business value to the organization. The KMS architecture consists of KM roles within the enterprise, KM processes and supporting technologies (A. Steenkamp & Konda, 2003). Kaldi, Aghaie, & Khoshalhan (2008) claim that besides supporting the organization's strategic goals and objectives, KMS must support the organization at all other levels. The adoption of KMS must take place at the individual level, ranges to the organization level and is influenced by many factors. At the organizational level, factors include the systems uniqueness, adopter attributes, company characteristics and environmental changes. On the other hand, user acceptance is influenced by factors such as level of acceptance, perceived usefulness and other individual factors (Kaldi, et al., 2008).

KMS is a combination of KM and information technology to facilitate capturing, storing, sharing and applying knowledge throughout the enterprise by using information technology acting as an enabler.

2.1.4 The Role of Knowledge Management in Organization

Organizations nowadays are implementing and adopting KM in their business processes. The main purpose of KM is to manage the essential knowledge that adds value to organization business. KM comprises a set of actions intended at designing and influencing processes of knowledge has become the most

dominant new organization practice (Kautz & Mahnke, 2003). Moreover, knowledge currently is regarded as one of the vital resources of modern organization (Moczydlowska, 2007). In fact, during the global economy, unstable changes and strong competitive market, knowledge played a major role in establishing the company's position on the market, opportunities for development and capital growth as a result (Moczydlowska, 2007).

Additionally, as products and processes increase in their complexity and the pressure to maintain and create competitive advantage through fast and constant innovation, current companies replying on efficient management of the knowledge developed through their research and activities (Parikh, 2001). Managing knowledge inside the organizations has grown to be more and more critical since numerous organization's activities are knowledge-driven (Sunassee & Sewry, 2002).

In the contemporary environment of most organizations, knowledge occupies the center spot of the business and is considered a strategic resource. Moreover, knowledge becomes increasingly important in terms of management of the enterprise, which leads to having KM used comprehensively in practice of enterprise management (H. Li, 2008). Additionally, an effective KM is influenced by two kinds of knowledge capability: infrastructure and process which both needed to be deployed to maintain organizational competitiveness (Gold, Malhotra, & Segars, 2001).

These previous literature reviews stress the importance that KM can play and illustrate that KM has a key role in organizations. For KM to succeed there is a

need to describe the knowledge processes in relation to corporate business work. In the next subsection, a description of the KM processes is given.

2.1.5 Knowledge Management Process Theories

A KM process is essential in modern and successful organizations, which look at knowledge as a major factor for being competitive. KM has been seen as a fast response to weaknesses and threats that affect the ways a business functions and is organized. This section describes various KM processes reported in the literature reviews (see Table 3).

KM Process	**Description of Process**							**Reference**
	1	2	3	4	5	6	7	
Practical Development KM	Initiation	Generate	Modeling	Repository	Distribution and Transfer	Use	Retrospect	L. Hsiangchu & C. Tsai-Hsin (2000)
A Theoretical Base of KM Applications	Acquisition	Coordination and Induction	Transmission and Diffusion	Creation				Zhang, Shouju, Jiang, & Liu (2000)
Role of IT	Creation	Storage and Retrieval	Transfer	Application				Alavi & Leidner (2001)
Research & Development / IT Company	Acquisition	Organize	Disseminate	Application				Parikh (2001)
Potential Differences with Information Management	Discovery	Acquire	Creation	Storage and organization	Sharing	Use and Apply		Bouthillier & Shearer (2002)
KM Learning	Relate value	Acquire	Organize	Enable Reuse	Transfer			Lytras and Pouloudi (2003)
KM Platform	Identify	Acquire	Preparation	Allocation	Disseminate	Usage	Retention	Stollberg, et al.(2004)

Analysis of Gaps in Published KM Research	Creation and Generation	Storage and Retrieval	Transfer	Application	Roles and Skills			Peachey and Hall (2005)
Product Development	Identify Knowledge	Capture	Select	Stored	Service			Deng and Yu (2006)
KM Architecture	Organizatio n and Retention	Creation and Acquisition	Disseminatio n	Utilization				Supyuenyon g Islam (2006)
KM Process	Process about Knowledge	Process for Knowledge	Process from Knowledge					Alryalat and Alhawari (2008)

Table 3 Taxonomy of KM Process

L. Hsiangchu & C. Tsai-Hsin (2000) divide the KM framework into six stages: Initiation, Generation, Modeling, Repository, Distribution and Transfer, Use and Retrospect. The Initiation stage is concerned with an awareness of the need for the knowledge and identifying the knowledge requirements and core competence. The Generation stage is about identifying what knowledge exists in the organization; who owns it; identifying the thought leader and importing and collecting knowledge from external sources or learning from obtainable knowledge. The Modeling stage deals with justifying the produced knowledge. The repository stage is required for maintaining the explicit knowledge and facilitates sharing. The Distribution and Transferring stage manages knowledge distribution to other individuals. Knowledge Use explains knowledge development as a commercial value. Finally, Retrospection stage deals with process examination. Figure 6 illustrates the KM framework proposed.

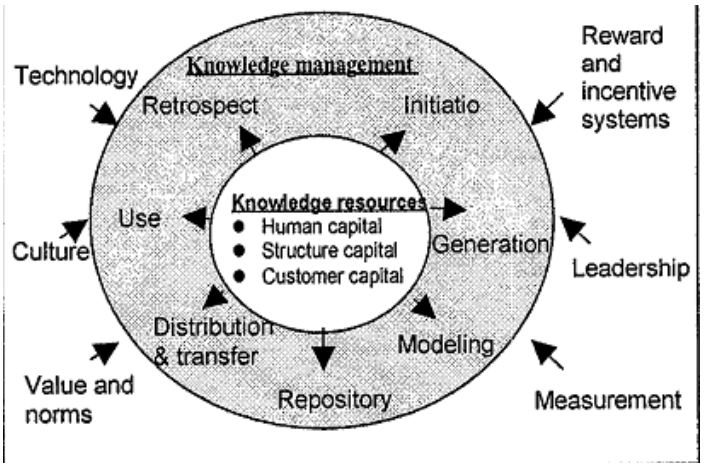

Figure 6 KM Framework (Hsiangchu & Tsai-Hsin, 2000)

Alavi & Leidner (2001) propose that KM process should be delineated into Knowledge Creation, Storage and Retrieval, Transfer and Applications. The Knowledge Creation process deals with combining new sources of knowledge. Knowledge Storage and Retrieval supports organization memory and allows individuals to access knowledge. Knowledge Storage provides coding and indexing of knowledge for later recovery. Knowledge Transfer provides communication channels and faster access to knowledge sources. The last step of the process is Knowledge Application, which assists in applying knowledge in different sites through workflow automation.

Parikh (2001) presents another interesting theory of KM cycle to channel the Knowledge. This cycle contains four processes by which organizations are able to adapt KM. The four cycles are Knowledge Acquisition, Organization, Dissemination and Application. Knowledge Acquisition is an activity that deals with finding and acquiring knowledge in knowledge-based resources. The firm should make conscious efforts to sense, search and define relevant knowledge and its sources. Next, the Knowledge Organization process involves refining, organizing and storing the knowledge collected. Knowledge is first filtered to

identify and cross-list the dimensions that are useful for different Research and development projects. Then, Knowledge Dissemination involves who gets what knowledge (personalization) and how (distribution). Not all collected information and knowledge are useful to everybody. Irrelevance can confuse the interpretation and application of relevant knowledge. Finally, Knowledge Application can be considered as an activity to increases applying knowledge to a new scenario and learning from it. Figure 7 illustrates this KM cycle.

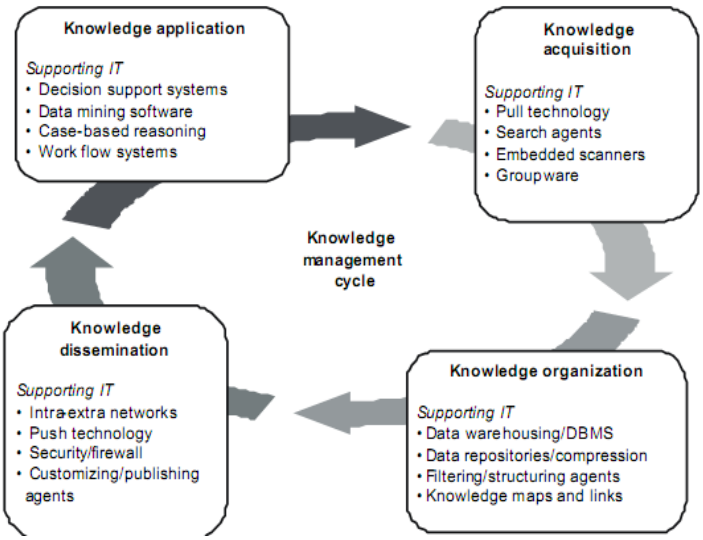

Figure 7 KM cycle (Parikh, 2001)

Another KM process model, proposed by Bouthillier & Shearer (2002), is divided into six steps: Discovery, Acquisition, Creation, Storage and Organization of the Knowledge, Sharing, and finally, Use and Application step. Discovery engages in tracing internal knowledge contained by the organization, which can be valuable when one department is not aware of knowledge existence in another department. The Acquisition step eases importing knowledge from the external source into the organization. The Creation step involves the formation of new knowledge from different sources by either combining internal knowledge with another internal knowledge to create new knowledge, or analyzing information

to create new knowledge. Knowledge Storage and Organization involves the storing and organizing information to provide a better understanding of knowledge. Knowledge Sharing engages in transmitting knowledge from one individual to one of more individuals. At the end, using and applying knowledge indicate the success of KM cycle. Figure 8 illustrates this conceptual framework for KM processes.

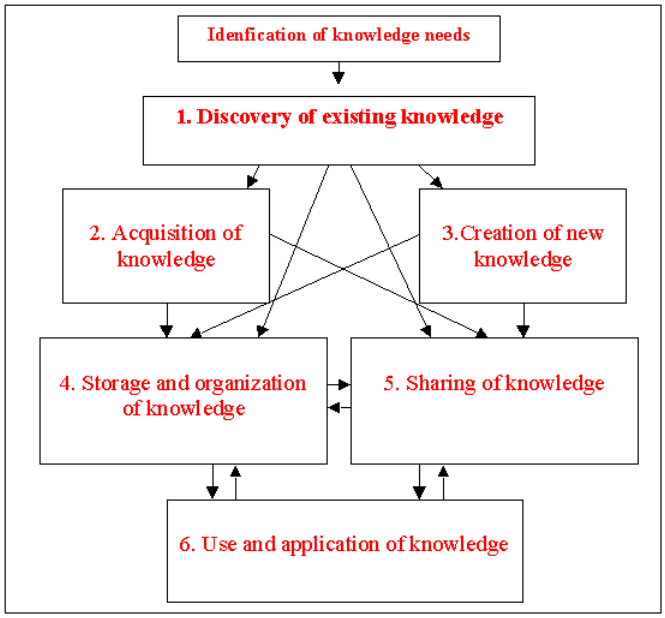

Figure 8 Conceptual Framework for KM Processes (Bouthillier & Shearer, 2002)

Stollberg, et al., (2004) describe the KM process as Knowledge Identification, Acquisition, Preparation, Allocation, Dissemination, Usage, and finally, Maintenance. Knowledge Identification focuses on comprehending the attributes of the required knowledge, selecting the obtainable applicable knowledge and assigning the knowledge assets which need to be studied and produced. The Knowledge Acquisition process concentrates on discovering the required knowledge such as buying, consulting, researching and development and self-creation. Knowledge Preparation focuses on how to present information easily. Knowledge Dissemination ensures the distribution of knowledge. Knowledge

Use guarantees usability of knowledge among individuals through KM systems. Lastly, Knowledge Maintenance process maintains the KM system and keeps it up-to-date.

According to Zhang, Shouju, Jiang, & Liu (2000) the KM process is divided into four processes. First, the Knowledge Acquisition focus is to extract knowledge from data, refines knowledge from information and access knowledge from the knowledge base. Second, Knowledge Coordination and Induction means re-illustrating knowledge and classifying it to provide access in a proper way. Third, Knowledge Transmission and Diffusion provide the transfer and sharing of knowledge beyond the barriers of time and social culture. The purpose of Knowledge Creation is to produce new knowledge based on both the human cleverness and existed knowledge.

Supyuenyong & Islam (2006) reveal that KM process can be separated into Knowledge Organization and Retention, Knowledge Creation and Acquisition, Knowledge Dissemination and finally, Knowledge Utilization. Knowledge Organization and Retention examine knowledge for reliability according to organization needs and implement classification through filtration and indexing. Knowledge Creation and Acquisition contain several sub-processes such as capturing, searching, gathering and synthesis, based on recognizing organization requirements and establishing the KM strategy to acquire new knowledge from internal or external sources. The Knowledge Dissemination process involves sharing knowledge among individuals within an organization and knowledge transfer between the company and their third parties. Lastly, Knowledge Utilization is described as an application by integrating knowledge among the organization's services and products.

Peachey & Hall (2005) describe KM processes in terms of five processes: Creation and Generation, Storage and Retrieval, Transfer, Application and finally, Knowledge Roles and Skills. Knowledge Creation and Generation focuses on describing the different methods of generating new knowledge from within the organization and from outside. Knowledge Storage and Retrieval processes use data mining and learning tools referred to as organization memory. Knowledge Transfer describes the relocating of knowledge between individuals, from individuals to explicit sources and between groups and organizations. The Knowledge Application process describes integrating knowledge into organizational practices by using technology to guarantee effectual use of knowledge. Finally, Knowledge Roles and Skills illustrate the importance of roles and skills existence to perform capturing, distributing and using knowledge.

Alryalat & Alhawari (2008) propose that KM process include the three main processes. Starting with the Process about Knowledge to capture knowledge, Process for Knowledge to create Knowledge need, and Process from Knowledge to apply knowledge. The first KM process deals with the idiom knowledge, which refers to understanding how to capture the needed knowledge to solve specific problems that have occurred. The second process of KM focuses on the process for knowledge to create additional knowledge. This process refers to Knowledge Creation, which considers creating new knowledge in the organization as its major priority. The third process called Process from Knowledge is to be applied through organizations' products, services and processes that yield in attaining high standards of improvement and progress. Figure 9 illustrates this KM process model.

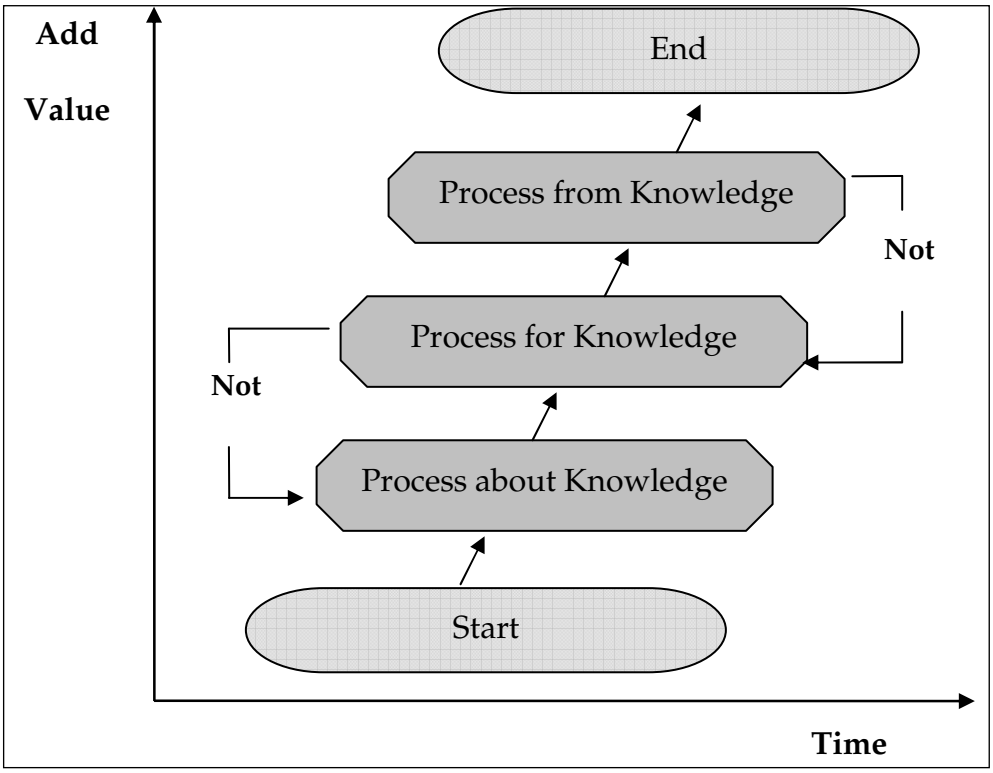

Figure 9 Proposed KM Process (Alryalat et al., 2008)

Deng & Dejie (2006) propose KM processes with five steps: Identifying, Capturing, Selecting, Storing and Serving. The process starts with identifying knowledge of corporations. The Identified knowledge is captured and collected in a form compatible by computers. The Knowledge Selection evaluates the knowledge based on the relevance, value and accuracy before storing it in the repository. Next, the Knowledge Selected will be organized into an archive and stored in the repository. Finally, the knowledge manager provides service to knowledge seekers.

L. Miltiadis & A. Pouloudi (2003) propose the following six processes of KM: Relating Value, Acquiring, Organizing, Enable Reusing, Transferring and Using. The Relating Value process demands that the team members verify,

identify, filter and select the knowledge objective. The Acquiring process refers to the facility of the project team member to formalize, codify, represent, format and map the knowledge fundamentals to secure their existence in a usable format. The Organizing process consists of the storing, classifying and transforming the knowledge. The Enable Reuse process supports the adoption and additional knowledge usage. The Transfer process has to be designed to address the concern of knowledge paths, where knowledge repositories and specific knowledge objects are linked to people, and this promotes the exploitation of knowledge. The Knowledge Using has to transform knowledge into reusable formats to construct meanings of higher value and of course has to support the learning process. Figure 10 illustrates this KM framework.

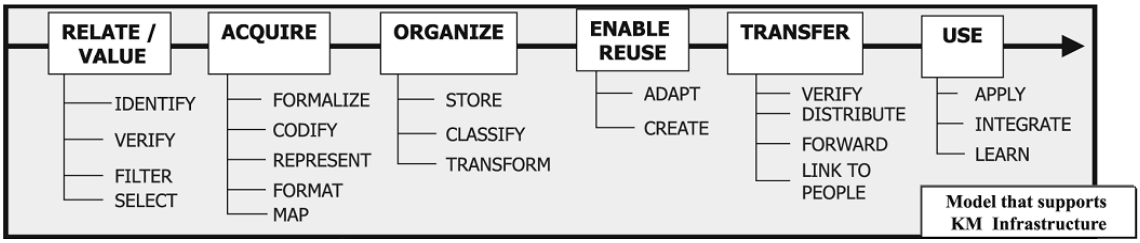

Figure 10 The KM Process Model (Lytras & Pouloudi, 2003)

As illustrated in Table 3, the classification of KM process allows researchers to compare and better analyze the processes when dealing with KM. Many of the models described above are broad enough to provide a complete analysis of the knowledge flow in the organization. The supplied KM theories tackle different roles in the organization; and we can see that KM plays a role in developing better products, or contributes to the learning process, or provides different types of useful applications. Therefore, KM can play different roles and have an impact on different levels of organization. There are several theories listed in Table 3, with each KM theory having a distinguish role and purpose with some similarity on how to execute the process.

2.1.6 Application of Knowledge Management

KM can be used in different fields, ranging from education, project management, software engineering, the medical field and more. Below are examples of KM applications in a variety of fields.

In education, the goal of information-based education is to realize the optimization of teaching and studying, which means to communicate the knowledge to students using the best possible way. The objective of KM is to convey appropriate knowledge to the right person by the best method in the suitable time. KM is not only to manage clear knowledge, but also additionally to pay attention to the management of individual hidden knowledge. Moreover, to determine the dormant knowledge of students and advance the sharing and communication of knowledge, which can make students be the constructor and producer who can establish an active resource base with nonstop updating (Y. Li, Wang, Liu, & Wu, 2007).

Leung & Chan (2007) claim that KM includes the means to gather, store, manage, assess, and distribute information across the learning community. In the learning process, a student may like to share knowledge with other students and learn from them. After doing some exercises, students can learn and reflect on these practices. They recognize rules and patterns in practice. Leung & Chan (2007) suggests a web-based KM system to facilitate students' learning of some practical IT skills such as programming. The system can provide ways for students to communicate regularly. In addition, it brings immediate and real-time information and skill to students. Moreover, KM defines electronic learning in ways that make it more suitable and a beneficial part of learning culture.

Therefore, it is found that collaborative knowledge creation and sharing can be supported by the system. Finally, its success is dependent on a number of factors: students' engagement, familiarity of the technology and careful class plan design (Leung & Chan, 2007).

Owen (2006) develops a KM framework to utilize when performing a task is based on approach to KM and assumes that knowledge is created, transferred and reused due to an individual performing a specific task. Knowledge is created in a project by the project team member completing the task, therefore, an organization needs to ensure that knowledge from one project is available for use on future projects to reduce rework. According to Owen (2006), the reuse and transfer of knowledge can improve project management capabilities such as learning, memory and cycle time resulting in continuous learning. The framework will develop guidelines for creating, sharing and reusing knowledge in a project management environment which resulted in improved project management maturity (Owen, 2006).

KM can be applied in hospitals to use highly specific knowledge to solve healthcare problems within different resource restrictions. The hospital is considered as a knowledge-intensive industry operating in extremely challenging commerce environments (Jih, Chen, & Chen, 2006). Therefore, hospitals must view KM processes as a significant aspect of their management activities. Consequently, KM represents a practical strategy as hospitals strive simultaneously to provide quality medical services, improve operational efficiency and conform to the government's documentation and reporting regulations (Jih, et al., 2006).

According to Mayrhofer. D., Heilmeier P., Nirankari. R., & Back. A. (2005) the EADS Military Aircraft (EADS-M) is facing typical challenges related to globalization, research & development and KM. These challenges include the improvement in transparency and re-use of knowledge and development of a knowledge sharing culture. Additionally, the company is facing an imminent loss of knowledge due to the company's age pattern. Therefore, the implementation of KM in the organization is essential. The adoption of KM in EADS-M is preformed based on a structure, which consists of KM requirement analysis and transfer (Mayrhofer, D., et al., 2005). This resulted in complete sets of methodologies to allow EADS-M to select the most suitable action for each case and match the specific requirements. Also, EADS-M plans to continuously delegate KM activities to functioning units in order to make KM a part of their everyday work (Mayrhofer, D., et al., 2005). This goal is already supported by the current form of organization, as the KM department is training employees of operative units to serve as knowledge engineers within their business units. Finally, the main success factors for the fast acceptance of KM initiatives are based on a mixed top-down/bottom-up approach and close collaboration of the KM department with the strategy department as well as with operative units (Mayrhofer, D., et al., 2005).

2.2 Risk Management

Sections 2.2.2 and 2.2.3 is based on a recently published paper by Alhawari, S., Thabtah, F., Karadsheh, L., Hadi, W. (2007), "A Risk Management Model for Project Execution", 9th IBIMA Conference on Information Management in Modern Organizations, Marrakech, Morocco.

2.2.1 Risks in the Enterprise

Risks in an organization can span the gamut of natural disasters, security breaches, failings of human resource, third-part vendors, financial turmoil, unstable business environments and project failures. Therefore, this section will describe the different types of risks encountered in common organizations.

Risk is an uncertain event or condition that, if it occurs, has a positive or a negative effect on at least one project objective, such as time, cost, scope, or quality (where the project time objective is to deliver in accordance with the agreed-upon schedule; where the project cost objective is to deliver within the agreed-upon cost) (*A Guide to the Project Management Body of Knowledge : PMBOK guide*, 2004). A risk may have one or more causes and, if it occurs, one or more impacts. Also, risk conditions could include aspects of the project's or organization's environment that may contribute to project risk, such as poor project management practices, lack of integrated management systems, concurrent multiple projects, or dependency on external participants who cannot be controlled (*A Guide to the Project Management Body of Knowledge : PMBOK guide*, 2004).

Furthermore, risk refers to all events, occurrences and actions that may prevent you or your organization from realizing its ambitions, plans and goals. Risk surrounds us in our personal and professional lives and is a potential problem that might happen. Regardless of the outcome, it is a good idea to identify risk, assess its probability of occurrence and estimate its impact. The reasons for studying RM vary, for instance, some people study it to prepare for a career in a specific field and others study it as a part of a general business curriculum (Alhawari, Thabath, Karadsheh, & Hadi, 2008).

2.2.2 Risk Management Impact On Project Outcomes

Most projects or business venture take place in a changeable environment in which many drawbacks exist that might negatively impact the outcome of project success. A project is considered successful if it meets the requirements determined by the stakeholders, such as security, efficiency, reliability, maintainability, functionality, integration, and other requirements (Powell & Kelin, 1996). May (1998) claims that the high failure rate of projects is in fact, due to not taking preemptive actions to evaluate and handle the risks involved. Furthermore, a study by researchers illustrated that 35% of deserted projects are not discarded until the implementation stage of the project (Ewusi-Mensah & Przasnyski, 1991). This implies that project managers are doing a poor job of identifying or terminating projects that are likely to fail due to risks encountered during the project life cycle. RM is concerned with identifying risks, understanding risks and drawing up plans to minimize their effect on project. RM can be seen as a series of steps that help a software team to understand and manage uncertainty (Bandyopadhyay, et al., 1999).

Padayachee (2002) describes risk as any variable in the project that causes project failure. A risk must contain two elements, namely uncertainty and loss (Padayachee, 2002). RM refers to strategies, methods and supporting tools to identify, and control risk to an acceptable level (Bruckner, et al., 2001). RM has the intent to take counter measures that either prevents risks or mitigates the impact of a risk. Several authors, including Powell & Kelin (1996) argue that RM should form a primary part of the project management process.

RM is a distinct discipline, which integrates knowledge from a variety of other business fields. It is the discipline where wide varieties of methodologies are brought to bear on a specific problem. RM is very important and integral part of

any business and well recognized by the project management institutions (Del Cano & Cruz, 2002).

The RM objective is to identify all applicable risks in a project, business or product. It involves ranking the above elements based on their importance, frequency of occurrence, level of impact and then establishes the actions needed to control the identified risks. It is possible for every individual risk aspect to be documented in further details (Cule, Schmidt, Lyyttnen, & Keil, 2000). Since no one can predict what losses will occur, the objective of RM is to ensure that no risk will occur during the execution of a project in order to minimize losses to an acceptable level. If a loss occurs, then the objective of RM has failed to achieve the objectives intended, which prevent the organization from pursing their goals.

2.2.3 Risk Management Process Theories

Different research contributions found in the Risk Management processes literature are provided in this sub-section. There are varieties of RM processes used in organizations today and these are summarized in Table 4. The RM processes are documented by presenting an overview of a number of existing process models.

References	**Description of Process**							**Main Dimension/ RM Process**
	1	**2**	**3**	**4**	**5**	**6**	**7**	
(Boehm and Bose, 1994)	Risk identification	Risk analysis	Risk control planning	Risk monitoring				Software development process

(Higuera & Haimes, 1996)	Risk Identification	Risk Analyze	Risk Plan	Risk Track	Risk Control	Risk Communication		Software risk management
(Kontio, 1997)	Review Define Goals	Risk Identification	Risk Control Planning	Risk Analysis	Risk Control	Risk Monitoring		Role in software engineering
(Cornford, 1998)	Risk Identification	Risk Analysis	Risk Planning	Risk Tracking	Risk Control			RM as verification and validation
(Jurison, 1999)	Risk Identification	Risk Analysis	Risk Prioritization					Software project management
(Bandyopadhyay et al., 1999)	Risk Identification	Risk analysis	Risk monitoring					Software development
(Bruckner, et al., 2001)	Goal definition review	Risk Identification	Risk Analysis	Risk Planning	Risk Tracking	Risk Control		Data warehouse system
(Beck et al., 2002)	Risk Identification	Risk Evaluation	Risk Evaluation	Risk Monitoring				RM in insurance field.
(Smith and Merritt, 2002)	Identify Risks	Analyze Risks	Prioritize and map risk	Resolve Risks				Controlling product development
Project Management Body of Knowledge 3rd edition (2004)	RM planning	Qualitative risk analysis	Quantitative risk analysis	Risk response planning	Risk monitoring and control			Project management
(Sommerville 2006)	Risk Identification	Risk Analysis	Risk Planning	Risk Monitoring				Software engineering
Systems and software engineering - Life cycle processes - Risk management, (2006)	Plan and implement risk management	Manage the project risk profile	Perform risk analysis	Perform risk monitoring	Perform risk treatment	Evaluate RM process		Software Risk Management Process
TOGAF (2009)	Risk classification	Risk identification	Initial risk assessment	Risk mitigation	Risk monitoring			Risk architecture

Table 4 Taxonomy of Risk Management Processes

Beck et al., (2002) portray RM as four processes. The first process is Risk Identification, which is the process of identifying the threats on the business. The threats according to security taxonomy are strategic risks, operational and systems risks, legal and regulatory risks and financial risks. The second process is a Risk Evaluation to produce a list of all possible threats to the business in

relation to the likelihood and their severity. The third process is Risk Control, which is deciding the best suitable and cost-effective measures that need to be executed in order to control the risks. Such measures may involve Risk Avoidance, Risk Reduction, and Risk Transfer. The fourth process is Risk Monitoring, which provides a review of the organization's ability to deal with incidents that might result in business interruption. Implementing Risk Identification, Evaluation and Control measures minimize the likelihood and severity of Risk, both in terms of potential financial and reputation losses of an incident, but risks can never be entirely eliminated.

Cornford (1998) divides RM process into the first process of Risk Identification, which includes a variety of technological content, environmental communications, the execution and operation approaches, programmatic constraints and the mission duration. The second process is the Risk Analysis of the consequences of the possible risks by scoring their impact on the necessities should they occur. The result is a requirement-driven risk list where failures are listed based on their impact to weighted requirements. The Risk Planning process has the following design rules, process controls, testing, modeling, and inheritance. Risk Tracking contains a tool to display the number of report formats to be used by dissimilar personnel for different reasons. Risk Control is designed for the implementation. This allows the project team to effectively control risk and watch its growth or decline as the design evolves and the results of implementation become available.

Kontio (1997) divides RM process into six steps:

1) Goal Definition: review the stated goals for the project, refine them and define implicit goals and constraints explicitly.
2) Identification: identify potential threats to the project using multiple approaches.

3) Analysis: classify risks, complete risk scenarios, estimate risk effects, estimate probabilities, and utility losses for risk scenarios.
4) Control and Planning: select the most important risks, propose controlling actions and the actions for implementation.
5) Control: implement the risk controlling actions.
6) Monitoring: monitor the risk situation.

Figure 11 illustrates the proposed Risk method by Kontio (1997).

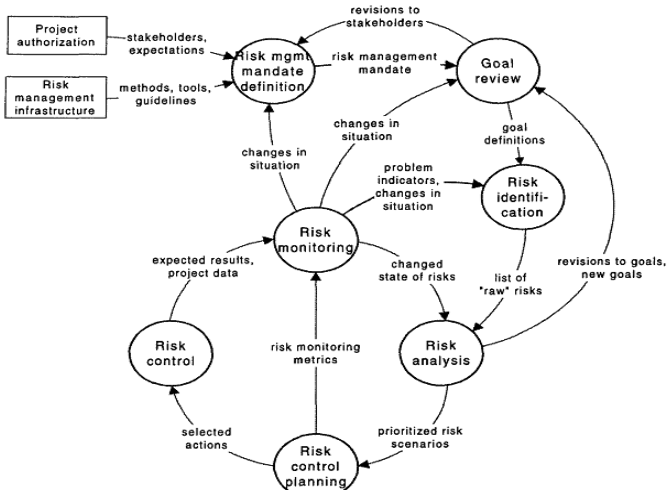

Figure 11 The RiskIT RM Cycle (Kontio, 1997)

Boehm & Bose (1994) segregate RM into four processes. First, the Risk Identification is used to locate potential threats. Secondly, the Risk Analysis classifies and consolidates risks. Thirdly, the Risk Control planning is used to select the most important risks to control planning, and lastly, the Risk Monitoring, which is observing the situation of risks.

A framework proposed by Jurison (1999) describes the risk assessment in three steps; the first one is Risk Identification, which is purposed to develop a list of risks that can adversely impact the project outcome. The second step is Risk Analysis, which is intended to assess the risk exposure, the likelihood and

impact of each risk and the final step is the Risk Prioritization, which is used to produce a list of risks prioritized by the impact.

Smith & Merritt (2002) claim that RM process contains the following processes:

- Identifying risks using brainstorming techniques to discover any risks that prevent the progress of the project.
- Analyzing risks by the team members to determine if a certain risk is worth migrating or not.
- Prioritizing and mapping risk to establish a seriousness of the risk according to their impact.
- Resolving risks.
- Implementing plans to prevent risk from occurring.

Sommerville (2006) states that RM involves the following stages:

1) Risk Identification used to identify project, product and business risks.
2) Risk Analysis to assess the likelihood and consequences of these risks.
3) Risk Planning to draw up plans to avoid or minimize the effects of the risk.
4) Risk Monitoring to guarantee the effectiveness of the methods followed and to monitor the risks throughout the project.

Figure 12 illustrates this RM process.

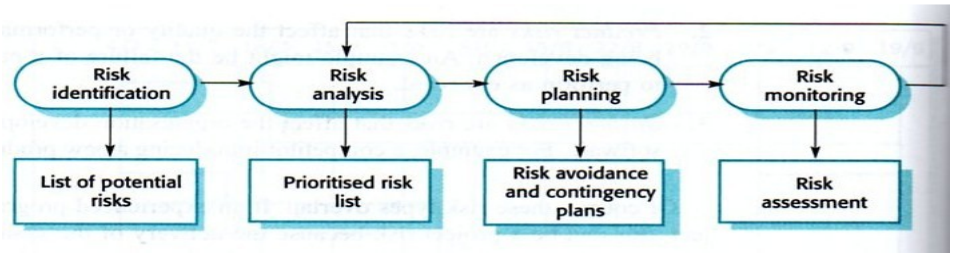

Figure 12 The RM Processes (Sommerville, 2006)

A research done by M. Bruckner, et al., (2001) describes the RM process named as easyREMOTE RM process, which contains:

1) Goal Identification process to define project objectives and stakeholders.

2) Risk Identification process to identify all relevant risks.
3) Risk Analysis process, which contains several steps such as risk probability, risk impact and risk exposure.
4) Risk Planning process, which contains risk contingency strategy, risk tracking and risk control.

Figure 13 shows the proposed easyREMOTE RM process.

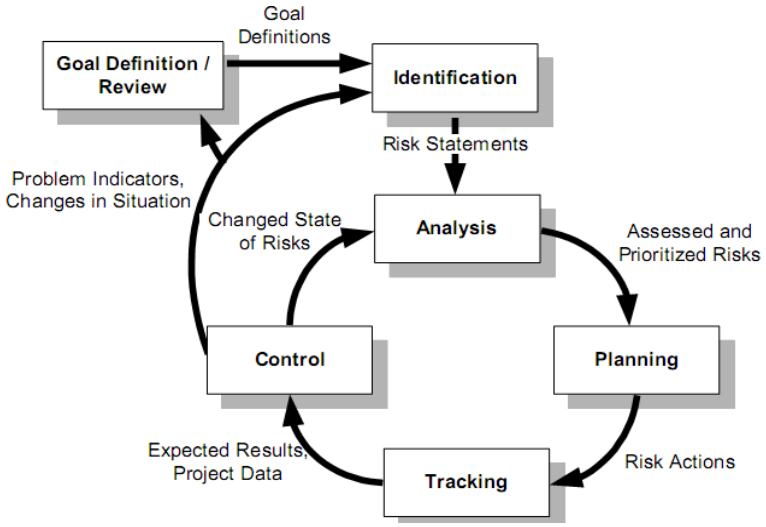

Figure 13 easyREMOTE RM Process (M. Bruckner, et al., 2001)

The RM model by P. Higuera & Y. Haimes (1996) describes a RM process in six steps starting with an Risk Identification process to recognize all risks. The second step is the Risk Analysis process to convert risk data into appropriate information. Then the Risk Planning process converts the risk information into actions, and tracks the process to monitor the risk status and actions taken to mitigate the identified risks. The Risk Control process corrects any divergence from their planned actions, and finally the Risk Communication process stresses the occurrence and the importance of RM.

The International Organization for Standardization ("Systems and software engineering - Life cycle processes - Risk management," 2006) define RM as a

continuous process for systematically addressing risk throughout the life cycle of a product or service. It can be applied to risks related to the acquisition, development, maintenance or operation of a system. This process consists of the following activities:

1) Plan and implement RM.
2) Manage the project risk profile.
3) Perform risk analysis.
4) Perform risk monitoring.
5) Perform risk treatment.
6) Evaluate the RM process.

Figure 14 describes this RM process model.

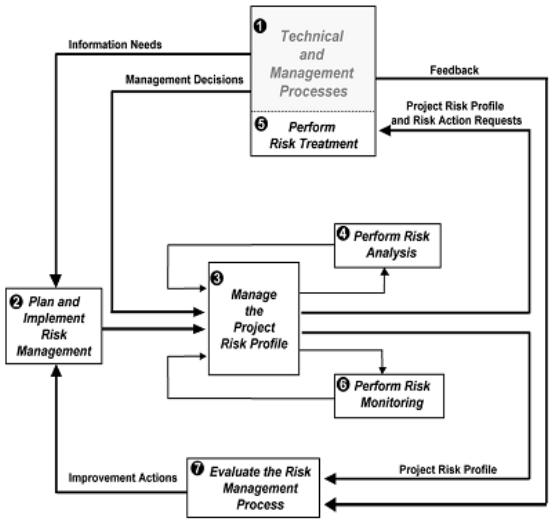

Figure 14 RM Process Model (IEEE,2006)

Another description of RM process as described by (TOGAF, 2009) documents the following activities:

1) Risk Classification based on time (schedule), cost (budget) and scope. Risk factors could also include client relationship risks, contractual risks, technological risks, scope and complexity risks, environmental (corporate) risks, personnel risks, and client acceptance risks.
2) Risk Identification identifies the risks and then determines the strategy to address them throughout the transformation.

3) Initial Risk Assessment classifies risks with respect to affect and frequency in accordance with scales used within the organization.
4) Risk Mitigation refers to the identification, planning, and conduct of actions that will reduce the risk to an acceptable level.
5) Risk Monitoring used to monitor the mitigating actions.

Moreover, according to (*A Guide to the Project Management Body of Knowledge : PMBOK guide*, 2004) the following RM activities are identified:

1) RM Planning: deciding how to approach, plan and execute the RM activities for a project.
2) Risk Identification: determining which risks might affect the project and determine their characteristics.
3) Qualitative Risk Analysis: prioritizing the risks for subsequent further analysis by assessing and combining their probability of occurrence and impact.
4) Quantitative Risk Analysis: numerically analyzing the effect on overall project objectives of identified risks.
5) Risk Response Planning: developing options and actions to enhance opportunities and to reduce threats to project objectives.
6) Risk Monitoring and Control: tracking identified risks, monitoring residual risks, identifying new risks, executing risk response plans and evaluating their effectiveness throughout the project life cycle.

Figure 15 illustrates RM model by PMBOK.

Figure 15 PMBOK's Model for RM

Analyzing these previous RM process theories indicates that all of them have similar steps in breaking down the RM process and some are broken down into finer granularity and more details. In addition, some theories list clearly the tools and techniques used in KM, which result in providing richer and enhanced RM process.

2.2.4 Applications of Risk Management

RM can be used in different fields, ranging from an education, project management, software engineering, military, the medical field, etc. Below are examples of RM applications in a variety of fields.

Roy (2004) introduces a concept of RM for software development projects. RM must be an integrated part of the project management framework if it is to be effective. The intended is to minimize the chances of unexpected events, or more specifically to keep all potential outcomes under solid management control. In addition, RM is also concerned with making judgments about how risk events are to be treated, valued, compared and combined. Therefore, the author introduced a ProRisk Management Framework that intended to account for a number of the key RM principles required for managing the process of software development. It also provides a support environment to make operational these management tasks. Moreover, this framework focuses attention on primary project components: the business domain in which the project is created and the operational domain when the project is actually carried out. ProRisk management Framework offers a range of new capabilities for the RM of

software development projects. Figure 14 illustrates the proposed ProRisk management framework.

