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Post-Project Risk Perception and Systems Management Reaction

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by

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The objective of this research is to identify whether risk management in projects has any role in risk management in systems. Projects, systems, and risk management are three integral concepts in the management of various enterprises and agencies. Risk management is a common concept in systems and project processes. To avoid failures or crisis during their life cycles, projects and systems managers practice risk management. Projects and systems have well defined life cycles during which the risk is defined, controlled, and managed. Risk management is conducted in each phase of projects and systems. Projects are initiated to close certain operational gaps or to expand the capabilities of the system for better management and operation. The outputs of these projects are to be integrated into larger systems. This research investigates if the risk initiating events during these projects could cause a failure or crises in the system.

This Dissertation is dedicated to my mother who did not forget me in her prayers, to my dad who put all the efforts to bring me to this level of education, and also my wife who supported me during the tough times. In addition, I would like to thank my sons who helped me by their supportive feelings, to my brothers and sisters who expressed their pride in my work and to all who love me and wish me the best in my work to produce this dissertation.

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إلى كل من يسعده حصولي على هذه الشهاده من الأقارب و الأصدقاء و خصوصاً والدي وأولادي وزوجتي و إخواني وأخواتي, كما أقدم هذا العمل إلى كل من ساعدني على إنجازه بما فيهم الدكتور المشرف على الرساله و اللجنه المشاركه وكل من ساعدني في إنجاز البحث الميداني والنظري.

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CHAPTER 1:

1 INTRODUCTION

1.1 Problem Statement

Projects have a very strong relation to systems since projects mostly become parts of larger systems. Systems usually initiate projects to execute certain tasks that are parts of the system's life cycle. These tasks should not have any effects on the systems operations during project execution. Then the outputs of these tasks are to be integrated into the system. These projects are initiated within the systems for two primary purposes: (1) to close certain operational gaps or (2) to expand the capabilities of the system. The issue raised in this research effort is whether failure events occurring within a system could be traced back to initiating events in the project or in its integration. Is it possible to reduce or eliminate risks within the system by managing the initiating events of risk in the projects? The objective is to identify whether projects have any role in risky events in the systems. In spite of the impotence of this issue in the fields of project and systems management, there were very few studies that addressed this issue.

Statement of Purpose: The main purpose of this research is to investigate whether risk initiating events during the project lifecycle could propagate to the system after the project is completed and integrated into the system.

Risk management is not only critical in avoiding system failures or disasters but also in the field of project management. To support the purpose of this dissertation, the research efforts are to explore and clarify whether risk is perceived the same way in project management compared to systems management. The efforts are also to address if systems and projects have common or different risk management processes. Identification of the system's reaction to the project's risk initiating events is crucial in supporting the purpose of this research.

1.2 Research Issues

Projects as one of the management strategies are widely adopted by most, if not all, organizations, enterprises, and government agencies. Project management has become very popular among systems across most, if not all, industries. Extensive studies have been published about project and project management. Thus, management of systems uses projects to execute tasks without disrupting systems operations. Project management as well as systems management adopted a very rigorous risk management process in order to avoid any undesirable events during the execution of the project or during the life cycle of the system. Risk management processes in projects are continuous while the project is under execution and terminated with project completion. However, risk management processes in systems are also continuous and continue over the whole lifecycle of the system until it is disposed of. Risk management practices are applied in each phase of the system in a continuous process.

The objectives of this research are to:

1. Describe whether risk initiating events within the project can propagate to the systems after projects are completed and integrated.
2. Propose what can be done during the project lifecycle to mitigate or eliminate any risk propagation from the project to the system.

CHAPTER 2:

2 LITERATURE REVIEW

Systems, project, and risk management have been extensively addressed in the literature. The following sections discuss the findings in the literature about these three main domains: projects, risks, and systems.

2.1 Project and Project Management (PM)

2.1.1 What is a Project?

A project is defined in different ways in the literature. Reiss (1993, p. 11) defined a project as "a human activity that achieves a clear objective against a time scale." However, Steiner (1969) defined a project as "an organization of people dedicated to a specific purpose or objective. Projects generally involve large, expensive, unique or high risk undertakings which have to be completed by a certain date, for a certain amount of money, within some expected level of performance" (Williams 1995, p. 19). Project Management Institute (PMI) (2004, p. 5), describes a project as "a temporary endeavor undertaken to create a unique product, service, or results." However, other literature bounds the project as a task that has to be completed within the famous three dimensions of time, cost and quality (or performance). The following figure shows the triangular representation of a project.

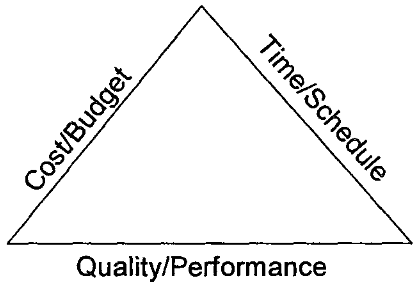


Figure 1: Project management representation; Source: Atkinson, 1999

2.1.2 Project Management (PM)

Turner (1996) defined project management (PM) as "the art and science of converting vision into reality" (Atkinson 1999, p. 338) which is a very high level definition. Atkinson defined PM as the "application of a collection of tools and techniques to direct the use of diverse resources toward the accomplishment of a unique, complex, one-time task within time, cost and quality constraints" (Atkinson 1999, p. 337). However, The British Standard for Project Management more formally defines PM as "The planning, monitoring and control of all aspects of a project and the motivation of all those involved in it to achieve the project objectives on time and to the specified cost, quality and performance" (Atkinson 1999, p. 338). Nonetheless, both definitions limited the management of a project by the three boundaries: time, cost and quality. Others look at project management beyond the boundary of the three dimensions. PMI defined project management as "the application of knowledge, skills, tools, and techniques to project activities to meet project requirements" (PMI 2004, p. 8). Perera and Holsomback (2005) looked at PM differently stating that "project management is the function of planning, overseeing, and directing the numerous activities required to successfully achieve the requirements, goals, and objectives of the project/program, within the specified cost and schedule constraints" (Perera and Holsomback 2005, p. 2).