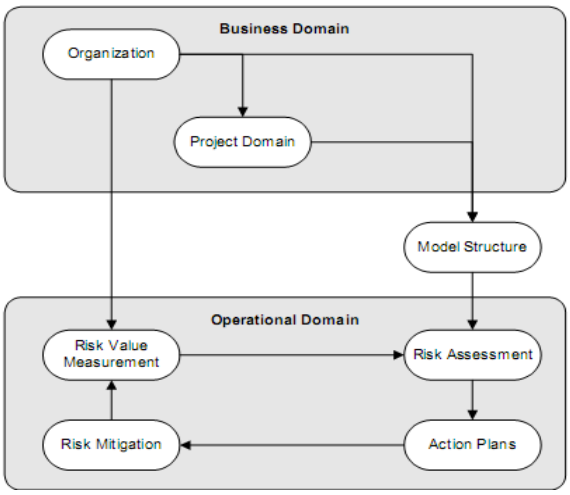

Figure 16 The ProRisk Management Framework (Roy, 2004)

Cha, Juo, Liu, & Chen (2008) stated that both business continuity management (BCM) and RM processes are very important to current organizations. RM ensures that the organizations have the ability to limit losses in the events of severe contingencies or disasters. BCM helps organizations identify potential security incidents and adopt cost-effective countermeasures to the incidents. However, current RM methodologies typically ignore the different focuses about risks in RM processes and BCM processes. Therefore, even though an organization has established its RM processes, it may need to re-assess the risks for BCM processes. The authors propose a RM system, called RiskPatrol to provide an integrative view about risks for RM and BCM processes. RiskPatrol provides an easy way for people to retain enough information for BCM while they do the risk assessment in RM process, and vice versa. The reduction of redundant risk assessment work in RM and BCM processes can hopefully overcome the deficiencies of current RM approaches. Figure 17 illustrates the RiskPatrol framework.

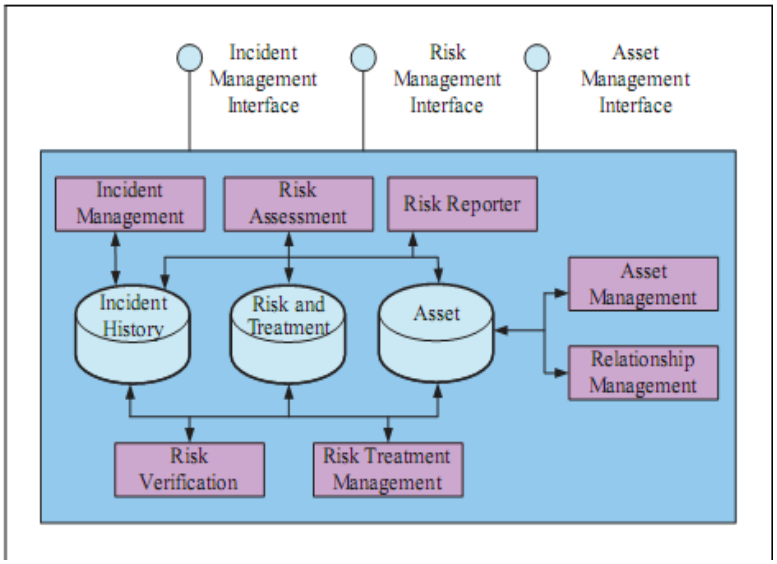

Figure 17 RiskPatrol Framework (Cha et al., 2008)

Na & Jinlin (2007) claim that National Defense Projects suffer from risks in technical challenges, unstable system requirements, missing schedule milestones, unpredictable funding and cost overruns. A national defense project risk management system (NDPRMS) is a risk information-centric system that is used to benefit the National Defense project manager. The authors define NDPRMS as a risk information-centric system. It consists of five fundamental elements: database, knowledge-base, method base, model base, case database and above all the bases, 9 different functions are designed to support users making the decisions. Key techniques guarantee the system to be validated and accepted. Based on the workflow of national defense project experts' risk analysis process, the authors developed a design guideline for the RM engineers, domain specialists, and related NDPRMS operational mechanism to user's workflow.

NASA and DLR (German Aerospace Center) have been working together to create the Stratospheric Observatory for Infrared Astronomy (SOFIA) (Datta,

2007). SOFIA is a Boeing 747SP (Special Performance) aircraft extensively modified to accommodate a 2.5 meter reflecting telescope and airborne mission control system. The author describes how the SOFIA program handled one safety issue through an appropriate use of NASA's RM Process. The NASA RM process is used to identify, analyze, plan, track, control, and communicate effectively the risks both within the team and to upper levels of management. Supposedly, each risk goes through these five functions sequentially. However, in practice, the activities associated with the five functions often occur concurrently or iteratively instead of sequentially. The NASA RM process is a continuous process where the risks are assessed regularly in order to achieve program success. The SOFIA program follows this process and its RM team includes all participants (Datta, 2007).

2.3 The value of Knowledge Management to Risk Management in IT Projects

The researcher examined different KM and RM background theories. This created a deep insight and understanding of KM and RM processes. Additionally, the researcher established which KM processes might have a positive impact on RM.

The management of predictable and unpredictable risks that may affect the objectives and the outcome of projects are becoming increasingly important to the responsible personnel. To answer that growing need, a more reliable systematic RM methodology is required. One of the main problems in current approaches is that the Risk Management Process (RMP) is dealt with as a stand-alone process, and not as an integral part of the general project process (Sharmak, Scherer, & Katranuschkov, 2007).

Furthermore, many activities can carry some amount of uncertainty, thus several relationships will exist between the RMP and the internal or external project environment. These complex interdependencies and relationships require dealing with a substantial amount of information. Therefore, the use of a RM knowledge base is essential. Also, the needed RM information can be obtained from a large number of available resources, such as expert judgment, sessions and brainstorming, data from current and prior projects, commercial databases containing infrastructural and environmental data (Sharmak, et al., 2007).

Knowledge Capture records and documents the appropriate knowledge of risks by utilizing KM capture tools and techniques. Knowledge Capture will attempt to obtain risks' information through tacit or explicit resources. The tacit knowledge is based on team and stakeholders experience in preceding IT projects. Also, the explicit knowledge can be lessons learned, previous documentation and best practices. The purpose is to capture as much as possible of knowledge from the team members and experience stakeholders. Alternatively, the lack of Knowledge Capture will cause the project team to spend more time in searching for risks.

Knowledge Discovery will attempt to determine the knowledge by examining internal knowledge contained within the organization. Knowledge Discovery might assist in finding out risks not realized by the team or stakeholders. In fact, Knowledge Discovery can examine the repository to seek new knowledge by identifying valid, novel and perhaps useful patterns in data not discovered before. For example, according to study by Faries, Travassos, & Rocha (2003) similar projects risk data may help project manager during the estimates of occurrence likelihood and impact to analyze how this risk has behaved in similar

projects of the organization, verifying if it has become a problem, its consequences and the impact it has caused.

Knowledge Sharing facilitates the process of exchanging tacit and explicit knowledge from experts by establishing well-designed communication channels. Knowledge Sharing can help team members to have better understanding of the IT project scope and objectives. The sharing helps in faster learning and avoiding common mistakes occurred before, thereby resulting in reducing risks for IT projects. Moreover, Farias, et al. (2003) claims that risk planning can be enriched by using knowledge and experience acquired by the various managers while working on several organization projects. On the other hand, the lack of effective Knowledge Sharing will cause the project team to miss important risks related to their IT projects. Also, the lack of sharing can create issues in the RM processes and the RM controls may not be sufficient. The search of the truth outside of the isolation is very important in order to get better answers (Rodriguez-Montes & Edwards, 2008).

The Knowledge Repository might contain all previous IT projects with lessons learned, best practices and identified risks. The Knowledge Repository can be a live database with real time monitoring of IT projects. The access to such knowledge means that the tool is capable of enabling the use of past successes and failures which is captured to minimize risks in future project management activities (Kayis, et al., 2007). Farias, et al. (2003) stated that knowing how many similar projects in which a risk was predicted and how many projects in which a risk has occurred may also help the manager in the estimating the likelihood of risk occurrences. Therefore, Knowledge Repository through special software can alert team members during the project execution for any undetected risks.

Consequently, having an up-to-date repository that can be used by project team to obtain the most relevant risks information can be beneficial during project execution. In fact, Rodriguez-Montes & Edwards (2008) state that the lack of knowledge access can create failures. Weak means of transferring knowledge can provide insufficient knowledge of the operation, poor assessments of the lessons learned and poor understanding of the present and forecasts through risk knowledge.

The aim of examining KM and RM processes is to find the links between these two fields and to enhance the RM process by making it more efficient and effective. The purpose is to save time and money for the projects by avoiding the tendency to repeat the same previous mistakes and to disseminate the information to the right people at the right time during project execution. Ensuring the database is up-to-date increases the efficiency of the project team and ensures that no knowledge of risks is overlooked. The database documents each new risk discovery encountered and establishes a procedure to capture and store knowledge throughout the life cycle of the project. Moreover, applying knowledge, establishing training and awareness sessions and utilizing a web knowledge portal with an easy to use interface will provide convenient and timely access to information.

2.4 Summary and Conclusion

This chapter provided a review of the theoretical foundation for this research project in the areas of KM and RM, with some applications. The chapter started with an introduction to KM and RM. The discussion was based on the available literature relating to KM, KM components, KMS, the role of KM in the organization and finally the applications of KM in a variety of fields. Also, the

chapter discussed risks in enterprises, RM theories, RM process theories and applications of RM in a number of fields were examined.

The literature emphasizes the importance of applying KM and RM in the organization in relation to a different field of business. The KM might enhance the competitive advantage and the essential knowledge of the organization. KM has become an important subject since knowledge is considered as a competitive element for individuals, firms and nations.

On the other hand, RM is concerned with identifying risks, source of risks and developing plans to minimize risks to acceptable level. Also, RM needs revolutionizing to enhance the alignment of risk with organization's strategy, improve risk response judgments, minimize process shocks and loses, better capturing of opportunities and enhanced cross-enterprise risks identification and management.

The next chapter will describe the different types of risk encountered in IT projects. It also provides a description of RM's role in IT projects and the contribution RM might make to enhance the IT projects execution. Finally, several RM theories will be described with the focus on the variety of IT projects.

CHAPTER 3 FOCAL THEORY AND APPLICATIONS

This chapter will discuss the risks encountered during IT projects and examines different RM processes theories. Section 3.1.1 discusses risks found in IT projects, followed by the role of RM processes in IT projects in Section 3.1.2. Lastly, Section 3.1.3 examines RM process theories applied to IT projects. .

3.1 Risk Management in IT Projects

3.1.1 Risks in IT Projects

In a study by Standish Group, CHAOS Summary 2009, Jim Johnson, Standish Group CIO (2009) claims that "This year's results show a marked decrease in project success rates, with 32% of all projects succeeding, which are delivered on time, on budget, with required features and functions". He stated "44% were challenged which are late, over budget, and/or with less than the required features and functions, and 24% failed, which are canceled prior to completion or delivered and never used." Also, "These numbers represent a downtick in the success rates from the previous study, as well as a significant increase in the number of failures". Moreover, they are a low point in the last five study periods. This year's results represent the highest failure rate in over a decade" (Johnson, 2009).

According to Doughty (2005) high failures in delivery of IT projects continues to occur in the UK. These problems are not unique to Government, but when public sectors' projects are not delivered on time, citizens lose out both as taxpayers and as customers because additional expenditures are required to rectify problems

and the achievement of anticipated benefits is deferred. These shortcomings can be widespread and have many adverse impacts. The impacts are on citizens, the ability to manage Information Systems, financial management, business development and achievement of anticipated benefits.

In fact, RM is a distinct discipline, which integrates knowledge from a variety of other business fields. It is a discipline where varieties of methodologies are brought to stand on a specific problem. RM is very important and integral part of any business and well recognized by the project management institutions (Del Cano & Cruz, 2002).

In terms of IT projects, risks can vary, whether it is a software development project, security project, outsourcing project, or specific programming task. Boehm & Bose (1994) claim that any project involves several classes of participants (customer, development, user, and maintainer), each with own satisfaction criteria. For customers and developers budget overruns and schedule slips are unsatisfactory. For users' products with the incorrect functionality, user-interface shortfalls, performance deficit, or reliability deficit are unacceptable. Also, for software maintenance personnel poor-quality software is intolerable (Boehm & Bose, 1994).

IT projects are known for their high failure rate. In-depth interviews with IT professionals from leading firms in Western Australia were undertaken to determine how IT risks were managed in their projects. The respondents ranked 27 IT risks in terms of likelihood and consequences to identify the most important risks (Baccarini, Salm, & Love, 2004). The top 5 ranking risks, were personnel shortfalls; unreasonable project schedule and budget; unrealistic expectations; incomplete requirements; and diminished window of opportunity

due to late delivery of software. Furthermore, the respondents overwhelmingly applied the treatment strategy of risk reduction to manage these risks. Additionally, these strategies were primarily project management processes, rather than technical processes. Therefore, this demonstrates that project management is a RM strategy. In particular, managing stakeholders' expectations is a specific risk treatment that helps to manage several key IT risks (Baccarini, et al., 2004).

Maguire (2002) claims that the risk issues in reference to software development process were not viewed as an essential subject of discussion. On the other hand, most organizations hope to implement systems successfully while still assuming their regular business processes. Yet, new systems are not implemented in a timely manner and many authors concur that the first step in developing a business continuation plan is to carry out a risk assessment. Examples of risks associated with software development are (Maguire, 2002):

1. Implementing an earlier or unused platform: failure to deal with known and unknown bugs.
2. Multi-tasking potential: inability to handle user numbers and response times.
3. Changes to the development team by having several project managers.
4. Lack of thorough examination and testing in a live environment.
5. Lack of analysis in business areas.
6. Failure to satisfy the system requirements of the different stakeholders.
7. Consultancy support: numerous providers of consultancy with disparate aims and objectives.
8. System substitution – lack of contingency planning.
9. Availability of qualified staff.

Furthermore, Sommerville (2006) points out that there are three categories of risks:

1) Project Risk: These risks affect the project schedule or resources.

2) Product Risks: These risks affect the quality or performance of the software being developed.
3) Business Risks: These risks affect the organization developing the software.

Furthermore, the author defines six types of risks that can arise in software engineering:

1) Technology Risk: These risks are derived from hardware or software technologies applied during the development of s system.
2) Organizational Risks: These types of risks resulted from the organizational environment where software is being developed.
3) Tools Risks: Risks which resulted from using Computer Aided Software Engineering CASE tools and other supported application software to assist in developing software.
4) People Risks are associated with individuals in the development team.
5) Requirements Risks are derived from changes to the customer requirements and the process of managing the requirement changes.
6) Estimation Risks: These risks are derived from the management estimates of the system characteristics and the resources required building the system.

Syed, Arshad, & Azlinah (2008) claim a project might involve outsourcing IT system to a third party. Also, IT outsourcing entails a number of decisions regarding a variety of issues. It can be the choice of the activities to outsource and of the activities to keep in-house, the selection of a service provider, or the identification of the most appropriate way to manage an outsourcing contract. Risks in IT outsourcing projects can be divided into four processes namely (Syed, et al., 2008):

1) Analysis of Decision to Outsource: This serves as preliminary research that should be carried out before entering IT outsourcing activities. It is important to perform research during the initial stage to gather information on IT outsourcing and the risks of doing so.
2) Selection of Service Provider: Proposals that are received are evaluated against the organizations' needs. The process of selecting the service provider will then be conducted. Proper selection of a service provider is necessary to reduce the risk of IT outsourcing.

3) Contract Management: The contract should be seen as the most important element to secure an outsourcing plan. Therefore, organizations conducting contract negotiation must define their needs and requirements clearly.
4) On-Going Monitoring: performing this process will enhance the ability to mitigate risks by identifying potential problems before they become catastrophic and thus contribute to success in IT outsourcing.

Another study by Addison & Vallabh (2002) explain that software project risks are considered to be an issue that need to be addressed and thereafter controlled. The authors list the most common risks encountered regularly during the software projects:

1) Unclear or misunderstood scope/objectives.
2) Unrealistic schedules and budgets.
3) Lack of senior management commitment to the project.
4) Failure to gain user involvement.
5) Inadequate knowledge/skills by project personnel.
6) Lack of effective project management methodology.
7) Misunderstanding the requirements.
8) Often developers and analysts think of additional capabilities or changes, resulting in unsatisfied user and unnecessary costs.
9) Developing the wrong software functions.
10) Subcontracting resulting in a short fall in externally developed components.
11) Introduction of new technology that has not been used successfully at other companies.
12) The failure to manage end user expectations.

By examining the literature reviews, IT projects can range from software development, outsourcing, communications and implementing a new security infrastructure. Also, these IT project risks might have a particular management in a different project. Risks are resulting from many factors involved in the projects. Each factor will depend on the type and purpose of the project. In the next section, the researcher will examine the RM in IT projects.

3.1.2 Role of Risk Management in IT Projects

This section will explore the role of RM in different types of IT projects.

Roy (2004) points out that software development projects are particularly demanding for risk analysis. They include a wide variety of risk factors across a number of different stakeholder's predetermined perspectives. RM for software projects is intended to minimize the chances of unanticipated events, or more purposely to keep all possible outcomes under firm management control (Roy, 2004). Moreover, RM must be an integrated part of the project management framework if it is to be effective. Furthermore, RM is concerned with making judgments about how risk events are to be treated, valued, compared and combined (Roy, 2004). The propose of RM is to develop a detailed analysis of the organization and project domains to develop a complete set of risk factors and to ensure they are appropriately organized to reflect all the stakeholders and the various risk perspectives that are required (Roy, 2004).

P. Higuera & Y. Haimes (1996) state that the goal of Software Engineering Institute (SEI) Risk Program is to enable engineers, managers, and other decision makers to identify, sufficiently early, the risks associated with software acquisition, development, integration, and deployment so that appropriate management and mitigation strategies can be developed on a timely basis. Since time is critical, the goal is to act early before the source of risk develops into a major crisis. According to P. Higuera & Y. Haimes (1996) the purpose is to be responsive in risk mitigation and control rather than be proactive in risk prevention and control. Risk Mitigation and Control is the goal of well defined RM. The value of RM methodology and tools is to buy smarter, manage more effectively and identify opportunities for continuous improvement. Benefits

achieved with RM are the ability to gain information, manage databases more efficiently, improve industry and review and evaluate progress.

Maguire (2002) claims that a high number of IT projects failures have put RM higher in the agenda of prospective project management teams. These failures created a major pressure on the system developers to try harder and take the risk out of IT implementation. Maguire (2002) points out that there are many risk factors to consider before the IS goes live at the end of the project. Some risk factors can include for example, risk associated with new technology, project size and failure. Since there are many things that might go wrong during the process of system development, organizations should simultaneously attempt to reduce risk and increase security during system implementation. Maguire (2002) recommends risk assessment to be performed at the start of a project, and at least before system design, to determine the level of risk and to create a plan to manage them. Furthermore, Maguire (2002) concludes based on the use of a live case study that there is a need to develop a risk analysis methodology that incorporates the key issues that need to be addressed before a system goes live. Therefore, with RM the elements of risk have to be isolated at early stages resulting in more projects that are successful and fewer chance of failure.

Tesch et al. (2007) indicate that the failure of IT systems development projects has been well documented. While there are many reasons for these failures, they can typically be categorized as cost, time and performance or quality issues. Tesch et al. (2007) identify a list of 92 risk factors that were presented to members of the PMI for ranking. The result of the ranking was the categorization of systems development risk factors as well as the judgment of their perceived importance of each specific risk within each category. The purpose of the Tesch et al. (2007) research is to better understand IT project risk factors from a Project

Management Professionals (PMP) perspective. Furthermore, to develop how to use the strategies both by creating a project management system with well-defined roles and by describing how to use the strategies at certain key points during a project's life. The result is a Project Risk Management approach involves the systematic process of identifying, analyzing and responding to project risk. According to Tesch et al. (2007) project risk involves understanding the probability for problems as they might hinder project success. Finally, the objectives of the project RM are to minimize the probability and impact of potential risks while maximizing the probability and impact of potential opportunities.

3.1.3 Risk Management Process Theories Applied to IT Projects

Roy (2004) suggests a ProRisk management framework for software development projects. This framework contains two domains and each domain includes several processes:

1) Business domain in which the project is created.
2) Operation domain: when the project is actually carried out.

The business domain identifies the economic environment in which the project is being undertaken, and the susceptibility of the organization to the performance of the project team and the exposure to external risk factors. Also, it estimates the knowledge and knowledge of the organization for the project, and the level of assurance that the project can be successfully concluded.

The operational domain provides the following:

1) Undertake the necessary measurement of risk values as guided by organizational views and policies.
2) Complete detailed assessments to identify the key risk factors within the assumed modeling framework.

3) Identify and explain the action plans aimed at reducing key risk values.
4) Implement these plans and then re-assess the effected risk factors.
5) Wrap these steps in a continuous cyclic process that must be applied for the duration of the project.

Dey et al. (2007) propose a RM framework designed from a developer's perspective. It contains seven steps for managing risks in software development projects:

1) Analyzing functional requirements: The software performs organizational functions in an integrated way. Therefore, a strong requirement analysis with the involvement of functional people is required for its success.
2) Establishing scope of the software development project and developing work breakdown structure: The functional requirement analysis along with information system design establishes software development project scope.
3) Identifying risky work packages. The work packages which are vulnerable to time, cost, and quality targets failures are then identified with active involvement of both functional and IT executives.
4) Identifying risk events: Risk events are then identified for each risky work package using various tools and group consensus.
5) Analyzing risk. Probability and severity of the risk events are analyzed using qualitative and quantitative tools with the active involvement of the stakeholders.
6) Developing RM plan. A RM plan is then developed in response to undesirable risk events before they occur. The plan is assessed with respect to contribution in reducing the effect of risk. Then, risk responses are implemented if they have been potential to reduce project risk substantially.
7) Controlling risk. RM plan suggests various strategies for all likely risk events depending on the probability and severity along with the perceptions of the stakeholders. Therefore, a dynamic control mechanism needs to be established to make faster decisions when any risk event occurs.

Figure 18 below describes the proposed RM framework for software development.

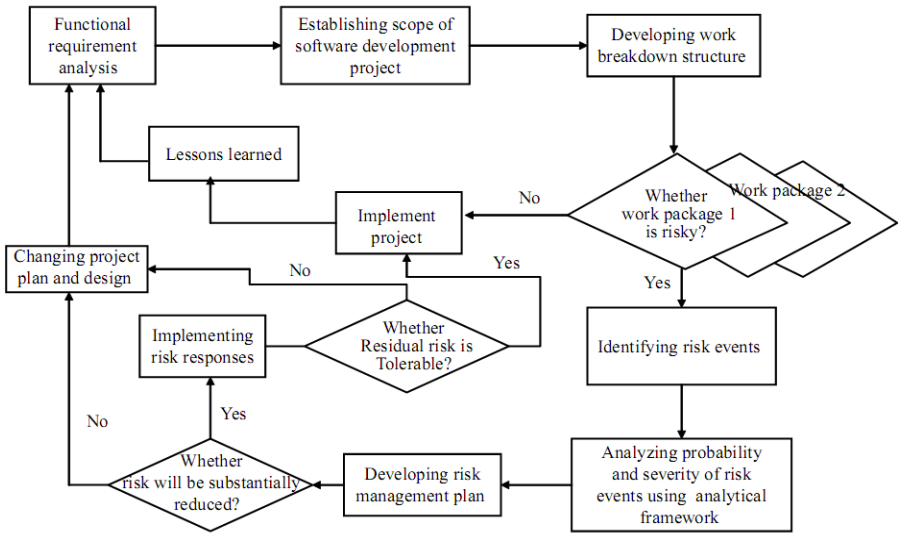

Figure 18 RM Model for Software Development (Dey et al., 2007)

Zardari (2009) points out six steps of the RM process: identify, analyze and prioritize, plan and schedule, track and report, control, and learn. The process of managing each risk goes through all of these steps at least once, and often cycles through numerous times.

1) Identify: Risks are to be considered risks before they become problems and to incorporate this information into the project management process.

2) Analyze: This process examines the risks in depth to determine the magnitude of the risks, how they relate to each other, and which ones are the most important.

3) Plan and Schedule: The decisions and mitigation methods are developed based on current knowledge of project risks.

4)Track & Report: Tracking monitors the status of specific risks and the progress in their respective action plans; Risk reporting ensures that the operations staff, service manager, and other stakeholders are aware of the status of top risks and the plans to manage them.

5) Risk Control is the process of executing risk action plans and their associated status reporting.

6) Risk Learning formalizes the lessons learned and uses tools to capture, categorize, and index that knowledge in a reusable form that can be shared with others.

Figure 19 illustrates RM processes.

Figure 19 RM Process (Zardari, 2009)

3.2 Summary and Conclusion

In this chapter, a review of risks encountered in IT projects has been presented. There are different types of risks and each depends on the kind of IT project involved. Risks can vary whether it is a software development project, or security project, or outsourcing project, or specific programming task. The role of RM was described in reference to several kinds of IT projects. In the last section, a description of RM framework describing the processes developed by different authors for IT projects. The authors explained how RM could benefit IT projects at the beginning and during the project.

The purpose of RM is to develop a detail analysis of the project and to establish a comprehensive list of risks. RM assists project team to make better decisions, communication and to resolve any risk issues in effective matter. RM for IT projects described in the literature reviews share almost common steps. Few of them portrayed the use of KM tools to capture knowledge for future reuse.

The next chapter, Chapter 4 will discuss the research design. The research design contains the research philosophy, classification, approach and strategy adopted in this research. Also, a research conceptualization and demonstration of concept are explained. Moreover, Chapter 4 will portray data collection methodology, research validation and finally the research design limitation.

CHAPTER 4 RESEARCH DESIGN

In this chapter, the research process model and research strategy are elaborated as well as the research methodology. The research strategy is based on interviewing 10 experts in the field of KM and RM. The researcher has taken into account the different research philosophies, research approaches and methods needed to conduct research in the research domain, such as to conceptualize the research domain of discourse and the solution, and also to verify these models in terms of the research goals and objectives and validate the research hypothesis.

Research philosophies are described providing the context for choosing the appropriate methods and techniques of the research methodology including the description of the approach, purpose, strategy and data collection. Figure 20 illustrates the research process methodology flowchart adapted from Steenkamp & McCord (2007), in which the flow of research tasks, and the decisions made during a research project are illustrated. This model was used to guide the research processes supported by specific research methods during the research project.

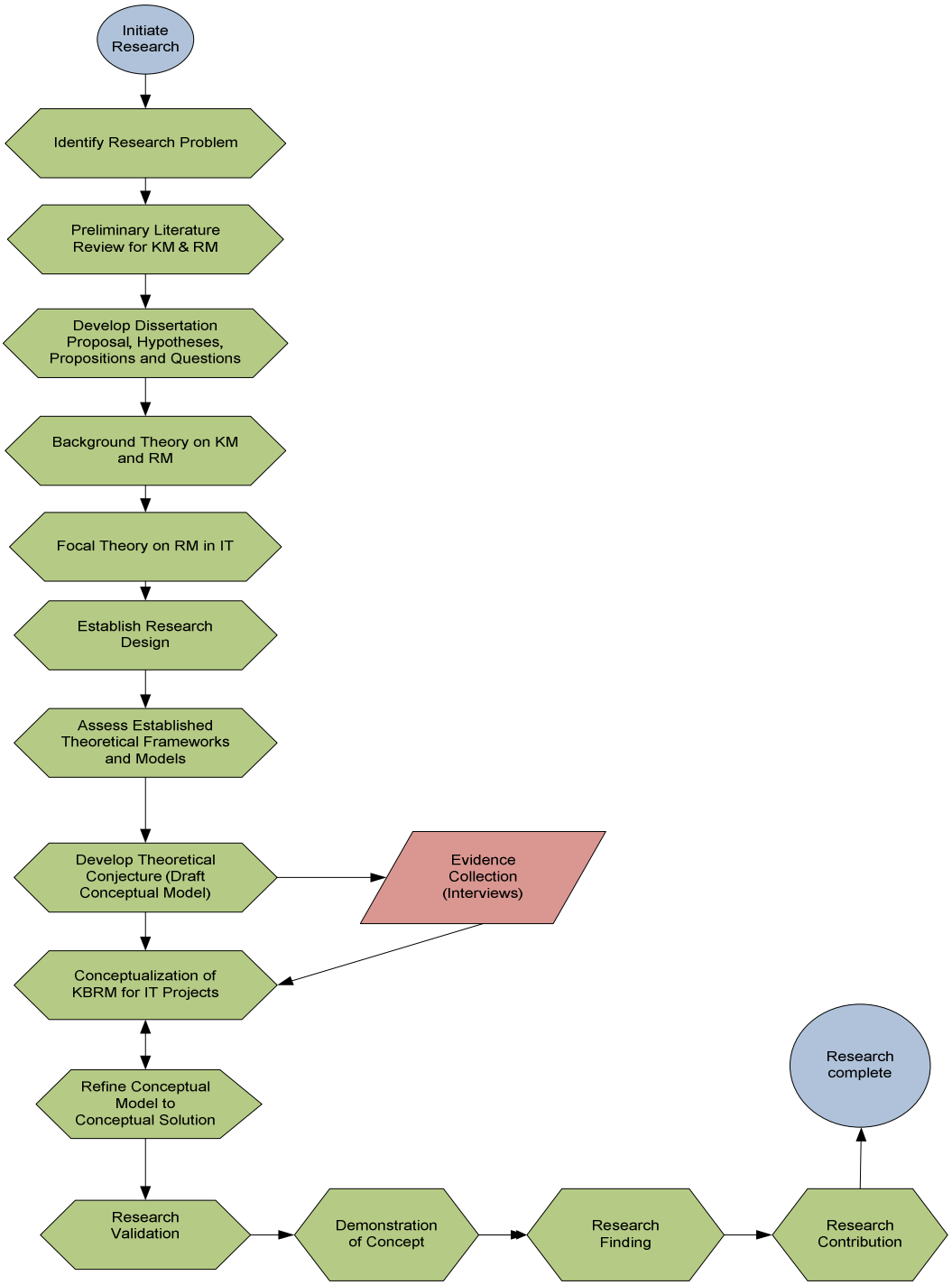

Figure 20 Research Process Model Map (adapted from Steenkamp & McCord, 2007)

Table 5 details the key features of the research design under consideration for this research project, which will be elaborated more in the coming sub-sections.

Purpose of study	Research Question	Research Approach	Strategy of Enquiry	Knowledge Claims	Research Method	Evidence Collection
Exploratory						
To investigate little understand relationship between two major topics	RQ1. How does the integration of KM and RM improve RM processes?	Qualitative	Narrative Design	Constructivist Assumptions	Literature Review	Published research Existing body of knowledge
Descriptive:						
To describe the events, which happened during the KM and RM integration and the relationship between both.	RQ1. How does the integration of KM and RM improve RM process?	Qualitative	Narrative Design	Constructivist Assumptions	Literature Review Assessment of established theoretical framework Development of conceptual models	Published research Existing body of knowledge
Conceptualization						
Describe the knowledge capture, discover, sharing and repository processes. Describe the elements of RM and their relationships. Examine the need for KM	The generic classes are RM processes, knowledge -Risk Capture/ Discovery/ Sharing/ Repository / Education	Qualitative	Narrative design	Post positivist Assumptions Constructivist Assumptions	Meta-Modeling by developing a class diagram for major elements of KM and RM	Published research Existing body of knowledge Researcher Insight based on experience

and RM for IT projects						
Explanatory:						
To identify and explain the relationship between KM and RM in IT projects.	RQ2. How does the integration of KM and RM processes improve the organization 's ability to manage risks in IT?	Qualitative	Conceptualization Conceptual Model Conceptual Solution A structured methodology for conceptual solution is described.	Positivist Assumptions	Literature Review	Published research Existing body of knowledge Discussions with Experts experience Peer review
Validation	H0: The integration of KM principles in support of RM processes, when applied to IT projects, may improve the organization 's ability to manage risks response planning by enhancing risk identification, analysis and mitigation.	Qualitative	Interviews Triangulation	Post positivist	In-depth interviewing	Data analysis

Table 5 Salient Features of the Research Design

4.1 Research Philosophies

Research philosophy is an important topic to understand and provide the context in which the world may be viewed. Easterby-Smith et al. (1997) identify three reasons why the exploration of philosophy may be important with particular reference to research methodology: 1) It can help the researcher to refine and specify the research methods to be used in a study, i.e. to simplify the research strategy to be used. This would contain the type of evidence gathered and its origin, the way in which such evidence is interpreted, and how it helps to answer the research questions posed. 2) Knowledge of research philosophy will enable and assist the researcher to assess different methodologies and methods and avoid unsuitable use and unnecessary work by identifying the limitations of particular approaches at an early stage. 3) It may help the researcher to be creative and innovative in either the selection or adaptation of methods that were previously outside his/her experience.

The research adopted the Positivist philosophy as a research method with justification for employing it in this dissertation to explore the relationship between KM and RM in terms of a process model. The research approach is based on fundamental philosophical theories, where IS researchers have debated competing philosophical paradigms for research, mostly represented by the two labels positivism and interpretivism (Myers, 1997).

4.1.1 Positivist Philosophy

Positivist research implies that the research work involves an observable social reality and the output of the work can be the deviation of law. It views the researcher as an objective analyst and interpreter of a tangible social reality. The fundamental tenet of positivism is the assumption that the researcher is

independent of, and neither affects nor is affected by, the subject of research (Remenyi, Williams, Money, & Swartz, 1998).

The positivist philosophy embraces a conception of truth in which verifiable statements concur with the ascertainable facts of reality. Truth is therefore not dependent on the belief alone but on the belief that can be verified through examination and observation of external reality. Speculation and assumptions related to knowledge, based on the metaphysical are discarded. The exploration and examination of human behaviors, such as feelings are beyond the scope of positivism. The elements and focus of positivism have a profound effect on those involved in social research, and on the continuing quantitative-qualitative debate (Crossan, 2003).

With positivism, it is believed that reality is stable and can be observed and described from an objective viewpoint. Positivism relates to the philosophical stance of the natural scientist. This involves working with an observable social reality, and the end result can be law like generalizations similar to those in the physical and natural sciences (Saunders, Lewis, & Thornhill, 2007).

Positivists supposedly believe that reality is separate from the individual who observes it. They apparently consider the subject (the researcher) and the object (the phenomena in the world that are their focus) to be two separate, independent things. Positivists try to build knowledge of a reality that exists beyond the human mind. They also believe that human experience of the world reflects an objective, independent reality and that this reality provides the foundation for human knowledge. Positivists believe that the objects they research have qualities that exist independent of the researcher. Positivists tend

to use laboratory experiments, field experiments and surveys as their preferred research methods. They seek large amounts of empirical data that they can analyze statistically to detect underlying regularities (Weber, 2004).

4.1.2 Justification for Selecting the Positivism Research Approach

The Positivism approach was selected for this research project. There are three reasons for using Positivism research approach:

1. The Positivism approach has a number of features that make it appropriate for this research project:
    - Establishing the relationship among different variables.
    - Hypotheses can be formulated based on research questions and preliminary insight into the research phenomenon.
    - Phenomenon under study may be conceptualized.
    - Data may be collected through convenient means (such as doing a survey, conducting interviews) to verify the draft conceptual model, and develop the refined model..
    - The conceptual framework can often be demonstrated through convenient methods (simulation, prototype, virtualization).
    - Hypothesis can be validated.
    - Reliability can be achieved (repeatable results).

2. Positivists theoretically try to construct knowledge of a phenomenon (an actuality) that exists further than the human mind. They actually believe that human experience of the world imitates an objective, independent reality and that this actuality presents the foundation for human knowledge (Weber, 2004).

4.2 Research Classification

There are many methods available to perform research studies, which can be categorized according to how much the researcher knows about the problem

before starting the investigation (Yin, 2003). Nevertheless, there are three classifications of research obtainable when dealing with a research problem. These are exploratory research, descriptive research and explanatory research (Yin, 2003). The researcher will adopt exploratory research methods. Both descriptive and explanatory research methods are described in the next sub-sections.

4.2.1 Exploratory Research

Exploratory research guides the development of research questions and hypotheses and may not seek to test the hypotheses (Yin, 2003). Also, exploratory research is a valuable means of finding out what is happening; to seek new insights; to ask questions and to assess phenomena in a new light (Robson, 2002). Exploratory research is designed to allow the researcher to inspect some phenomenon and develop the suggestive ideas (Yin, 2003). The purpose of this research category is to collect as much information as possible relating to a specific problem. Exploratory research is often used when a problem is not well known or the available knowledge is not complete. This method is best suited for information gather when performing an exploratory research is interview (Yin, 2003).

4.2.2 Descriptive Research

The goal of descriptive research is to depict a precise profile of situations, people or events (Robson, 2002). It may be an extension to part of exploratory research (Saunders, et al., 2007).

Descriptive research provides different realities of description related to individuals or events that happen. It provides a clear picture of phenomena on which you desire to gather data previous to the compilation of the data (Saunders, et al., 2007).

4.2.3 Explanatory Research

Tellis (1997) states that explanatory cases are suitable for doing causal studies. In very complex and multivariate cases, the analysis can make use of pattern-matching techniques. Yin & Morre (1987) conducted a study to examine the reason why some research findings get into practical use. They used a funded research project as the unit of analysis, where the topic was constant but the project varied. The utilization outcomes were explained by three rival theories: a knowledge-driven theory, a problem-solving theory, and a social-interaction theory.

Knowledge-driven theory means that ideas and discoveries from basic research eventually become commercial products. Problem-solving theory follows the same path, but originates not with a researcher, but with an external source identifying a problem. The social-interaction theory claims that researchers and users belong to overlapping professional networks and are in frequent communication (Tellis, 1997).

Moreover, explanatory research seeks to establish the relationships between variables. The focus is on studying a problem or situation to provide a clarification on the relationship between variables (Saunders, et al., 2007).

4.2.4 Justification for Selecting the Descriptive, Exploratory and Explanatory Research

The researcher relied on explanatory, exploratory and descriptive research in writing the dissertation. The research purpose and questions disclose that this study is descriptive since the intent was to gather and analyze the linked data to verify the hypotheses of the research. Moreover, the data gathered was employed to portray the area of research and draw some conclusion. It is also explanatory because the researcher has defined hypotheses to be tested and then examined whether the data collected can be utilized to support or disprove those hypotheses and used to explain the relationship between variables related to the research. Furthermore, it is an exploratory because the researcher attempts to investigate little understands of the relationship between two major topics.

The next section describes the research approach and used by the researcher. It explains the nature of quantitative approaches and the justification for using a qualitative approach.

4.3 Research Approaches

There are three main research approaches used when performing research in the domains of management and IT: Quantitative and Qualitative and mixed methods (Yin, 2003). The difference between the approaches lies in the use of numbers and statistics to process the research data. The choice between the two

approaches is influenced by the description of the research problem and the needed data for solving this research problem.

Both approaches have their strengths and weaknesses and neither one of the approaches is better. The finest research method to employ for a study relies on the study research reason and the supplementary research questions (Yin, 2003). The research adopted qualitative approach, which is described in the following section.

4.3.1 Qualitative Research

The Qualitative approach attempts to discover hypotheses, sometimes for generating qualitative projects. This type of research examines an entire environment or context and attempts to find patterns within it. Qualitative research chooses samples from individuals that are the most likely to contribute to an understanding of the problem. This research approach uses interviews, essays and observation as its data (Medley, 2001). The Qualitative approach enables researchers to gain empathic understanding of social phenomena; facilitates recognition of subjective aspects of human activities and experiences, and aids the research in developing insights into group's lifestyles and experiences that are meaningful, reasonable and normal to those concerned (Brown & Lioyd, 2001).

Brown & Lioyd (2001) define the qualitative approach as a small detailed sample to produce a plausible and coherent explanation of the phenomenon under study. The purpose is to examine a phenomenon or interaction and to understand it. The results are not usually statistically generalized.

The Qualitative approach developed in the social sciences to enable researchers to study social and cultural phenomena. Examples of qualitative methods are action research, case study research and ethnography. Qualitative data sources include observation and participant observation, interviews and questionnaires, documents and texts and the researcher's impressions and reactions (Myers, 1997). Qualitative methods typically use an inductive approach where the author would collect data and develop the theory as result of the data analysis (Saunders, et al., 2007) .

4.3.2 Justification of Selecting Qualitative Research Method

This dissertation focuses on the qualitative method of collecting information from the respondents. The grounds for choosing the qualitative approach as an appropriate approach for this research are as follows:

The focus of the research is to propose a conceptual framework, describing an integrated framework for some KM processes and processes of RM called KBRM framework in order to improve RM. Consequently, qualitative research is employed in the study with the hypothesis that must be proven or disproved. This research starts with the presentation of the KBRM as a research framework, then with the hypotheses. Furthermore, the data will be collected to address the hypotheses; this ultimately enabled the researcher to test the hypotheses with particular data that could result in confirmation or verification of our original theories drawing on the whole research approach with the deductive trait.

Based on above reasons, a qualitative approach was selected for the present dissertation. The following section will summarize the overall research strategy in the IS environment.

4.4 Research Strategy

Research strategy provides an overall direction for the research including the process by which the research is conducted (Remenyi, et al., 1998). The emphasis turns out to lay on the research strategy available to collect the data. "Each strategy can be used for exploratory research, descriptive research, or explanatory research" (Yin, 2003).

The research strategy is a general plan of how you will go about answering the research question you have established. It will contain clear objectives, derived from the research question, specify the sources from which data will be collected and the constraints the research might encounter (Saunders, et al., 2007).

There are different strategies for performing research: interviews, survey, history, experiment and analysis of archival records and case study. The research adopted interview as a method of collecting data.

4.4.1 Interviews

Interviews provide the opportunity for the person being interviewed to ask questions when a question is not clear or the question is not understood. The interview also allows for immediate feedback and the opportunity to provide an explanation on the respondents (interviewee) side and on the interviewer's side. For example, if the meaning or context is not clear to the person being interviewed the interview can provide reasons and examples addressed specifically to the interviewee's response. Also, the interviewer can target experts on the field instead of having a random sample. It also allows for further discussions if the interviewer is not satisfied with the outcome.

Interviews can be structured, semi-structured or completely open and closed. In a structured interview, specific lists of questions are asked. An unstructured interview allows respondents to give their reactions to general issues in the absence of specific questions.

Also, questionnaire can be used for descriptive or explanatory research (Saunders et al., 2007). The design of a questionnaire differs according to how it is administered and, in particular, the amounts of contact of with the responders. Saunders et al., (2007) indicates that the design of a questionnaire can be divided into self administered questionnaire and interviewer administered questionnaire. Self administered questionnaires are usually completed by respondents; such questionnaires could be delivered and returned via email or internet (internet mediated questionnaire), or posted to respondents who return them by post after completion (postal questionnaire), or they could be delivered by hand to each responded and collected later (delivery and collection questionnaire) (Saunders et al., 2007). On the other hand, the interviewer's questionnaire includes a structured interview where the respondents need to answer a predetermined set of questions based on standardized questions and ask the questions face to face. Telephone questionnaire refers to contact respondents and administer the questionnaire using the telephone (Saunders et al., 2007).

For the purpose of this research, structured questions and unstructured questions were used where a set of questions were presented to the respondent in advance. The purpose of this was to provide the respondent with enough time to gather relevant information and to prepare for the interview.

4.4.2 Justification for using Interviews Strategy

This section justifies the use of an interview in the research project. There are different research strategies existing in Information Systems such as interview, experiment, survey, history, an analysis of archival records and a case study (Yin, 2003). Each strategy has its own advantage and disadvantage based on three conditions: 1) The type of research question posed. 2) The extent of control an investigator has over actual behavioral events. 3) The degree of focus on contemporary, as opposed to historical or event (Yin, 2003). However, the boundaries between each strategy are not always sharp, since there are large overlaps among them (Yin, 2003).

This research relies on interviews as a strategy for collecting information from the respondents. Also, the focus of the interviewing research is the curiosity in other people's stories and experiences. The reasons for utilizing the interview strategy is because interviews allow a depth of response, ensure questions comprehensibility, flexibility and adaptability and provide the ability to capture non-verbal responses (Galliers, 1992; Krathwohl, 1997). Finally, the interview data were used to validate the conceptual solution.

Moreover, the following are the advantage of using interview (*Research in Social Science*, 2006):

- Interviews are flexible and can provide the researcher with detailed and latest information that the researcher may not have expected.
- Any unclear question by the interviewee can be cleared due to the dialogue involved.
- If the response to the question is not clear, than the interviewer can ask follow-up questions.

Because of the above reasons, an interview methodology was chosen in the dissertation to gather information about the characteristics, actions, or opinions of experts.

4.5 Research Conceptualization

This conceptual framework was created based on an in-depth study of KM and RM. The researcher examined profoundly different KM literature reviews in background, processes and applications as well as RM in terms of background, processes and application. Due to huge background of both KM and RM, the researcher started examining the possibility of linking KM and RM together. One of the links between the KM and RM can be the processes. Then, the researcher studied in-depth several literature reviews related to processes for both KM and RM to understand its input, process and output. Every process is a collection of structured activities and tasks to produce a specific service or product; therefore, RM might be impacted by external factors such as KM, which is a subject in its own right.

The analysis of major processes of KM and RM provided a possibility of finding a link between them. Next, the author created a meta-model containing class diagrams illustrating the major components of KM and RM. Using this class diagram, the author identified the relationships between KM and RM.

The following tools and techniques have been used on this research project: Microsoft Visio, WinWord and PowerPoint for the creation of the different models listed above. The purpose of the models is to provide a visual description of the major elements of KM and RM processes interacting with each other.

4.6 Data Collection Methodology

There are two kinds of data normally used in researches: primary data and secondary data (Saunders et al., 2007). Primary data is recognized as data that is gathered for a specific research, especially in response to a particular problem,

for the first time. Primary data can be collected by questionnaires (Saunders et al., 2007). Whereas secondary data is the data that already exist. Like the literature study, this secondary data has been previously collected and assembled for some studies. Secondary data collection methods include all data resources that could be available to the researcher to facilitate obtaining the necessary information for a research purpose (Saunders et al., 2007).

The first source of data collected is from interviews with ten experts in the fields of RM and KM. The author used structured and unstructured interviews to examine the impact of one variable on another and to validate the conceptual framework. The interviews included 9 categories with a total of 44-close-ended questions and 2 open-ended questions. The questions were based on Likert scale to allow interviewees to specify their level of agreement to a statement. Finally, the Likert scale used a five ordered response levels. The Likert scale measures the degree to which a person agrees or disagrees with the question, where respondents indicate their extent of agreement with a statement from a scale of 1 to 5, 1 = strongly agree, 2 = agree, 3 = neutral, 4 = disagree and 5 = strongly disagree (Saunders et al., 2007).

The second source of data for qualitative research came from the KM models and frameworks from the published research work in the areas of KM and RM. The published data on KM and KM taxonomies, frameworks and models were used to determine the adequacy of a comprehensive KM framework to investigate the value and impact of KM to RM.

4.7 Demonstration of Concept

To demonstrate the conceptual solution to the research problem, the KBRM (RiskManIT) framework and supporting methodology were applied in chapter 7. This application of the conceptual solution demonstrated the conceptual framework and methodology developed in this dissertation to implement knowledge-based tools and techniques during the RM process execution.

4.8 Research Validation

4.8.1 Preliminary Design

To ensure the reliability and validity of the Questionnaire, several criteria must be considered when designing a questionnaire survey (Saunders, et al., 2007). The selection of question wording, questionnaire design and layout were adopted. Attention is paid to the choice of wording since the language of questionnaires is an important attribute of their effectiveness and should reflect the respondent's own language usage. It is also important that the question wording or response definitions in an interview be consistent with the wording and definitions (Saunders, et al., 2007). Items in the questionnaire are designed to be simple, clear, short, and technically accurate and at an appropriate reading level (Saunders, et al., 2007). In addition, the Pre-tested stage will increase the content validity of the questionnaire.

The questionnaire starts with a brief description of the meaning of the main concepts, and it gives the instructions on how to answer each section of the questionnaire. The questionnaire will include many questions, which are in agreement with the aims and objective of this research.

4.8.2 Pre-Test

According to Wong (2006) the questionnaire must be introduced carefully to the responders to ensure a high response rate. In addition, the Pre-test stage was used to increase the content and face validity by examining the appropriateness of the questions to the context of the study. The delivery and collection of the questionnaire pre-tests were performed, which include the expert's review, focus groups and reconfirming review.

The expert's review was three academic experts who evaluated the questionnaire. Based on their recommendations, a few items were added, deleted and modified in the initial questionnaire.

4.8.3 Other Validation

The validity of the research increases by using diverse sources of evidence (Yin, 2003). A number of different steps were taken to ensure the validity of the study:

- Data was collected by specific closed-ended questions and open-ended questions. See Appendix A and C.
- Data was collected from the reliable sources, from respondents with experience in RM and KM.
- Interview questions were made based on literature review and frame of reference to ensure the validity of the result.
- Questionnaire has been pre-tested by the responded before starting the interview.
- Triangulation used three aspects of research to increase the ability to interpret the findings, better understanding to the framework, reveal unique findings and increase validation.
- Provide a structured methodology for applying the conceptual solution.
- Present criteria for validation of the conceptual framework.

4.9 Research Design Limitation

Because this research is the first step to developing a comprehensive framework and methodology for enterprise RM utilizing KM approach, the reference theories and applications are limited. This limitation results because the ability to fully examine the created conceptual framework and methodology is lacking experimentation in a real world enterprise environment. Also, there is a time constraint on the dissertation research project. The demonstration of concept proposed in this chapter 7 was not applied in a real world company.

CHAPTER 5 CONCEPTUALIZATION OF KBRM FOR IT PROJECTS

5.1 Introduction

This chapter provides an elaborate description of the proposed framework for the integration of KM and RM of IT projects. The rationale and need to integrate the project management activities of Risk Management with a Knowledge Management System is provided in Section 5.2. The framework for the Knowledge Management processes is identified in Section 5.3. Then the proposed KBRM processes framework for IT projects (RiskManIT) is discussed in Section 5.4. Finally, Section 5.6 summarizes the conceptualization performed in the research project.

5.2 The Need for Integrating KM and RM for IT Projects

The author realizes the importance of KM in every aspect of private life and business based on the author's previous research in KM and practical experience in business. Furthermore, risks surround us in our personal and professional lives and RM identifies potential problems that might happen. Moreover, most tasks require many complicated steps, processes or procedures to accomplish. Therefore, to execute a task or process successfully, it is essential to have the appropriate and right knowledge, allowing us to make the right decisions and responses called for during the task execution.

Tasks, processes or procedures are executed to achieve some goals and objectives and it is important to achieve them with minimum loss. In this research, it is argued that knowledge is indeed needed and must be integrated carefully with RM to ensure correct execution. To obtain the integration of KM with the RM

processes, the relationship between knowledge and risk has been examined to produce an integrated framework.

Software projects have several risks that require KM involvement. Murthi (2002) lists the possible software risks as:

1) Requirements: Unclear or uncertain requirements introduce large risks. This is the most common type of risk and is probably responsible for most failed or delayed projects.
2) Technology: At some point in development (usually late in the cycle), the team discovers that the technology cannot satisfy system requirements. For example, team members could assume that the database they use is not easily corrupted, but when they actually build the system, they found that it has bugs that can cause it to become corrupted frequently.
3) Resources: When a project does not get the required people, money, facilities, or equipment, the shortfalls degrade both schedule and morale. Identifying an alternative resource can help. For example, another team might be willing to share some of its server capacity until the new server arrives.
4) Skills. These risks arise if, for instance, the team is unfamiliar with the technology or business process. Providing training and bringing in consultants with the missing skills, who can mentor the team, will help mitigate this risk.
5) Integration: Most applications must integrate with other applications. Miscommunication and misunderstandings cause systems to miss sharing accepted interfaces; hence they do not functional correctly together as expected. Communication is the key to reducing this risk.

Therefore, KM contributes to better requirements analysis, communication and sharing of skills, which may result in more efficient project progress.

Rodriguez-Montes & Edwards (2008) indicate that effective RM process modeling cannot be achieved without the assistant of a well established KM process model. Therefore, a well defined, designed and integrated KM and RM framework is essential to improve decision-making in IT projects (Rodriguez-Montes & Edwards, 2008). The goal of RM is to be more efficient in order to get

better solutions for risk issues and to extend the experience, results, and solutions to more problems. RM also promotes the use of technology in an improved manner by having the organization use an integral risk information system

Barquin (2006) claims that RM must be considered as part of a KM environment. If you look at "risk" as a knowledge domain, then many of the KM practices are clearly applicable. Henry Kissinger once said "an issue ignored is a crisis invited." Therefore, RM solutions are crucial to avert these potential crises and managing risks within the context of a KM framework will give the agency a robust programmatic base.

Moreover, new management methods have surfaced to deal with changes and a several authors recognize KM and RM views as very significant in competitiveness and strategy (Dalkir, 2005), (Dickinson, 2001). Risk Management and Knowledge Management must be viewed holistically. Based on a study by Shaw (2005), KM as a discipline can add positively to RM implementation in reference to data and information management, risk-knowledge sharing, analysis consolidation and reporting. Furthermore, RM is a discipline that organizations can no longer afford to ignore. KM must site right at the heart of the RM strategy, if companies are serious about both mitigating the effects of the threats their operations encounter and seizing the opportunities that are passed their way (Scott, 2002).

There are several inspiring reasons for a KM driven approach to RM. A company cannot manage its risks effectively if it cannot manage its knowledge (Neef, 2005). RM is a highly critical and important process for successful project execution and is a knowledge-intensive area. The success of implementing RM

depends mainly on the amount, access and quality of knowledge, which applies to a wide variety of projects. A proactive RM process depends in the capability of the corporation to utilize knowledge of its own employees regarding risk alleviation and enables the project team members to receive accurate and timely information about potential risks that might occur (Neef, 2005). Also, G. Dickinson (2001) presents knowledge as a means to decrease the risk; therefore modeling risk knowledge is one of the pieces of knowledge management to be employed. Risk-knowledge donates to control, business strategy and underwriting processes because these activities depend on human actions and risk knowledge transfer has value in those processes.

The lack of documentation on the success or failure of past projects is one reason for inefficient RM utilization or non-utilization in software development projects. Besides RM knowledge, the past experience analysis is fundamental to helping project managers in the planning and controlling of risks. Risk Response Planning can be enriched by using knowledge and experience acquired by the various managers while working on the several organization projects. Therefore, it is necessary that risk knowledge be captured and stored throughout the project's development, to enable the future utilization of risk knowledge (Farias, et al., 2003).

The study by Rodriguez-Montes & Edwards (2008), presents the concept of Risk Knowledge Management (RIKMAN) as the application of KM processes to support Enterprise RM. To get this support it is necessary to use an Enterprise Risk Knowledge Management System (ERKMAS) where the risk modeling process is a component. A Risk Response Planning requires organization experience, as it is strongly centered on the experience and knowledge acquired from former projects. Risk planning can be enriched by using knowledge and experience acquired by the various managers while working on the various

organization projects. It is also necessary for risk knowledge to be packaged and stored throughout project development, in order to use it in future (Boffoli, Cimitile, Persico, & Tammaro, 2005).

In a research conducted by Sallmann (2007), the existing RM services didn't take advantage of KM. Introduction of KM concepts would provide competitive advantage against the changing risk environment. One way corporate risk managers in industry could improve their capabilities and services is by applying a new knowledge-based approach. Sallmann (2007) indicates that KM is a keystone component which is identified as missing in the current state of major risk analysis trends. Sallmann (2007) outlines the RM processes as: risk identification, risk assessment, risk analysis, risk handling and risk monitoring. This author based his findings on intensive literature reviews and identified a wide range of risk identification tools such as inspection analysis, document analysis, organizational analysis, interviews, checklists and technical analysis methods. In risk analysis processes, lessons learned and best practices can be used to elicit knowledge. Risk handling applies the relevant lessons learned and best practices captured in the risk analysis process. In risk monitoring, the reapplying of the knowledge-based RM process ensures the success of the RM role. Finally, knowledge gathered throughout the process is collected and stored in the form of new lessons learned and best practices, which can be reapplied in other projects (Sallmann, 2007) .

Several authors have mentioned the risks encountered during IT projects and how KM might play an important role in enhancing the execution of RM. Most authors recognized how well integrated KM and RM models are crucial to improve IT projects executions. However, none of the authors defined a clear and comprehensive framework to demonstrate how to integrate the KM and RM processes together.

The next paragraphs will be focused on finding the links between KM processes and RM processes. Figure 21 illustrates a context diagram for the KBRM integration.

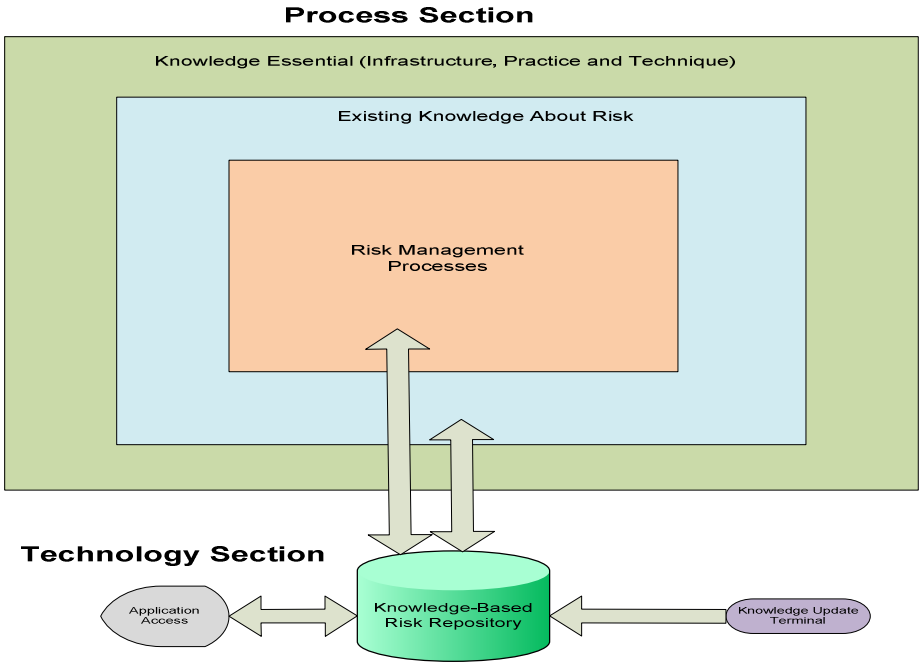

Figure 21 Context Diagram for the Proposed Knowledge-Based Risk Integrated Framework

Figure 21 contains two sections, the technology represented by the repository environment and the process section represented by KM and RM environment. It also portrays knowledge essentials as components that contain the foundation for utilizing knowledge and the practices and techniques options used to employ, capture and share knowledge throughout KM processes. Figure 22 illustrates the interaction of employees with the proposed KBRM framework using Use Case tools.

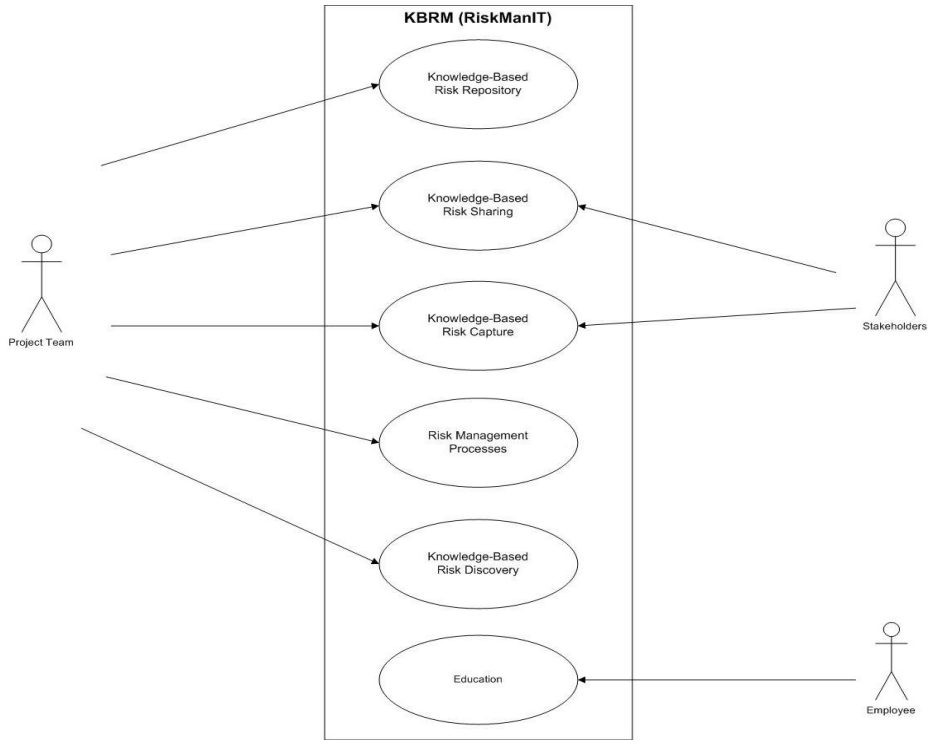

Figure 22 Use Case Context Diagram for the Proposed KBRM Framework

Figure 23 is a UML class diagram of the meta model of the proposed KBRM framework. The purpose of the UML diagram is the modeling of the important components of the proposed KBRM framework and their relationships using a graphic notation, and is instantiated after adoption by a client.

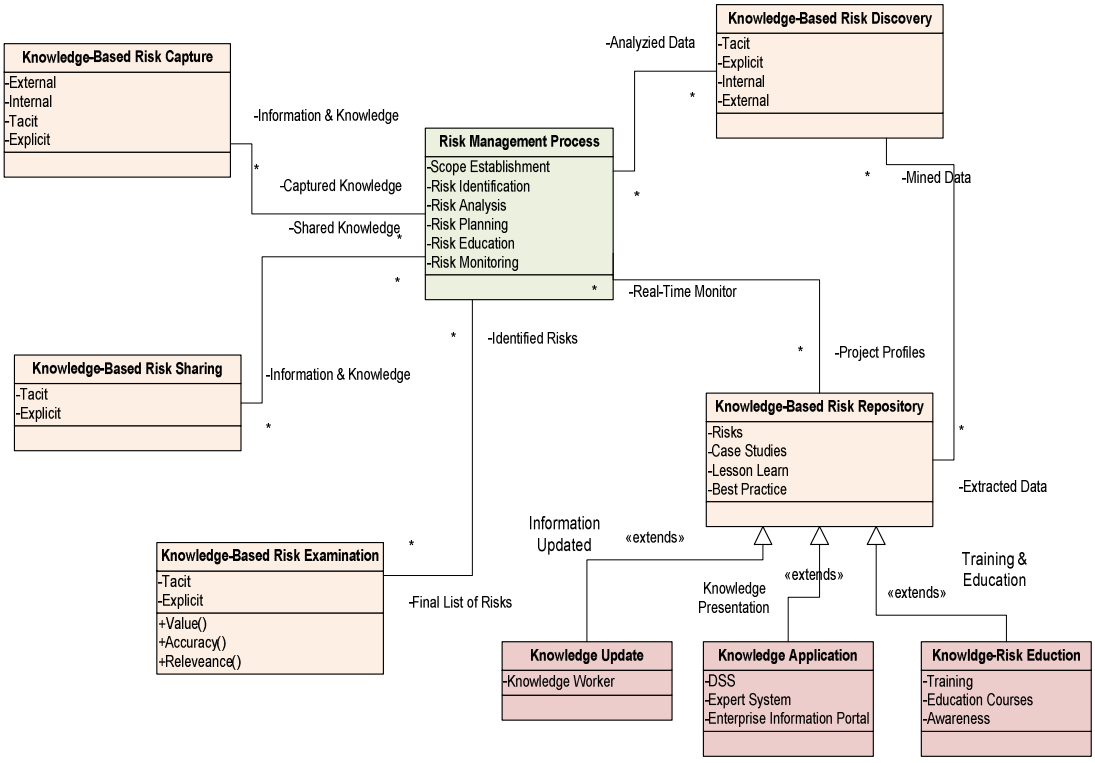

Figure 23 Meta-Model for the Proposed KBRM Framework

The important components of the proposed KBRM framework in abstract format are described in the following sections to assist in the understanding of the KBRM framework.

The role of Knowledge-Based Risk Capture (KBRC) is to capture the right knowledge whether tacit or explicit and use both internal and external sources based on requests, which are submitted to the requester. The knowledge capture enables obtaining the appropriate information based on previous experiences and encounters. Knowledge capture must be submitted to the RM process at the right time and the information must be from the right person. This establishes a well defined and relevant identified risk and determines the scope of the project. The purpose of KBRC is to save the project team time and money by not having

to searching for information from previous projects. The result is a well-defined project risk profile.

Knowledge-Based Risk Discovery (KBRD) utilizes data mining tools to discover new risks that are associated with a particular project. This process also analyzes existing data from the previous projects and discovers any relation or trends for the existing project. The result of this process is in identifying the most relevant risks to the current project and thereby save the team time and money.

The purpose of Knowledge-Based Risk Examination (KBREx) is to inspect the list of risks collected in the previous process and provide only the confirmed list according to the IT project's objectives and goals.

Knowledge-Based Risk Sharing (KBRS) allows employees to engage in RM activities by organizing, categorizing and monitoring risks as they relate to each business process. In fact, knowledge sharing across functions enables employees to develop a big picture view of the company and identify the enterprise risks that span the organization and the interrelationships of those risks ("The New Age of Innovation: Managing Global Networks to Unlock Customer-Created Value in Your Company," 2008). The importance of this process is to have the team share their tacit and explicit knowledge on risks encountered in preceding work and their experience. The team can also share their thoughts by analyzing previous projects in a joint team environment, result in an enhanced risk analysis and planning process.. The purpose of KBRS is to communicate explicit or tacit knowledge of risks effectively across the project team. This sharing prompts learning from previous experiences, which helps to identify any triggers for risks in the current project.

The Knowledge-Based Risk Evaluation (KBRE) assesses the progress of the risk execution and monitoring by capturing any new encountered experiences or lessons learned. This process will help in enriching the KM repository by collecting and storing of additional information, so it can be used in future projects.

Knowledge-Based Risk Repository (KBRR) is considered as the heart of the Knowledge-Based Risk conceptual framework. This repository contains all experiences, case studies, lessons learned and best practices. The KBRR can be used by the team to formulate their risk mitigation, analysis and planning. Moreover, KBRR can be used to indentify subject matter experts related to the project. Data updating and modification of risk processes and related information of the knowledge-based database can be updated and modified by the KBRR. Furthermore, KBRR can provide a real-time notification during the project execution of potential risks, and this can result in detecting risks that might otherwise be overlooked by the team, preventing a loss of time and money. KBRR also supports education and training based on previous project experiences to enhance the experience of employees and expand their knowledge.

The purpose of Knowledge-Based Risk Education (KBREdu) is to provide training and education to enhance the team's knowledge for future encountered situations that closely match a previous experience. Training and education help teams to be prepared for risks that might occur on future projects and may assist in the avoidance of mistakes. This may result in saving time and money on future IT projects.

5.3 A Framework for KM processes

This section draws on the following research publication: Karadsheh, L.; Mansour, E.; ALHawari, S.; Azar, G; and El-Bathy, N.; (2009), entitled "A Theoretical Framework for Knowledge Management Process: Towards Improving Knowledge Performance", Journal of Communications of the IBIMA, 7, pp 67-79.

The importance of implementing the KM framework for organizations is to provide guidelines for executing KM successfully, save time and efforts and to avoid inaccuracies. Therefore, the authors have proposed and developed a conceptual and coherent Model of KM as shown in Figure 24. This model was developed after a thorough investigation of various models presented in the research classification of KM processes in Table 3. The main emphasis is placed upon the processes of Knowledge Infrastructure, Knowledge Combination, Knowledge Filtering, Knowledge Repository, Knowledge Sharing, Knowledge Application and Knowledge Performance. These elements are explained in this section.

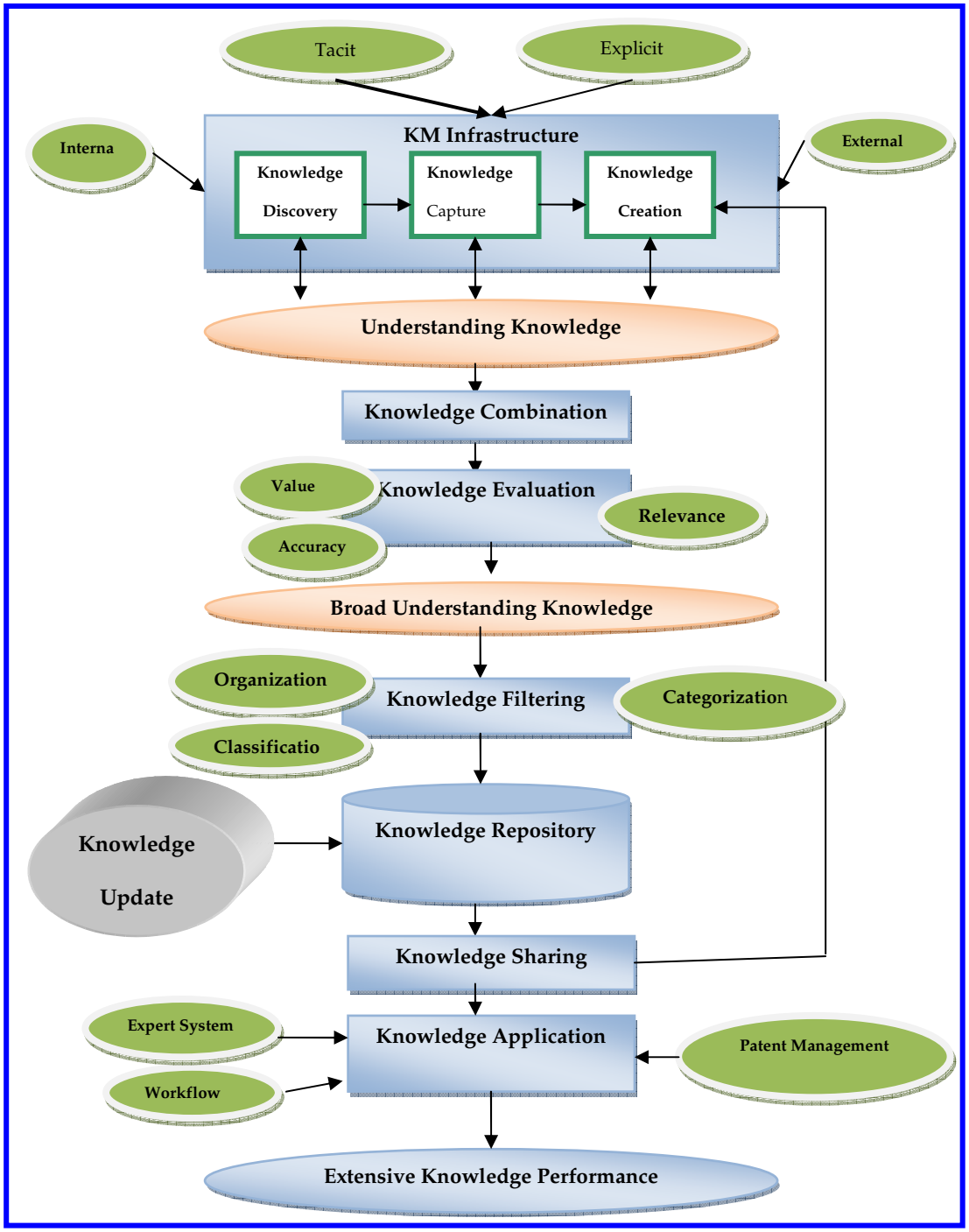

Figure 24 Conceptual Framework for Knowledge Management Process

5.3.1 Knowledge Infrastructure

Knowledge Infrastructure is the first element in this conceptual framework and relies on building the appropriate culture for Knowledge Management System (KMS). It also establishes the awareness of the importance of KM among the individuals in the organization. Therefore, the Knowledge Infrastructure promotes understanding of the knowledge domain , the related strategic capabilities and/or the comprehension of knowledge requirements (Lai & Chu, 2000). The role of the knowledge worker in contributing to knowledge plays a major part in the success or failure of the KM cycle execution. Knowledge Discovery relies on the support of the upper management for successful execution, and if higher management does not endorse the KM, the knowledge workers may not contribute resulting in KMS failure.

Abdullah, Selamat, Sahibudin, & Alias (2005) argue that knowledge infrastructure establishes different technologies to provide information retrieval and presentation. These technologies include can be an intranet, which provides an easy and customizable interface to knowledge workers, groupware allowing knowledge works to communicate in a non-real-time approach using discussion groups and agent technology to monitor knowledge resources for any new or updated knowledge. New and updated knowledge can be acquired by adding or changing information based on the user's preferences and interests. Furthermore, Gold et al., (2001) explains that knowledge infrastructure consists of technology, structure, and culture, and the knowledge process cycle is essential for effective KM. The knowledge Infrastructure is established in three stages:

1. The first stage is the Knowledge discovery: This is a method for developing new tacit or explicit knowledge from data or information or from a mixture of

previous knowledge (Becerra-Fernandez, et al., 2004). In addition, Sun & Gang (2006) describe Knowledge Discovery as the process of locating precious knowledge assets that exists in the organization. Knowledge Discovery is also used to excavate the valuable intellectual capital from the database, documentation and the tacit of experts (Sun & Gang, 2006).

The Knowledge Discovery process involves finding knowledge from either internal sources within the organization or external sources. It searches through the large sum of data and chooses the applicable information. It relies on digging out information from a variety of data sets utilizing modern experimental and examination techniques. It also relies on individuals who have the knowledge but may not be able to express it publicly. Furthermore, this process is useful in discovering knowledge which exists within a large, nonhierarchical or geographically diffuse organization (Bouthillier & Shearer, 2002). Knowledge Discovery relies on tools such as data mining and interviews. Data Mining assists knowledge hunters to discover preferred knowledge or unforeseen valuable knowledge from an enormous database. The interviewing process will with incentives encourage individuals to express the knowledge they possess (Sun & Gang, 2006).

2. The second stage is Knowledge Capture. Knowledge Capture is the process of reclaiming either explicit or tacit knowledge residing in people, artifacts or organizational bodies (Becerra-Fernandez, et al., 2004). Also, note that Knowledge Capture symbolizes the gaining of knowledge with essential competences and experiences for the creation and updating of the selected knowledge areas. Moreover, Knowledge Capture confines knowledge using matching technologies and symbols to formalize knowledge in the format used by computers (Deng & Dejie, 2006).

Furthermore, T.H. Davenport and Prusak (1998) illustrate Knowledge Capture as a process of obtaining the needed knowledge from sources such as buying and consulting, Research and Development (R&D) and learning and self-creation.

The significance of Knowledge Capture also depends on the culture and objectives of the organization (Sun & Gang, 2006). Consequently, Knowledge Capture is implemented using database holding indexes of external sources that can be important for the organization (Sun & Gang, 2006). Furthermore, Peachy & Hall (2005) portray Knowledge Capture for finding and acquiring knowledge in the knowledge-based resources.

3. Knowledge Creation is a process of creating new knowledge through the combination of internal knowledge with another internal knowledge and analysis of information to create new knowledge (Bouthillier & Shearer, 2002). Moreover, Knowledge Creation relies on the selection of both the internal and external knowledge needed by the organization (Sunassee & Sewry, 2002).

Organizations should recognize the enterprise requirements by comprehending their tasks, responsibilities and the knowledge needed (Supyuenyong & Islam, 2006). Furthermore, the organization needs to recognize the old, existing and new knowledge which might be desirable during the route of the KM endeavors and for business in the broad sense (Sunassee & Sewry, 2002).

Additionally, Sun & Gang (2006) claim that knowledge creation in the organization focuses on creating new products, enhancing ideas and provides more effective services or new ideas. Also, the knowledge creation process is attractive if the obtainable knowledge does not match needs or it is exclusive (Sunassee & Sewry, 2002). Additionally, the Knowledge Creation depends on the organization culture, organization objectives and research efforts (T.H. Davenport & McElroy, 2000). Furthermore, Knowledge Creation uses technological components such as brainstorming, decision support system, enterprise information portal, artificial intelligence, business intelligence, data mining and knowledge discovery tools (Ying-Hsun, Chou, & Gwo-Hshiung, 2007).

The three stages Knowledge Discovery, Knowledge Capture and Knowledge Creation promote a knowledge understanding of the specific topics relevant to the organization's goals and objectives. The three stages can interact with each other to enhance the knowledge obtained into the Knowledge Combination, which serves as a temporary repository.

5.3.2 Knowledge Combination

The Knowledge Combination process collects information discovered, captured and created into a single portfolio. This collected information is combined and prepared to go through an evaluation, filtering and then storage to prepare it for sharing and application. The Knowledge Combination process can be viewed as a temporary repository of collected information from the Knowledge Infrastructure.

5.3.3 Knowledge Evaluation

The Knowledge Evaluation process is used to assess the knowledge based on the value; accuracy and relevance after the knowledge have been combined from different sources. Sunassee & Sewry, (2002) claim that knowledge can be assessed based on the relevance to the organization, management strategy and business strategy. Moreover, knowledge must be evaluated to ensure knowledge is accurate and valuable before it can be shared in next processes (Sun & Gang, 2006).

This obtained knowledge, derived from different sources, can be either inaccurate, without value to the organization, or unrelated to the core business.

Moreover, any new obtained knowledge can be undeveloped knowledge with many mistakes (Sun & Gang, 2006). Therefore, the evaluation process is used to assess if the new knowledge merits further development (Sun & Gang, 2006).

De Rezende & de Souza (2007) state that evaluation is focused on quality and synthesizing knowledge for future application. The purpose is to determine the relevance and value of information. Also, the trust degree of knowledge must be established and redundant knowledge must be discarded. The uncertainty degree of unproven knowledge must be reduced. The identification and solutions for problems related to conflicting knowledge must developed. Finally, the use of multiple views in cases of unsolved contradictory knowledge must be supported. The output is a deeper and broad understanding of the knowledge in hand.

5.3.4 Knowledge Filtering

Knowledge Filtering prepares knowledge to be stored in the next process, after going through classification, categorization and organization. Knowledge also will be classified based on the sensitivity of the information and the access restrictions mandated by law or regulation to particular classes of people. Furthermore, knowledge can be categorized to recognize, distinguish and understand the information based on a specific purpose or type. Categorizing can be used to make practically significant differentiation between dissimilar categories of knowledge.

Lai & Chu (2000) recommend classifying knowledge by index, where knowledge can be linked, combined and integrated. In other words, this stage is concerned

with organizing knowledge and representing it to the Knowledge Repository for future retrieval.

Furthermore, knowledge can organize and rearrange the information based on certain rules and map the knowledge into specific requirements. Additionally, Knowledge Filtering structures the information with indexes, links and catalog for storage (Parikh, 2001). Knowledge is filtered to identify and cross-list the dimensions that are useful for different research and development projects.

5.3.5 Knowledge Repository

The Knowledge Repository serves as storage for the knowledge collected in the past stages. Therefore, this Knowledge Repository is the organization memory and serves the purpose of knowledge assets retention. Sun & Gang (2006) indicate that the Knowledge Repository must have sufficient storage media to accumulate knowledge and prevent valuable expertise from disappearing. Also, Knowledge Repository importance relies on the amount of knowledge accruing, objectives of organization, infrastructure and culture (Huber, 1991).

Moreover, Lai & Chu (2000) state that to preserve the explicit knowledge and smooth the progress of additional sharing, it is important to accumulate the significant knowledge. There are important decisions regarding what knowledge and how it should be positioned into the repository. Finally, updating the knowledge residing in the repository is an important task, and it can be assigned to particular knowledge workers to maintain up-to-date information and remove obsolete information. One approach to knowledge repositories is database systems, expert yellow-pages, frequent-ask-question

(FAQ), standard operation procedures (SOP), enterprise informational portal and centralized file management (Ying-Hsun, et al., 2007).

5.3.6 Knowledge Sharing

Knowledge Sharing concerns transferring and sharing knowledge among the individuals in the organization. In addition, this process is considered as a core process of the KM, since the main goal and objectives of the KM research and practice is to foster the flow of knowledge among individuals (Chua, 2004), (Shin, 2004). Moreover, a successful Knowledge Management system is a shared system where people can retrieve and contribute to the knowledge pool as well. In fact, people must speak the same language to be able to share knowledge.

Knowledge Sharing is executed by distributing and employing knowledge chosen from within the organization or outside (Sun & Gang, 2006). Furthermore, during sharing of knowledge, a new knowledge might be created by combining the shared knowledge and existing knowledge (T.H. Davenport & McElroy, 2000). Knowledge Sharing can be further expanded to include personalization and distribution (Parikh, 2001). Also, Knowledge Sharing structure is based on job expert training, training centers, focus group meetings, workshop and knowledge sharing councils (Ying-Hsun, et al., 2007).

According to Parikh (2001), intranets and extranets provide a suitable platform for Knowledge Sharing. User profiles can be use to personalize presentation and access to knowledge. Push technology can be used to automatically update and alert users when a change occurs. Therefore, to support Knowledge Sharing initiative, a mixture of inducement and co-operative structures of behavior within the culture of the organization are required.