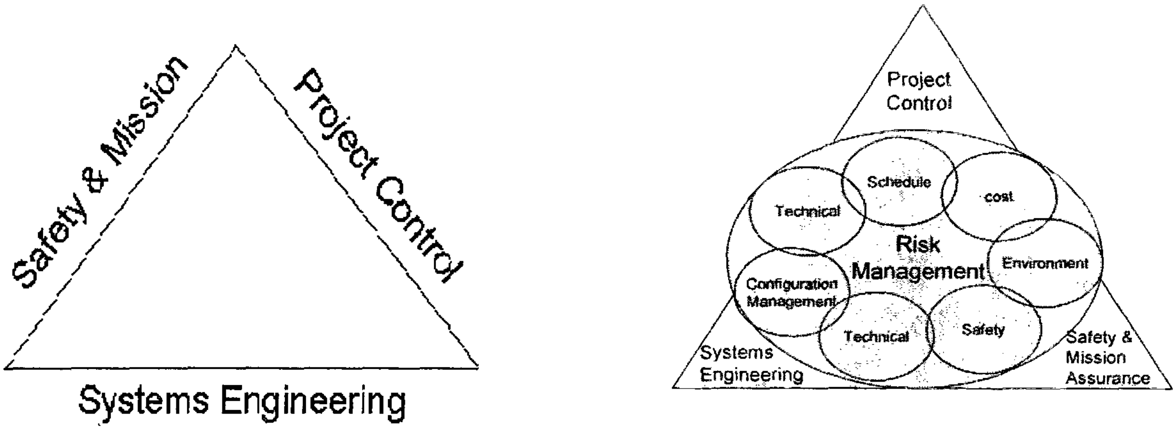


Figure 2: Project and system engineering relation; Adopted from NASA model (Perera and Holsomback 2005)

Perera and Holsomback (2005) also suggested a kind of interaction between risk management and project management, shown in Figure 2. It is noticeable that Figure 2 has systems engineering as one part of project and risk management, which is the main discussion of this research effort. Nonetheless, the safety and mission of the project are also portrayed together as an integral part of project management. Based on F igure 2, there is an inter action between project control, project mission and systems engineering. The next section discusses how project managers are using the systems approach to accomplish projects objectives and how they have their system engineers manage the different mini-projects or modules within a project and their interactions to complete the project.

2.1.3 Project Success

Project managers are well aware that good PM is about good risk management (RM). Most companies and agencies have developed standards and procedures for risk handling and management, especially in high-risk fields such as nuclear plants and space explorations. NASA, for example, developed its own risk management process to avoid or minimize any undesired consequences of unplanned events (Perera and Holsomback 2005). Many studies in the field of PM indicated that the major factor of project success is planning (Dvir and Lechler 2004). "Numerous empirical studies of project management success factors suggested planning as one of the major contributors to project success" (Dvir and Lechler 2004, p. 3)

Projects must be managed to achieve their goals and will not succeed if these goals and objectives are not clear, well defined and documented. Success in project management used to be viewed from the perspective of meeting the three dimensions of PM which were illustrated in Figure 1 (meeting schedule, budget and performance). However, the relative importance among these three dimensions varies from one project to another. Some have cost or budget as the critical dimension, while others have time as the most important dimension for success, a good example is information technology projects. Performance could also be primary success criterion for projects, especially in the health industry. Figure 3 illustrates how emphasis on each dimension affects project execution. In all three approaches, the project still has to meet all three criteria, but one will be more critical than the others.

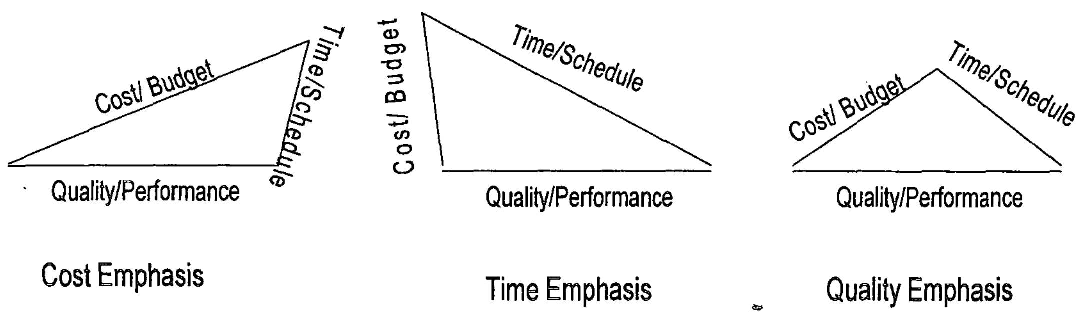


Figure 3: Different perspectives towards Projects main components

Scholars believe that it is not easy to define the success of projects, knowing that most, if not all, projects in different fields fail. For example, a project will not be successful until the project attains success considering the changes in objectives between phases and the variations of stakeholders' project success dimensions (Williams 1995). Salapata and Sawle (1986) considered a project successful only if the following groups perceive success:

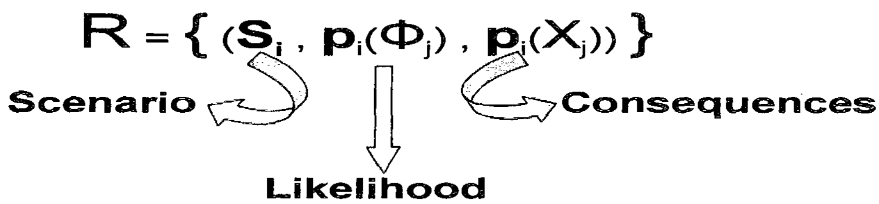
- Clients (considering performance, budget and reputation),
- Builder (considering profit, reputation, client and public satisfaction),
- Public (environment, reliability, and cost) (Williams 1995).

As addressed in the previous section, PM is a process of planning, monitoring and controlling an executed project. All of these are future activities and are exposed to changes in the environment which may cause changes or even the termination of projects. This is why risk management in projects is critical for success. Raz and Michael (2001) considered risk management one of the key PM processes. PM has to identify risks early enough in the process and take the necessary action to eliminate or mitigate these risks. The following section will discuss risk and how it should be managed in projects.