Sun & Gang (2006) assert that Knowledge Sharing contains the following sub-processes: Knowledge Representation, Knowledge Distribution and Knowledge Utilization. Knowledge Representation is to represent knowledge in a clearer and storable way. Knowledge Distribution supports the spread of knowledge throughout the organization. Finally, Knowledge Utilization supports Knowledge Application.

5.3.7 Knowledge Application

The purpose of Knowledge Application is to apply and represent information to knowledge seekers in an appropriate matter. Knowledge application is also the solution to wrapping knowledge to guarantee widespread usage. Moreover, knowledge application translates information into practical tools and enables using the knowledge into the real world. Knowledge Application presents the knowledge in clearer and storable way (Sun & Gang, 2006).

Lai & Chu (2000) emphasize that knowledge can be available to individuals through human interactive processes or by using information technology. Moreover, technology can support knowledge applications by implanting knowledge into organizational practices. Likewise, knowledge can be pushed based on two strategies: push and pull (T.H. Davenport & Prusak, 1997). Push strategy makes a decision on what information is to be allocated to whom and automatically alert users of changes, while pull strategy is based on user requests and needs. Also, Knowledge Applications are based on technological components such as: workflow, expert system, patent management systems and enterprise information portal (Ying-Hsun, et al., 2007). Consequently, applying and having a value adding knowledge culture guarantee successful execution (Ying-Hsun, et al., 2007).

5.3.8 Knowledge Performance

Knowledge Performance, the final stage in the KM cycle, concentrates on evaluating every KM system and ensures it is performing according to the organization goals and objectives. Moreover, KM goal is to capitalize on the knowledge assets to reach maximum attainable business performance (T. H. Davenport & Prusak, 1998). Also, Knowledge Performance is concerned with evaluating the process, performance and impact of KM and perceives if new knowledge was created (Lai & Chu, 2000). Additionally, KM can improve a business process by contributing to Knowledge Performance, which can evaluate the impact of the change and provide a further enhancement.

Abdullah, et al. (2005) note that measurements can be implemented to benchmark the system to ensure quality and productivity to increase the Return of Investment (ROI). Also, Moczydlowska (2007) claim that measurement methods are based on different processes used to provide information on the amount of knowledge resources, their type and their exploit in pursue of organizational goals. Furthermore, Knowledge Performance can measure the Knowledge Sharing performance among the employees. Additionally, Knowledge Performance can evaluate the current potentials of the employees and how much gain was obtained from using the system. Finally, Knowledge Performance can evaluate the incentive and reward structures for sharing knowledge and pinpoint internal inconsistency (Massey & Montoya-Weiss, 2003).

It is not necessary for this knowledge processes to be a sequential process. Some activities may have a feedback to or from the others. Since some latter processing can be a base for some former processing processes. For example, during the

Knowledge Sharing process, if a new knowledge is created it has to go through the knowledge life cycle.

5.4 The Proposed KBRM Process Framework for IT Projects (RiskManIT)

The proposed KBRM framework illustrates the integration of some KM processes with RM processes to enhance risk identification, analysis, risk response planning, execution and monitoring by capturing and utilizing the appropriate and relevant risks based on organization goals and objectives. The purpose is to develop a road map for organizations to implement this conceptual framework for IT projects.

This section is adapted from the research publication: Karadsheh, L.; Alhawari, S.; El-Nathy, N.; Hadi, W.; (2008). "Incorporating Knowledge Management and Risk Management as a Single Process" which was accepted for the Proceeding of the GBDI Tenth International Conference, Las Vegas, October (2008).

Figure 25 illustrates an enhanced KBRM framework, called RiskManIT, which differs from the published framework mentioned in the previous paragraph. It contains additionally the Knowledge Application and Education component to provide a portal to access the latest information from the Knowledge-Based Risk Repository (KBRR) and provides for updating the knowledge relevant to risks residing in the repository. The Knowledge Essentials was also added to the framework. The Knowledge-based Risk Capture (KBRC), Knowledge-Based Risk Discovery (KBRD), Knowledge-Based Risk Examination (KBREx), Knowledge-Based Risk Sharing (KBRS), Knowledge-Based Risk Evaluation (KBRE), Knowledge-Based Risk Repository (KBRR) and Knowledge-Based Risk

Education (KBREdu) are illustrated in relation to RM processes shown in Figure 25.

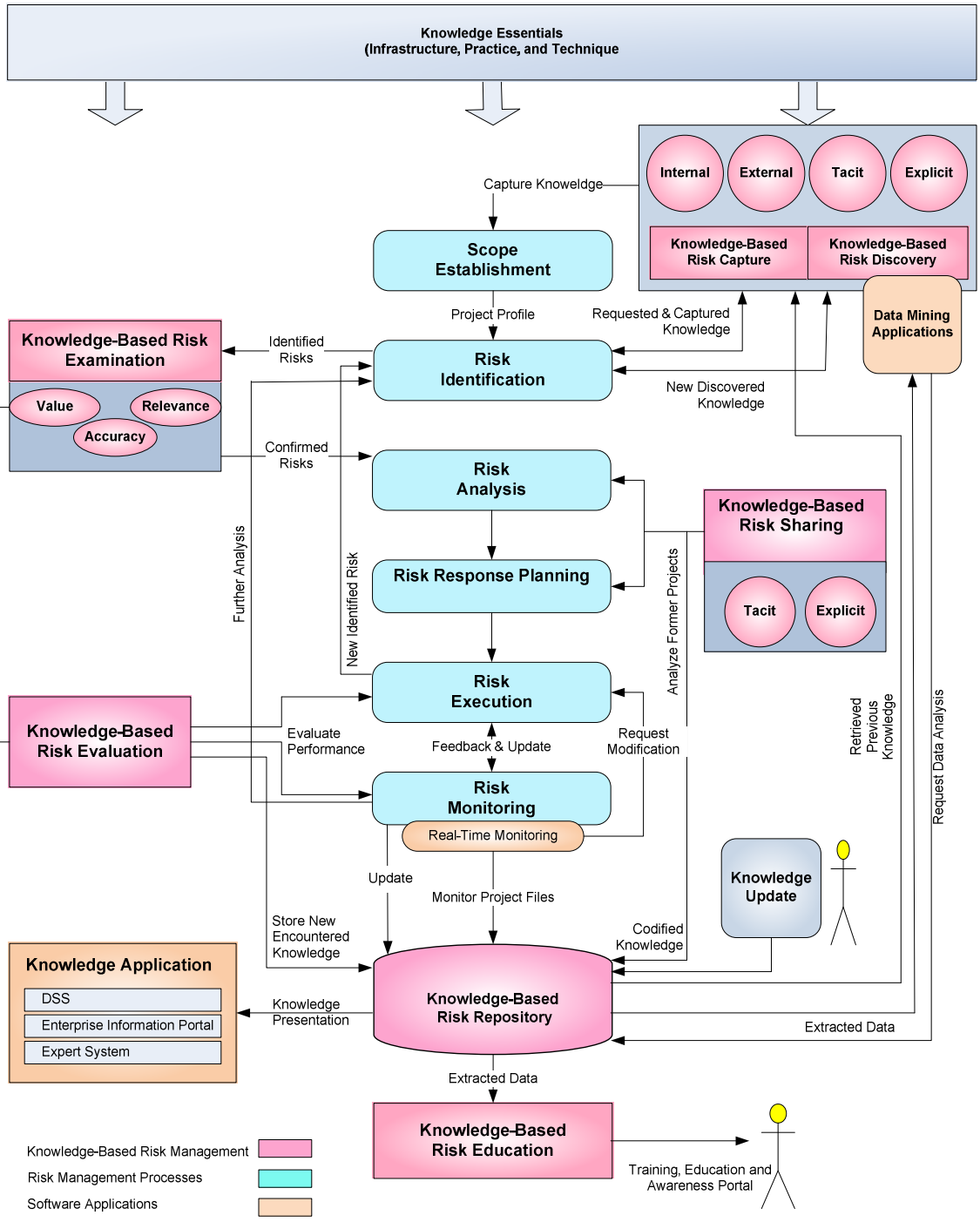

Figure 25 Conceptual Framework for Knowledge-Based Risk Management (RiskManIT)

5.4.1 Knowledge Essentials

Knowledge Essentials contains two important primary items, namely Knowledge Infrastructure and KM Practices and Techniques to support the KBRM framework.

5.4.1.1 Knowledge Infrastructure

Knowledge Infrastructure represents social capital, the relationships between knowledge sources and users and is operated by technology (the network itself), structure (the relationship) and culture (the context in which the knowledge is created and used) (M. E. Jennex, 2005).

The technology can be a document management system and yellow pages used as KM systems to facilitate knowledge capture and storage. In fact, there are also various software solutions that can be used to support these KBRM techniques: to help identify experts, to collect and distribute important information, to capture lessons learned, and to complete business research and analysis (Neef, 2005). Moreover, KM technologies can support risk modeling process in tasks such as: reading data, monitoring data quality, retrieving data and supporting software structures for quantitative analysis. These technologies are associated with data mining, data warehousing, project management, intranets, extranets, portals, knowledge base, taxonomies and ontologies or in explicit technological solutions for learning, content management, collaboration or management of workflow (Rodriguez-Montes & Edwards, 2008).

Structure promotes collective rather than individual behavior, thus encouraging interpersonal interaction and sharing of knowledge among employees. Finally, culture is defined by (Gold, et al., 2001) as "shared and widely accepted values

and visions that permeate in mind to direct work practice or facilitate necessary changes." The purpose is to infuse knowledge vision to everyone visibly, regularly, and extensively (Chan & Chao, 2008).

Sivan (2000) presents nine essential keys to building a strong foundation of Knowledge Infrastructure. The value of the keys stems mostly from their capacity to bring together the various players within an organization in a unified KM effort. The nine keys are arranged vertically, according to three processes: planning, implementing, and evaluating; and arranged horizontally, according to three centers of focus: individual, contextual, and organizational. Figure 26 illustrates the nine keys to a Knowledge Infrastructure.

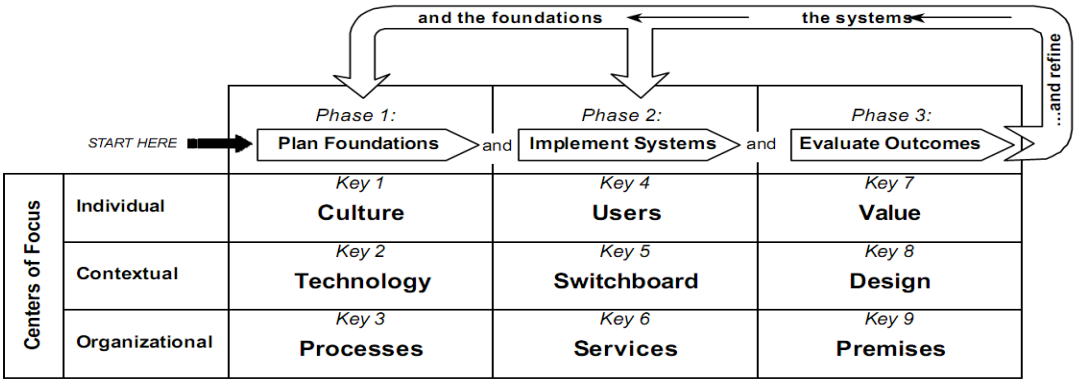

Figure 26 The Nine Keys of a Knowledge Infrastructure (Sivan, 2000)

Figure 26 provides suggested keys which are more or less relevant to a particular situation; one key may be the critical one, another less so. The nature of each key depends on the context of the organization. The main focus is on Phase 1 because Knowledge Infrastructure is built on three complementary foundations: culture, technology and processes. The culture must understand that knowledge is not static, KM is a core business process, all knowledge can't be fully managed all the

time and knowledge culture is both internal and external (Sivan, 2000). Next, technology should be utilized such as KM-specific software to resolve challenges comprehensively (Sivan, 2000). Finally, knowledge processes with the cultural and technological foundations in place, are the actual organizational procedures which can be "knowledge-ized." (Sivan, 2000). The three foundations of culture, technology, and processes are essential to the planning stage of building a Knowledge Infrastructure (Sivan, 2000).

Therefore, Knowledge Infrastructure is an essential organizational capability for effective KM and it should be viewed as a strong foundation for executing a successful KBRM processes. This requires having a strong knowledge culture supported by upper management, well embedded KM in business processes and a strong technology infrastructure to carry out the KM execution.

5.4.1.2 Knowledge Management Practices and Techniques

While KM technology uses IT with the focus on explicit knowledge, KM techniques use people learning with the focus on tacit knowledge. Also, KM techniques support the risk modeling knowledge process, which is associated with interdisciplinary work, interdepartmental work. KM allows for controlling the whole process from problem definition to solution evaluation. Some of these techniques are: communities of practice, forums, training, conferences, post project reviews, mentoring, yellow pages and so on (Rodriguez-Montes & Edwards, 2008).

Neef (2005) lists some important KM techniques and systems used by organizations:

- Knowledge Mapping: A process by which an organization determines "who knows what" in the company. It has many forms, including skills mapping, where employees list specialty knowledge and project experience, which is then captured in a repository and made available through the company's KM portal.
- Communities of Practice (CoP): These are naturally-forming networks of employees with similar interests or experience, or with complementary skills, who would normally gather to discuss common issues.
- Hard-Tagging Experts: This is a KM process that combines knowledge mapping with a formal mentoring process. Experienced employees are identified or "hard tagged" so they will become part of a consultation pool that will be available when special advice is needed on developing incidents.
- Learning: Employees should share experiences and techniques with others in the company so that there is a continuous and dynamic process of knowledge sharing and learning taking place.
- Encouraging a knowledge-Sharing culture with regular and consistent communication on values and on processes that encourage sharing of ideas and early identification of risks.
- Perform, monitoring and reporting: The need to measure, monitor, and boast of organizational performance.
- Community and stakeholder involvement is the key to good KM. It helps company leaders sense and respond to early concerns from outside parties and keep stakeholders informed of company policy.
- Business research and analysis: is the ability of a company to gain access to enormous amounts of business research and analysis materials. Companies need to create an information gathering capacity, developing a knowledge "research and analysis" capability in order to search for, organize and distribute information from internal and external sources concerning local political, cultural, and legal concerns.

Also, Becerra-Fernandez, et al., (2004) propose additional KM techniques and tools that may be use by organizations:

- Data mining can be used to create new explicit knowledge to help solving business problems in different areas such as: marketing, retail, banking, insurance, telecommunication and operations management.
- Stories telling techniques to capture and transfer tacit knowledge.
- A best Practice repository contains successful efforts and it is applicable to business processes.

- Lessons learned captured from previous projects.
- Expertise-locator (EL) system helps in locating intellectual capital. The purpose is to catalog knowledge competencies for future access.

Knowledge Essentials is a very important structure to KM processes and may be looked at as the base for RM executions. Moreover, Knowledge Infrastructure contains components that focus on building a base system to capture and distribute knowledge for use throughout the organization (M. E. Jennex, 2005). Therefore, KM Practices and Techniques provide several options and techniques to be used and chosen by the organization to capture tacit or explicit knowledge and share it throughout the KM processes. KM Practices and Techniques also rely on Knowledge Infrastructure to provide the essential knowledge to companies.

5.4.2 Knowledge-Based Risk Capture

In this section, the impact of the Knowledge Capture concept on some RM processes is examined. KBRC supports two important RM processes: Scope Establishment and Risk Identification. In the beginning, a description of KBRC purpose is provided followed by its impact on Scope Establishment and Risk Identification.

5.4.2.1 Knowledge-Based Risk Capture Process

In this conceptual framework, the Knowledge Capture process focuses on capturing both explicit and tacit knowledge, which exists within people and artifacts inside and outside the organization (Becerra-Fernandez, et al., 2004). Its main components are the internalization and the externalization processes (Nonaka & Takeuchi, 2004). Externalization engages in converting tacit

knowledge into explicit knowledge such as concepts, visual and words (Nonaka & Takeuchi, 2004). Internalization involves converting of explicit knowledge into tacit knowledge, which represents the learning concept.

Knowledge Capture relies on several mechanisms to support the elicitation of both tacit and explicit knowledge (Becerra-Fernandez, et al., 2004). The mechanism is the source of capturing explicit and tacit knowledge through different means. The mechanisms for externalization are models, prototypes, best practices and lessons taught (Becerra-Fernandez, et al., 2004). Consequently, the mechanism for internalization is learning by doing, on-the-job training, learning-by-observation and face-to-face meetings. Finally, any organization must create mindful efforts to detect, investigate and classify relevant knowledge to capture it (Parikh, 2001). Figure 27 illustrates the activities, input and output associated with the KBRC process.

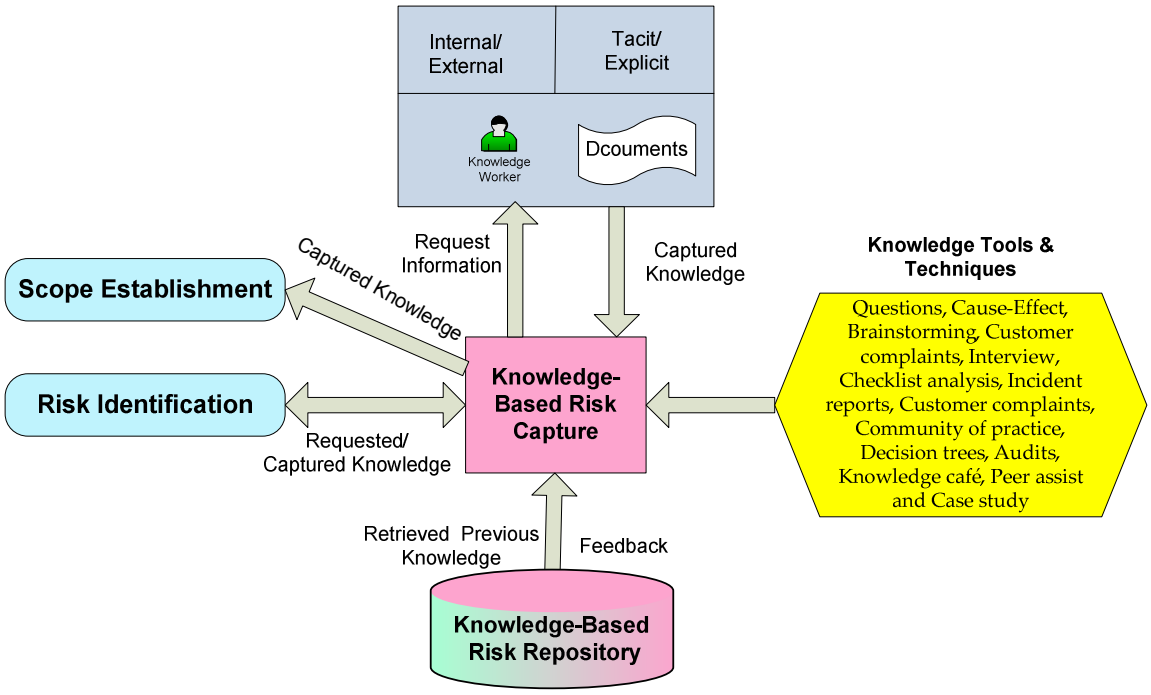

Figure 27 Knowledge-Based Risk Capture Process

5.4.2.2 Scope Establishment

KBRC supports the first process of RM, namely Scope Establishment. In a study by Mees (2007), Scope Establishment contains the scope of the RM process by describing the targeted information system, its boundaries and environment, and its identity and objectives of stakeholders. Moreover, Stonebumber, Oguen, & Feringa (2002) indicate that system characterization is required to define the scope of the effort by establishing the boundaries of the IT system which are identified, along with the resources and the information that constitute the system. The purpose of system characterizing is to establish the scope of the risk assessment effort, delineate the operational authorization (or accreditation) boundaries and provides information (e.g., hardware, software, system connectivity, and responsible division or support personnel) essential to defining the risk.

During this process, the information requirements from the stakeholders are captured to help in making informed decision involving risks. Also, all information regarding the project will be captured, and includes the following:

1. Establish RM policies describing the guidelines under which RM is explicitly defined.
2. Description of the procedures to be followed in the RM process.
3. Establish the roles and responsibilities for performing RM.
4. Assign the needed resources.
5. A description of the process for evaluating and improving the RM process, along with how information will be captured for lessons learned.

Furthermore, any relevant lessons from a prior use of the process should be incorporated into this implementation of the process ("Systems and software engineering - Life cycle processes - Risk management," 2006).

KBRC helps to review the goal definition, organization mission and vision as defined. The purpose of goal definition is to state the goals of the organization, clearly defines the constraints and implicit goals and analyzes the objective of the stakeholders (Kontio, et al., 1998). Moreover, this process promotes reviewing the strategy and defining the goals to clearly outline the objective, expectation and constraints (Kontio, 1997).

Kayis et al. (2007) developed a comprehensive RM tool called Intelligent Risk Mapping and Assessment System (IRMASe). The first process is Context Establishment, which defines organizational and user details, project objective, ownership, management support, regulatory requirements, nature of the project, type of project, schedule cut-off dates, estimated project budget, mitigation budget and government and/or regulatory authorities that needs to be complied. The purpose is to establish an overall risk profile by assigning a weighting to the infrastructure of the organization after the user's responses to a series of questions, covering the above-mentioned issues. The answers will be captured based on questions retrieved from the Expert Interview Facility (EIF); a database where all phase questions are stored and displayed to the users via the virtual workbench. The virtual workbench is to promote interactions with other project participants and facilitate communication. Figure 28 describes IRMAS.

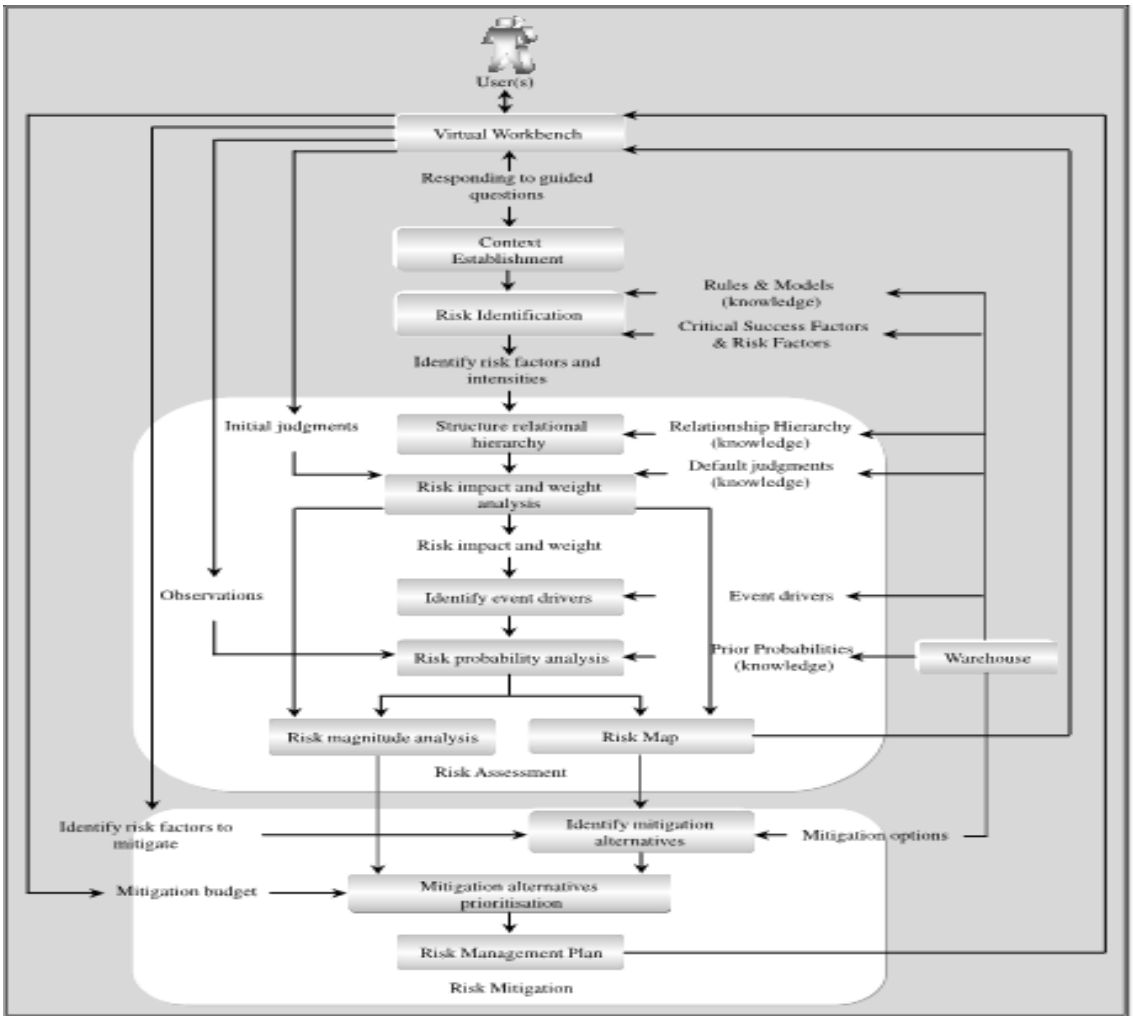

Figure 28 Intelligent Risk Mapping & Assessment Systems IRMAS

Furthermore, Knowledge Capture helps organizations to acquire any predefined approaches to RM such as risk categories, common definition of concepts and terms, standard templates, roles and responsibilities and authority levels for decision-making. Also, defined or included project scope is at the beginning of RM process for common understanding of the project scope among all project stakeholders and describe the project's major objectives (*A Guide to the Project Management Body of Knowledge : PMBOK guide*, 2004).

Also, Project Management Institute (*A Guide to the Project Management Body of Knowledge : PMBOK guide*, 2004) recommends adding risk cost elements and schedule activities which will be developed for inclusion in the project budget and schedule, respectively. Risk responsibilities will be assigned. General organizational templates for risk categories and definitions of terms such as levels of risk, probability by type of risk, impact by type of objectives and the probability and impact matrix will be tailored to the specific project.

The output of this process is a complete project profile with information regarding the IT project in hand. The goal is to provide information on the objectives, information system, schedule, resources needed and requirements.

5.4.2.3 Risk Identification

Risk Identification is studying a situation to realize what could go wrong in the product design and development project at any given point of time during the project. Sources of risk and potential consequences need to be identified, before they can be acted upon to mitigate risk (Ahmed, Kayis, & Amornsawadwatana, 2007).

Also, Risk Identification determines which risks might affect the project and documents their characteristics (Barati & Mohammadi, 2008). The purpose of Risk Identification is to identify a list of risks to which the IT project is exposed. The Risk Identification process is lengthy and creative. It relies on well trained, highly experienced human experts who are able to think creatively and imaginatively about the range and probability of future outcomes attached to a wide variety of events related to the project and its political and economic environment (Rezaie, Haghnevis, & Sajedi, 2007). Therefore, Knowledge Capture plays an important role in acquiring the knowledge of risk. As a result,

the KBRC process captures all risks from previous reports, lessons learned, other similar incidents and relevant articles as explicit knowledge. In terms of tacit knowledge, this process plays a major role in capturing the knowledge of risks from people based on their experience and relies on problem solving expertise. The result of the captures is stored in the explicit form containing the list of identified risks and is accessible to involved personnel.

Also, during this stage the historical and current RM circumstance and risk state information are captured. This helps in enriching project risk profile, which contains the total of all the individual risk profiles and risk states ("Systems and software engineering - Life cycle processes - Risk management," 2006).

According to Project Management Institute (*A Guide to the Project Management Body of Knowledge : PMBOK guide*, 2004) Risk Identification is an iterative process because new risks may become known as the project progresses through its life cycle. The frequency of iterations and who participates in each cycle will vary from case to case. Therefore, utilizing KM Tools and Techniques continuously and iteratively is required to ensure accurate and complete set of identified risks is essential.

Additionally, this process could result in constructing a comprehensive list of all applicable risks to the organization or to a particular project. Cornford (1998) claims that the sources of risks can be from surrounding environment, technology content, operation and constraints. Therefore, this process should be implemented repeatedly to ensure a comprehensive collection of risks. Moreover, the KBRC process is very critical because it relies on the expert's contemplation and experiences captured.

The researcher examined different literature reviews portraying the tools and techniques used in capturing knowledge. Some of the techniques are interviewing experts and stakeholders, brainstorming sessions, auditing reports, questionnaires and customer complaints (Alhawari, et al., 2008). Also, Stonebumer, et al. (2002) list the techniques used to gather risk information relevant to IT systems:

- Questionnaire: Develop a questionnaire concerning the management and operational controls planned or used for the IT system.
- On-Site Interviews: Interviews with IT system support and management personnel can enable risk assessment personnel to collect useful information about the IT system. Also, a site visit allows observing and gathering information about the physical, environment and operations.
- Document review: Policy documents (e.g., legislative documentation, directives), system documentation (e.g., system user guide, system administrative manual, system design and requirement document, acquisition document) and security-related documentation (e.g., previous audit report, risk assessment report, system test results, system security plan, security policies) can provide good information.
- Use of automated scanning tool: Proactive technical methods can be used to collect system information efficiently. For example, a network mapping tool can identify the services that run on a large group of hosts and provide a quick way of building individual profiles of the target IT system(s).

Furthermore, another recommendation to capture knowledge of risk by A Guide to the Project Management Institute (*A Guide to the Project Management Body of Knowledge : PMBOK guide*, 2004) uses the following tools and techniques:

- Documentation reviews,
- Information gathering techniques (brainstorming, Delphi technique, interviewing, root cause identification, SWAT analysis),
- Checklist Analysis,
- Assumptions Analysis,
- Diagramming Techniques (Cause-and-effect diagrams, System or process flow charts, Influence diagrams).

Additional approaches to identifying risk may include the use of risk questionnaires, taxonomies, brainstorming, scenario analysis, lessons learned, and prototyping or other Knowledge Capture approaches. Repeatable identification processes may be used to assist in the capture of lessons learned. Where possible, events, hazards, threats, or situations that can create risks should be identified to aid future risk treatment ("Systems and software engineering - Life cycle processes - Risk management," 2006).

The Risk Identification process facilitates and supports the following techniques (Ahmed, et al., 2007):

1. A checklist to record prearranged critical issues are examined for indication of the potential risk situation (Cross, 2001).
2. An influence diagram is a graphical symbol of the structure of the decision context such that decisions, uncertain events, consequences and their interrelationships are graphically itemized (Clemen & Reilly, 2001).
3. A cause-and-effect diagram is a graphical illustration of source causes of quality problems, where main reasons of the final problem are grouped and broken down into detailed sources (Russell & Taylor, 2000).
4. Failure mode and effect analysis (FMEA) provides a structure for determining causes, effects and relationships in a technical system. FMEA is used to determine failures and malfunctions through exploration of failure modes, consequences of a system component failure so that solutions for rectifying these problems can be visualized (Australia, 1999).
5. Fault tree analysis is a visual technique for breaking down failure in the system into source events (Cross, 2001).
6. Event tree analysis is a graphical representation of potential consequences arising from a failure where possible consequences are generated and broken down from an initial event (Cross, 2001).

The Risk Identification module in Intelligent Risk Mapping and Assessment System (IRMAS) utilizes a repository of questions covering different types of risks (financial, resources, communication, organizational, external, technical and

schedule) which are potential risk items related to the nature of project, project environment, organization, product, process partners, etc. (Kayis, et al., 2007). If Risk Identification requires more information, then, KBRC acquires knowledge from the repository and feed it to Risk Identification process.

Another reminder to the project team is not to assume that certain project risks are already known, and therefore, do not need to be listed. Because even with the best practice management processes in place; it could still occur and cause problems on a project over time. Therefore, it should be addressed rather than ignored (Wona, 2008).

There are numerous tools and techniques that can be use to elicit knowledge from the experts, key stakeholders, project team members or from explicit resources. Depending on the organization culture, business processes and technology infrastructure, some tools and techniques are suitable and some are not. Each one can be use in a certain time and occasion. No such tools are wrong or better than the others are. Having several tools and options to choose from provides better results, which are imperative.

The output of risk identification is a complete documentation, which describes the IT project assessed, a clear picture of the environment surrounding the IT project and the purpose and objective of the project. Also, Kayis, et al. (2007) states that the output of Risk Identification might contain:

1) List of identified risks with root causes and assumption.
2) Lists of potential responses to serve as input to risk planning.
3) Root causes of risk (Barati & Mohammadi, 2008).

Risk Identification may also contain valuable information captured to assist in starting the project based on solid information with "what to do" "how to do" "why to do" as well as "not to do" scenarios (Kayis, et al., 2007). This results in an IT risk project profile.

5.4.3 Knowledge-Based Risk Discovery

The impact of Knowledge Discovery on Risk Identification is examined in this section. A description of KBRD is followed by its support to the Risk Identification process and its link to KBRR.

Knowledge Discovery is defined as the development of a new tacit or explicit knowledge from data and information or from the fusion of prior knowledge (Becerra-Fernandez, et al., 2004). In fact, discovering new tacit knowledge relies on the combination, in which multiple bodies of explicit knowledge or data or information are fused to create, more complex sets of explicit knowledge (Nonaka, 1994). Therefore, linking Knowledge Discovery to the repository might be important to obtain the right knowledge.

KBRD starts by discovering organizational knowledge in relation to IT projects or any other type of project by sharing of tacit knowledge, so this unexplored knowledge can be amplified inside the organization. After that, the shared tacit knowledge is converted into explicit knowledge to form a new concept. At this point, the organization determines if the new concept is sufficiently relevant to be validated in order to justify it. Also, new concepts are converted into a template, where the created knowledge is extended to other organization teams, or even to external elements (de Rezende & de Souza, 2007).

The KBRD process in the organization requires discovering new risks or replacing the existing risks that don't apply to the organization in the current time based on the organization's tacit and explicit knowledge (Pentland, 1996). Figure 29 illustrates the activities, input and output associated with KBRD process.

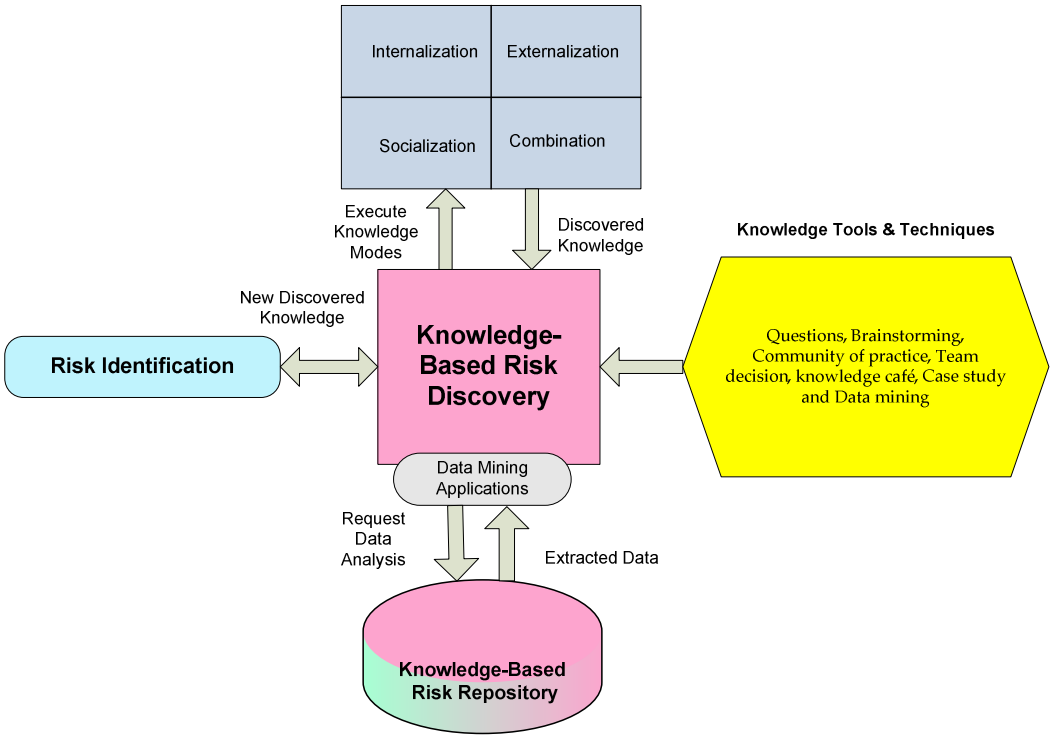

Figure 29 Knowledge-Based Risk Discovery Process

5.4.3.1 Risk Identification

Knowledge Discovery assists in discovering new risks associated with the company or a particular project. Managing risk appropriately requires project members to identify what the risks are, sources which might include a variety of causes such as technology content, surroundings interaction, constraints and operations and execution approaches (Cornford, 1998). In addition, Risk

Identification will be implemented repeatedly for evaluation purposes and coping with changes through KBRD and KBRC processes.

There are four modes of Knowledge Discovery identified as socialization, combination, externalization, and internalization (Nonaka, 1994):

1) Socialization represents the conversion of tacit knowledge to new tacit knowledge. According to I. Nonaka & R. Toyama (2003) socialization is the process of converting new tacit knowledge through shared experiences in day-to-day social interaction. Therefore, tacit knowledge can be acquired only through shared direct experience, such as spending time together or living in the same environment (Nonaka & Toyama, 2003). Having employees interacting with each other socially and sharing their experience allows them to identify possible risks using team meetings and discussions techniques. Also, Rodriguez-Montoes & Edwards (2008) suggest the social interaction among the RM employees and shared risk modeling experience is preformed.
2) Combination refers to the process of discovering new explicit knowledge. According to I. Nonaka & R. Toyama (2003) explicit knowledge is collected from inside or outside the organization and then combined, edited, or processed to form more complex and systematic explicit knowledge through the Combination process. The new explicit knowledge is then disseminated among the members of the organization. Therefore, this process combines different risks and re-categorizes the risks based on their severity. Also, merging, categorizing, reclassifying and synthesizing the risk modeling process is preformed (Rodriguez-Montes & Edwards, 2008). Moreover, creative use of the computerized communication networks and large-scale repository can facilitate this mode of knowledge conversion (Nonaka & Toyama, 2003).
3) Externalization: Such tacit knowledge is articulated into explicit knowledge through the process of Externalization. Additionally, tacit knowledge is made explicit so that it can be shared by others to become the basis of new knowledge such as concepts, images, and written documents (Nonaka & Toyama, 2003). Externalization assists in transferring tacit knowledge into new explicit knowledge to be shared by stakeholders through collaboration and discussion such as brainstorming (Alavi & Leidner, 2001). This helps in transferring the

risks stored as tacit knowledge into explicit knowledge ready for sharing and collaboration. Moreover, this process helps in articulation of best practices and lessons learned in the risk modeling process (Rodriguez-Montes & Edwards, 2008).

4) Internalization is a process based on generating new tacit knowledge from explicit knowledge. According to I. Nonaka & R. Toyama (2003) this stage can be understood as praxis, where knowledge is applied and used in practical situations and becomes the base for new routines. Thus, explicit knowledge, such as product concepts or manufacturing procedures, has to be actualized through action, practice, and reflection so that it can really become knowledge of one's own. Therefore, by analyzing and examining current or previous incident reports, an employee can discover new risks not previous identified. The tools such as brainstorming, questionnaires, team dialog and checklist can be considered as knowledge discovery tools to unleash hidden risks. This helps in exploiting all accessible information for the project to widen the potential risks (Cornford, 1998). Also, this process helps in learning and understanding from discussions and mathematical modeling review (Rodriguez-Montes & Edwards, 2008).

Knowledge Discovery contains several techniques and tools that can be deployed during the Risk Identification process to discover new risks not declared by the key stakeholders or project team members. The result of this process is a comprehensive list of identified risks created based on knowledge discovering techniques and tools formed explicitly and output to Risk Identification process.

5.4.3.2 Knowledge-Based Risk Repository

KBRD using data mining tools to uncover new relationships among explicit data that may lead to predictive or categorization models that create new knowledge (Becerra-Fernandez, et al., 2004). Therefore, Knowledge Discovery is the process of analyzing data from different perspectives and summarizing it into useful information (Qi, 2008), so it can be used to identify risks related to a specific project. Also, data mining software is one of a number of analytical tools for

analyzing data. It allows users to analyze data from many different dimensions or angles, categorize it, and summarize the relationships identified (Qi, 2008). Furthermore, processes by which risks are initially identified will vary between organizations but usually include one or more of the following: site visits, input from key project participants, brainstorming sessions with an assembled risk team, and information extracted from a repository of risk data compiled from previous experience (Tah & Carr, 2001). Therefore, KBRD can be used to access the repository searching for previous information through data mining tools. Data mining refers to extracting or "mining" knowledge from large amounts of data. Knowledge Discovery as a process may consist of an iterative sequence of the following steps:

1) Data cleaning: remove noise and inconsistent data.
2) Data integration: where multiple data sources may be combined.
3) Data selection: where data relevant to the analysis task are retrieved from the database.
4) Data transformation: where data are transformed or consolidated into forms appropriate for mining by performing summary or aggregation operations.
5) Data mining: an essential process where intelligent methods are applied in order to extract data patterns
6) Pattern evaluation: identify the truly interesting patterns representing knowledge based on some interestingness measures.
7) Knowledge presentation: where visualization and knowledge representation techniques are used to present the mined knowledge to the user (Han & Kamber, 2005).

Figure 30 illustrates data mining as steps in the process of Knowledge Discovery.

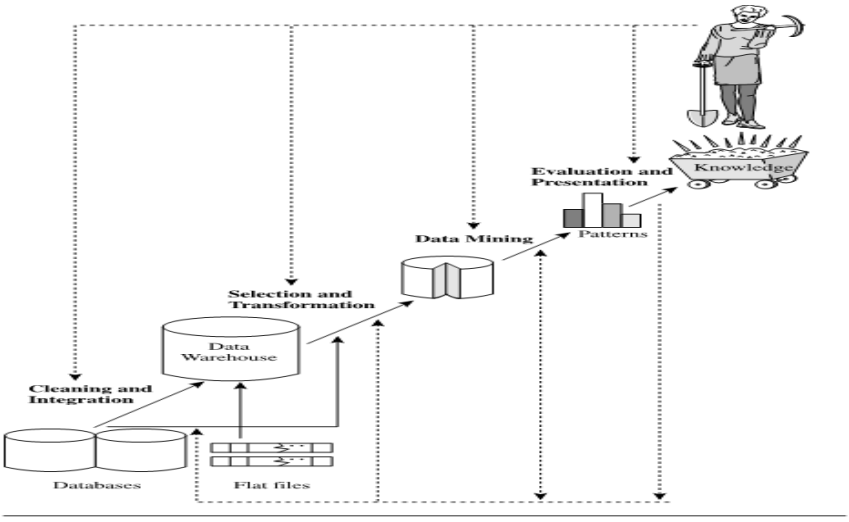

Figure 30 Data Mining as a Step in the Process of Knowledge Discovery (Han & Kamber, 2005)

KBRD through interaction with a KBRR can also discover new trends in the IT projects. As stated by (Becerra-Fernandez, et al., 2004), Knowledge Discovery interacting with the Knowledge-Based Risk Management (KBRM) repository, utilizing data mining tools can be employed to discover trends in the data that were not known previously. For example: given the profile of a new project, it is possible to collect information about any other project that has similarities with the current one, be aware of people that are interested in the same subject, or identify documents that talk about the same argument (Agostini, Albolino, De Michelis, De Paoli, & Dondi, 2003).

Moreover, KBRD can perform pattern discovery on previous stored IT projects with the new IT project. Senator (2005) claims that supporting this pattern matching task is the task of discovering patterns. While pattern matching may be thought of as inference, pattern discovery is more properly thought of as learning. Pattern matching and pattern discovery are really complementary – a pattern is discovered because of the existence of many instances and a pattern instance is matched from the pattern template (Senator, 2005). Therefore, KBRD

can help identify risks more efficiently and effectively utilizing data mining tools.

In fact, KBRD and KBRC complement each other, resulting in producing comprehensive, consistent and complete lists of risks. In addition, the general tools and techniques used in the previous two processes will include the documentation evaluation, brainstorming and origin grounds identification (Kasap D. & Kaymak, 2007) as an example, indicating a similarity of using some tools with the exception of data mining. Moreover, the tools and techniques mentioned above must be employed in each organization based on the culture and technology availability. Some tools and techniques might be suitable in some organization, while some others are unsuitable; this depends on the culture of the organization and technology infrastructure. Therefore, the selection of the appropriate tool or technique is a vital judgment. Finally, many of these tools and techniques will also be used in the next processes to contribute to the success of the IT projects.

5.4.4 Knowledge-Based Risk Examination

The researcher introduced the concept of Knowledge Examination in an attempt to inspect the impact of knowledge on RM. This process might act as middle between risk identification and risk analysis.

KBREx process focuses on examining carefully the content of risk against accuracy and correctness (Karadsheh et al., 2008). The knowledge is exposed to a methodical examination in order to inspect it with close attention (AlKhaldi, Karadsheh, & Alhawari, 2006).

Therefore, all collected lists of project risks will be compiled into a single list with the duplicates removed (Wona, 2008). The objective of this process is to support the Risk Identification activity and to produce the confirmed risks that are applicable to the IT project. In addition, analyzing the prospective risks through assigning a value on the impact on the progress of a project requires a knowledge brainstorming and team discussion sessions (Cornford, 1998). Figure 31 illustrates the activities, input and output associated with KBREx process.

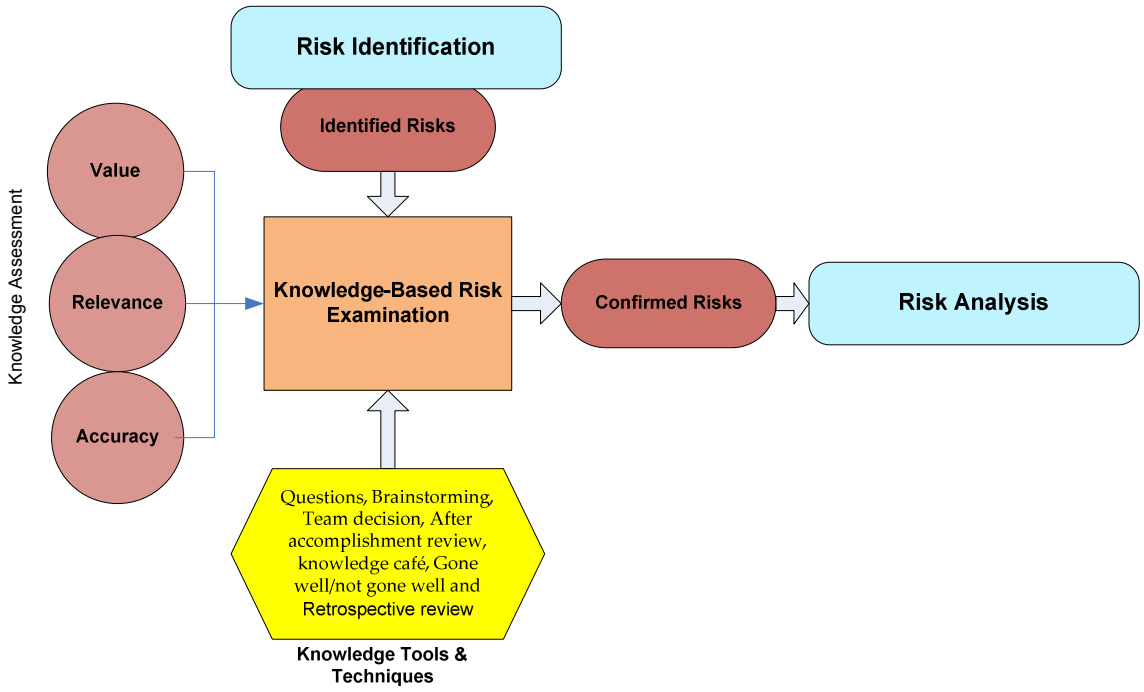

Figure 31 Knowledge-Based Risk Examination Process

KBREx process is used to assess the knowledge based on the value, accuracy and relevance after the knowledge has been combined from different sources (Karadsheh, et al., 2009). The knowledge in this process is referring to the knowledge of risks. Knowledge can be assessed based on the relevance to the organization, management strategy and business strategy (Sunassee & Sewry, 2002). Consequently, KBREx helps to assess the identified risks based on its

value, relevance and accuracy in reference to the IT project. Moreover, knowledge must be inspected to ensure knowledge is accurate and valuable before it can be shared in next phases (Sun & Gang, 2006). Therefore, once risks had been inspected and confirmed then the risks are ready for the Risk Analysis process.

Finally, KBREx process assists in evaluating risks and eliminates unrelated risks not associated to the project progress or company's objectives and goals (Karadsheh et al., 2008). The purpose is to convert the nominee risk to the confirmed list for the IT project. This final confirmed list is ready for the next process of RM, which is risk analysis.

5.4.5 Knowledge-Based Risk Sharing

The researcher attempts to study the effects of Knowledge Sharing on some RM processes. KBRS supports two important RM processes: Risk Analysis and Risk Response Planning. This section provides a detailed description of KBRS and its impact on the two RM processes, followed by a description of both Risk Analysis and Risk Response Planning.

KBRS is based on distributing knowledge among stakeholders to exchange their tacit knowledge about the risks and document the newly identified risk. Knowledge Sharing is executed by disseminating and exploiting the captured or discovered knowledge from the organization, whether the source is internal or external (Sun & Gang, 2006). Knowledge Sharing is the process through which explicit or tacit knowledge is communicated to other individuals (Becerra-Fernandez, et al., 2004). As well, Knowledge Sharing supports the transfer of

knowledge to another stakeholder involved in discovering new risks or mitigating the impact of the risks.

Additionally, Bouthillier & Shearer (2002) describe Knowledge Sharing process engagement as the conveying of knowledge from individual to another individual. Thus, Knowledge Sharing has emerged as one of the mainly dominant new organizational practices resulting in lessening the lost time needed in hunting for the appropriate expert (Kautz & Mahnke, 2003). Consequently, Knowledge Sharing relies on having the team working together, learning and communicating to share the risks associated with the organization during the Risk Analysis and Planning.

Consequently, distributing and employing the knowledge of the risks elected or produced exterior or within the organization is executed by Knowledge Sharing (Sun & Gang, 2006). KBRS is viewed as an iterative process for both the Risk Analysis and Planning processes because during Risk Analysis, a new risk might be exposed and this requires knowledge collaboration to assess its impact and severity.

KBRS supports knowledge transfer from individual to another individual in a collaboration environment. Therefore, the sharing of knowledge provides the grounds for personalization and codification. Personalization is based on individual to individual interaction to nurture the network and society practices (Papadaki & Polemi, 2008). On the other hand, codification is an individual-to-individual document tactic, with a purpose to add to the repository with best practices, case studies and how-to conduct (Papadaki & Polemi, 2008). Consequently, this process provides support for knowledge codification of risks, personalization support, cooperation support and communicative approach.

Furthermore, the team involved in evaluating the risks surrounding either the project execution or the organization can share their experiences in the progress, as well as providing input to the Risks Analysis or the Risk Response Planning processes for the purpose of modifying the sub-processes of both. Through this process, the team decides on which method is appropriate in executing Risk Analysis and Risk Response Planning. Tools used to facilities the Knowledge Sharing process is the best practice repository, alert system, lessons-learned and expertise locator systems (Baccarini, et al., 2004).

Neef (2005) stresses the importance of having a knowledge-sharing culture; which is the central success of a KBRM framework. This knowledge-sharing culture is the concept that values the expectations for ethical behavior, which needs to be communicated widely and effectively throughout the organization. In short, integrity has to become part of the corporate culture. There needs to be regular and consistent communications on values and on processes that encourage sharing of ideas and early identification of risks (Neef, 2005).

In a study by Rodriguez-Montes & Edwards (2008), risk modeling knowledge can be transferred through presentations, portals, meetings, discussions, collaboration activities, content management design, distribution and testing reporting. Also, Knowledge Sharing is different when it comes to individuals, individuals in groups, between groups, across groups, and groups to organization. All of these differences necessitate actions between the members to improve the communication processes and willingness to share by nurturing the existence and richness of transmission channels such as: unscheduled meetings, informal seminars, coffee breaks, quality of knowledge transfer channels, taxonomies, metadata, forums, bulletins, interdisciplinary solution search,

feedback sessions, discussing forums and so on. Figure 32 illustrates the activities, input and output with KBRS process.

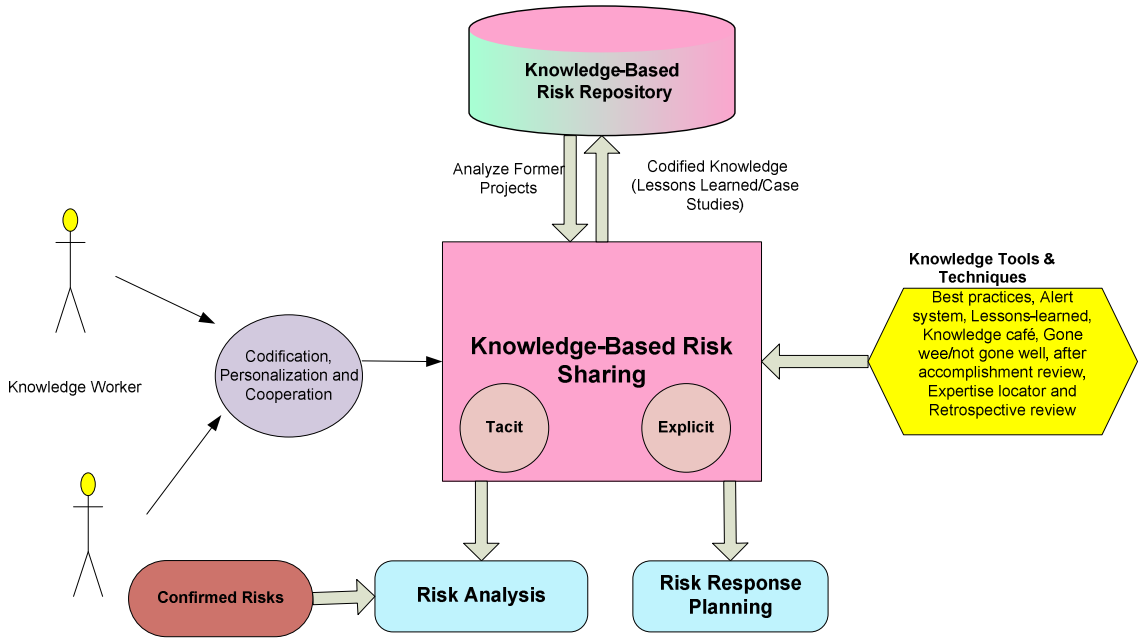

Figure 32 Knowledge-Based Risk Sharing Process

5.4.5.1 Risk Analysis

Risk Analysis facilities the conversion of risk data into decision making information (Higuera & Haimes, 1996). Based on the confirmed risks identified in the previous stage, risk analysis will perform analysis on each risk. The team members will share their experience on confirmed risks based on probability of occurrence, impact and extend of loss. This phase will contain 1) Probability of event occurring. 2) Risk impact to measure the severity of risk. 3) The extent of loss to determine the risk disclosure to list all risks and threats (Alhawari, et al., 2008).

According to the International Organization for Standardization ("Systems and software engineering - Life cycle processes - Risk management," 2006) the probability of occurrence and consequences of each risk identified shall be estimated. The estimates can be quantitative or qualitative depending on the organization. The stakeholders should share their knowledge in determining which risks will be assessed using a qualitative scale or quantitative scale.

Moreover, Wona (2008) indicates that Risk Analysis can be used to assess the probability (or likelihood), the impact (or consequence) and the detect ability of each item on the master list. This can be done by assigning each item on the list a numerical rating such as on a scale from 1 to 4 or a subjective term such as high, medium, or low. Detect ability is optional, but it can be simple to assess - if a risk is harder to see, then it is a riskier item. If it is easier to catch early, such as loss of management support or loss of a key resource, then it is lower risk.

During the Risk Analysis, the data collected is being renovated into decision making information (Alhawari, et al., 2008). Also, Risk Analysis will categorize the risk based on the probability of occurrence, impact and extend of loss (Higuera & Haimes, 1996). Another important step is the sharing knowledge in the process and to break the planning team into subgroups with each subgroup given a portion of the master list. Each subgroup can share their knowledge and then identify the triggers (warning signs) for its assigned list of project risks. All triggers should be noted, even minor ones. Normally there will be at least three triggers for each risk (Wona, 2008).

The output of the Risk Analysis process is a detailed description of every confirmed risk, severity, impact, priority, probability and impact estimates. This phase provides the means to establish the needed security controls in order to

reduce the impact of the risk to an acceptable level by the organization (Alhawari, et al., 2008).

5.4.5.2 Risk Response Planning

Risk Response Planning assists in converting the knowledge of risk into action and judgment and involves developing actions to deal with each risk, prioritizing measures and creating a management plan (Higuera & Haimes, 1996). This phase takes the information collected to formulate plans, strategies and actions and its ultimate goal is to reduce both the probability of risk occurring and the degree of that loss (Bruckner, et al., 2001). The Risk Response Planning process recommends the risk treatment actions needed in the later stages and requires selecting the proper security control methods according to the impact and the probability of risks. This phase also provides different execution possibilities and examines different "What-if" options.

According to Project Management Institute (*A Guide to the Project Management Body of Knowledge : PMBOK guide*, 2004), Risk Response Planning is the process of developing options and determining actions to enhance opportunities and reduce threats to the project's objectives. It includes the identification and assignment of one or more persons (the "risk response owner") to take responsibility for each agreed-to and funded risk response. Risk Response Planning addresses the risks by their priority, inserting resources and activities into the budget, schedule and project management plan, as needed. Also, planned risk responses must be suitable to the implication of the risk, cost effective, timely and realistic within the project context, agreed upon by all parties involved and owned by a responsible person. Selecting the best risk response from several options is often required.

Risk Response Planning turns risk information into decisions and actions. Planning involves developing actions to address individual risk, prioritizing risk actions and creating an integrated RM plan. The goal will include: 1) Reduction of the probability that a risk will occur (Bruckner, et al., 2001). 2) Reduction of magnitude of loss, or 3) Change of the consequence of a risk (Bruckner, et al., 2001). The process output according to Beck, et al. (2002) are simple rules, process controls, testing, modeling and inheritance.

The team shares their knowledge on selecting the best alternative for risk treatment in risk action requests. Whenever a risk treatment alternative is recommended in a risk action request, an evaluation shall be made by the stakeholders to determine if the risk is acceptable. If the stakeholders determine that actions should be taken to make a risk acceptable, then a risk treatment alternative shall be implemented, supported by the necessary resources, and monitored and coordinated with other project activities ("Systems and software engineering - Life cycle processes - Risk management," 2006). Moreover, Knowledge Sharing helps the team in Risk Analysis process to identify possible preventive actions for the threats and enhancement actions for the opportunities (Wona, 2008).

Furthermore, it is important to analyze the strategy of the risk treatment adopted in similar projects and verify the efficiency of control and contingency actions that were planned. This way, the manager learns from the facts of former projects, avoiding the recurrence of problems and reusing actions which were previously successful in the risk mitigation or contingency (Farias, et al., 2003). Once stakeholders reach an agreement on which risk treatment is accepted. A

detail treatment plan should be defined including a description of how the plan is to be executed.

During this stage the reporting and communication is established to the stakeholders. There will be internal and external reporting. The purpose is to share the knowledge obtained during the execution process ("A Risk Management Standard," 2002):

- Internal reporting: different levels within an organization need different information from the RM process.
- External reporting: a company needs to report to its stakeholders on a regular basis setting out its RM policies and the effectiveness in achieving its objectives.

Knowledge Sharing plays a vital role in establishing a collaborative environment that fosters the exchange of knowledge during IT projects. This might result in enhancing RM execution by reducing lost time in search for answers, faster learning and efficient executions of activities during certain RM processes.

5.4.6 Knowledge-Based Risk Evaluation

This section introduces the concept of Knowledge Evaluation and its effect on RM processes. The KBRE process serves as an assessment process for the Risk Execution and is done on a regular on-going basis by tackling risks in weekly, monthly or quarterly basis (Kasap D. & Kaymak, 2007).

Murthi (2002) claims that it is a good idea to set a date in the immediate future for the post-project review, in which the team will go over everything, good and bad, about the project with an eye toward improving the next one. The post-project review purpose is to look at lessons learned and future improvements in

project management. Therefore, any new knowledge might be stored in the KBRR for future use.

Consequently, all risk items will go through reassessment in terms of probability of occurrence and impact. This process will function as a continuous process leading to either retiring an existing risk once a solution is attained or identifying a new risk (Fayda, Ulusoy, & Meyanli, 2003). During the process, Knowledge Evaluation of experience encountered throughout the execution of the risk project will assist in modifying the process to maintain accuracy. Obtaining of information encountered during the risk execution should be stored in the KBRR in reference to the IT project. Figure 33 illustrates the activities, input and output associated with KBRE process.

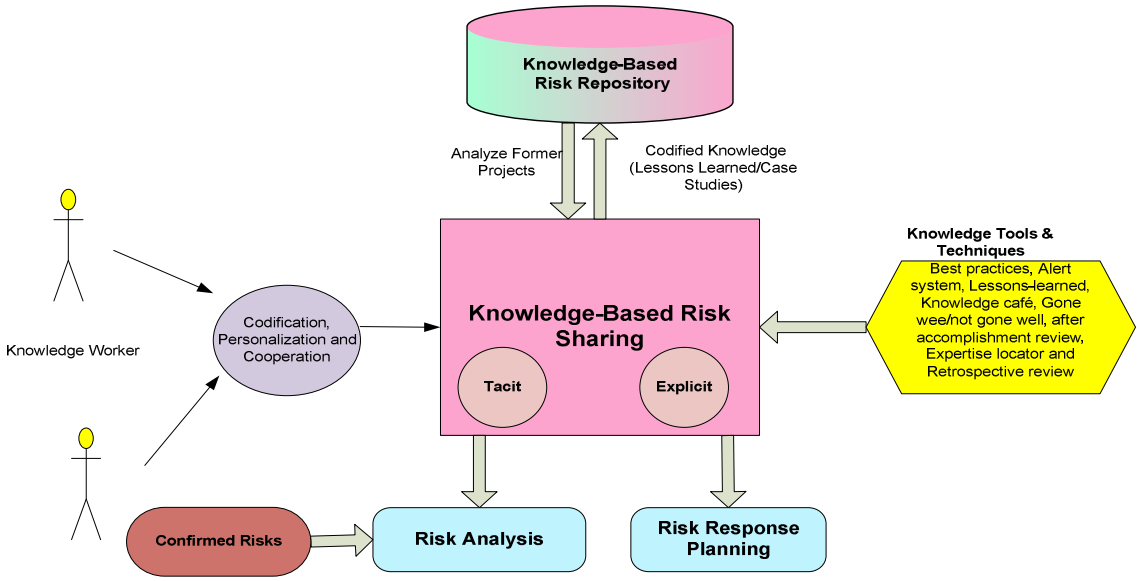

Figure 33 Knowledge-Based Risk Evaluation Process

5.4.6.1 Risk Execution

Risk Execution is the process of developing options and determining actions to enhance opportunities and reduce threats to the project's objectives. Risk Execution also addresses the risks by their priority, inserting resources and activities into the budget, schedule and project management plan, as needed. Planned risk responses must be appropriate to the significance of the risk, cost effective in meeting the challenge, timely, realistic within the project context, agreed upon by all parties involved and owned by a responsible person (*A Guide to the Project Management Body of Knowledge : PMBOK guide*, 2004).

According to Mees (2007), risk can be treated in a number of ways:

- Risk avoidance: Means simply not performing the activity that carries the risk.
- Risk reduction: This involves approaches that reduce the probability of the vulnerability being triggered or reduce the impact when the vulnerability is triggered. Risk control is implemented.
- Risk transfer: This means passing the risk on to another party that is willing to accept the risk, typically by contract or by hedging. A good example is insurance. According to Blakley, McDermott, & Geer (2001) risk transfer can be done in two ways:
    a. The business disclaims liability when it undertakes an activity with the explicit understanding that it will not be held responsible for the consequences of certain adverse events.
    b. Business transfer liability by entering into an agreement; by engaging into activity with a counter-party who will be responsible for the consequences of certain adverse events.
- Risk retention: Means accepting the loss when it occurs. Applicable to low impact risks. According to Blakley, et al. (2001) some businesses chooses to set aside funds to offset the cost of retained risks, it is said to self-insure against these risks.

5.4.6.2 Risk Monitoring

Risk Monitoring is viewed as a feedback process to reevaluate recent results of Risk Execution. The purpose of Risk Monitoring is to:

1) Review and update the individual risk states and the RM context.
2) Assess the effectiveness of risk treatment.
3) Seek out new risks and sources. ("Systems and software engineering - Life cycle processes - Risk management," 2006)

Risk must also be monitored to ensure that any control measures are working and to enable effective action to be taken if the risk occurred. The monitoring process continues to ensure that the assessment and handling procedures are effective and, if so, that the corrective action and strategy are working. If any of these proves to be negative, the risk may need to be reanalyzed or a new handling strategy may need to be adopted. Risks may also be removed only from the project if their chance of occurrence has passed or if they have been dealt with (Tah & Carr, 2001). Removing the risk from the project does not mean no documentation is preformed for future reference.

According to Project Management Insitiute (*A Guide to the Project Management Body of Knowledge : PMBOK guide*, 2004), Risk Monitoring is the process of:

- Identifying, analyzing, and planning for newly arising risks,
- Keeping track of the identified risks and those on the watch list,
- Reanalyzing existing risks,
- Monitoring trigger conditions for contingency plans,
- Monitoring residual risks and,
- Reviewing the execution of risk responses while evaluating their effectiveness.

Also, Risk Monitoring might require altering the current execution plan, ending the risk or even initiating a contingency plan if the current plan is found to be

ineffective and requires starting from the beginning of the risk process if a new risk has been identified (Perera & Holsomback, 2005). This might require starting from Risk Identification, which in turn needs to communicate with KBRC for further analysis and examination.

Furthermore, Project Management Insitiute (*A Guide to the Project Management Body of Knowledge : PMBOK guide*, 2004) claims that Risk Monitoring can involve choosing alternative strategies, executing a contingency or fallback plan, taking corrective action, and modifying the project plan. The risk response owner reports occasionally to the project manager on the effectiveness of the plan, any unanticipated effects, and any mid-course correction needed to handle the risk appropriately. Risk Monitoring also includes updating the organizational process assets, including project lessons-learned repositories and RM templates for the benefit of future projects.

Additionally, the team will meet to assess the risk project performance and to exchange their knowledge accordingly. The purpose is to share their experience and assess the outcome. According to "Systems and Software engineering - Life cycle processes - Risk management "(2006) three steps are important to monitor risk performance:

- Monitor risk throughout the life cycle for changes in their state using measures that will be recorded in the project risk profile.
- Measures shall be implemented and monitored to evaluate the effectiveness of risk controls. The cause of an ineffective control should be identified and remedied promptly. Criteria should be set by the team to determine when a risk is no longer needed to be monitored for control effectiveness.
- The system shall be continuously monitored for new risks and sources throughout its life cycle. New risks and sources shall be communicated to the stakeholders after risk analysis.

According to Institute of Risk Management ("A Risk Management Standard," 2002) any monitor and review process should determine whether improved knowledge would have helped to reach better decisions and identify what lessons could be learned for future assessments and management of risks. Consequently, Risk Monitoring can be evaluated by the KBRE process occasionally typically every bi-week.

The importance of Knowledge Evaluation is to provide an assessment for Risk Execution and Monitoring processes. This Knowledge Evaluation might result in enriching the repository with new information, modifying existing activities, identifying or retiring risks and providing a valuable feedback on the progress of RM project.

5.4.7 Knowledge-Based Risk Repository

The importance of having an integrated, dynamic and live repository for both KM and RM is examined in this section. The benefits of the Knowledge-Based Risk Repository and possible improvements to IT project success rates are reviewed also.

The lack of documentation on the success or failure of experiences is one of the reasons for inefficient RM utilization or non-utilization in software development organizations. The analysis of past experiences is fundamental in the planning and controlling of risks (Farias, et al., 2003). Wona (2008) states that upon completion of RM process, a master document, known as a risk register or risk matrix, is created. The most effective format for this document is a table, because it will allow a great deal of information to be conveyed in a few pages. The columns in the table can include risk description, probability, impact, detect

ability, triggers, preventive actions and contingency plan. Other columns, such as the quantitative value, can be added as appropriate.

Tah & Carr (2001) suggest a knowledge management system (KMS) should be developed to monitor risk, task and project profiles, and this will eventually provide decision support by suggesting risks and actions that may affect specific task types on new projects, based on previous project risk reports. Therefore, the purpose is to integrate the KM repository and RM repository as single storage area to maintain an up-to-date analysis of the risk information (Stollberg, et al., 2004).

The KBRR process preserves all the experiences captured during the previous projects by storing them in a single repository. This repository contains significant information, such as lessons learned and best practices stored in a computerized database. Additionally, the Risk-Knowledge Repository provides useful information for future risk analysis applicable to a wide variety of future projects (Karadsheh, et al., 2008). Lengyel (2009) claims that lessons can be appended to the risk record by program and project risk managers to help identify new risks and develop better plans for dealing with known risks. When a new risk is identified, the team can use related KBRs and other risks as sources to develop their risk mitigation, analysis and documentation approach.

To enrich the KBRR and keep it up to date, Blakley, et al. (2001) recommends collecting a comprehensive list of information security vulnerabilities. The information, which needs to be gathered and regularly updated, includes the ease and frequency of exploitation, ease and speed of recovery from exploitation. Furthermore, Blakley, et al. (2001) suggest that information is to be gathered about all security incidents experienced by the business worldwide. This

information will contain what vulnerabilities were exploited and how the response and recovery were handled.

Research conducted by Williams, Walker, & Dorofee (1997) found that several work groups kept risk information in their repository after the risks were closed. This information would be an incredible advantage to the organization on future projects. One group also documented lessons learned: When a risk was closed, they captured a record documenting the rationale for closing, successful and unsuccessful actions, assumptions that were proven wrong, mitigation costs and project savings or return on investment.

Papadaki & Polemi (2008) emphasize that knowledge codification can support information security RM. Stakeholders will be able to find the relevant RM knowledge. A codification strategy probably works best for certain types of knowledge that is not expected to change frequently. Participants can then easily retrieve methods and best practices that have proven themselves in the past and reuse them accordingly.

Moreover, KBRR can provide support for information security and RM personalization. Papadaki & Polem (2008) indicate that a personalization strategy could prove useful to enable participants to find who knows what. Furthermore, personalization techniques are also valuable to support the discussions and negotiations between stakeholders (Papadaki & Polemi, 2008). Therefore, the repository can be linked to KBRC to assist in finding previous risks for a particular project. Alternatively, to find the right person with experience in dealing with certain risks so this individual can be assigned a role. Moreover, a repository can push only the vulnerabilities and control measures that apply to the system and its scope context (Mees, 2007).

This repository can serve as a real-time modification of the consequential risks by providing up-to-date information for the project (Cornford, 1998). In risk monitoring, the real time monitoring of this process can help in modifying the risk execution process to maintain an update of the risk lists, which in turn will be stored in the repository of the KBRR system. If any new risk emerges during the software development as an example, it will be referenced immediately through the repository against previous similar projects to establish if there is a previous lesson learned or best practice to assist in dealing with this risk efficiently. Therefore, the integration of knowledge and risk repositories become essential to provide real time access and update information to enable fast evolving in the face of environment changes (Karadsheh et al., 2008).

KBRR may also be considered as a knowledge warehouse that is collation of information captured from generic engineering expertise, lessons learned (in-depth internal expertise), case studies (internal and external case-based knowledge), best practices (external benchmarking) and engineering standards. The access to such knowledge means that the tool is capable of enabling the use of past successes and failures captured to minimize risks in project management (Kayis, et al., 2007). The main components of the knowledge warehouse are (Kayis, et al., 2007):

- Case studies based on specific projects were primarily used by either interviewing or capturing information and identifying critical success and failure factors. A repository of risk items identified was populated with a summary of both internally and externally used case studies. A description of the risks including risk event drivers, mitigation strategies implemented, risk consequence and probability constitute the database of case studies. The user will be able to locate the number of occurrence of the same risks in several projects both within their organization and externally.

- Lessons learned is in-house knowledge captured based on past projects because the success factor can be derived from historical lessons learned. Furthermore, the lessons learned can also help in identifying the location of critical risk items, which are identified based on success factors from lessons learned and may be used to update Risk Identification (Kayis, et al., 2007), or Scope Establishment stages through the Knowledge Capture process. The gathering of information from several interviewees on the same project served to validate and provide increased credibility of the findings (Kayis, et al., 2007).
- Best practices transfer excellence from several sources into the organization, and serve to populate the repository with respect to identification of risk items and mitigation strategies.
- Profiles can be used, for example, to set up profiles of customers and suppliers, which are stored in the knowledge warehouse.

Therefore, having a live repository containing all projects' information is valuable to the project team and according to Wona (2008) provides a great amount of saving in time and establishes a risk mentality into your project culture. Figure 34 illustrates the activities, input and output associated with KBRR.

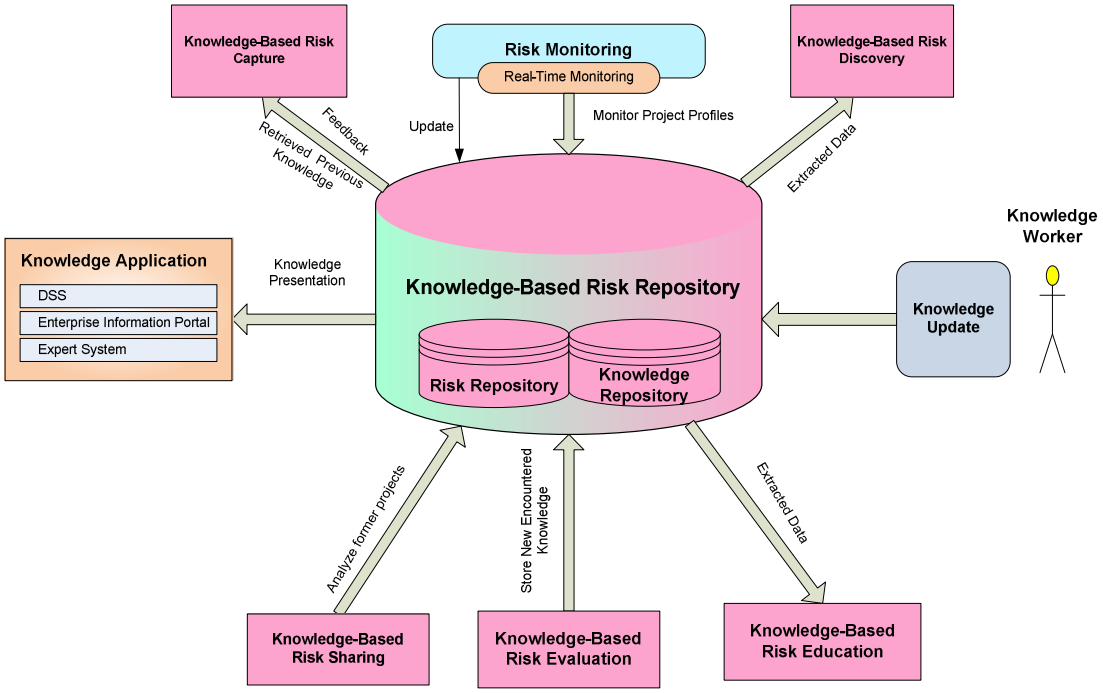

Figure 34 Knowledge-Based Risk Repository Process

KBRR represents the heart of the RM process, with data coming in and out to serve the RM in IT projects. This KBRR should be designed as a dynamic repository that is constantly feeding and storing information for immediate use at any time and any place.

5.4.7.1 Knowledge Update

Updating knowledge residing in the repository is an important task and it can be assigned to a particular knowledge worker to maintain the up-to-date information and remove outdated information (Karadsheh et al., 2009). Also, knowledge workers duties can be discovering and validating new knowledge, continuously validating and tuning of existing knowledge, retirement of obsolete knowledge, controlling and tracking the application of knowledge, and

documentation and communication of knowledge to affected business and technical staffs (Senator, 2000).

To enrich KBRR, Mees (2007) suggests that all risks can be imported from outside sources, for instance from the coalition partners, and are added at the level of the list with risks to be qualified. The probability and impact they received in the RM they originate from, will be used as a starting point, but will typically be adapted to take into account the role of the information they relate to in the information system that is being evaluated (Mees, 2007). Therefore, the KBRR updates will not be limited to internal sources and can be expanded to external sources resulting in rich information ready to be shared and used.

This knowledge worker will be involved from the beginning of the IT project until the end. The involvement will range from attending meetings such as brain storming, team discussion, user's questionnaires, interviews and observation. The purpose is to ensure that any new knowledge is codified according to the organization's standard. This ensures that no knowledge is lost and the codified knowledge in the repository is updated for future projects.

5.4.7.2 Knowledge Application

Knowledge application provides a portal to access latest information on the KBRR and an update to knowledge of risks residing in the repository. For example, expert system, Decision Support System (DSS) and enterprise information portal are tools used to facilitate access.

The development of the enterprise data warehouse, with data mining, data statistics and data analysis can produce implicit knowledge about the enterprise

The KBRR enables this information to be found, accessed, and updated. The, improvement, application and feedback of knowledge can be exercised through the excellent knowledge-base management system designed based on DSS (Liping, 2005). Also, Papadaki & Polemi (2008) claim that expert system can be linked to the repository to allow users to easily find colleagues based on experience, interests or projects on which they work.

5.4.8 Knowledge-Based Risk Education

The stored knowledge of risk in the repository can serve as a training, education and awareness tool. KBRR serves as a collection of best practices, lessons learned, and what we know to aid in shaping the potential actions and judgment in light of unpredictable environment surrounding the organization (A. Malhotra, 2002). An education portal can be design to provide training and knowledge transfer through easy-to-use interface to KBRR.

KBREdu is aimed on providing a list of previous encountered risk for similar cases or projects, thereby improving the team's ability to deal with future encountered situations that closely match a previous project. Since, individual project lessons may be gathered to help in identifying systemic risks ("Systems and software engineering - Life cycle processes - Risk management," 2006), then this can be served as a learning and education tool for future projects. Additionally, this process helps in providing training and education to deal with any risk that might occur in a future project and to avoid previous mistakes.

According to Lengyel (2009), the concept of knowledge-based risk (KBRs) is defined as risk record, with associated knowledge objects, which provide a storytelling description of how risk was mitigated and what worked and what

didn't. The goal is to transfer knowledge in risk context. This enables the team to review lessons captured and to be able to answer questions such as, "What was the control and mitigation strategy? Did it work? How were cost, schedule and technical performance affected?" This results in adding tacit knowledge to the individuals and makes them better prepared for future projects.

Figure 35 illustrates the activities, input and output associated with KBREdu process.

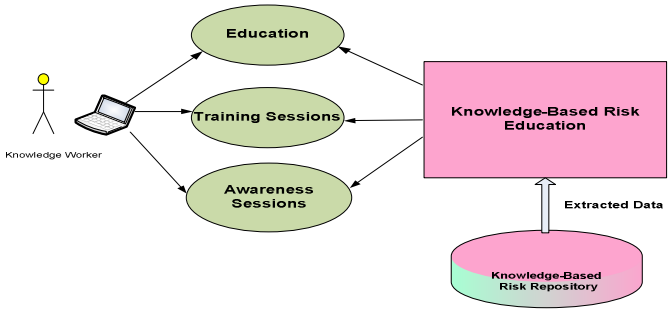

Figure 35 Knowledge-Based Risk Education Process

5.5 Summary

This chapter presents a conceptual framework for integrating KM with RM called KBRM (RiskManIT). The rationale for integrating KM and RM for IT projects is presented in Section 5.2. A comprehensive review of frameworks for KM processes based on the available literature is presented in Section 5.3. Finally, Section 5.4 discusses the proposed KBRM process framework for IT projects.

CHAPTER 6 DATA ANALYSIS AND FINDINGS

6.1 Introduction

The purpose of the data collection was to obtain data from subject matter experts in the fields of KM and RM based on the KBRM (RiskManIT) conceptual solution presented in Chapter 5. This chapter explains the process of interviewing the experts in Section 6.2. Section 6.3 discusses and illustrates the results of interviewing the experts based on the KBRM conceptual framework components. To achieve this purpose, close-ended and open-ended questions were compiled. In Section 6.4, a triangulation is performed to examine three different sources and findings to either support or refute findings. Finally, Section 6.5 presents a summary and conclusions.

6.2 Interviews with Experts

Ten experts were with extensive knowledge of KM and RM were identified based on the discussion of research methodology covered in section 4.6. The interviews included nine categories with a total of 44 close-ended questions and 2 open-ended questions.