2.2 Risks Management

2.2.1 What is Risk?

The word risk generally means negative results from bad or unexpected events (Perminova et al. 2008). Williams et al. (1997) defined risk as "the possibility of suffering harm or loss; danger" (Williams et al. 1997, p. 77). Fishburn (1984) defined risk as bad events. Statman and Tyebjee (1984), however, defined risk as a high probability of failure, while Bunyard (1982) looks at risk as "software defects" (Williams 1995, p. 24). Risk has also been considered as a future problem of systems or projects (Cervone 2006). However, Kaplan gave a more comprehensive definition of risk. He stated that when talking about risk, we are asking three questions: What can go wrong? How likely is that? What are the consequences? (Kaplan 1997). He formulated the above questions as follows:



Source: Adopted from Kaplan, 1997(Kaplan 1997)

There are several reasons for risk threats, including markets, technology, social networks, organizations and politics (Stephan and Badr 2007). Other causes of risks are related to human factors that include people, personnel and organizations. Risk could be transferred to other businesses, avoided, mitigated, reduced or accepted (i.e. to tolerate the consequences). Risk varies in level from tolerable to crisis (Stephan and Badr 2007). Based on company strategies, they can tolerate risk to a certain degree but usually not up to the crisis level. Levels of risk are estimated by its consequences and its likelihood. Stephan and Badr (2007) classified levels of consequences (insignificant, minor, major and catastrophic) and classified likelihood (rare, unlikely, possible, likely and almost certain). they used subjective values (low, medium and high) to relate the likelihood and consequences. An example of consequences and likelihood levels is illustrated in Table 1 (Stephan and Badr 2007).

Table 1: Consequences and Likelihood combination

	Consequences				
Likelihood	Insignificant	Minor	Moderate	Major	Catastrophic
Rare	M	M	H	L	H
Unlikely	H	M	M	M	H
Possible	L	L	L	M	M
Likely	L	L	M	H	H
Almost certain	M	M	L	H	H

Adopted from (Stephan and Badr 2007)

2.2.2 Risk Management (RM)

Most of the literature on the RM process views this process in five steps. These steps are shown in Figure 4.

Figure 4: Typical risk management process: Adopted from (Perera and Holsomback 2005) and (Chapman 1997)

The steps for RM are:

- Identification of Risk: It is the answer to the question "What can go wrong?" Risks can be identified from project data constraints or requirements, fault-tree analysis results, failure modes and effects analysis (FMEA) results, test data, and expert opinion (Perera and Holsomback 2005).
- Analysis: It is the answer to the questions "What is the likelihood?" and "What are the consequences?" It is to assess and evaluate the possible risks.
- Plan: It is to plan the appropriate action to eliminate the threat of risk or to mitigate the consequences of risk.
- Tracking: It is to suggest some methods to address the effectiveness of the proposed action against risk or to take action on the risk under monitoring that starts to be more risky.

- Control: It is feedback used to evaluate what actions should be considered for certain risk and take the necessary corrective actions.

William (1995), as shown in Figure 4, suggests that the RM process has to be continuous in order to be effective where customers and supplier must continuously monitor and manage their list of risky items and suggest what could be done (Williams 1995). The purpose of risk management is to identify potential problems before they happen in order to properly identify the proper risk handling processes for an anticipated event (Perera and Holsomback 2005). Risk management is applied to:

- Reduce the risk of failure of unplanned or planed actions,
- Identify and prioritize risks,
- Control decision making processes,
- Minimize and mitigate the impact of disasters (Perera and Holsomback 2005).

However, open, clear and continuous communication is mandatory for effective RM. For effective RM, the following steps are recommended:

1. Management buy-in: Without management support for risk management, there is no way for the process to be efficient.
2. RM plan: There has to be a clear RM plan.
3. Eval uate and integrate: Evaluate and integrate the RM process with respect to the decision making process.

4. Monitor and control: Monitor and control the effectiveness of the process (Perera and Holsomback 2005).

However, Lister identified the following steps for effective RM:

1. Identify risk,
2. Determine the bad aspects of each risk,
3. Determine which risk to manage,
4. Take action and con trol over time,
5. Plan (contingency planning) (Lister 1997).

There is another view of risk which states that risk cannot be managed if its sources are unknown and if there is no clear vision of the results of the response to the risk (Chapman 1997). Finally, Lister brought up an interesting note about risk in which he stated that only "stupid risks are bad" (Lister 1997, p. 20). He defined "stupid risks" as those that are taken though it was possible to avoid them with minimal loss in benefits and with marginal expenses (Lister 1997).

2.2.3 Project Risk Management (PRM)

Earlier, project, project management, risk and risk management were discussed. Combining those concepts, NASA suggests the following definition for Project Risk Management (PRM): "Project risk management seeks to anticipate and address uncertainties that threaten the goals and timetables of a project" (Wu et al. 2006, p. 708). PRM is considered one of the main processes in project management (PMI 2004). For many reasons beyond the control of the project manager and the project team, most projects suffer budget overrun and major and minor completion or time delays. Wu et al. (2006) suggest that to overcome those challenges that might be potential problems in PM, one has to adopt effective risk management (Wu et al. 2006).

In managing a project, the project manager is the one who is in charge of the RM processes that include resource allocation and project planning (Perera and Holsomback 2005). Other team members are supposed to identify, analyze, plan, track, control and communicate risk among the various teams of the project and to project stakeholders in general, especially management. Raz and Michael (2001) claimed that PRM is a process that has to be implemented from the beginning of the project (the definition phase) through the planning, execution and control phases including completion and closure phases.

2.2.4 Project Risk Management Processes

Several RM processes have been suggested to handle risk in projects. The selected risk process has to be applied to all phases during the lifecycle of the project. These processes have to be implemented by clients as well as contractors. Boehm (1991) proposed a two-stage process to handle risk:

- Risk assessment, which includes risk identification, analysis and prioritization;
- Risk control, which includes risk planning, resolution and monitoring, tracking, and corrective actions (Raz and Michael 2001).

Fairley (1994), on the other hand, suggests seven steps for PRM which are:

- Risk identification,
- Assessment and probability,
- Mitigate identified risk,
- Monitor risk,
- Prepare a contingency plan,
- Manage crisis,
- Recover (Raz and Michael 2001).

The Project Management Institute (PMI) has four phases for PRM: identification, quantification, response development and control (Raz and Michael 2001).