6.2.1 Interview Design

The questions included two parts. The first part contains nine categories with close-ended questions on: Knowledge-Based Risk Capture, Knowledge-Based Risk Discovery, Knowledge-Based Risk Sharing, Knowledge-Based Risk Examination, Knowledge-Based Risk Sharing, Knowledge-Based Risk Evolution, Knowledge-Based Risk Repository, Knowledge-Based Risk Education and

Knowledge Essentials. The aim was to examine the relationship between KM processes and RM processes based on the conceptual framework of Chapter 5. The second part has two open-ended questions to acquire the experts' insight on the possibility of integration KM and RM processes, and to determine which KM processes have the most impact on RM based on their experience and knowledge.

Answers to the questions are based on the Likert scale to measure respondents' attitudes by asking the extent to which they agree or disagree with a particular question or statement. There are five possible ordered response levels for selection. Answers scaled from 1 to 5, where 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree and 1 = strongly disagree. Appendix A of this dissertation includes the interview questions and appendix B the consent form.

6.2.2 Interview Administration

Emails were sent to selected experts asking them if they can participate in the interview process. Once an email was returned with an acceptance, the questions and the consent form were forwarded to the respondents prior to the interviews with an attached cover letter providing some background of the research study. Then, a follow-up interview was conducted either face-to-face, or by telephone due to the unavailability of users, or because of their locations.

6.2.3 Experts

Ten experts were chosen based on their experience in KM and RM. Also, all of them have another diverse knowledge in areas such as Information Technology, Management Information System, Project Management, Customer Relation

Management, Process Methodology and Software Engineering. Moreover, all participants have long years of experience in their field and work in diverse industries ranging from small to large corporations. Additionally, job positions of the experts range from academic professors, specialists, and consultants to IT managers. Finally, some experts were located in different countries such as Jordan and Saudi Arabia.

6.3 Processing of Collected Data

There are two sub-sections; the first contains the analysis of the closed-ended questions and the second portrays the analysis of the open-ended questions.

6.3.1 Analysis of Closed-Ended Questions

The collected data was divided into tables based on the categories. The table contains questions and the interviewee's answers. Agree and strongly agree was combined as agree. Disagree and strongly disagree was combined as disagree. A neutral answer was considered as disagree in this research. Neutral can have several reasons, such as "Do not know enough about the question" or Do not care about it. Finally, a minimum of 70% is considered as fully supportive of the questions.

6.3.1.1 Knowledge-Based Risk Capture Results

The Risk Capture Results are examined to determine the impact of knowledge capture on scope establishment and risk identification processes. Table 6 lists the questions and the results.

Knowledge-Based Risk Capture	
Questions	**Results**
1) Knowledge Capture stage focuses on capturing both the explicit and tacit knowledge that exists within the employees and documents, whether from internal or external source?	100 % of the interviewees agreed.
2) Does capturing of knowledge from employees and documents play an important role in determining stakeholders' requirements, mission, goals, constraints and roles and responsibilities to create better scope establishment for the project?	70% agree of the interviewees agreed, while 30% disagreed.
3) Does capturing previous project information play an important role in enriching the project profile by comparing it with similar projects to save time and money?	80% agree of the interviewees agreed, while 20% disagreed.
4) Capturing risk information from previous reports, lessons learned, other similar incidents and relevant articles helps in identifying risks more efficiently?	100 % of the interviewees agreed
5) Knowledge Capture uses techniques to capture knowledge of risks, such as interviewing experts and stakeholders, brainstorming sessions, auditing reports, questionnaires and customer complaints?	100 % of the interviewees agreed.
6) Risk Identification and Knowledge Capture are iterative processes because new risks may become known as the project progresses through its life cycle.	100 % of the interviewees agreed.

Table 6 Knowledge-Based Risk Capture Analysis

Table 7 summarizes the data based on the frequency distribution, relative frequency and percent frequency. Figure 36 displays the distribution of responses (percentages that agree, disagree, etc.) in the form of a bar chart, with one bar for each response category.

Knowledge-Based Risk Capturing						
Questions	Frequency Distribution (Agree)	Frequency Distribution (Disagree)	Relative Frequency Distribution (Agree)	Relative Frequency Distribution (Disagree)	Percent Frequency Distribution (Agree)	Percent Frequency Distribution (Disagree)
Q1	10	0	1.0	-	100.0	-
Q2	7	3	0.7	0.3	70.0	30.0
Q3	8	2	0.8	0.2	80.0	20.0
Q4	10	0	1.0	-	100.0	-
Q5	10	0	1.0	-	100.0	-
Q6	10	0	1.0	-	100.0	-
Total	55	5	0.9	0.1	91.7	8.3

Table 7 Summarized Data for Knowledge-Based Risk Capture

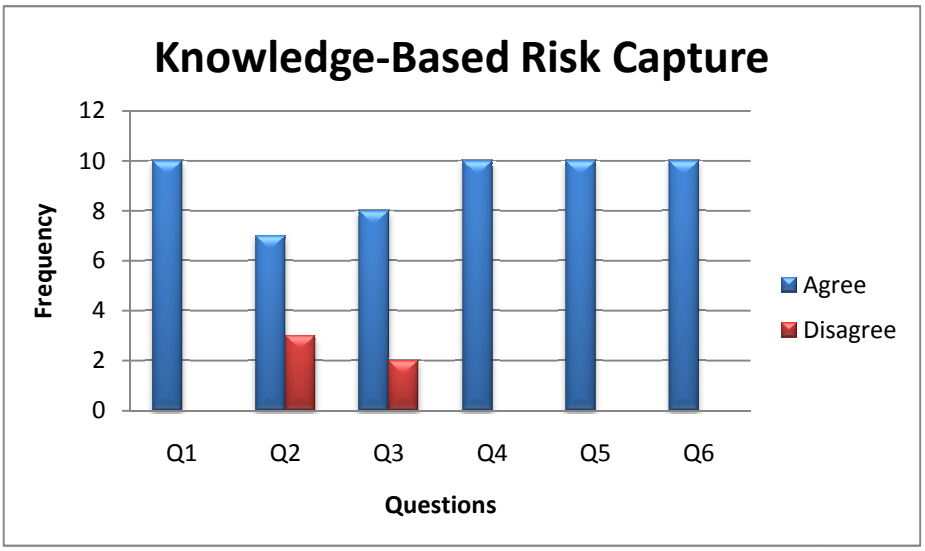

Figure 36 Distribution of Responses for Knowledge-Based Risk Capturing

The interview results show 91.70% agreed to the importance of Knowledge Capture on the RM. We can conclude that the majority agrees on the importance of capturing knowledge from internal or external sources and from tacit or explicit data. Capturing knowledge from previous projects, lessons learned, interviewing experts and brainstorming can also enrich the project profile. Finally, the interaction between Risk Identification and Knowledge Capture is an iterative process. Therefore, KBRC has a positive impact on Risk Identification and Scope Establishment.

6.3.1.2 Knowledge-Based Risk Discovery Results

The impact of Knowledge Discovery on Scope Establishment and Risk Identification is evaluated in this section. Table 8 lists the questions and the results.

Knowledge-Based Risk Discovery	
Questions	**Finding & Results**
1) The purpose of Knowledge Discovery is to obtain a tacit or explicit knowledge from data and information or from the blending of previous knowledge	100 % of the interviewees agreed.
2) Knowledge Discovery attempts to identify IT project information by sharing of tacit knowledge, so that an individual's unexplored knowledge may be amplified inside the organization.	70% agree of the interviewees agreed, while 30% disagreed.
3) Knowledge Discovery uses data mining techniques and tools to access stored IT projects in the repository to uncover previous project information or extract data patterns similar to the current project. For example: given the profile of a new project, it is possible to collect information about any other project that has similarities with the current one.	90% agree of the interviewees agreed, while 10% disagreed.
4) Techniques such as brainstorming, questionnaires, team dialog and checklists can be used for Knowledge Discovery that can be used to unleash hidden risks. This helps in exploiting all accessible information for the project to widen the potential risks.	100 % of the interviewees agreed.
5) Data mining software is an analytical tool for analyzing data. It allows users to analyze data from many different dimensions, categorize it, and summarize the relationships identified; the result may be a comprehensive list of risks for a specific project.	60% agree of the interviewees agreed, while 40% disagreed.

Table 8 Knowledge-Based Risk Discovery Analysis

Table 9 summarizes the data based on the frequency distribution, relative frequency and percent frequency. Figure 37 displays the distribution of responses (percentages that agree, disagree, etc.) in the form of a bar chart, with one bar for each response category.

Knowledge-Based Risk Discovery						
Questions	Frequency Distribution (Agree)	Frequency Distribution (Disagree)	Relative Frequency Distribution (Agree)	Relative Frequency Distribution (Disagree)	Percent Frequency Distribution (Agree)	Percent Frequency Distribution (Disagree)
Q1	10	0	1.0	-	100.0	-
Q2	7	3	0.7	0.3	70.0	30.0
Q3	9	1	0.9	0.1	90.0	10.0
Q4	10	0	1.0	-	100.0	-
Q5	6	4	0.6	0.4	60.0	40.0
Total	42	8	0.8	0.2	84.0	16.0

Table 9 Summarized Data for Knowledge-Based Risk Discovery

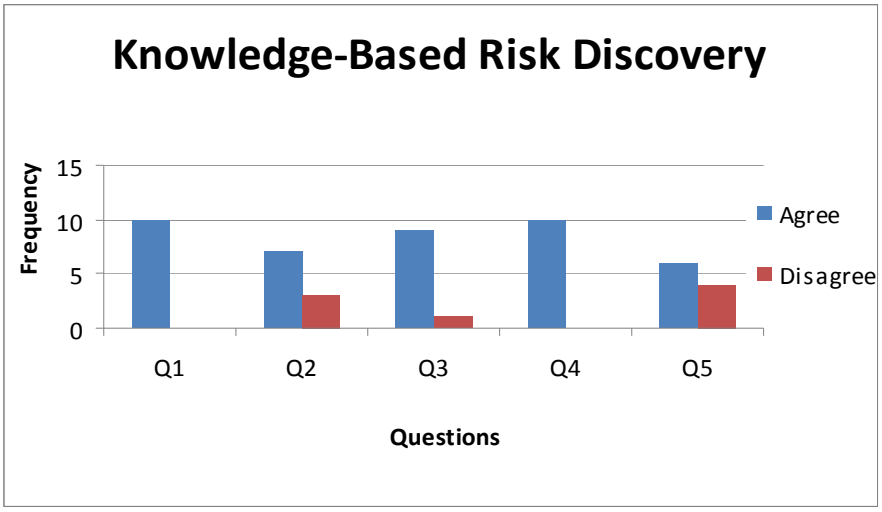

Figure 37 Distribution of Responses for Knowledge-Based Risk Discovery

The interview results show that 84% agree to the importance of Knowledge Discovery for the RM processes. We can conclude that obtaining tacit or explicit knowledge from information or from blending of preceding knowledge is possible. Also, using data mining tools to access the repository can help in uncovering previous project information similar to the current project. Finally, brainstorming, questionnaires, team dialog and checklists can be used to unleash hidden risks. This helps in exploiting all accessible information for the project to widen the potential risks. Therefore, KBRD has a positive impact on risk identification.

6.3.1.3 Knowledge-Based Risk Examination Results

This section examines the impact of knowledge examination on RM processes. Table 10 lists the questions and the results.

Knowledge-Based Risk Examination	
Questions	**Finding & Results**
1) The purpose of Knowledge Evaluation is to carefully examine the list of risks against accuracy, value, relevance and project	100 % of the interviewees agreed.

objectives in reference to an IT project.	
2) Knowledge Evaluation attempts to filter the identified risks before feeding the information for risk analysis.	90% agree of the interviewees agreed, while 10% disagreed.
3) Knowledge Evaluation eliminates risk not related to the project's progress or the company's objectives and goals.	70% agree of the interviewees agreed, while 30% disagreed.
4) Some of the techniques that may be used in Knowledge Evaluation are brainstorming and team discussion sessions to discover risks.	50% agree of the interviewees agreed, while 50% disagreed.

Table 10 Knowledge-Based Risk Examination Analysis

Table 11 summarizes the data based on the frequency distribution, relative frequency and percent frequency. Figure 38 displays the distribution of responses (percentages that agree, disagree, etc.) in the form of a bar chart, with one bar for each response category.

Knowledge-Based Risk Examination						
Questions	Frequency Distribution (Agree)	Frequency Distribution (Disagree)	Relative Frequency Distribution (Agree)	Relative Frequency Distribution (Disagree)	Percent Frequency Distribution (Agree)	Percent Frequency Distribution (Disagree)
Q1	10	0	1.0	-	100.0	-
Q2	9	1	0.9	0.1	90.0	10.0
Q3	7	3	0.7	0.3	70.0	30.0
Q4	5	5	0.5	0.7	50.0	50.0
Total	31	9	0.8	0.2	77.5	22.5

Table 11 Summarized Data for Knowledge-Based Risk Examination

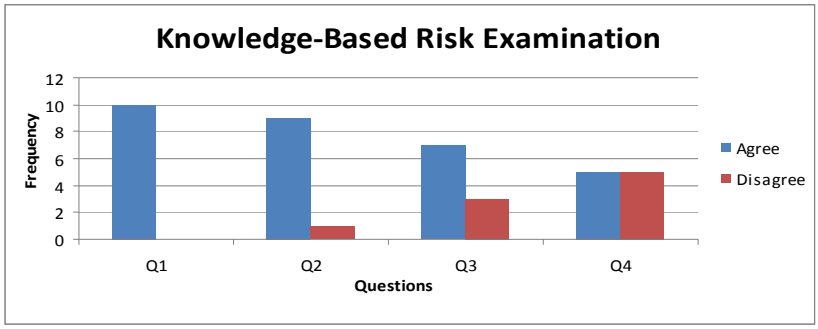

Figure 38 Distribution of Responses for Knowledge-Based Risk Examination

Over seventy seven percent of the interviewees agreed to the importance of Knowledge Examination on the RM. We can conclude that knowledge examination inspects the identified list based on accuracy, value and relevance. The output of this process is a confirmed list ready to be fed to Risk Analysis. Therefore, KBREx has a positive impact on RM processes.

6.3.1.4 Knowledge-Based Risk Sharing Results

The impact of knowledge sharing on risk analysis and Risk Response Planning is evaluated. Table 12 lists the questions and the results.

Knowledge-Based Risk Sharing	
Questions	**Finding & Results**
1) Knowledge Sharing is the process in which explicit or tacit knowledge is communicated to other individuals.	100 % of the interviewees agreed.
2) Knowledge Sharing is executed by disseminating and exploiting the captured or discovered risks from the organization whether the source is internal or external.	90% agree of the interviewees agreed, while 10% disagreed.
3) Risk analysis and planning rely on having team working together, learning, and communicating to share the risks associated with the IT project.	80% agree of the interviewees agreed, while 20% disagreed.
4) Knowledge Sharing is viewed as an iterative process for both the risk analysis and planning processes because during risk analysis, a new risk might expose and requires knowledge collaboration to reassess its impact and severity.	100 % of the interviewees agreed.
5) Techniques used to facilitate the Knowledge Sharing process is best practices, repository, alert system, lessens-learned and expertise locator.	100 % of the interviewees agreed.
6) Knowledge Sharing enhances risk analysis by having team share their experience on identified risks based on probability of occurrence, impact and extend of loss to produce more accurate results.	100 % of the interviewees agreed.
7) Knowledge Sharing improves team ability during Risk Response Planning process to formulate plans, strategies, actions and recommended risk treatment to enhance opportunities and reduce threats to the project's objectives.	90% agree of the interviewees agreed, while 10% disagreed.
8) Knowledge Sharing attempts to assist project team work by accessing the knowledge repository of former projects, avoiding the recurrence of problems and apply reuse actions that were previously successful in the risk mitigation or contingency.	100 % of the interviewees agreed.

Table 12 Knowledge-Based Risk Sharing Analysis

Table 13 summarizes the data based on the frequency distribution, relative frequency and percent frequency. Figure 39 displays the distribution of responses (percentages that agree, disagree, etc.) in the form of a bar chart, with one bar for each response category.

Knowledge-Based Risk Sharing						
Questions	Frequency Distribution (Agree)	Frequency Distribution (Disagree)	Relative Frequency Distribution (Agree)	Relative Frequency Distribution (Disagree)	Percent Frequency Distribution (Agree)	Percent Frequency Distribution (Disagree)
Q1	10		1.0	-	100.0	-
Q2	9	1	0.9	0.1	90.0	10.0
Q3	8	2	0.8	0.2	80.0	20.0
Q4	10		1.0	-	100.0	-
Q5	10		1.0	-	100.0	-
Q6	10		1.0	-	100.0	-
Q7	9	1	0.9	0.1	90.0	10.0
Q8	10		1.0	-	100.0	-
Total	76	4	1.0	0.1	95.0	5.0

Table 13 Summarized Data for Knowledge-Based Risk Sharing

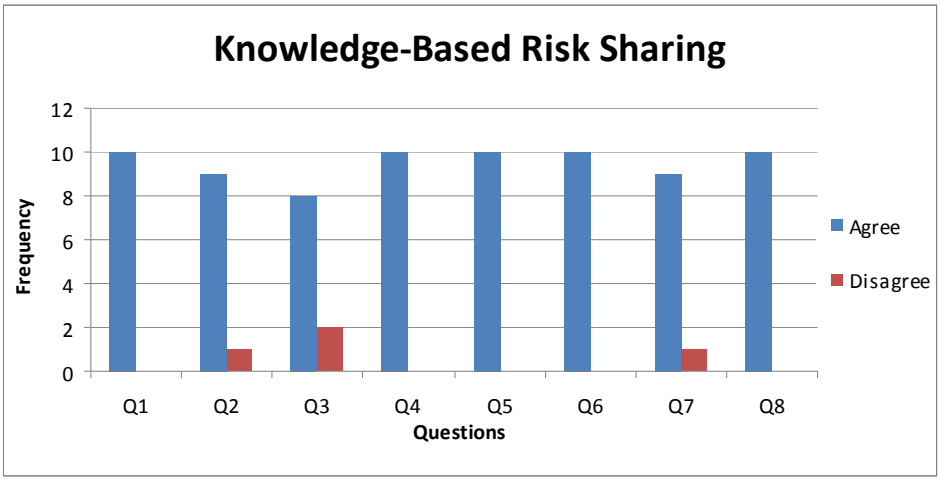

Figure 39 Distribution of Responses for Knowledge-Based Risk Sharing

The interview results indicate a 95% agreement on the importance of Knowledge Sharing for RM. We can conclude that majority agrees on Risk Analysis and Planning relying on having team working together, learning, and

communicating to share the risks associated with the IT project. Also, Knowledge Sharing is viewed as an iterative process since a new risk might be exposed and requires knowledge collaboration to reassess its impact and severity. Furthermore, Knowledge Sharing can access the repository searching for information to enhance opportunities, improve reuse and reduce threats to the project's objectives. Finally, the Knowledge Sharing process utilizes the best practices, repository, alert system, lessens-learned and expertise locator. Therefore, KBRS has a positive impact on Risk Analysis and Risk Response Planning.

6.3.1.5 Knowledge-Based Risk Evaluation Results

The impact of Knowledge Evaluation on Risk Execution and Risk Control is evaluated using the questions and results shown in Table 14.

Knowledge-Based Risk Evaluation	
Questions	**Finding & Results**
1) Knowledge Evaluation attempts to assess risk execution and risk control mechanism in on-going basis by tackling risks on weekly, monthly or quarterly basis.	80% agree of the interviewees agreed, while 20% disagreed.
2) Knowledge Evaluation may positively impact risk execution process by having the team addresses the risks by their priority, inserting resources and activities into the budget, schedule, and project management plan, as needed.	90% agree of the interviewees agreed, while 10% disagreed.
3) Risk monitoring attempts to utilize Knowledge Evaluation by ending risk, altering the current execution plan, initiating a contingency plan, examine the effectiveness of the plan, deals with any unanticipated effects, and any mid-course correction needed to handle the risk appropriately.	90% agree of the interviewees agreed, while 10% disagreed.
4) Knowledge Evaluation may enrich knowledge repository with lessons learned and best practices.	90% agree of the interviewees agreed, while 10% disagreed.
5) Knowledge Evaluation assists in reaching a better decisions and identifying what lessons could be learn for future assessments and management of risks.	100 % of the interviewees agreed.

Table 14 Knowledge-Based Risk Evaluation Analysis

Table 15 summarizes the data based on the frequency distribution, relative frequency and percent frequency. Figure 40 displays the distribution of responses (percentages that agree, disagree, etc.) in the form of a bar chart, with one bar for each response category.

Knowledge-Based Risk Evaluation						
Questions	Frequency Distribution (Agree)	Frequency Distribution (Disagree)	Relative Frequency Distribution (Agree)	Relative Frequency Distribution (Disagree)	Percent Frequency Distribution (Agree)	Percent Frequency Distribution (Disagree)
Q1	8	2	0.8	0.2	80.0	20.0
Q2	9	1	0.9	0.1	90.0	10.0
Q3	9	1	0.9	0.1	90.0	10.0
Q4	9	1	0.9	0.1	90.0	10.0
Q5	10		1.0	-	100.0	-
Total	45	5	0.9	0.1	90.0	10.0

Table 15 Summarized Data for Knowledge-Based Risk Evaluation

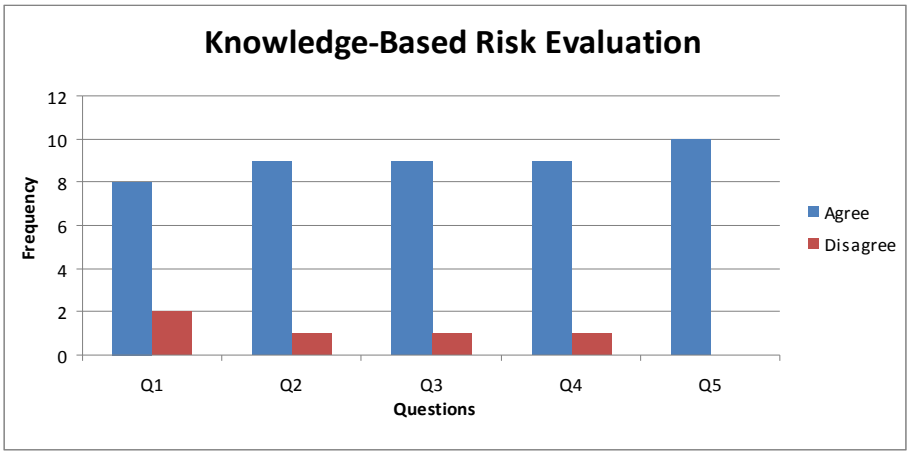

Figure 40 Distribution of Responses for Knowledge-Based Risk Evaluation

The interview results illustrate that 90% agreed on the importance of Knowledge Evaluation for the RM. We can conclude that majority agrees on the importance of Knowledge Evaluation on Risk Execution and Risk Control. Knowledge

Evaluation helps in reassessing the risk project progress positively by addressing risk issues and reaches better decisions. Finally, Knowledge Evaluation can enrich Knowledge Repository with new lessons learned and best practices for future management of risks. Therefore, KBRE has a positive impact on risk execution and risk monitoring.

6.3.1.6 Knowledge-Based Risk Repository Results

The evaluation of integrating Knowledge and Risk Repository on RM processes is discussed in this section. Table 16 lists the questions and the results.

Knowledge-Based Risk Repository	
Questions	**Finding & Results**
1) The lack of documentation on the success or failure of past experiences in IT projects is one of the reasons for inefficient RM executions.	80% agree of the interviewees agreed, while 20% disagreed.
2) Having a live repository containing all projects' information is valuable to the project team, and provides saving in time and helps to establish a risk mentality into your project culture.	80% agree of the interviewees agreed, while 20% disagreed.
3) Knowledge Repository may contain all the experiences, lessons learned, security incidents, case studies gathered during the previous processes in a single repository.	90% agree of the interviewees agreed, while 10% disagreed.
4) Knowledge Repository may be linked to Knowledge Capture process to assist in finding previous risks for a particular project or to find the right person with experience in dealing with certain type or risks.	100 % of the interviewees agreed.
5) Knowledge Repository may serve as a real-time modification of significant risks by providing up-to-date information during project execution process.	80% agree of the interviewees agreed, while 20% disagreed.
6) Any new risk emerge during the risk execution can be referenced immediately through the database against previous similar projects to establish if there is a previous lesson learned or best practice to assist in dealing with this risk efficiently.	70% agree of the interviewees agreed, while 30% disagreed.
7) Knowledge worker may be assigned to update the information, remove obsolete information and ensure any new tacit or explicit knowledge is codified for future use.	80% agree of the interviewees agreed, while 20% disagreed.
8) Application portal connected to the Knowledge-Risk Repository may provide access to answers for problems, clarify uncertainties and search for experts.	90% agree of the interviewees agreed, while 10% disagreed.

Table 16 Knowledge-Based Risk Repository Analysis

Table 17 summarizes the data based on the frequency distribution, relative frequency and percent frequency. Figure 41 displays the distribution of responses (percentages that agree, disagree, etc.) in the form of a bar chart, with one bar for each response category.

Knowledge-Based Risk Repository						
Questions	Frequency Distribution (Agree)	Frequency Distribution (Disagree)	Relative Frequency Distribution (Agree)	Relative Frequency Distribution (Disagree)	Percent Frequency Distribution (Agree)	Percent Frequency Distribution (Disagree)
Q1	8	2	0.8	0.2	80.0	20.0
Q2	8	2	0.8	0.2	80.0	20.0
Q3	9	1	0.9	0.1	90.0	10.0
Q4	10		1.0	-	100.0	-
Q5	8	2	0.8	0.2	80.0	20.0
Q6	7	3	0.7	0.3	70.0	30.0
Q7	8	2	0.8	0.2	80.0	20.0
Q8	9	1	0.9	0.1	90.0	10.0
Total	67	13	0.8	0.2	83.8	16.3

Table 17 Summarized Data for Knowledge-Based Risk Repository

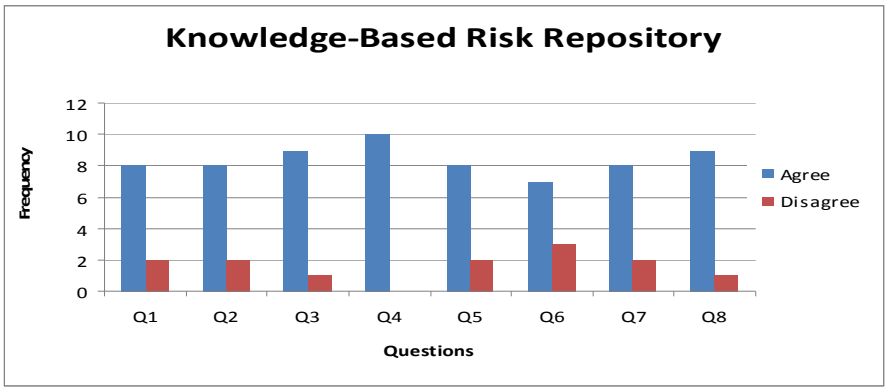

Figure 41 Distribution of Responses for Knowledge-Based Risk Repository

The interview results showed that 83.8% agreed regarding the importance of the Knowledge Repository on the RM. We can conclude that the lack of documentation on the success or failure of past experiences in IT projects is one of the reasons for inefficient RM executions. The live Knowledge Repository containing all projects' information is valuable to the project team. This

repository can contain all the experiences, lessons learned, security incidents, case studies gathered during the previous processes and can be linked to the Knowledge Capture processes. This will assist in identification of finding previous risks or finding the right person with experience in dealing with certain risks. The Knowledge Repository can also serve as a real-time modification of significant risks by providing up-to-date information during the project execution process. Finally, a knowledge worker is needed to ensure that the database is up-to-date and having an application portal enhances the ability to find answers and clarify uncertainties. Therefore, KBRR has a positive impact of RM processes.

6.3.1.7 Knowledge-Based Risk Education Results

The impact of Knowledge-Based Risk Education on RM processes and employees is considered in this section. Table 18 lists the questions and the results.

Knowledge-Based Risk Education	
Questions	**Finding & Results**
1) The stored collection of knowledge of risks in the repository can serve as training, education and awareness tool to current and future employees.	100 % of the interviewees agreed.
2) Knowledge Education is aimed on providing a list of previous encountered risk cases or projects stored in the repository to teach existing and/or new employees.	100 % of the interviewees agreed.
3) Training and education help employee to deal with any risk that might occur in future project and to avoid mistakes happened in the past.	100 % of the interviewees agreed.

Table 18 Knowledge-Based Risk Education Analysis

Table 19 summarizes the data based on the frequency distribution, relative frequency and percent frequency. Figure 42 displays the distribution of responses (percentages that agree, disagree, etc.) in the form of a bar chart, with one bar for each response category.

Knowledge-Based Risk Education						
Questions	Frequency Distribution (Agree)	Frequency Distribution (Disagree)	Relative Frequency Distribution (Agree)	Relative Frequency Distribution (Disagree)	Percent Frequency Distribution (Agree)	Percent Frequency Distribution (Disagree)
Q1	10		1.0	-	100.0	-
Q2	10		1.0	-	100.0	-
Q3	10		1.0	-	100.0	-
Total	30	0	1.0	-	100.0	-

Table 19 Summarized Data for Knowledge-Based Risk Education

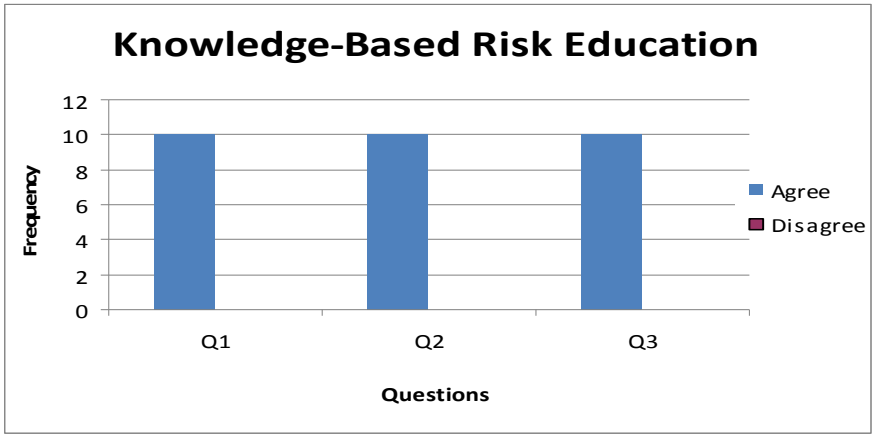

Figure 42 Distribution of Responses for Knowledge-Based Risk Education

All interviewees agreed on the importance of KBRedu on the RM. We surmise from this that majority agree on the importance of knowledge education for employees by promoting better training, education and awareness. Therefore, KBREdu has a positive impact on RM processes.

6.3.1.8 Knowledge Essentials Results

This section examines the impact of knowledge tools and techniques on RM processes. Table 20 lists the questions and the results.

Knowledge Essentials

Questions	Finding & Results
1) Appropriate technologies such as data mining, data warehousing, project management, intranets, extranets and portals for example, may support KM initiatives?	100 % of the interviewees agreed.
2) Developing and promoting a culture of knowledge discovery, capturing and sharing help RM initiatives.	100 % of the interviewees agreed.
3) Having a clear procedure of utilizing knowledge within the organization can promote a better execution of RM.	100 % of the interviewees agreed.

Table 20 Knowledge Essentials Analysis

Table 21 summarizes the data based on the frequency distribution, relative frequency and percent frequency. Figure 43 displays the distribution of responses (percentages that agree, disagree, etc.) in the form of a bar chart, with one bar for each response category.

Knowledge Essentials						
Questions	Frequency Distribution (Agree)	Frequency Distribution (Disagree)	Relative Frequency Distribution (Agree)	Relative Frequency Distribution (Disagree)	Percent Frequency Distribution (Agree)	Percent Frequency Distribution (Disagree)
Q1	10		1.0	-	100.0	-
Q2	10		1.0	-	100.0	-
Q3	10		1.0	-	100.0	-
Total	30	0	3.0	-	100.0	-

Table 21 Summarized Data for Knowledge Essentials

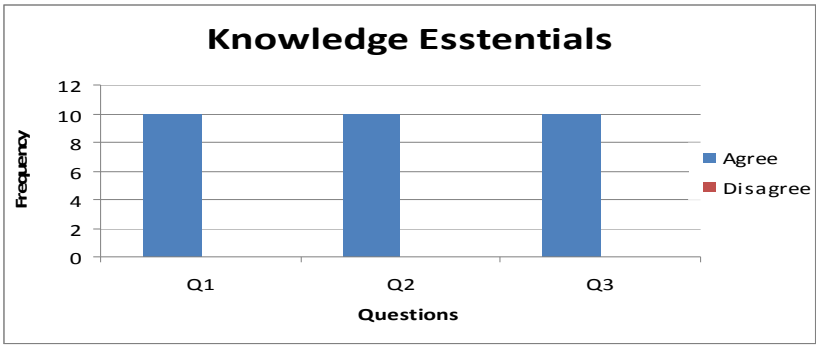

Figure 43 Distribution of Responses for Knowledge Essentials

The interview results show 100% agreed on the importance of Knowledge Essentials to the RM and how technologies, culture and clear procedures in this process can impact RM processes positively.

6.3.2 Analyses of Open-Ended Questions

Open-ended questions were formulated to structure the conversation and also to provide guidance and focus on the specific information that was needed for the research, within the interview process. The following open-ended questions formed part of the interview process:

1. How does the integration of KM and RM processes improve the organization's ability to manage and mitigate risks in IT projects in your opinion?
2. Which KM processes (Capture, Discovery, Share, Evaluate, Examination and Repository) are the most important to an efficient RM? Why?

6.3.2.1 Analysis of Question One

The purpose of question one is to determine to what extent the respondent understood the importance of integrating the KM and RM processes.

Based on the interviews for question 1, it was clear that many interviewees agreed how important it is to understand the purpose, scope requirements and business impact of projects that require KM. Some interviewees point out that KM and RM go hand-in-hand by utilizing previous knowledge from earlier projects. Since information is a valuable asset to any organization. Therefore, by integrating KM and RM, organizations would have a way to learn from past mistakes and avoid it in future projects. Additionally, a systematical

documentation of IT projects problems and issues in a repository can provide a baseline for improvement of future projects.

Another interviewee pointed out that the integration of KM and RM can help in discovering, capturing and treating risks efficiently. It is important to create a culture of knowledge that fosters and integrates it in every business process not only RM. KM is vital to RM, without appropriate KM, RM will fail. The importance of KM and RM in their IT projects progress was discussed by another interviewee. There are emphases on utilizing KM before, during and after every phase of the project. This includes collecting and documenting information, which result in improving the progress of RM.

An interviewee stated that KM is more of a formal way to conduct the RM process. KM can support the process and will assist the Project Manager (PM) in informing the RM process. A KM can be a valuable asset if properly used. KM is being done from an informal view but it is not explicitly called out in current RM processes.

An interviewee also acknowledged that the lack of knowledge might result in project failure due to a lack of knowledge sharing during project progress. Also, project failure can be the result of not capturing the appropriate knowledge at the right time, or discovering needed knowledge. Inappropriate or lack of KM implementation will result in lack of understanding of the goals and objective of projects, which translate into execution failure. Moreover, this interviewee ascertains from experience that a company cannot manage its risks effectively if it cannot manage its knowledge.

6.3.2.2 Analysis of Question Two

The purpose of question two is to understand the respondent's insight based on answering the closed-ended questions and understand the conceptual framework. The interviews based on question 2 clearly indicate that all knowledge processes are equally important and hold the same weight of importance. Others stated that knowledge capture, discovery, sharing and evaluation are most important, since written documentation does not provide the exact understanding that a verbal explanation or idea would.

Moreover, some interviewees point out that all KM processes are important, while two interviewees stated that knowledge examination is the least since it can be integrated with knowledge capture. Another claimed that knowledge evaluation and examination will usually have better indicators with shared knowledge. Furthermore, an interviewee mentioned that knowledge evaluation can be performed at the end of every process.

One of the interviewee stated that all of them seem to be important and it would be hard to say which one is most important. If you do not do one, then the other parts of the process may not be done efficiently or effectively. The interviewee agreed with the hypothesis that KM can be added to the RM process to improve the odds of success for an IT project. Finally, another interviewee pointed out the importance of KM capturing and sharing. Also, a redundant capture and share process will provide tangible benefits, since the remaining processes serve to formalize and refine the KM capturing and sharing processes.

6.4 Triangulation

Triangulation is the mixture of two or more data sources, investigators, methodological approaches, theoretical perceptions (Denzin, 1970; Kimchi, Polivka, & Stevenson, 1991), or analytical methods (Kimchi, et al., 1991) within the identical study. These mixture results in a data triangulation, investigator triangulation, methodological triangulation, theoretical triangulation, (Denzin, 1970; Patton, 2002), or analytical triangulation (Kimchi, et al., 1991). When two or more data sources along with two or more researchers, the result is a complex triangulation which is referred to as multiple triangulations (Denzin, 1970; Polit & Hungler, 1995).

Patton (2002) advocates the use of triangulation by stating "triangulation strengthens a study by combining methods. This can mean using several kinds of methods or data, including using both quantitative and qualitative approaches". Triangulation may also include multiple methods of data collection and data analysis, but does not suggest a fixed method for all the researches. The methods chosen in the triangulation to test the validity and reliability of a study depend on the criteria of the research (Golafshani, 2003). Furthermore, triangulation might enhance the completeness and confirmation of data in research findings of qualitative research. The use of both quantitative and qualitative strategies in the same study is a viable option to obtain complementary findings and to strengthen research results (Thurmond, 2001). The point of triangulation is to remove bias and increase the researcher's truthfulness of a proposition about some social phenomenon using triangulation (Denzin, 1970). Finally, triangulation is defined as "a validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study" (Creswell & Miller, 2000).

The author adopted theoretical triangulation, since the intent was to increase the level of confidence of the accepted hypothesis or theory, when the data findings are tested against an opposing hypothesis or theoretical framework (Mitchell, 1986). Theoretical triangulation is the use of multiple theories or hypotheses when examining a phenomenon (Denzin, 1970). The intent is to conduct the study with multiple lenses and questions in mind, to lend support to or refute the findings (Thurmond, 2001).

6.4.1 Validate Findings

This section examines three different sources and findings. The validation is based on the following:

- Literature reviews.
- Interviewee viewpoints, and
- Conceptual framework.

Table 22 describes the KBRC triangulation activities.

	Literature Reviews	**Interviewees Viewpoint**	**Conceptual Framework**
Knowledge-Based Risk Capture	1. The business domain estimates the knowledge and knowledge of the organization for the project (Roy, 2004). 2. During scope establishment: the information requirements from the stakeholders are captured to help in making informed decision involving risks ("Systems and software engineering - Life cycle processes - Risk management," 2006). 3. Knowledge capture helps organizations to capture any predefined approaches to RM such as risk categories, common definition of concepts and terms, standard templates, roles and responsibilities, and authority levels for decision-making. Also, define or include project scope at the beginning of RM process for common	Based on the interview result, 91.70% agreed to the importance of knowledge capture on the RM. We can conclude based on this result that majority agrees on the importance of capturing knowledge from internal or external and from tacit or explicit sources. Also, capturing knowledge from previous projects, lessons learned, interviewing experts and brainstorming can enrich project profile. Finally, the interaction between risk identification and knowledge capture is an iterative process.	The role of KBRC is to capture the right knowledge whether tacit or explicit and from internal or external sources based on request and submitted to the requester. The knowledge capture will obtain the appropriate information based on previous experiences and encounters and submitted to RM process at the right time and information to the right person. This help is establishing well defined and relevant identified risk and well established scope of the project. The purpose is to save project team the time and money in searching for information in previous projects.

	understanding of the project scope among all project stakeholders and describes the project's major objectives (*A Guide to the Project Management Body of Knowledge : PMBOK guide*, 2004). 4.Risk identification is performed by team using a brainstorming approach based on experience (Sommerville, 2006). 5. A comprehensive RM tool called Intelligent Risk Mapping and Assessment System (IRMASe) can be use to capture risks profile based on series of questions (Kayis, et al., 2007).		There are numerous tools and techniques that can be use to elicit knowledge from experts, key stakeholders or project team. Depending on the organization culture, some tools and techniques are suitable and some are not. Each one can be use in a certain time and occasion. No such tools are wrong or better than the other but having the option to choose from to provide better results are imperative. The result is a well defined project risk profile.
Conclusions	The three sources agreed that KBRC has a positive impact on risk identification and scope establishment.		

Table 22 Knowledge-Based Risk Capture Triangulation

Table 23 describes the KBRD triangulation.

	Literature Reviews	**Interviewees Viewpoint**	**Conceptual Framework**
Knowledge-Based Risk Discovery	1. Knowledge discovery assist in discovering new risks associated with a particular project. Managing risk appropriately, requires identify what are the risks, sources which might include a variety of causes such as technology content, surroundings interaction, constraints and operation and execution approaches (Cornford, 1998). 2. The tools such as brainstorming, questionnaires, team dialog and	Based on the interview result, 84% agreed to the importance of knowledge discovery on the RM processes. We can conclude that majority agrees that obtaining tacit or explicit knowledge from information or from blending of previous knowledge is possible. Also, using data mining tools to access repository can helps in uncovering previous project information similar to the current project. Finally, brainstorming, questionnaires, team dialog and checklists can be used to unleash hidden risks. This	Knowledge-Based Risk Discovery (KBRD) utilizes data mining tools to discover new risks that are associated with a particular project. Also, this process will analyze existing data from previous projects and discover any relation or trends to the existing project. Moreover, knowledge discovery contains several techniques that

	checklist can be considered as knowledge discovery tools to unleash hidden risks. This helps in exploit all accessible information for the project to widen the potential risks (Cornford, 1998). 3. Data mining or knowledge discovery is the process of analyzing data from different perspectives and summarizing it into useful information (Qi, 2008). 4. Given the profile of a new project, it is possible to collect information about any other project that has similarities with the current one, be aware of people that are interested in the same subject, or identify documents that talk about the same argument (Agostini, et al., 2003).	helps in exploiting all accessible information for the project to widen the potential risks.	can be deployed during the risk identification process to discover new risks not declared by the key stakeholders or project team. The result of this process is in identifying the most relevant risks to the current project saving the team time and money.
Conclusions	The three sources agreed that KBRD has a positive impact on risk identification.		

Table 23 Knowledge-Based Risk Discovery Triangulation

Table 24 describes the KBREx triangulation.

	Literature Reviews	**Interviewees Viewpoint**	**Conceptual Framework**
Knowledge-	1.Focuses on exposing the knowledge to a methodical examination in order to inspect it with close attention (AlKhaldi, et al., 2006). 2. Knowledge must be inspected to ensure knowledge is accurate and valuable before it can be	Based on the interview result, 77.5% agreed to the importance of knowledge examination on the RM. We can conclude that majority agrees that knowledge examination inspects the identified list based on accuracy, value and relevance. The output of this process is a confirmed list ready to be fed to risk analysis.	KBREx purpose is to inspect the list of risks collected in the previous process and provide only the confirmed list according to the project's objectives and goals. This final confirmed list is ready for the next process of RM, which is risk analysis.

Based Risk Examination	shared in next phases (Sun & Gang, 2006). 2.After identifying risks, a risk review is preformed based on inputs of team and stakeholders to validate risks as a "confirmed risk" (Blokdik, Engle, & Brewster, 2008). 3. All collected lists of project risks will be compile into a single list with the duplicates removed (Wona, 2008).		
Conclusions	The three sources agreed that KBREx inspect the list of risks collected in the previous process and provide only the confirmed list according to the project's objectives and goals.		

Table 24 Knowledge-Based Risk Examination Triangulation

Table 25 describes the KBRS triangulation.

	Literature Reviews	**Interviewees Viewpoint**	**Conceptual Framework**
Knowledge-Based Risk Sharing	1.KM contributes in better requirements analysis, communication and sharing of skills, result in more efficient project progress (Murthi, 2002). 2. KM as a discipline can add positively to RM implementation in reference to data and information management, risk-knowledge sharing (Shaw, 2005). 3. Risk Response Planning	Based on the interview results 95% agreed to the importance of knowledge sharing on the RM. We can conclude that majority agrees on Risk analysis and planning rely on having team working together, learning, and communicating to share the risks associated with the IT project. Also, knowledge sharing is viewed as an iterative process since a new risk might expose and requires knowledge collaboration to reassess its impact and severity. Knowledge sharing can access the repository searching for information to enhance opportunities, improve reuse and	KBRS allows employees to engage in RM activities by organizing, categorizing and monitoring risks as they relate to each business process. In fact, knowledge sharing across functions also enables employees to develop a big picture view of the company and identify the enterprise risks that span the organization and the interrelationships of those risks ("The New Age of Innovation: Managing Global Networks to Unlock Customer-Created Value in Your Company," 2008). The important of this process is to have the

	can be enriched by using knowledge and experience acquired by the various managers while working on the several organization projects (Farias, et al., 2003). 4. Distributing and employing of the knowledge of the risks elected or produced exterior or within the organization is execute by knowledge sharing (Sun & Gang, 2006). 5. The tools used to facilities the knowledge sharing process is best practices database, alert system, lessens-learned and expertise locator (Baccarini, et al., 2004).	reduce threats to the project's objectives. Finally, knowledge sharing process utilizes best practices, repository, alert system, lessens-learned and expertise locator. Therefore, KBRS has a positive impact on risk analysis and Risk Response Planning.	team share their tacit and explicit knowledge on risks encountered in previous work and their experience. Also, the team can share their thoughts by analyzing previous projects in a joint team environment, result in enhancing risk analysis and planning processes. KBRS purpose is to communicate explicit or tacit knowledge of risks effectively across project team and stakeholders. This sharing prompts learning from previous experience , which also helps to identify any triggers for risks in the project. Knowledge sharing plays a vital role in establishing a collaborative environment the foster the exchange of knowledge during RM projects. This might result in enhancing RM execution by reducing lost time in search for answer, faster learning and efficient executions of activities during certain RM processes.
Conclusions	The three sources agreed that KBRS is vital for risk analysis and Risk Response Planning. KBRS plays a vital role in establishing a collaborative environment the foster the exchange of knowledge during risk analysis and planning.		

Table 25 Knowledge-Based Risk Sharing Triangulation

Table 26 describes the KBRE triangulation.

	Literature Reviews	**Interviewees Viewpoint**	**Conceptual Framework**
	1. Risk learning formalizes the	Based on the interview results, 90%	The KBRE assesses the progress of

Knowledge-Based Risk Evaluation	lessons learned and uses tools to capture, categorize and index that knowledge in a reusable form that can be shared with others (Zardari, 2009). 2. (Murthi, 2002) stated it is a good idea to set a date in the immediate future for the post-project review, in which the team will go over everything, good and bad, about the project with an eye toward improving the next one. 3. All risk items will go through reassessment in terms of probability of occurrence and impact. This process will function as a continuous process leading to either retiring an existing risk once a solution is attained or identifying a new risk (Fayda, Ulusoy, & Meyanli, 2003). 4. According to Institute of Risk Management ("A Risk Management Standard," 2002) any monitor and review process should determine whether improved knowledge would have helped to reach better decisions and identify what lessons could be learned for future assessments and management of risks.	agreed to the importance of knowledge evaluation on the RM. We can conclude that majority agrees on the importance of knowledge evaluation on risk execution and risk control. Knowledge evaluation helps in reassessing the risk project progress positively by addressing risk issues and reaches better decisions. Finally, knowledge evaluation can enrich knowledge repository with new lessons learned and best practices for future management of risks. Therefore, KBRE has a positive impact on risk execution and risk monitoring.	the risk execution and monitoring by capturing any new encountered experiences or lessons learned. This process will help in enriching repository by feeding more information, so it can be use in future projects. The importance of KBRE is by providing an assessment for risk execution and monitoring processes. This knowledge evaluation might result in enriching the repository with new information, modifying existing activities, identifying or retiring risks and providing a valuable feedback on the progress of RM project.
Conclusions	The three sources agreed that KBRE has positive impact on risk execution and monitoring by capturing any new encountered experiences or lessons learned. Also, KBRE can enrich repository by supplying more information, so it can be use in future projects.		

Table 26 Knowledge-Based Risk Evaluation Triangulation

Table 27 describes the KBRR triangulation.

	Literature Reviews	Interviewees Viewpoint	Conceptual Framework
Knowledge-Based Risk Repository	1. The ability to gain information and database more efficiently, improve industry and review and evaluate the progress made in RM (Higuera & Haimes, 1996). 2. Having a live repository containing all projects' information is valuable to the project team, and according to (Wona, 2008) provides a great amount of saving in time and helping to establish a risk mentality into your project culture. 3. (Blakley, et al., 2001) recommends collecting a comprehensive list of information security vulnerabilities. The information needs to be gathered and regularly updated about the ease and frequency of exploitation, and ease and speed of recovery from exploitation. 4. (Papadaki & Polemi, 2008) stated that knowledge codification can support information security RM. Precipitants will be able to find relevant RM knowledge. 5. knowledge workers duties is the update of knowledge or discover and validate new knowledge, continuous validating and tuning of existing knowledge, retirement of obsolete knowledge, controlling and tracking	Based on the interview results, 83.8% agreed to the importance of knowledge repository on the RM. The lack of documentation on the success or failure of past experiences in IT projects is one of the reasons for inefficient RM executions. Also, a live repository containing all projects' information is valuable to the project team. Moreover, knowledge repository may contain all the experiences, lessons learned, security incidents, case studies gathered during the previous processes in a single repository. Furthermore, knowledge repository may be linked to knowledge capture process to assist in finding previous risks or to find the right person with experience in dealing with certain type or risks. Also, knowledge repository may serve as a real-time modification of significant risks during project execution process. Finally, a knowledge worker is needed to ensure that the database is up-to-date..	KBRR, which is considered as the heart of the knowledge-Based Risk framework. This repository contains all experiences, case studies, lessons learn and best practices. The KBRR can be used by the team to formulate their risk mitigation, analysis and planning. Moreover, KBRR can be used to find out who knows what in any subject related to project. KBRR can be used to modify any risk processes if any information matches what on the database. Also, KBRR can provide a real-time notification during the project execution for potential risk, this result in detecting risks that might be overlooked by the team; otherwise the project might suffer from money and time loss if not detected on time. Moreover, KBRR support education and training based on previous projects experiences to enhance the experience of employees and expand their knowledge. Therefore, without well established and solid repository, the amount of saving in time and help to establish a risk

	the application of knowledge, and documentation and communication of knowledge to affected business and technical staffs (Senator, 2000). 6. A repository can served as a real-time modification of the consequential risks by providing up to date information for the project (Cornford, 1998).		approach into your project culture is reduced resulting in jeopardizing the project progress.
Conclusions	The three sources support KBRR as a crucial element of RM. The KBRE contains all experiences, case studies, lessons learn and best practices. Also, KBRE can be an expert locator, progress modifier, real-time notification during the project execution and support education and training sessions based on its content.		

Table 27 Knowledge-Based Risk Repository Triangulation

Table 28 describes the KBRE triangulation.

	Literature Reviews	**Interviewees Viewpoint**	**Conceptual Framework**
Knowledge-Based Risk Education	1. Risk learning formalizes the lessons learned and uses tools to capture, categorize, and index that knowledge in a reusable form that can be shared with others (Zardari, 2009). 2. According to (Lengyel, 2009), the concept of knowledge-based risk (KBRs) is defined as risk record, with associated knowledge objects, which provide storytelling description of how risk was mitigated and what worked and what didn't. The goal is to transfer knowledge in risk context. This able the team to review lessons captured to be able to answer questions such as, "What was the control and mitigation strategy?" Did it	Based on the interview results, 100% agreed to the importance of KBREdu on the RM. We can conclude that majority agrees on the importance of knowledge education on employees by promoting better training, education and awareness. This results in more efficiency in executing IT brisk projects.	KBRR support education and training based on previous projects experiences to enhance the experience of employees. KBREdu purpose is to provide training and education to enhance the team's knowledge for future encountered situations that closely match a previous experience. This process helps in providing training and education to deal with any risk that might occur in future project and to avoid mistakes happened.

	work? How were cost, schedule and technical performance affected?" 3. knowledge workers duties is the updating of knowledge or discovering and validating new knowledge, continuous validating and tuning of existing knowledge, retirement of obsolete knowledge, controlling and tracking the application of knowledge, and documentation and communication of knowledge to affected business and technical staffs (Senator, 2000).		
Conclusions	The three sources support agrees that KBREdu provides better training, education and awareness sessions.		

Table 28 Knowledge-Based Risk Education Triangulation

Table 29 describes the Knowledge Essentials triangulation.

	Literature Reviews	**Interviewees Viewpoint**	**Conceptual Framework**
Knowledge Essentials	1. Knowledge infrastructure represents social capital, the relationships between knowledge sources and users, and is operated by technology (the network itself), structure (the relationship), and culture (the context in which the knowledge is created and used) (Jennex, 2005). 2. Some of these techniques are: communities of practice, forums, training, conferences, post project reviews, mentoring, yellow pages and so on (Rodriguez-Montes & Edwards,	Based on the interview results, 100% agreed to the importance of Knowledge Essentials on the RM and how technologies, culture and clear procedures in this process can impact RM processes positively.	Knowledge Essentials contains two important primary items, which is knowledge infrastructure and KM practices and techniques to support the KBRM framework. Knowledge Infrastructure is essential organizational capabilities for effective KM and it should be viewed as a strong foundation for executing a successful KBRM processes. This requires having a strong knowledge culture supported by upper management, well embedded KM in business processes and a strong technology infrastructure to carry out the KM execution.

	2008). 3. Neef (2005) listed some important KM techniques and systems used by organizations: Knowledge Mapping, communities of practice, hard-tagging experts, encouraging a knowledge-sharing , perform monitoring and reporting, Community and stakeholder involvement.		Also, KM practices and techniques provide several options of techniques to be use and choose from by the organization to capture tacit or explicit knowledge and share it throughout the KM processes.
Conclusions	The three sources agreed that Knowledge Essentials provides the necessary technologies, culture and clear procedures to execute RM processes.		

Table 29 Knowledge Essentials Triangulation

6.5 Summary and Conclusions

This chapter explains the process of interviewing experts, portrays the results of interviews and the triangulation methodology for validation of the information obtained.

Ten experts were identified based on their knowledge on the KM and RM. The interviews included 9 categories with a total of 44 close-ended questions and 2 open-ended questions (Appendix A). Answers are based on Likert scale to measure respondents' attitudes by asking the extent to which they agree or disagree with a particular question or statement. Finally, theoretical triangulation was performed to increase the confidence of the hypothesis or theory.

The overall result of the interviews for all categories is that 90.2% agreed with the conceptual framework design. The theoretical triangulation resulted in more confidence in the KBRM conceptual framework, because there is a match between the three sources of information: literature reviews, interviewee viewpoints and conceptual framework.

The open questions indicated that all respondents have a solid understanding and agreed on the importance of integrating KM with RM processes. All respondents agreed on the value of knowledge capturing, sharing, evaluation, repository and education to RM processes. Very few others put more emphasis on knowledge capturing and sharing than on the other processes.

The overall result of the interviews and the triangulation provides confidence and validation to the KBRM conceptual framework (presented in Chapter 5). The

analysis of the interview data reveals some interesting findings about the way the experts view the importance of integrating KM with RM processes as a framework. Also, the triangulation provided confidence, validity and convergence of the literature review, KBRM framework and experts' view to the research. This study has significant contributions in increasing our understanding about the impact of KM on RM to enhance RM processes.

CHAPTER 7 METHODOLOGY FOR APPLYING THE KBRM CONCEPTUAL SOLUTION

7.1 Introduction

This chapter describes a structured methodology for applying the KBRM (RiskManIT) conceptual solution. Guidance is provided regarding the RM and KM Processes. Recommendations for the adoption of knowledge-based tools and techniques, and examples of input and output artifacts are provided. The chapter has the following structure: Section 7.2 discusses the proposed methodology. Next, Section 7.3 portrays a description of the knowledge management techniques. Finally, Section 7.4 presents a summary and conclusions.

7.2 Proposed Methodology

The author proposes a structured methodology for implementing the conceptual framework for KBRM (RiskManIT). Part of the demonstration is adapted from (Blokdik, et al., 2008): "Presentations, Blueprints, Templates and Complete Risk Management Toolkit Guide for Information Technology Processes and Systems" Emereo Pty Ltd and (*Risk Management Plan*, 2008).

7.2.1 Scope Establishment

The purpose of scope establishment is to define the organizational, strategic and RM background in which the rest of the RiskManIT project will take place. The objectives and requirements are identified in this stage from stakeholders. The purpose of the project is determined in addition to the scope, resources and

timeline. Also, the criteria according to which risk will be assessed should be established, and the structure of the analysis is defined.

7.2.1.1 Strategic and Organizational Background

Aligned with Morrison (2008) the purpose of this section is to delineate the affiliation between the organization and its environment and identify the organization's strengths, weaknesses, opportunities and threats. Next, identify the internal and external stakeholders and consider their objectives, requirements, viewpoints, observations and establish communication policies with them. Also, the organization should determine the critical elements, which might support or impair its ability to manage the risks it faces.

The organizational background takes into account the organization's goals and objectives and the existing strategies to achieve them. There should be a close relationship between the organization's mission and strategic objectives and the management of the risks to which it is vulnerable. Strategic RM involves the risk evaluation and prioritization, which links the strategic planning process to operational planning.

7.2.1.2 Risk Management Background

RM background establishes the goals, objectives, strategies, scope and parameters of the IT project to which the RiskManIT and supporting methodology is being applied. The following should be undertaken based on meetings between the project team with stakeholders to capture the needed information:

1. Define the project and set objectives.
2. Define the extent of the project in terms of time and location.

3. Identify any studies and resources required.

7.2.1.3 Risk Evaluation Criteria

The project team must decide the criteria against which risk is to be evaluated. These criteria will be used during the risk analysis process. The following criteria are proposed as examples:

1. Impact is the maximum amount of damage that will be suffered if some event occurs. The risk associated with that event increases as the exposure increases.
2. Probability defines how likely is the risk will actually occur? The higher the probability the greater the risk.
3. Severity is the amount of damage to happen. The greater the severity, the higher the risk. Severity is associated to probability: if we can determine how likely an event to occur and extend of the suffering as a consequence, we can establish a good ground of the risk we are running into.
4. Time horizon describes the duration of an exposure, the longer the time period, the higher the risk.

7.2.1.4 Stakeholder Identification

Not all stakeholders will necessarily share the same concerns; have unified opinions, or priorities. When identifying affected stakeholders, a systematic approach often works well by examining the defined project and determining which stakeholder would be affected. Examples of stakeholder to consider are:

1. Decision-makers.
2. Individual who are directly affected by a decision or activity.
3. Internal stakeholders such as employees, management, senior management and contractors.
4. Union or staff representative groups.
5. Partners in the decision, such as financial institutions or insurance agencies.
6. Regulators and other government organizations that have authority over activities.
7. Business partners.

8. Clients and customers.
9. Suppliers and service providers.
10. Individuals or groups interested in issues related to the IT Project proposal such as project manager, architects, designers, developers and deployment staff.

Table 30 illustrates a template for identifying the key stakeholders as they relate to the project manager's expectations.

Stakeholder	Relationship with Project Manager	Expectations of Project Manager
▪ IS Director	Executive Sponsor	Sponsor provides the project manager guidance on the business objectives and supports the Project manager efforts to achieve them

Table 30 Template for Key Stakeholders

7.2.1.5 Risk Project Team players

This section proposes some typical members in the RM team.

The *Project Manager* is to write and approve the Project Risk Management Plan, define the RM process, participate in the process and take ownership of risk mitigation planning and execution. The *Risk Manager* is responsible for leading the RM effort, sponsoring risk identification activities, facilitating communication throughout the execution of the RM process and ensuring the PRD is maintained and that the statuses assigned to risks and risk activities are current. The *Risk Analyst's* role is to evaluate risks, maintain the RM repository and facilitate communication throughout the execution of the processes. Project stakeholders such as IT staff and vendors is to participate in the RM process by

providing candidate risk input, and supporting risk mitigation planning and execution activities.

7.2.1.6 Knowledge Techniques and Tools for Scope Establishment

Knowledge Capture will obtain the stakeholder's requirements using knowledge-based techniques and tools such as:

1. Techniques
   - Brainstorming to collect the requirements.
   - Knowledge mapping to determine the experts for this particular project.
   - Stories telling techniques to capture and transfer tacit knowledge based on previous experiences.
   - Interview key stakeholders.
   - Collect explicit knowledge such as models, prototype, best practices and lesson taught related to the project.
2. Tools including data mining can be used to access the repository to obtain information from previous projects similar to the current project.

Below are questions that may be asked to the team members and stakeholders to capture information and to address concerns:

1. What is the policy, program, process or activity of the organization?
2. Who are the key stakeholders?
3. What are the major outcomes expected of the IT project?
4. What are the dollar values as result of this IT project?
5. What are the strengths and weaknesses?
6. What are the major threats and opportunities the project or program presents?
7. What are the significant factors in the internal and external environment? (This should include the geographic, economic, political, environmental, social and technological factors that could affect the process.)
8. What is the best way to structure the risk identification phase?
9. What problems were identified in previous reviews?
10. What risk criteria should be used?

Table 31 is a template for determining stakeholder's needs.

ID	Stakeholder Name	Stakeholder/ User Type	Stakeholder Need (in order of priority)	Cost in US	Time in Person Days	Status (Proposed/ Approved)	Reference to Detailed Requirement

Table 31 Template of Stakeholder's Needs

Table 32 is a template for performing an analysis of stakeholders' role and their perceptions.

Stakeholder Name & ID	Stake in the project	Potential impact on Project	What does the Project expect the Stakeholder to provide?	Perceived attitudes and/or risks	Stakeholder Management Strategy	Responsibility

Table 32 Stakeholders Analysis and their Perceptions

The final output of this process is an IT project profile containing the answers to the questions captured from the stakeholders, and other project related information such as aim and objective summaries, resources, stakeholders, project team and requirements from which management can make a decision on whether or not to proceed with the proposed project.

7.2.2 Risk Identification

Understanding the scope, objectives and the deliverables of the project will considerably impact the possible risks to consider and on the substitute strategy

for dealing with the risks. Identifying what, why and how risk events can occur is the foundation for additional analysis. This step should identify any risks arising from the IT project to generate a comprehensive list of risks that could impact on the objectives. Seven key risk areas should be addressed when conducting any risk identification process. These areas with some examples are:

1. Commercial and legal risks exist when operating in the real world such as copyright, trademark infringement and liability.
2. Economic / Financial risks can result if the output of the project is not salable at the price that will cover the cost and operating of the project.
3. Technology risks associated with using new technology during the IT project.
4. Operational risks can be the result of executing a business function.
5. Political risks such as investing a project in a foreign nation due to possible changes in the regulations.
6. Human resource risks: Findings a qualify individuals to execute an activity or the absence of a key personnel.
7. Occupational Health & Safety / Environmental / Disability access risks.

To reduce the probability of unintentionally missing a potential risk, it is recommended to systematically identify risks under each of the above headings for your activity or project.

Identifying Candidate Risks

This step involves collecting candidate risk input from project participants and reviewing these candidate risks. Candidate risks are risks that have a strong probability of occurrence, and measured to become "identified risks". Table 33 is a template for identifying risks.

Is it a risk? Is the concern a risk? A risk is a **potential event** that would have an **impact** on the success of the project if the event were to occur. The following considerations support the question "*Is it a* risk*?*"
Impact: This step identifies consequences of the risk materializing. Is the impact of the potential risk event on the project significant enough to warrant enclosure in the RM process? This is an initial, informal determination of the risk impact. A formal assessment of the risk impact is done in *Risk Analysis process*.

Potential Event. What is the minimum probability of the potential risk event occurring? This question considers the degree of uncertainty of the potential risk event. Risk events that have already occurred represent issues, not risks. However, if there is little or no probability of the risk event occurring, the risk may not warrant addition in the RM process. Potential risk events that have an extremely low probability of occurring do not necessarily require the risk to be formally recognized by the IT Project RM process. This is an initial, informal determination of the risk probability. A formal assessment of the risk probability is done in *Risk Analysis process*.

Table 33 Identifying Candidate Risk

Once the candidate risk is confirmed, it becomes an identified risk. Then, risk identification should start listing the possible sources of risk and potential risk events. Table 34 shows a template of the risk identification form.

Risk ID	Risk Identified	Risk's Area	Description	First Indicator	Owner	Identified by
Assign a number	List identified risk	Technology, operation, human resources, etc….	Describe each risk in the form (Event, cause, impact)	Describe the earliest indicator or trigger condition that might indicate that the risk is turning into a problem.	Assign each risk action to an individual.	Enter name, title, phone and email address

Table 34 Risk Identification Form

7.2.2.1 Knowledge Techniques and Tools for Risk Identification

The team meets to determine the possible risks that might affect the IT project. The Knowledge Capture and Discovery will be applied to answer the following questions when identifying risks:

1. When, where, why, and how are the risks likely to occur?
2. What is the source of each risk?
3. What are the stakeholder's expectations?
4. What is the potential cost in time, money and disruption to customers of each risk?

Some recommended techniques for identifying risks based on knowledge of stakeholders, participants and IT staff includes:

1. Audits or physical inspections.
2. Accident / Incident reports.
3. Brainstorming and Delphi techniques.
4. Decision trees.
5. Checklist analysis.
6. History.
7. Interview / focus groups.
8. Personal or organizational experience.
9. Scenario analysis.
10. Strengths, weaknesses, opportunities and threats (SWOT) analysis.
11. Survey or questionnaires.
12. Cause-and-effect diagram can be used to identify the source of risks.
13. Customer complaints.
14. Documents review such as policy, system and security documentation.
15. Community of practice (CoP).

Tools such as data mining can access the repository for the following purposes:

1. Analyze and examine the current or previous incident reports to determine whether a new risk not being identified before has been identified.

2. Analyze previous projects, risks, lessons learned, best practices to discover any patterns, trends and similar projects to identify risks.

The output represents explicit knowledge in the form of a comprehensive list of identified risks, a clear picture of the environment surrounding the IT project, purpose and objectives, and knowledge captured from participants and stakeholders. In the Risk Identification process, stakeholders propose risks based on different sources and perspectives and some risks may be relevant and some not.

All collected risks will go through an inspection based on KM techniques used in capturing the knowledge of stakeholders and participants. The purpose is to assess all risks based on the value, relevance and accuracy. Moreover, all risks can be assessed based on the relevance to the organization, management strategy

and business strategy. The result is a confirmed list of only risks applicable to the current IT project. The final confirmed list is fed to risk analysis.

7.2.3 Risk Analysis

The purpose of risk analysis is to divide the minor acceptable risks from the major risks and provide data for the subsequent treatment of those risks. Each risk identified can be used to determine the existing controls. Analysis of the risk in terms of consequence and probability in the context of those controls is performed. The analysis should consider the range of potential consequences and how likely they are to occur. Consequence and probability are combined to produce an estimated level of risk.

The estimated levels of risk are compared against the criteria established in risk identification and a prioritized list of the risks requiring further action is prepared. Table 35 can be used for assessing the consequences of the risks.

	Consequences →			
Risk 1				
Risk 2				

Table 35 Consequences of Risks

During risk analysis, each potential risk event is analyzed to determine:

- The probability that the risk will occur.
- The impact of the risk if it occurs.
- Timeframe for risk occurring.

Risk Probability Classification

Determining risk probability involves considering the possibility of the risk occurrence. The Criteria for Risk Probability in Table 36 provide a guide for the

risk probability as high, medium, or low. In the KBRR, probability is recorded as a percentage from 1% to 99%. The determination of risk probability is subjective and based on a qualitative process that considers the criticality of internal and external project factors within the specific context of the IT Project.

Probability Category	Probability	Description
Very High	0.90	Risk event expected to occur
High	0.70	Risk event more likely than not to occur
Probable	0.50	Risk event may or may not occur
Low	0.30	Risk event less likely than not to occur
Very Low	0.10	Risk event not expected to occur

Table 36 Risk Probability Definitions (*Risk Management Plan*, 2008)

Risk Impact Classification

The classification determines the risk impact by considering the consequences the risk would have on the project if the risk event occurs. Risk impact is a description of the anticipated consequences of a risk event occurring. The Criteria for Risk Impact in Table 37 is a guide for evaluating the risk consequences and determining the risk impact, expressed as "low", "medium," or "high". In the KBRR, impact is recorded as a number from 1 to 5. Impact values 1 and 2 correspond to a Low value, 3 is Medium, and 4 or 5 is High.

IMPACT	CRITERIA
High (4 or 5)	Risk consequences include one or more of the following: • Significant schedule delay. For example, delay in a critical path activity by more than 2 months. • Significant cost increase. For example, project budget or cost increase by more than 20%. • Significant technical change. For example, system performance decreases by more than 50%. • Significant resource change. For example, loss of more than 20% of personnel, or loss of more than 10% of key management personnel. • Significant political repercussions. For example, non-compliance with current legislation that involves significant penalties. • Significant user dissatisfaction. For example, more than 20% of users are extremely dissatisfied with more than 20% of system functions or performance characteristics.
Medium (3)	Risk consequences include one or more of the following, but do not include any consequences identified as "High" above: • Moderate schedule delay. For example, delay in a critical path activity by 2-8 weeks, or delay in a non-critical path activity by more than 1 month. • Moderate cost increase. For example, project budget increase by 10-20%. • Moderate technical change. For example, system performance decreases by 20-50%. • Moderate resource change. For example, loss of 10-20% of personnel, or loss of 5-10% of key management personnel. • Moderate user dissatisfaction. For example, 10-20% of users are extremely dissatisfied with 10-20% of system functions or performance characteristics, or more than 20% of users are moderately dissatisfied with more than 20% of system functions or performance characteristics.
Low (1 or 2)	Risk consequences include one or more of the following, but do not include any consequences identified as "High" or "Medium" above: • Minor schedule delay. For example, delay in a critical path activity by less than 2 weeks, or delay in a non-critical path activity by less than 1 month. • Minor cost increase. For example, project budget increase by less than 10%. • Minor technical change. For example, system performance decreases by less than 20%. • Minor resource change. For example, loss of less than 10% of personnel, or loss of less than 5% of key management personnel. • Minor user dissatisfaction. For example, less than 20% of users are extremely dissatisfied with less than 20% of system functions or performance characteristics.

Table 37 Definition of Risk Impact Scales (*Risk Management Plan*, 2008)

Establish Risk Timeframe

The risk timeframe is the period of time within which the risk is expected to occur. The Criteria for Risk Timeframe in Table 38 is a guide for evaluating the period of time a risk is expected to occur and determining the risk timeframe, expressed in terms of a short-term, medium-term, or long-term.

TIMEFRAME	CRITERIA
Short-Term	The risk is expected to occur within a very short period of time, e.g., • 180 days.
Medium-Term	The risk is expected to occur within the near future, e.g., > 180 and • 360 days.
Long-Term	The risk is expected to occur in the far future, e.g., > 360 days in the future.

Table 38 Criteria for Risk Timeframe (*Risk Management Plan*, 2008)

Verify/Determine Risk Exposure

The risk exposure is derived from the risk attributes of impact and probability, and is used in conjunction with a timeframe to prioritize risks for mitigation and escalation. Risk exposure for each risk is determined from the intersection of the risk's impact and probability in Table 39. In the Knowledge-Based Risk Repository, risk exposure is calculated by multiplying the impact (a number from 1 to 5) times the probability (0.01 to 0.99). Risk exposure categories fall into the following: low < 1.67, medium for values ≥ 1.67 and ≤ 3.34, and high > 3.34. The risk exposure value and the risk timeframe are then used to calculate the risk severity. Risks that fall into the yellow-shaded cells of the matrix are the next highest priority, followed by risks that fall into the green-shaded cells.

Risk Exposure:	**Probability**			
Impact		High	Medium	Low
	High	High	High	Medium
	Medium	High	Medium	Low
	Low	Medium	Low	Low

Table 39 Guide for Determination of Risk Exposure (*Risk Management Plan*, 2008)

Verify/Determine Risk Severity

The severity of the risk is a determination of the importance of the risk based upon: 1) Potential impact of the risk on the project, 2) The probability of occurrence, and 3) Risk timeframe. Table 40 contains a guide for evaluating risk impact, risk probability and risk timeframe to determine the risk severity, and to prioritize the risks in terms of high, medium, or low.

Risk Severity:	**Exposure**			
		High	Medium	Low

Time Frame	Short-Term	High	High	Medium
	Medium-Term	High	Medium	Low
	Long-Term	Medium	Low	Low

Table 40 Guide for Determination of Risk Severity (*Risk Management Plan*, 2008)

An evaluation of each risk is now undertaken to determine those risks that are acceptable and those that require further treatment. This step should evaluate the level of risk found with the criteria established in Scope Establishment process. Some reasons why a risk may be acceptable include:

- The level of risk is so low that specific treatment in not suitable given the available resources.
- There is no treatment available.
- The costs of treatment outweigh the benefit.
- Opportunities presented outweigh the threats to such an extent that the risk is acceptable.

7.2.3.1 Develop Recommended Mitigations

Mitigation is a response to a risk, designed to reduce or eliminate the probability and/or impact of the IT risks: Risks mitigations can be done by one of the following:

1. Elimination – removing the threat of the risk event occurring by eliminating the cause.
2. Reduction – reducing the severity of the risk by either reducing the impact on the project, the probability of occurrence, or both.
3. Acceptance – accepting the consequences of the risk event. Acceptance can be active (e.g., developing a contingency plan to be executed if the risk event occurs), or acceptance can be passive (e.g., taking no action, allowing the risk event to occur, and accepting the resulting consequences).

If no mitigation actions are available, the risk impact is accepted. Recommended mitigation is developed by the Risk Owner with the assistance of the Risk Manager and Risk Analyst and will be reviewed and approved by the Project

Manager. The Recommended mitigation will be further defined in a response plan to be entered into the Risk Plan document.

7.2.3.2 Risk Review

The Project Manager, the Risk Manager and the Risk Analyst review the risks with the Project Sponsors to validate all the risk information identified at this time, including the Risk Class, Risk Impact, Risk Probability, Risk Timeframe, Risk Severity and Recommended Mitigations. The Risk Review will include stakeholders as needed. Risk information is revised based on input from the reviewers. The result of this step is to validate the risk as a "confirmed risk".

Table 41 is a form to document the output of the risk analysis with a comprehensive data on every confirmed risk with its severity, impact, priority, probability, mitigation actions, contingency, risk owner, deadline, status and approver.

Risk Analysis

Project Name:

#	Risk	Impact on Project	Cost $	Probability	Impact	Timeframe	Exposure	Severity	Mitigating Actions	Contingency	Risk Owner	Deadline	Status	Approved by
n	*<Identify the risk>*	<A brief description of the risk and its impact on costs, schedule etc>	$ Identify the cost associated with this risk			L / M / H			<Describe what is currently done on the project to reduce the impact of the risk.>	<Describe the course of action if the risk does materialize: alternate solution, reduction in functionality etc.>	Person responsible	MM/DD/YY		Risk Manager

Table 41 Risk Analysis Form

7.2.3.3 Knowledge Tools and Techniques for Risk Analysis

Knowledge sharing plays an important role in enriching the risk analysis process with tacit and explicit knowledge. The project team shares their experience by performing analysis on each identified risk. The project team meets to exchange their thoughts and experience on which method might be appropriate in executing the risk analysis process. The team members will discuss their experience on confirmed risks based on probability of occurrence, impact and extend of loss. Techniques for Risk Analysis include:

- Best practice, alert system and lessens-learned.
- Expertise locator might be needed to share tacit and explicit knowledge.
- Risk Modeling to transfer knowledge through presentation, portals, discussions, collaboration activities and testing reporting.
- Review case studies from previous projects.
- Quick evidence review (QER) to review research and evidence on a particular issue.
- Gone well/not gone well Tools
- Team discussion and brainstorming performed by analyzing former projects accessed from the repository.

7.2.4 Risk Response Planning

The purpose of Risk Response Planning is to take ownership of risk mitigation by assigning risk ownership, developing risk mitigation, contingencies, developing measurements, reviewing and approving risk mitigations and measurements, translating mitigations into action plans and updating risk measures in the KBRR. The following are steps that may be taken to develop this plan:

1. Assign Risk Owner, who is the person to be assigned responsibility for developing risk mitigations, contingencies, measurements, mitigation

action plans and implementing and tracking mitigation action plan progress.

2. Developing mitigation and contingences: Develop the plan designed to eliminate, reduce, or accept the risk. The Risk Owner is responsible for developing mitigations for the risk based on previously identified mitigations or it can be developed independently.
3. Develop measurements to track the risk mitigation actions and to measure the effectiveness of the actions. The Risk Owner is responsible for developing measurements of risk mitigation. Contingency plan measurements will be focused on the effectiveness of the contingency plan in addressing the actual impacts of the event.
4. Review mitigation, contingencies and measurement: The team can review the risk mitigations, contingencies, and measurements developed by the Risk Owner. The Project Manager will review this information to determine if the risk has been assigned the appropriate probability, impact, and timeframe and provides direction regarding whether the mitigation and contingency plans are appropriate for the severity of the risk. If needed, risk mitigations, contingencies and measurements are revised based on the review.
5. Approval of the mitigation, contingencies and measurements by the Project Manager.
6. Update project information in the KBRR based on Risk Response Planning, Risk Mitigations, Risk Measurements and Mitigation and Contingency Action Plans developed by the Risk Owner.

Table 42 is a template to be used for Risk Response Planning. This table contains risk number, title, description, originator, date of identification, category, impact criteria, probability, timeframe, exposure, severity, changes, strategy, treatment and treatment date.

Risk Response Planning

Risk No.	Risk Title	Risk Description	Originator	Risk Identified (MM/DD/YYYY)	Risk Category	Risk Impact Criteria	Risk Probability	Risk Timeframe
Risk ID	A brief (phrase or one sentence) description of the candidate risk that captures the key subject of the candidate risk or summarizes the risk description	Concise description of the candidate risk. Capturing a statement of risk includes considering and recording the conditions that are causing concern of a possible loss to the project.	Name and organization of the person who identified and submitted the candidate risk to the Risk Manager/Risk Analyst.	Date the candidate risk was either identified or submitted to the Risk Manager	Operational, IT System, political, human resources, financial	High (5 or 4), Medium (3), Low (1 or 2)	High > 65%, Medium between 65% to 35%, Low < 35%	Short-term expected to occur within a very short period of time, e.g., • 180 days, Medium-term is expected to occur within the near future, e.g., > 180 and • 360 days, Long-Term: expected to occur in the far future, e.g., > 360 days in the future

Risk Exposure	Risk Severity	Risk Owner	Change in Risk	Risk Strategy	Risk Treatment	Risk Treatment Date MM/D/YY
High, Medium or Low	High, Medium or Low	Name of person assigned To mitigate the risk	Getting worse, unchanged, improving	Accept, avoid, control, investigate, reduce and transfer	To be confirmed	Date

Table 42 Example of Risk Response Planning

7.2.4.1 Knowledge Tools and Techniques for Risk Response Planning

The project manager takes the collected information to prepare plans, strategies and actions and to develop Risk Response Planning document as stated in Table 42. The techniques used in this process are:

- Team discussion and brainstorming on selecting the best alternative for risk treatment in risk action requests and identifying the possible preventive actions for the threats and enhancement actions for the opportunities.
- Team creates explicit reporting for internal and external use.
- Peer assist is a technique used to gather knowledge and insight from other teams before embarking on a project or activity.
- Community of practice (CoP).
- Gone well/not gone well.
- Retrospective review is an in-depth discussion that happens after the completion of a project, event, or activity.
- After Accomplishment review used to evaluate and capture lessons learned.

7.2.5 Risk Execution

Risk execution involves the implementation of risk mitigation action plans and recording risk information changes in the KBRR. Low priority risks can be accepted and monitored. For those risks that are rated high, the risk execution step will develop and implement a specific management action plan that includes consideration of funding. The plan should use the Risk Treatment and Action Plan at Figure 34. Table 43 contains the treatment options.

TECHNIQUE	DESCRIPTION
ACCEPTANCE	This technique recognizes the risk and its uncontrollability. Acceptance is a "passive" technique that focuses on allowing whatever outcome to occur without trying to prevent that outcome. This technique is normally used for "low" or "very low" risks where a scope efficient means of reducing the risk is not apparent.