Skelton and Thamhain (2006) suggest the following list of practical risk categories in projects. The categories range from the change of customer requirements to technical difficulties as well as personal and organizational conflict. The categories are:

1. Changing project requirements initiated by customers;

2. Changing markets which cannot be controlled by project management or stakeholders;
3. Technical difficulties: this is challenging but can still be controlled by the project manager;
4. Technology changes: initiated by technology leaders and there has to be planning with those manufacturers to make sure that the project is not producing obsolete technology;
5. Loss or change in team members: The project manager has a strong role in this category. Projects within a business are competing for resources and stronger project managers win the needed resources;
6. Changing organizational priorities;
7. Conflict: could be internal to the project as well as external. Internal conflict includes interpersonal issues as well as unit resource allocation conflicts. External conflicts include competing for resources with other projects;
8. Changing management commitment;
9. Environmental quality problems;
10. New regulations;
11. Changing contractor relations;
12. Intellectual property disputes;
13. Changing social and economic conditions: beyond the control of the project manager (Skelton and Thamhain 2006).

2.3 Systems and Systems Management

2.3.1 What are Systems?

There is a need to differentiate between a systems approach and systems engineering. Systems engineering was first defined by Chase (1974) as "the process of selecting and synthesizing the application of the appropriate scientific and technical knowledge to translate system requirements into system design and subsequently to produce the composite of equipment, skills, and techniques that can be effectively employed as a coherent whole to achieve some stated goal or purpose" (Rhodes and Hastings 2004, p. 2). Another definition indicates that systems engineering is "a branch of engineering that concentrates on the design and application of the whole as distinct from the parts...looking at the problem in its entirety, taking into account all the facts and variables and relating the social to the technical aspects" (Rhodes and Hastings 2004, p. 2). The objective of systems engineering is to guide the engineering of complex systems (Kossiakoff and Sweet 2003).

Most of the practices used by systems engineers are adopted from the systems approach which will be discussed later. However, systems engineering can be differentiated from other engineering disciplines (mechanical, electrical and others) in the following three ways:

- Systems engineering (SE) focuses on the systems as a whole: it does not only consider an electrical sub-system or mechanical subsystem. Example: As a car driver, you only worry about the functionality of the car, not the functionality of each subsystem of the car. It does not matter to you if the electrical system of the car is functioning well if the car is not drivable. Systems engineers integrate the efforts of all sub-systems to have the whole system (the car in the example) operational. (Kossiakoff and Sweet 2003).

- Systems Engineers lead and guide the efforts of all other subsystems. They participate in the design of the system but not necessarily in the sub-systems. However, it is possible that systems engineers get involved even in sub-system design since they have to have the whole system operation and this may conflict with sub-systems (Kossiakoff and Sweet 2003).
- SE bridges the activities, input and output of each sub-system. For the system to operate correctly, each sub-system should operate correctly, not by itself, but in combination with the other sub-system. This is where SE is required (Kossiakoff and Sweet 2003).

However, a system was defined by several scholars in the literature; some scholars generally agreed upon some definitions. One is by Kast and Rosenxweig (1972) who declared that the system is a collection of things or parts that interact together to form an organized complex unitary whole (Kast and Rosenzweig 1972). However, Checkland (2000) defined a system as "Interconnected complexes exhibiting emergent properties that their parts do not exhibit in isolation" (Checkland 2000, p. S11-S12). A third definition is by Eisenberg and Goodall which states that a system is the relationship among complex mutually dependent components (Eisenberg and Goodall 1993). Kossiakoff and Sweet suggested that the most commonly used definition for system is a group of related parts working to achieve a common goal (Kossiakoff and Sweet 2003). However, Keating had a definition which relates SE with the systems approach: "Systems Engineering is a dynamically structured, holistic, and systems-based approach that contextually guides the design, analysis, deployment, operation, maintenance, and evolution of complex systems problem solutions. The SE approach assures that system outcome expectations are efficiently and continuously achieved throughout the system life cycle with minimal human costs" (Keating et al. 2001, p. 80)

A more comprehensive perspective to the systems issue discussed in this dissertation would be to consider the concept of a system of systems. A system of systems is where the concern addressed in this dissertation might apply. There are several definitions of systems of systems presented in (Keating et al. 2003). One of the definitions is presented by Sage and Cuppan (2001) which states that "Systems of systems exist when there is a presence of a majority of the following five characteristics: operational and managerial independence, geographic distribution, emergent behavior, and evolutionary development" (Keating et al. 2003, p. 37). The other definition was given by Kotov (1997): "Systems of systems are large scale concurrent and distributed systems that are comprised of complex systems" (Keating et al 2003, p. 37). Keating named the concept of a system of systems as a meta-system and defined it as "meta-systems are themselves comprised of multiple embedded and interrelated autonomous complex subsystems that can be diverse in technology, context, operation, geography, and conceptual frame. These complex subsystems must function as an integrated meta-system to produce desirable results in performance to achieve a higher-level mission subject to constraints"(Keating et al. 2004, p. 4). The last definition of a system of systems might be the most comprehensive since it includes all aspects that were presented in the previous definitions.

2.3.2 Systems Management

The phrase "systems management" was used in several earlier papers; however, none of those has a clear definition of this phrase. As such, this research effort is developing a definition that will be used in the context of project management and project risk management discussed in this research.

Management as a word can be traced back to old French (*management*) which means "the art of conducting and directing." However, the Latin origin is from "*manu agree*" which means "to lead by the hand" according to Merriam-Webster dictionary. Management is also defined as a process which includes planning, leading, organizing and controlling a group of people to achieve organization goals. It is also a process of getting activities or tasks completed efficiently with and through other people. Moreover, it is "the process of getting activities completed efficiently and effectively with and through other people" through executing the following functions: "Planning, Organizing, Staffing, Directing, Coordinating, Reporting, and Budgeting" according to web page of development of management organization (Choo.fisutoronto.ca, retrieved June 15, 2008).

The last definition of management might be the most comprehensive, since it includes most of the functions of managers including planning, organizing, staffing, motivating and communicating (Meredith and Mantel 2003). It also includes the consideration of resources which are vital to managers and businesses since without them no task can be executed and no job can be managed. Most of the definitions above included the notion of conducting and supervising as major tasks of management. The dictionary has a very close definition of management: "the act or art of managing: the conducting or supervising of something" based on Merriam-Webster dictionary, (Merriam-Webster, 2008).

From these definitions of management and systems, we can suggest a definition of "systems management" which is appropriate for the purpose of this research effort. This proposed definition should not only include the concepts of planning, organizing, controlling, staffing and directing, which are the components of management but also has to include the concept of interrelations of components to form the complex whole. Furthermore, the inputs (resources) and the outputs (products) of the system must also be included.

This research suggests the following definition for "systems management" which is:

The planning and allocation of resources to coordinate, control, communicate, and organize the operation of the components to achieve the system's objectives within the desired performance and quality.

In other words, it is the breakdown or allocation of resources and the integration of efforts to achieve goals.

A system is composed of subsystems or components organized in a hierarchical manner. The more components the system has, the more complex the system is. The more interactions there are between the system's components, the more complex it is (Keating et al. 2005). Moreover, human interactions within a system add more complexity to the system since human emotions and behavior are not consistent over time. In addition, the human subsystem called "soft system" by Checkland (2000) cannot be predictable which adds more complexity and risk to the system. However, each system, including its subsystems, should have a purpose or objectives for it to exist, and all the components, attributes and relationships are to achieve this objective. Each system, whatever its size, should have boundaries within which it operates. This also applies to subsystems (Blanchrad and Fabycky 2006).

The systems viewpoint can be a top-down view where the system is viewed as a black box which takes certain input and gives the desired output through which it interacts with the environment. The same concept applies to the subsystems that constitute the system which are considered black boxes that take inputs from other subsystems to give output to another subsystem in order for the system to achieve its desired output. In general, the holistic view of looking into the system is a major point of systems science (Blanchrad and Fabycky 2006)

Systems are not the same, and they differ in several attributes. The following are possible classifications of systems:

- Natural and human-made systems,
- Physical and conceptual systems,
- Static and dynamic systems,
- Closed and open systems (Blanchrad and Fabycky 2006),
- Soft and hard systems (Checkland 2000).

2.3.3 Systems Approach and Projects

As discussed earlier, projects "generally involve large, expensive, unique or high risk undertakings which have to be completed by a certain date, for a certain amount of money, within some expected level of performance" (Williams 1995, p. 19). This shows that the task that the project initiates is a complex one. Kossiakoff and Sweet (2003) put it in a different way to show how and why projects are initiated. They state that the level and complexity of the endeavor to engineer a new system require full coordination by a devoted team to lead its execution. This activity is called a 'project' (Kossiakoff and Sweet 2003). That is why they claim that systems engineering is an inherent part of project management.

Figure 5 shows the relation among systems, projects and the systems engineering function. As stated earlier, the systems engineering function is part of the project management activities that enable the project to succeed. It can also be noted that projects eventually become part of (or integrated into) a larger system. Projects can be initiated by themselves which means that they are systems themselves. Mostly, projects are initiated within systems, and their output is to be integrated into the system to gain a competitive advantage. Project circles, in Figure 5, are different in size indicating that projects come in different sizes in terms of resource, budget and schedule.

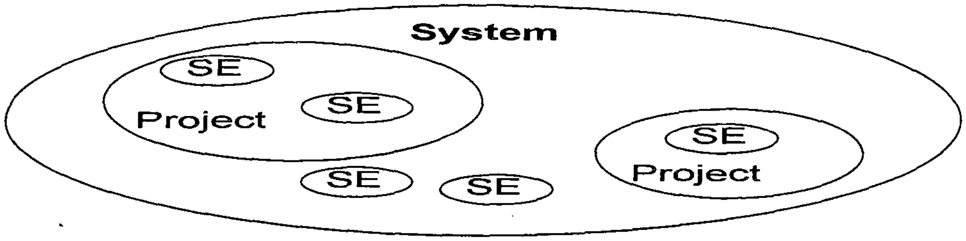


Figure 5: Relation among systems, projects, and Systems engineering functions

The following figure shows how the functions within each system are related. It shows that the systems are larger in size and have the largest number of components. The projects, on the other hand, are tasks within the system to be executed in a limited amount of time. Systems engineers are to coordinate different tasks within the project or the systems to make sure that the project will have the desired output.

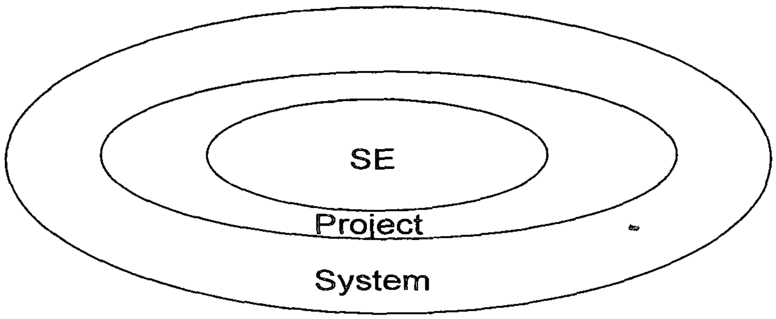


Figure 6: Functional relation among the concepts.

2.3.4 Risk in systems

Systems usually consist of numerous parts. These parts are interconnected and interact with each other. One of the purposes of the system is to ensure that required tools and technology are available to produce its intended products with certain performance and within the planned cost. However, there might be a chance of having an unpredictable outcome which poses a risk in system performance. The sources of these risks could be performance shortfall, environment sustainability, production issues or other unexpected consequences that might change the course of action and affect the cost and schedule. The most important step in managing risk in systems is to guide the system towards a course of action that has minimum risk and gives maximum results (Kossiakoff and Sweet 2003).

In every system, there are always uncertainties along the course of action to achieve the results or obtain the output of the system. These uncertainties are the sources of risk for the system. Risk management is introduced in SM to minimize the uncertainties that might be introduced during the lifecycle of the system. The RM process can be divided into two major stages which are risk assessment (planning and analysis) and risk mitigation (prioritization, handling and monitoring).

Risk assessment involves defining the weakest point and uncertain features of the system design. It also proposes ways or processes to reduce the probability that those features will cause design changes for the next steps in design or development. This step of RM considers two main components of risk: likelihood (the probability that a component of the system will fail) and impact (the consequence of that failure on the system). Based on the above discussion, it is noted that the risk assessment stages are: risk likelihood (probability of failure) and risk criticality (size of consequences).