TECHNIQUE	DESCRIPTION
AVOIDANCE	This technique uses an approach that avoids the possibility of risk occurrence. The following items represent ways of avoiding risks: 1. Work Scope Reduction 2. Changing the requirements and/or specifications 3. Changing the Statement of Work (SOW) 4. Changing the Technical Baseline 5. Developing and submitting Waivers and Deviations
CONTROL	This technique is made up of actions that are to be taken to reduce the risk probability or impact. Control-based actions occur at all points throughout the program's lifecycle and are typically the most common response. They typically identify an action or product that becomes part of the work plans, and which are monitored and reported as part of the regular performance analysis and progress reporting of the Program.
INVESTIGATION	This technique defers all actions until more work is done and/or facts are known. Investigation-based responses do not define any mitigation for reducing an individual risk. They are responses to risks where no clear solution is identified, and further research is required. Investigation may include root cause analysis. Investigative responses immediately and directly lead to a greater aggregated Program risk. This is because the probability quantifier for each risk includes the effect of the applied response, for which there is none, and the level of control quantifier indicates the level of influence to apply that response, which is low.
REDUCTION	Reduction is the active lowering of risk by a planned series of activities. Techniques include: • Rapid Prototyping • Early multi-discipline involvement • Consultant and/or • Simulation • Modeling • Trade Studies • Team Workshops • Advance design models • Reduce Dependencies • Customer involvement • Joint Applications development groups
TRANSFERENCE	Transference is the process of moving something from one place to another or from one party to another. In this, the risk can be transferred to the customer or to the contractor. This technique is best utilized during the proposal process. Transfer can also include the use of third party.

Table 43 Risk Treatment Options (*Risk Management Plan*, 2008)

Risk treatment and action plan WORKSHEET

Activity/Project: _____ Division/Unit: . . . . . .

Completed by: _____ Date: . . . . . .

Reviewed by:: . . . . . Date: _____

Correlating Ref from Risk worksheet	Treatment/Controls to be implemented	Risk rating after treatment/ controls	Person responsible for implementing treatment/controls	Timeframe	Date Completed	Risk and treatment/controls monitored/reviewed		Date completed
						How	When	

Figure 44 Risk Treatments and Action Plan Worksheet

7.2.5.1 Knowledge Tools and Techniques for Risk Execution

Project team develops options, determine the proper actions to enhance opportunities and reduce threats to the project's objectives. The techniques used in this process are:

- Team discussion and brainstorming: All risk items will go through reassessment in terms of probability of occurrence and impact. This process will function as a continuous process leading to either retiring an existing risk once a solution is attained or identifying a new risk.
- If a new risk is identified, then the process has to start from risk identification process. Table 44 describes a form that can be use to collect information on newly identified risk.
- Any sharing of experiences encountered throughout the execution of the risk project will assist in modifying the process to maintain accuracy.

- Gone well/not gone well is a quick and useful tool to get candid feedback at the end of an event or activity.
- After Accomplishment review used to evaluate and capture lessons learned.
- Root-causes analysis.

The output of risk execution process can be feedback or updates of the project progress and any new risks identified will be reported and codified for future use. Also, the team updates the KBRR of any new risk status information based on the implementation status of the action plans.

<Insert Project Name>
Risk Identification Form

This form is used to communicate a newly identified risk to the Project Manager.

Risk Number: _____

<A unique identifier is assigned by the Project Manager as the "risk number".>

1. Description of Risk Identified

<This section provides a description of what may happen that could be of detriment to the project.>

2. Description of the Impact on Project

<This section explains the impact that the risk could have on the project.>

3. Identified By

Name:
Title:
Phone:
Email:

<This section provides Risk Identifier contact information in case the Project Manager requires more information.>

4. Date of Identification

<Insert the date the Project Manager received the Risk Identification Form.>

Table 44 Newly Risk Identification Form

7.2.6 Risk Monitoring

Risk monitoring is used to insure that all steps of the RM process are being followed and, as a result, risks are being mitigated and contingency plans are followed as necessary. Risk Monitoring involves the oversight and tracking of risk mitigation and contingency action plan execution, re-assessment of risks, reporting risk status and recording risk information changes in the KBRR. Risk monitoring is also considered as a feedback to revaluate recent results of risk execution.

7.2.6.1 Knowledge Tools and Techniques for Risk Monitoring

The Risk Manager and Risk Analyst will re-assess the risk information in the KBRR to determine if any changes are needed, e.g., risk severity and timeframe. The Risk Analyst will report risk status as part of the weekly Project Risk Reports (summary and detailed ranked risks) to the Project Manager, Functional Managers, and other designated parties. Risk status reporting will focus on high severity risks. Information presented will include the status of risk mitigation and contingency action plans, changes in risk severity for known risks, new risks identified and any risks scheduled for retirement. Also, the Risk Analyst will maintain the risk information in the KBRR.

The knowledge techniques that can be use to reevaluate the recent results of risk execution:

1. Team discussion and brainstorming to discuss the result of the project and share their experience and evaluate the outcome.
2. Team discussion and brainstorming in choosing alternative strategies, executing a contingency or fallback plan, taking corrective action and modifying the project plan.
3. Updating the organizational process assets, including project lessons-learned databases and RM templates for the benefit of future projects.

4. Team meeting to identify what lessons could be learned for future assessments and management of risks.

Questions to Ask Stakeholders and Team Members

1. How often will project's risk status be checked and in what format (meeting, individual)?
2. What is reporting procedure of risks, effectiveness of mitigation etc.?
3. How often are risks reviewed and reevaluated?
4. What happens when new risks are identified?
5. What is the procedure for updating the Top Risk List?
6. What happens when mitigation is not effective or risk exposure increases?

7.3 Knowledge Management Techniques

During the RM life cycle several learning experiences, explicit and tacit knowledge is being exchanged. It is therefore, vital that the project team captures and records its learning, lessons learned and best practices so that others can benefit. The following knowledge techniques can be used throughout the risk project to ensure no knowledge is forgotten or missed.

7.3.1.1 Case Study

A structured case study can be created to facilitate knowledge sharing as an example. The case study can be created based on the purpose and indented audience and can be used during an activity or after an activity. An example case study template (Leask, Lee, Milner, Norton, & Dimple, 2008) has the following format:

1. Summary
2. Key learning.
3. Background to the problem.
4. Main issues and problems in detail - what was done – in chronological order.
5. Outcomes and impact.
6. Material resources required.
7. Human resources required.
8. Barriers and how were they overcome.
9. How could it be done better?
10. Contact for further information.

7.3.1.2 Community of Practice (CoP)

A Community of Practice is a network of individuals with common problems or interests, explore ways of working together, identify common solutions, and to share good practice and ideas. The purpose is to discuss a specific area of risk to encourage developing and sharing of new ideas and strategies. The benefit is solving any project issues encountered quickly, cut down on duplication of efforts and provides potentially unlimited access to expertise. CoP can be used before, during or after activities. An example is virtual communities is given by (Leask, et al., 2008).

Before setting up a community, the following main points must be considered (Leask, et al., 2008):

- Scope – what do you want to achieve? Who is your audience? What are the boundaries?
- Participants – who can make a major contribution? Do they share common needs and interests?
- Roles and responsibilities – who are the experts, leaders, champions, facilitators?
- Interest and involvement – how will you attract interest? How will you engage participants? How will you develop your community?
- Creating and sharing knowledge – how will you interact, learn and share?
- Moving forward – how will you add value? How will you evolve?

Communities can have a limited shelf-life once a group reaches a conclusion. As long as the learning is captured and redistributed, the success of the collaboration can inform others in the future.

7.3.1.3 Peer Assist

Leask, et al. (2008) indicate that people can use a peer assist capability to gather knowledge and insight from other teams before embarking on a project or activity. It partners those seeking assistance with a peer or group of peers who have expertise in a desired area.

A peer assists can last from an hour to a full day depending on the size of the project. Talking to experienced peers about the best way to approach new projects saves time and money and avoids repetition of mistakes. It also creates strong links across teams and relationships between people (Leask, et al., 2008).

A simple technique that works well involves of the following steps:

- Appoint a facilitator who is someone from outside the team who will ensure the participants achieve their outcomes.
- Select the participants and choose participants who have diverse knowledge, skills, and experience. There is no hard and fast rule about

minimum or maximum numbers but the right participants are particularly important.

- Share information by dividing the meeting time into four parts:
  1. Clarify the purpose: The receivers present the background and objectives of the project or task they are about to begin. They should also say what they hope to achieve in the peer assist.
  2. Encourage the peers to ask questions and give feedback: The peers discuss the receiver's situation and share ideas and experiences. The receivers should simply listen.
  3. Analyze what has been heard: This part is for the receivers to analyze and reflect on what they have learned and to examine options. The peers should take a back seat.
  4. Present the feedback and agree actions: The peers present their feedback to the receivers' analysis and answer any further questions.

7.3.1.4 Knowledge Café

A Knowledge Café brings people together to have open, creative conversation on topics of mutual interest. It can be organized in a meeting or workshop format, but the emphasis should be on flowing dialogue that allows people to share ideas and learn from each other. It encourages people to explore issues that require discussion in order to build a consensus around an issue (Leask, et al., 2008). Knowledge café can be used before, during or after each activity. A simple and recommended method that works well involves the following steps (Leask, et al., 2008):

1. Preparation for a knowledge café
   - Appoint a facilitator – someone who can encourage participation.
   - Identify a question relevant to those participating.
   - Invite interested parties.
   - Create a comfortable environment – a 'café' layout, with a number of small tables, supplied with tea and coffee, is one option.
2. During a knowledge café
   - The facilitator should introduce the knowledge café concept, any codes of conduct and finally pose the question.
   - Participants should arrange themselves into groups to discuss the question.

- Each participant in turn shares their knowledge and experience without interruption and giving everyone an opportunity to talk.
- After each participant has shared, the group continues the discussion together.
- The groups should eventually meet to exchange ideas and findings – these could be captured electronically or on paper.

3. After Knowledge Café
   - The real value of a Knowledge Café is what people take away with them in their heads, and the new connections they have made with people.
   - If the knowledge café is to be codified, the information may be distributed to participants after the session.

7.3.1.5 Knowledge Marketplace

Knowledge marketplace could be seen as a 'dating service' for knowledge.

It identifies what people know and what they need to know on a particular subject and then connects them appropriately. The knowledge marketplace can be facilitated online, via email or face-to-face. Furthermore, knowledge marketplace can be used before, during or after each activity., It can be used in many situations, and is particularly useful when delegating roles and responsibilities within a new project team (Leask, et al., 2008). Within the participating team or group, each person should take the following steps (Leask, et al., 2008):

1. Identify your knowledge requirements – These could be areas where you feel there are gaps in your knowledge.
2. Identify your knowledge offers – These would be areas where you have knowledge and experience to share with others.
3. Collect some basic information to start the connection process, for example: name, job title, organization, email address.

This information can be recorded in a form of an Excel spreadsheet, by email, or on a flip chart during the session. This information is then used to connect people to people and the sharing process can begin. The sharing process could be a

conversation or after the event has been recorded electronically and all the relationships mapped out and made available online.

7.3.1.6 Gone Well/Not Gone Well

A gone well/not gone well is a quick and useful tool to get honest feedback at the end of an event or activity. It allows all participants to say which aspects of event or activity worked and which did not in an open and accepting atmosphere.

This tool is a useful way to close a session and provides an opportunity to discuss the event. Gone well/not gone well can be used after each activity. It is especially useful in getting people to express more critical comments in a relaxed way (Leask, et al., 2008). It requires a flipchart to record the information. The flip chart is divided down the middle into two columns: 'Gone well' and 'Not gone well'. The facilitator asks the group to comment on anything to do with the event that went well or not so well (Leask, et al., 2008).

7.3.1.7 After Accomplishment Review

This review is a tool to evaluate and capture lessons learned. It takes the form of a quick and informal discussion at the end of a project or at a key stage within a project or activity. It enables the individuals involved to review what has happened, summarize new knowledge and decide what action should be taken next. This technique is conducted as soon as possible after specified stage or event or project. It is structured as an informal brainstorming session to build consensus on the following questions (Leask, et al., 2008):

1. What happened and why?
2. What was supposed to happen?

3. What went well?
4. What needs improvement?
5. Why were their differences?
6. What lessons can be learned from the experience?

7.3.1.8 Retrospective Review

A retrospective review is an in-depth discussion that happens after the completion of a project, event, or activity. It is structured to help the people involved to reflect on the project in detail. The review ensures that you:

- Retain learning from what has happened.
- Understand why it happened.
- Look at what went well, what needs improvement and what lessons should inform future work.

Every major project should conclude with a retrospective review. This is the main way of ensuring that lessons learned are recorded in an objective way and it also ensures that the information can be made available to others (Leask, et al., 2008).

7.4 Summary and Conclusions

This chapter provides a methodology with a set of templates to apply the KBRM (RiskManIT) framework in an enterprise, or government to manage risks in IT projects. The methodology follows a systematic set of steps to execute RM with KM. The RM processes are in accordance with the proposed conceptual solution KBRM framework in Chapter 5. Every RM process is described with activities along with KM enablement using proposed tools and techniques.

KM techniques such as a case study, community of practice (CoP), peer assist, knowledge café, gone well/not gone well, knowledge marketplace, after action

review and retrospective review are described in more detail to provide a road map to gather knowledge from key stakeholders, project team and stored it in the KBRR.

CHAPTER 8 SUMMARY OF RESEARCH AND CONTRIBUTIONS

The purpose of this chapter is: 1) to conclude the research carried out in this dissertation, 2) to list key finds of the research, 3) to list the contribution made by the research and 4) to propose areas of further work. The chapter begins by summarizing the research goal, questions and hypothesis. Subsequently, the key findings of the research are discussed. Afterwards, contributions to academia and industry arising from the research findings will then be discussed. Finally, identification of future research directions in the area of KM processes and RM processes are described.

This chapter revisits the research goal, questions and hypotheses mentioned in chapter 1 in Section 8.1. In Section 8.2, the key findings are evaluated and discussed. Section 8.3 discusses the research validation. Section 8.4 portrays the contribution made by the research. Section 8.5 depicts the future research possibilities.

8.1 Research Aim, Questions and Hypotheses

The importance of the research project is to investigate the feasibility of utilizing KM processes with RM processes and recommend an integrated knowledge and risk framework. The integration of KM processes and RM processes are a new research area and scientific research and literature supporting this topic is limited. However, the potential positive impact of knowledge infusion into RM processes makes it a rewarding area of research.

The aim of this research is to propose a conceptual framework that solves the problem of IT project failures by integrating KM and RM in a single framework. The following objectives guided the research:

- To enhance the Risk Response Planning (RRP) process of risk identification, analysis, and execution by capturing the appropriate and relevant risks to the organization goals and objectives.
- To align and integrate the KM and RM processes.
- Analyze KM and RM to find elements that will enhance both.
- Provide taxonomies of definitions for Data, Information, Knowledge and Wisdom, KM, KM processes and RM processes to provide better comparison and analysis to the reader.

This study aims at building a conceptual framework to provide answers to the following research questions flowing from the stated research problem:

1. How does the integration of KM and RM processes improve the organization's ability to manage and mitigate risks in IT projects?
2. What is the impact of knowledge capture on Scope Establishment and Risk Identification?
3. What is the impact of knowledge discovery on Scope Establishment and Risk Identification?
4. What is the impact of knowledge evaluation on RM processes?
5. What is the impact of knowledge sharing on risk analysis and planning?
6. What is the impact of knowledge evaluation on risk execution and monitoring?
7. What is the impact of having a live and dynamic knowledge and risk repository?
8. What is the impact of knowledge education on RM processes?
9. To what extend do KM tools, techniques, technologies and culture have impact on KM processes?

To answer the above questions (Section 8.3), the hypothesis for this research project is:

> *H0: The integration of KM principles in support of RM processes, when applied to IT projects, may improve the organization's ability to manage risks response planning by enhancing risk identification, analysis and mitigation.*

8.2 Key Findings of Research

The main findings derived from the research presented in this dissertation are:

1. A review of normative literature described a more detail KM theoretical framework. The proposed KM framework was described in Chapter 5.
2. Based on the review of normative literature performed in this research project a theoretical framework that describes the integration of KM and RM is lacking. Therefore, the proposed KBRM framework provides a valid process to describe the integration between KM and RM processes.
3. It is possible to formulate a methodology for integrating KM and RM processes, and show its application, as was done by demonstrating the concepts presented in this research project.

8.3 Answers to Research Questions and Research Validation

This research project has addressed the challenges facing organizations in the area of RM in IT projects. The conceptualization in the form of the KM and RM and the conceptual solution KBRM (RiskManIT) was supported by a group of experts in the fields of RM and KM as described in Chapter 6.

The findings validate the research questions by answering them as follows:

1. Knowledge Capture has a positive impact on scope establishment and risk identification. Therefore, the integration of KM and RM processes can form a valid KBRC.
2. Knowledge Discovery has positive impact on scope establishment and risk identification. Therefore, the integration of KM and RM processes can form a valid KBRD.
3. Knowledge Examination has a positive impact on RM processes. Therefore, the integration of RM and RM process can form a valid KBREx.
4. Knowledge Sharing has a positive impact on risk analysis and planning. Therefore, the integration of KM and RM processes can form a valid KBRS.
5. Knowledge Evaluation has a positive impact on risk execution and risk monitoring. Therefore, the integration of KM and RM processes can form a valid KBRE.

6. Having live and dynamic integrated knowledge and risk repository is essential to the organization to execute RM. Therefore, the integration of KM and RM processes can form a valid KBRR.
7. Knowledge Education has a positive impact on RM processes and employees. The integration of KM and RM repository provides better training, education and awareness. Therefore, the integration of KM and RM can form a valid KBREdu.
8. Knowledge Essentials utilizing KM tools, techniques, technologies and culture provide positive impact on RM processes.
9. The integration of KM and RM processes improve the organization's ability to manage the mitigate risks in IT projects.
10. A structured methodology for applying the KBRM (RiskManIT) conceptual solution is described in chapter 7 and this provides a clear way of applying the conceptual solution in an IT Projects.
11. The triangulation provided confidence, validity and convergence of the literature review, KBRM framework and experts' view to the research as described in Chapter 6.

In support of the hypothesis, the research validates the integration of KM in support of RM processes, when applied to IT projects, which improves the organization's ability to manage risk response planning by enhancing risk identification, analysis, and mitigation.

Conceptual model validation is defined as determining that the theories and assumptions underlying the conceptual model are correct, and that the model representation of the problem entity is "reasonable" for the intended purpose of the model (Shanks, Tansley, & Weber, 2003). The following Conceptual validation criteria have been presented to support the KBRM (RiskManIT) framework.

- A concept, or conceptual model, is reasonable if it has face validity. This criterion is useful to assess the apparent reasonableness of an idea. This could be demonstrated by deduction from past research or theories, or, it could be developed based on observation or induction (Khazanchi, 1996). Reasonability establishes that a concept or model is more than just a belief or conjecture. Moreover, Sargent (2009) affirms that face validity is about asking

individuals knowledgeable about the system, whether the model and/or its behavior is reasonable. For example, is the logic in the conceptual model correct and are the model's input-output relationships reasonable. In this research, experts were interviewed based on a questionnaire. The questions assess the expert's knowledge on KM and RM. The questions are also based on the interaction of the KBRM framework components, behaviors and impact of KM processes on RM processes.

- The feasibility criterion dictates that a conceptual framework has the quality of being workable or operationalizable (Khazanchi, 1996). The KBRM framework has been designed to be operationalizable based on the proposed methodology for applying the framework, and is described and illustrated in Chapter 7.
- The effectiveness criterion addresses the question: How effectively does the concept or conceptual model describe the phenomena under study(Khazanchi, 1996)? In addition an effective concept or conceptual model has the potential of serving our scientific purposes (Kaplan, 1964). An effective concept not only represents the phenomenon in question economically, it also guides and stimulates other scientific inquiries. The KBRM framework describes effectively the impact of KM processes on risk response planning, and it has been validated by the triangulation and experts' responses to the questionnaire. In addition, the KBRM framework guides and stimulates future research in developing a Knowledge-Based Risk System (KBRMS), and in implementing the KBRM framework as pilot studies in organizations.
- Another criterion is the accuracy. The model should accurately represent the semantics of the focal domain as perceived by the focal stakeholder(s) (Shanks, et al., 2003). The KBRM presented and illustrated the KM and RM processes as the focus of this research and has been validated by experts.
- A conflict-free criterion means that the semantics represented in different parts of the model should not contradict one another (Shanks, et al., 2003). The research presented KM and RM processes as an integrated framework working together without any contradiction. The data analysis of the interviewee responses and the triangulation supported the integration.

8.4 Contribution of the Research

This research contributes to the understanding of the KM, RM and related processes. The research has succeeded in proposing a framework that enriches current research by offering specification, justification and validation of a set of

interrelationships between important factors. Most importantly, this research describes an integration of KM and RM processes as the KBRM (RiskManIT) framework to improve RM. Moreover, the research described a structured methodology for applying the conceptual solution to enterprise IT project. The Conceptual solution was validated by experts in the field of RM and KM.

After reviewing research literature on KM and RM as reported in Chapter 2, the author has developed the following taxonomies:

1. Taxonomy of definitions of Data, Information, Knowledge and Wisdom to provide better comparison and analysis to the reader, as presented in Table 1.
2. Taxonomy of definitions of KM to provide better comparison and analysis to the reader, as presented in Table 2.
3. Taxonomy of definitions of KM processes to provide comparison and analysis to the reader, as presented in Table 3.
4. Taxonomy of definitions of RM processes to provide comparison and analysis to the reader, as presented in Table 4.
5. Provide step-by-step structured methodology for applying the conceptual solution for the integration of RM processes with KM processes, as presented in Chapter 7.
6. The conceptual solution framework received the support from the interviewees.

Table 45 summarizes the research contributions related to the purpose of study, research question, hypothesis, knowledge claims and summary of contribution.

Purpose of Study	Research Question	Hypothesis	Knowledge Claims	Summary of Contribution
1. To enhance Risk Response Planning (RRP) process of	1. How does the integration of KM and RM processes improve the organization's ability to manage	H0: The integration of KM principles in support of RM processes, when applied	Constructivist Assumptions	1. Taxonomy of definitions of Data, Information, Knowledge and Wisdom to provide better comparison and

risk identification, analysis, and execution by capturing the appropriate and relevant risks to the organization goals and objectives. 2. To align and integrate the KM and RM processes. 3. Analyze KM and RM to find elements that will enhance both. 4.Provide taxonomies of definitions for Data, Information, Knowledge and Wisdom, KM, KM processes and RM processes to provide better comparison and analysis to the reader	and mitigate risks in IT projects? 2. What is the impact of knowledge capture on Scope Establishment and Risk Identification? 3. What is the impact of knowledge discovery on Scope Establishment and Risk Identification? 4. What is the impact of knowledge examination on RM processes? 5. What is the impact of knowledge sharing on risk analysis and planning? 6. What is the impact of knowledge evaluation on risk execution and monitoring? 7. What is the impact of having a life and dynamic knowledge and risk repository? 8. What is the impact of knowledge education on RM processes? 9. To what extend do KM tools, techniques, technologies and	to IT projects, may improve the organization's ability to manage risks response planning by enhancing risk identification, analysis and mitigation.		analysis to the reader, as presented in Table 1. 2. Taxonomy of definitions of KM to provide better comparison and analysis to the reader, as presented in Table 2. 3. Taxonomy of definitions of KM processes to provide comparison and analysis to the reader, as presented in Table 3. 4. Taxonomy of definitions of RM processes to provide comparison and analysis to the reader, as presented in Table 4. 5. Provide step by step structured methodology for applying the conceptual solution for the integration of RM processes with KM processes, as presented in Chapter 7. 6. The conceptual solution framework received the support from the interviewees.

	culture have an impact on KM processes?			

Table 45 Summary of Research Contributions

To the best of the author's knowledge there has not been a KM and RM integrated framework in the literature for mediating risks in IT Projects. This has encouraged the author to examine available studies from available sources. This dissertation contributes to the body of knowledge of RM by providing a comprehensive framework and methodology for employing KBRM (RiskManIT) processes within organizations.

8.5 Future Research

Future research would aim to preserve and improve the predictive power of the framework proposed in this research. These research findings open up multiple avenues for future investigations:

1. Develop Knowledge-Based Risk Management System.
2. Implement the Knowledge-Based Risk (RiskManIT) Framework as pilot studies in organizations.
3. Automate the KBRM (RiskManIT) approach.

It is hoped that the findings of this research will suggest an adequate level of interest from both the KM and RM communities in the field of IT, and encourage further investigation to address RM using KM tools and techniques, as discussed in this dissertation.

APPENDIX A **APPENDIX A INTERVIEW QUESTIONS**

Dear

I am in the research phase of my doctoral program, Doctor of Management in Information Technology. The title of my dissertation is "A Framework for Integrating Knowledge Management and Risk Management for Information Technology Projects". With this letter I request your participation as a Risk/Knowledge Management Expert in my research project by completing a questionnaire and follow-up interview with me. Your participation is highly appreciated.

The purpose of the Questionnaire is to obtain your input regarding the impact of Knowledge Management (KM) processes on Risk Management (RM). This framework aims to align and integrate the KM and RM processes into a single KBRM process model. A conceptual framework has been developed which addresses the problem of IT project failures by enhancing risk identification, analysis, planning and execution, and by capturing the appropriate and relevant risks to the organization goals and objectives. The conceptual framework is given in Figure 1. The questionnaire is intended for research purposes only and all information provided will be confidential.

A follow-up-up interview with you is planned at a time convenient to you, and will require no more than half hour. You will not be asked for any organizational intellectual capital related information or any commitment of any kind during the interview. I will seek only your opinions and perspective on the issues important to the success of my research. Attached is the Informed Consent Form. Please sign it and return it to me along with the completed questionnaire.

A summary of the conceptual solution is presented below.

Best regards,
Louay Karadsheh

SUMMARY OF THE CONCEPTUAL SOLUTION

The proposed KBRM Framework in Figure 1 illustrates the integration of some KM processes with RM processes to enhance risk identification, analysis, planning and execution by capturing the appropriate and relevant risks relevant to organization goals and objectives. Adopting this framework should serve as a road map for organizations to implement knowledge-enabled Risk Management for IT projects.

The application of KM to Enterprise Risk Management (ERM) requires on the one hand the identification and development of knowledge processes, and on the other hand the identification of the integral knowledge that a knowledge worker requires in particular the risk modeling knowledge.

The KBRM framework contains Knowledge Application to provide a portal to access the latest information in the Knowledge-Based Risk Repository. Also, the knowledge essentials are contained in the framework. Other constructs in the framework are the processes of Knowledge-Based Risk Capture, Knowledge-Based Risk Discovery, Knowledge-Based Risk Examination, Knowledge-Based Risk Sharing, Knowledge-Based Risk Evaluation, Knowledge-Based Risk Repository and Knowledge-Based Risk Education.

Contact details

Name	E-mail	Phone Number
Louay Karadsheh	Louay.karadsheh@gmail.com	248-245-8219

Notes

The questions below are divided into two parts. Part One contains personal information and the second part includes questions related to Knowledge-Based Risk Management. Please answer both parts.

Part One: Personal Information

Area of specialization

Information Technology □
Management Information System □
Risk Management □
Marketing □
Customer Relationship Management □
Other_____

Years of experience _____ years
Company Size_____

Small Medium Large

Key Terms

Knowledge Examination: inspects carefully the list of collected knowledge based on the value, accuracy and relevance after the knowledge has been combined from different sources.

Knowledge Evaluation: is a process used to assess the knowledge based on certain criteria established b y the organization. For example: it can be used to evaluate the progress and performance of risk execution and control processes.

Knowledge Essentials: contains two important fundamental items, which are knowledge infrastructure (culture, technology, process) and KM practices and techniques to support the KBRM framework.

Questions

There are 9 categories, namely: -Knowledge-Based Capture, - Knowledge-Based Discovery, -Knowledge-Based Sharing, -Knowledge-Based Examination, - Knowledge-Based Sharing, -Knowledge-Based Evolution, -Knowledge-Based Repository, - knowledge-Based Education, -Knowledge Essentials and Open questions.

The answers will ranked from 1 to 5, where 5 means strongly agree, 4 agree, 3 neutral, 2 disagree and 1 strongly disagree.

Knowledge-Based Risk Capture

1) Knowledge Capture stage focuses on capturing both the explicit and tacit knowledge exists within the employees and documents, whether from internal or external source?

1	2	3	4	5

Comments:

2) Does capturing of knowledge from employees and documents play an important role in determining stakeholders' requirements, mission, goals, constraints and roles and responsibilities to create better scope establishment for the project?

1	2	3	4	5

Comments:

3) Does capturing previous project information play an important role in enriching the project profile by comparing it with similar projects to save time and money?

1	2	3	4	5

Comments:

4) Capturing risk information from previous reports, lessons learned, other similar incidents and relevant articles helps in identifying risks more efficiently?

1	2	3	4	5

Comments:

5) Knowledge Capture uses techniques to capture knowledge of risks, such as interviewing experts and stakeholders, brainstorming sessions, auditing reports, questionnaires and customer complaints?

1	2	3	4	5

Comments:

6) Risk Identification and Knowledge Capture are iterative processes because new risks may become known as the project progresses through its life cycle.

1	2	3	4	5

Comments:

Knowledge-Based Risk Discovery

7) The purpose of Knowledge Discovery is to obtain a tacit or explicit knowledge from data and information or from the blending of previous knowledge

1	2	3	4	5

Comments:

8) Knowledge Discovery attempts to identify IT project information by sharing of tacit knowledge, so that an individual's unexplored knowledge may be amplified inside the organization.

1	2	3	4	5

Comments:

9) Knowledge Discovery uses data mining techniques and tools to access stored IT projects in the repository to uncover previous project information or extract data patterns similar to the current project. For example: given the profile of a new project, it is possible to collect information about any other project that has similarities with the current one.

1	2	3	4	5

Comments:

10) Techniques such as brainstorming, questionnaires, team dialog and checklists can be used for Knowledge Discovery that can be used to unleash hidden risks. This helps in exploiting all accessible information for the project to widen the potential risks.

1	2	3	4	5

Comments:

11) Data mining software is an analytical tool for analyzing data. It allows users to analyze data from many different dimensions, categorize it, and summarize the relationships identified; the result may be a comprehensive list of risks for a specific project.

1	2	3	4	5

Comments:

Knowledge-Based Risk Examination

12) The purpose of Knowledge Evaluation is to carefully examine the list of risks against accuracy, value, relevance and project objectives in reference to an IT project.

1	2	3	4	5

Comments:

13) Knowledge Evolution attempts to filter the identified risks before feeding the information for risk analysis.

1	2	3	4	5

Comments:

14) Knowledge Evolution eliminates risk not related to the project's progress or the company's objectives and goals.

1	2	3	4	5

Comments:

15) Some of the techniques that may be used in Knowledge Evaluation are brainstorming and team discussion sessions to discover risks.

1	2	3	4	5

Comments:

Knowledge-Based Risk Sharing

16) Knowledge Sharing is the process in which explicit or tacit knowledge is communicated to other individuals.

1	2	3	4	5

Comments:

17) Knowledge Sharing is executed by disseminating and exploiting the captured or discovered risks from the organization whether the source is internal or external.

1	2	3	4	5

Comments:

18) Risk analysis and planning rely on having team working together, learning, and communicating to share the risks associated with the IT project.

1	2	3	4	5

Comments:

19) Knowledge Sharing is viewed as an iterative process for both the risk analysis and planning processes because during risk analysis, a new risk might expose and requires knowledge collaboration to reassess its impact and severity.

1	2	3	4	5

Comments:

20) Techniques used to facilitate the Knowledge Sharing process is best practices, repository, alert system, lessens-learned and expertise locator.

1	2	3	4	5

Comments:

21) Knowledge Sharing enhances risk analysis by having team share their experience on identified risks based on probability of occurrence, impact and extend of loss to produce more accurate results.

1	2	3	4	5

Comments:

22) Knowledge Sharing improves team ability during risk planning process to formulate plans, strategies, actions and recommended risk treatment to enhance opportunities and reduce threats to the project's objectives.

1	2	3	4	5

Comments:

23) Knowledge Sharing attempts to assist project team work by accessing the knowledge repository of former projects, avoiding the recurrence of problems and apply reuse actions that were previously successful in the risk mitigation or contingency.

1	2	3	4	5

Comments:

Knowledge-Based Risk Evaluation

24) Knowledge Evaluation attempts to assess risk execution and risk control mechanism in on-going basis by tackling risks on weekly, monthly or quarterly basis.

1	2	3	4	5

Comments:

25) Knowledge Evaluation may positively impact risk execution process by having the team addresses the risks by their priority, inserting resources and activities into the budget, schedule, and project management plan, as needed.

1	2	3	4	5

Comments:

26) Risk monitoring attempts to utilize Knowledge Evaluation by ending risk, altering the current execution plan, initiating a contingency plan, examine the effectiveness of the plan, deals with any unanticipated effects, and any mid-course correction needed to handle the risk appropriately.

1	2	3	4	5

Comments:

27) Knowledge Evaluation may enrich knowledge repository with lessons learned and best practices.

1	2	3	4	5

Comments:

28) Knowledge Evaluation assists in reaching a better decisions and identifying what lessons could be learn for future assessments and management of risks

1	2	3	4	5

Comments:

Knowledge-Based Risk Repository

29) The lack of documentation on the success or failure of past experiences in IT projects is one of the reasons for inefficient RM executions.

1	2	3	4	5

Comments:

30) Having a live repository containing all projects' information is valuable to the project team, and provides saving in time and helps to establish a risk mentality into your project culture.

1	2	3	4	5

Comments:

31) Knowledge Repository may contain all the experiences, lessons learned, security incidents, case studies gathered during the previous processes in a single repository.

1	2	3	4	5

Comments:

32) Knowledge Repository may be linked to Knowledge Capture process to assist in finding previous risks for a particular project or to find the right person with experience in dealing with certain type or risks.

1	2	3	4	5

Comments:

33) Knowledge Repository may serve as a real-time modification of significant risks by providing up-to-date information during project execution process.

1	2	3	4	5

Comments:

34) (Cornford, 1998) Any new risk emerge during the risk execution can be referenced immediately through the database against previous similar projects to establish if there is a previous lesson learned or best practice to assist in dealing with this risk efficiently.

1	2	3	4	5

Comments:

35) Knowledge worker may be assigned to update the information, remove obsolete information and ensure any new tacit or explicit knowledge is codified for future use.

1	2	3	4	5

Comments:

36) Application portal connected to the Knowledge-Risk Repository may provide access to answers for problems, clarify uncertainties and search for experts.

1	2	3	4	5

Comments:

Knowledge-Based Risk Education

37) The stored collection of knowledge of risks in the repository can serve as training, education and awareness tool to current and future employees.

1	2	3	4	5

Comments:

38) Knowledge Education is aimed on providing a list of previous encountered risk cases or projects stored in the repository to teach existing and/or new employees.

1	2	3	4	5

Comments:

39) Training and education help employee to deal with any risk that might occur in future project and to avoid mistakes happened in the past.

1	2	3	4	5

Comments:

Knowledge Essentials

40) Appropriate technologies such as data mining, data warehousing, project management, intranets, extranets and portals for example, may support KM initiatives?

1	2	3	4	5

Comments:

41) Developing and promoting a culture of knowledge discovery, capturing and sharing help RM initiatives.

1	2	3	4	5

Comments:

42) Having a clear procedure of utilizing knowledge within the organization can promote a better execution of RM.

1	2	3	4	5

Comments:

Open-Ended Questions

1) How does the integration of KM and RM processes improve the organization's ability to manage and mitigate risks in IT projects in your opinion?

2) Which KM processes (Capture, Discovery, Share, Evaluate, Examination and Repository) are the most important to an efficient RM? Why?

APPENDIX B **CONSENT FORM**

DISCLOSURE

My name is Louay Karadsheh, a doctoral candidate in the Doctor of Management in Information Technology program at Lawrence Technological University. The intent of this questionnaire is to gather data for my doctoral project entitled "A FRAMEWORK FOR INTEGRATING KNOWLEDGE MANAGEMENT WITH RISK MANAGEMENT FOR INFORMATION TECHNOLOGY PROJECTS. " The questions you will be asked concern Knowledge Management and Risk Management.

Filling it out is completely voluntary and you may stop at any time. There is no right or wrong answers. All answers will remain completely anonymous. You do not have to answer any questions that make you feel uncomfortable. When you are done please return it to me by email.

An analysis of the results and an explanation of the study will be available in the College of Management, Lawrence Technological University sometime around mid-year 2009. If you have any questions about this research, you can contact me at Louay.karadsheh@gmail.com or 248-245-8219.

This research project has been approved by the Institutional Review Board at Lawrence Technological University.

Thank you for your help.

INFORMED CONSENT FORM

A Framework for Integration Knowledge Management and Risk Management for Information Technology Projects

I, _____ agree to participate in the study exploring a Framework for Integration Knowledge Management and Risk Management for Information Technology Projects conducted by the Louay Karadsheh in Lawrence Technological University. I understand this research project is studying the impact of Knowledge Management on Risk Management to attempt to propose a conceptual framework that solves the problem of IT project failures. I understand:

- As a participant of this study the researcher will interview me for approximately thirty minutes, and that I will have an opportunity to review and make corrections to the notes taken during the interview after which the corrected document will be returned to the researcher.
- As part of my participation in this study, any information collected may not benefit me directly, but what I learn from this study should provide general benefits to employees, companies, and researchers
- That I may not receive any direct benefit from my participation in this study.
- My participation is completely voluntary and that I may withdraw at any time from this study.
- That some people may find it troubling to participate in some or all of the research activities required and I may decline to participate in any portions with which I feel uncomfortable.
- That my name or identity will not be used in reports or presentations of the findings of this research.
- There will be no compensation for participating, travel or lost time from work.

The information provided to the researchers will be kept confidential with the exception of the following, which must be reported under Michigan law.

1. (Suspected cases of child or elder abuse)
2. (Information that individuals intend to harm themselves or others)

I have read and understand this information and agree to participate in this study. I will be offered a copy of this form to keep.

Participant's Signature_____
Date_____

Investigator's Signature_____
Date_____

For questions or concerns about the research, please Louay Karadsheh at 248-245-8219. For concerns about your treatment as a research participant, please contact the Institutional Review Board (IRB) at Lawrence Technological University, IRB@ltu.edu

APPENDIX C **SUMMARY OF INTERVIEWEE**

RESUMES

1) She is a managing director for small size software Development Company. She is an expert in custom software development including Business Process Change and automation. She specializes in programming, process review analysis and business process change. She worked on several IT projects with 14 years of experience.
2) Vice president for IT Company. Information security certified with diverse background knowledge in IT and IS. He has worked on many IT projects for small and medium sized businesses. He has 20 years of experience.
3) Expert in processes methodology. Working for very large automobile company and has diverse knowledge in IT, business process, MIS and project managements.
4) IT Manager in a large telecommunication company. Worked in several IT projects related to mobile technologies and Risk Management. He has over 20 years of experience.
5) IT Manager in a medium size corporation with 10 years experience. She is specialized in communications and has experience in IT and project management.
6) An Associate Professor, MIS KFUPM, teaching undergraduate and postgraduate courses, 21 years teaching experience He has authored many articles in Information Systems, E-learning and knowledge Management. He is member International Association for Computer Information Systems (IACIS) editorial for many Journals, and IBIMA Conference Advisory Committee. He has been awarded a certificate on Online teaching from University Illinois October 2005.
7) An Assistant Professor and Head of MIS Department at university in Amman, Jordan. He has a PhD in Financial Information Systems from Brunel University, London, UK. His research Interest includes but not limited to Financial and Accounting Information Systems, Knowledge Management, Decision Support Systems, E-Business and Simulation. He has published more than 10 articles in refereed journal as well as national and international conference proceedings.

8) A general Manager of large organization and Associate professor in the Department of Management Information System at university. He received a PhD in Information Systems from Brunel University, U.K. His research interests are in Information Systems, methods of automating the process of trading in financial markets, Customer Relationship Management, and meta-analysis in information systems. He has written more than 30 papers for academic journals and international conferences on these topics. He taught 24 different modules in finance and information systems in various universities.
9) Has a PhD in Computer Information Systems. He is an assistant professor in the Department of Management Information System. His research interest includes Knowledge Management, Customer Relationship Management, Risk Management, and Data mining, information retrieval, and congestion control. He published 17 articles in refereed journal as well as international conference proceedings.
10) Has a master degree in Management Information Systems from the Amman Arab University for high graduate, Amman-Jordan. He is the logistics director in the public security directorate. He has completed his prerequisite courses for his PhD and just starting his thesis. His research interest includes Knowledge Management, Customer Relationship Management. He has published articles in international conference proceedings.

TERMINOLOGY AND ACRONYMS

KBRM - Knowledge-based Risk Management

RM – Risk Management

KM – Knowledge Management

KBRC – Knowledge-Based Risk Capture

KBRD – Knowledge-Based risk Discovery

KBREx – Knowledge-Based Risk Examination

KBRS – Knowledge-Based Risk Sharing

KBRE – Knowledge-Based Risk Evaluation

KBRR – Knowledge-Based Risk Repository

KBREdu – Knowledge-Based Risk Education

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