Risk mitigation, on the other hand, is the stage after which the risk is known and might be anticipated; therefore, a course of action could be taken to minimize the effect or lower its probability of occurrence. Risk mitigation includes the following steps:

- Technical and engineering review of design and system performance,
- Oversight of design engineering components,
- Risk analysis and testing,
- Validation by prototype and testing,
- Continuous evaluation of system requirements,
- Assessment of alternative solutions to risky issues.

2.4 Gap Analysis

Thus far, this dissertation has discussed three main concepts. The first is project and project management. Project and project management concepts and how projects can be successful were presented. This research has also discussed risk and risk management. Moreover, risks in projects and the process of risk management were discussed. The third concept discussed was what systems are and proposed a definition of "systems management" expression.

One objective behind this research effort is to discuss the relation between those concepts and how they are utilized in industry and government agencies. Based on the above discussion, risk is a common concept between project management and systems management. There is a project risk management process and a systems risk management process. Figure 7 shows the relation between project, risk and system.

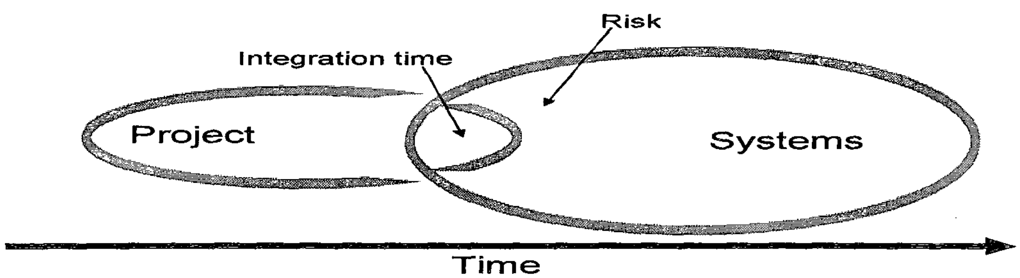


Figure 7: Relation between Project, Risk, and System

A project is a task that has to be completed within a limited budget and time schedule with specific levels of quality or performance. The primary concern of the project manager is not to overrun the limited budget or fall behind with the schedule to the degree that project performance is significantly degraded. The project has to have its output with the required technical specifications set up before being handled by the system management. The primary risks that project management is concerned with are satisfying and achieving the three main upper management constraints: budget, time and quality of the product. It is believed that most projects fail not because they did not deliver their output with the specifications but because they overrun their budget and planned time.

However, why did systems initiate a project in the beginning? Projects, from a system's perspective, are undertaken for two broad reasons: 1) to fill a gap within the system's set of capabilities or 2) to expand and add new system capabilities. The first is to close a gap within the operation of the system that causes system performance to decrease or become less effective or less efficient. Therefore, upper management intend to introduce a new process, plant, service or site to enhance the performance of the system by closing this gap. These projects can be physical (e.g. hardware) as well as soft or even human where technical capabilities would be needed to enhance system performance. Figure 8 below represents the gap and the project that is started to close this gap.

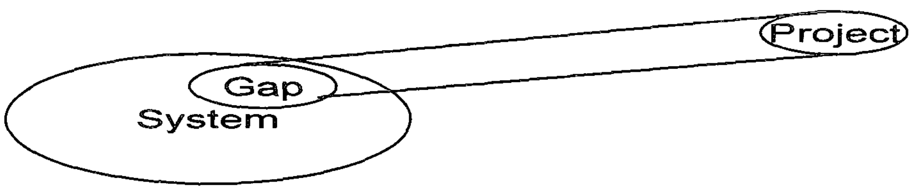


Figure 8: Projects and systems gaps.

Closing the gap in any system by a project could face three main challenges. First, there is a time horizon between the time the project is initiated and the time it is completed. The effect of this time horizon will depend on the industry. Nowadays, most, if not all, industries are highly dynamic and evolving, which means that projects have to be completed in a very limited time frame. The second challenge is the continuous changes in the gap that need to be filled (i.e. requirement creep). It is not only requirements that can change within the time of the project life cycle but also other dimensions such as available technology and system management policies which may have initiated the project. The third challenge has to do with emergence (change over time), where a system evolves from one situation to another. This puts more pressure on project management to continuously validate their effectiveness and efficiency.

The other reason for undertaking a project is expansion or addition of new sub-system capabilities. Systems have to possess all kinds of competitive advantages to compete within their market. Sometimes, it is about survival of organizations or systems to continue competing in the market. Projects allow a system to expand and attain this renewed competitive edge. Figure 9 below represents the idea of expansion of a system using a project.

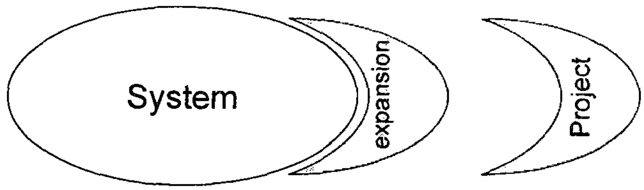


Figure 9: System expansion

The same concerns discussed above also apply here. Time is critical for expansion since competitors will not wait for the organization to finish its project. Everyone wants to be first in the market to gain the competitive advantage. Figures 10 and 11 illustrate the concerns.

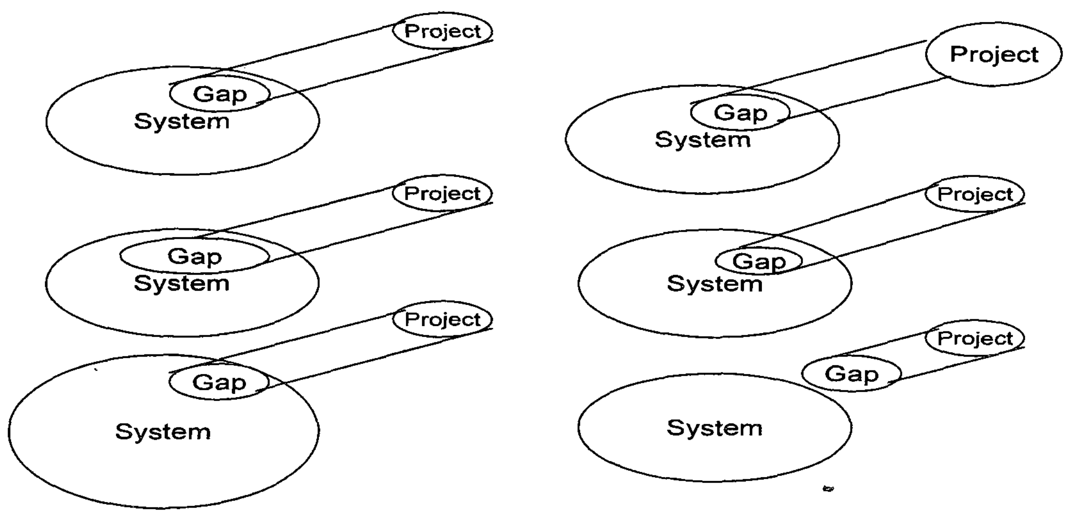


Figure 10: Possibilities of changes over time

Figure 11 represents the different scenarios that could happen over the time of project execution. These represent "what if" scenarios. What if the project is getting smaller to fit the gap? What if the gap is getting larger? What if the gap has been closed? What if the gap is not important for the system anymore? What if the system is getting larger? What if the gap is getting larger?

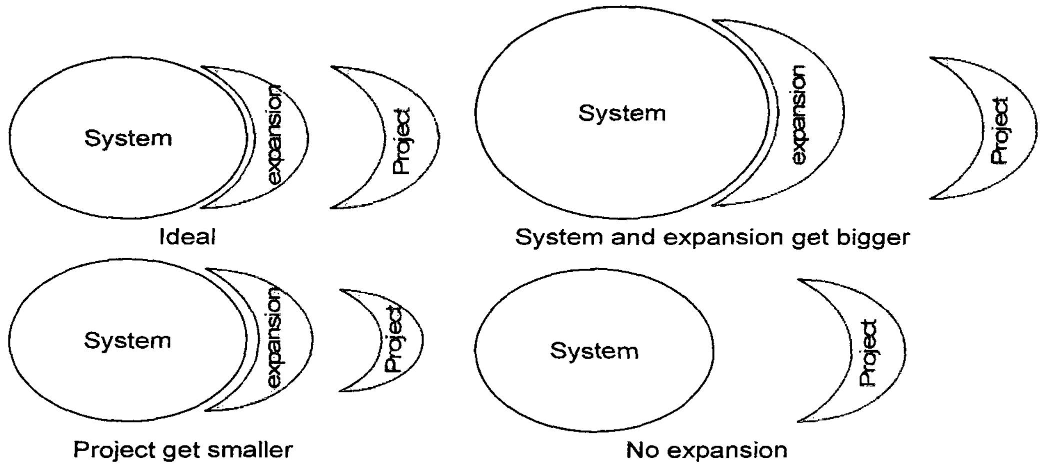


Figure 11: Expansion scenarios and issues

The "what if" scenarios for the expansion are fewer since expansion can consider the project output anyway. However, there are still some issues. What if the system gets larger? Will the project fit the needed expansion? What if the system gets smaller with cuts? Will that be useful for the system? What if the expansion is not needed anymore? Do we still go on with the project?

These scenarios are only part of the problem. There are more potential problems that might even be more critical for projects and systems success. When a project, whether to fill a gap or to expand the system, is completed, it has to be integrated with the rest of the system. The integration is a challenge by itself, especially after what we have discussed above with the "what if" scenarios. It is those risks that are not well defined in the above discussion of risk and project sections. When the project is completed, integrated, and working well, why do some of those project outputs, which will be a subsystem of the whole system, fail after a period of time? The following questions address the issues that might be the reason for systems problems:

1. Were there integration issues?
2. Did the risk in the project consider the risk within the system?
3. Was there an issue within the system that caused subsystem failure?
4. Was there an issue in the project that was not clarified in the system management?

For example, from personal experience, there was a huge multi-billion dollar project in an oil company. The project was to build a new gas plant which would include multiple plants to produce gas, process it and ship it for exportation. The project was completed and integrated with the corporation producing and shipping systems (pipeline). However, after a short period of time, there were some explosions in those plants; a few people died and a few others were hospitalized. Noting that the company had numerous plants, accidents like these were very rare, even nonexistent. Did the project do a good job in the turnover of the project output? Did the system take the project output for granted as it was new and supposed to work perfectly? Did project management make the systems people aware of the risks involved? Did the system integrate the new subsystem efficiently? All these questions are to be investigated and addressed through this research effort that will be developed based on this concept. These concerns can be illustrated in Figure 12.

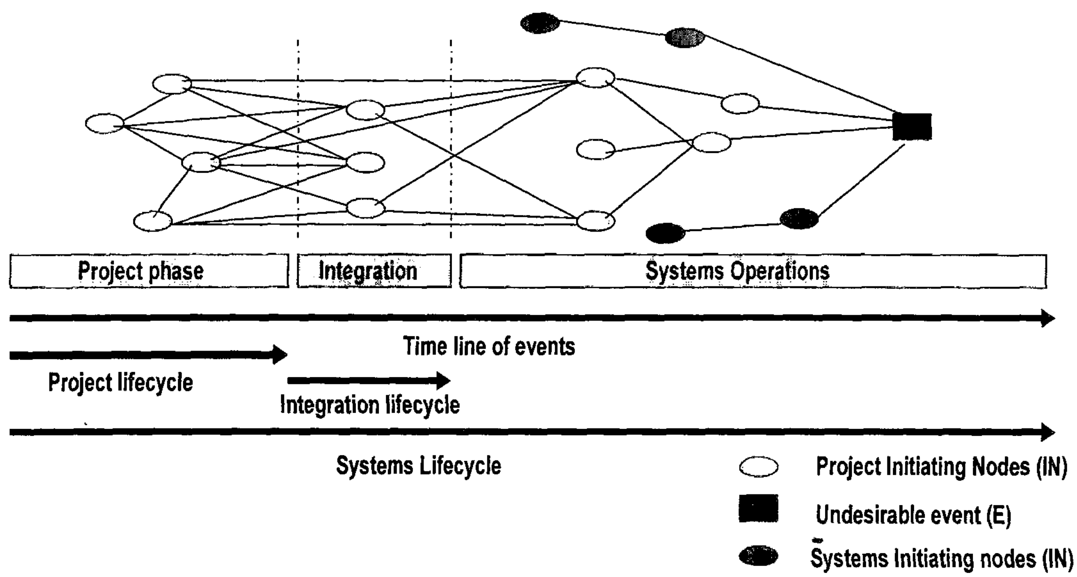


Figure 12: Risk event and Initiating Events

Figure 12 indicates that undesirable events in the system can be caused by initiating events from within the system, from the integration phase or even from the project phase. The above discussion raises a legitimate concern, which is that risk events during the systems operation phase can be avoided by managing the initiating events during the project and integration phase. The systems' risk can be reduced by managing the risks of project and integration risks.

2.5 Research Questions

There are a few questions that need be answered about the relation between projects, systems and risk management processes:

Research Objectives and Questions:

Describe how and why risk initiating events within the project can be propagated to the systems after projects are completed.

1.1. Is it true that risks can propagate from project phase to systems operation?

1.2. How does the current PRM process interact with the system risk management process?

1.3. Do risk initiating events propagate from the project phase to systems operation?

1.4. What is the role of project risks in systems operations' risk events?

1.5. Does PRM fail to identify risks that might propagate to systems operation after integration?

2. Propose what can be done during the project lifecycle to mitigate or eliminate any risk propagation from the project to the system.

2.1. What could be done during the project phase to mitigate or eliminate the propagation of risks to systems operation?

2.2. What could be done to minimize or eliminate inherited risks from projects prior to project integration?

2.3. How can project risks that might propagate to systems operation after integration be managed?

2.4. How can PRM be related to SRM in order to avoid failures during systems operation?

2.6 Research Formulation and Limitation

In the previous sections, several definitions were presented for the concepts being researched in this dissertation. Different scholars provided their different views of systems. However, the definition of a *project* was almost similar for most scholars. Among the definitions provided, this section will select the one that is considered in this study.

The first limitation is to choose which project definition is considered in this study. There are two definitions of a project that are adapted from previous research, studies, and findings. The first definition is the one proposed by the Project Management Institute (PMI 2004) which highlights the separation between projects and the systems:

"A project is a temporary endeavor undertaken to create a unique product, services, or result that will later be integrated into the larger system" (PMI 2004, p. 5).

This definition emphasizes the temporary nature of projects and their relation or integration into the system after completion. The other definition is provided by Steiner (1969), is more general and serves the other objective of the definition of project needed for this research effort:

"Projects generally involve large, expensive, unique or high risk undertakings which have to be completed by a certain date, for a certain amount of money, within some expected level of performance" (Williams 1995, p. 19).

This definition emphasizes the three major dimensions of projects which are the limitation of time, cost and performance.

It is more critical to choose the definition of a *system*. The term system is widely used within different contexts, and there is a need to choose a definition that applies to this study. Therefore, the definition of system that is considered for this research is the definition given by Kast and Rosenxweig (1972), generally agreed upon by most scholars, which states that the system is an organized complex whole that is a collection of things or parts interacting with each other forming a complex unitary whole *(Kast and Rosenzweig 1972).*

This definition includes the most important features of systems. First, it is a collection of parts or subsystems that constitute the whole system. These parts interact with each other to make a complex whole of the system. The unity of the system means that the output of each subsystem does not represent the output of the system. It is the collection of the outputs of the subsystems and the interaction between the subsystems and their outputs with each other that produce the output of the whole system. A project initiated by the system is a task that is being executed outside the operation of the system. However, after the task (project) is completed, it will be integrated within the system as either a subsystem or part of a subsystem. This means that the output of the project will interact with the other subsystems in a complex, emergent relationship to produce the final output of the whole system.

The third limitation in this study is that the risk that might emerge because of the interaction of the subsystems is not considered in this study. These interactions represent the operation of the system and all risks are considered under the risk management process of the system. The fourth limitation is similar to the last one. The project could also constitute multiple tasks that are supposed to be executed during the lifecycle of the project. The interactions of these jobs and their outputs are part of project operations and all risks are considered under the project risk management process.

The objective of this study, as stated in section 1.2, is to explore whether risks can propagate from the project to the system. Moreover, this research formulates a risk handling process that eliminates or mitigates this issue and minimizes the probability of having any risk events in the system that might be caused by an initiating event during a project's lifecycle.

CHAPTER 3:

3 RESEARCH APPROACH AND DESIGN

Project management is a mature field of study and there were many previous studies conducted in this field. Literature on this topic discusses almost all fields of project and project management. The literature covered almost all phases of a project from initiation, prioritization, resource allocation, engineering and design in addition to execution and completion. The amount of literature in each phase is different. For example, there was very little written on the completion phase of the project compared to other phases of the project (Dvir 2005). The literature approaches the topic from different perspectives. Moreover, different methods are used in conducting research. The papers that were used in the field of systems and project management were evaluated to develop the research methods that are appropriate for this research.

There are several philosophies and different approaches to conducting research. There are also different paradigms and several research designs that are used to develop research. A brief discussion of these philosophies, paradigms, approaches and methods, in addition to data collection methods, is provided in Appendix 1.

3.1 Research Methods Design

Before stating which methods are more appropriate for this research in the systems and project management field, we have to make the right decision regarding where the PM Field belongs in the philosophy and approaches of research discussed in Appendix 1. First, is the project management field empirical or rational? As we have discussed earlier, project management includes three major dimensions -- time, cost and performance -- all of which are tangible. The other suggested dimensions of PM and systems are planning, monitoring and controlling, and these concepts are applied to empirical entities. This drives the research toward an empirical, tangible research approach compared to a more rational, analytical approach.

The second issue is to decide if the research is positivist or constructivist. The nature of a project and PM deals with a solid schedule and limited budget to complete a task within a certain quality. The first two dimensions are both objective, where they are measured and quantified, while the latter is also quantified but it is subjective too and could be analytical. Therefore, the PM field could be both positivist and constructivist but tends more toward positivist. The same concept applies to qualitative versus quantitative. It is more quantitative than qualitative. It is only the human resource dimension of a project that could be arguably more qualitative while others are more quantitative.

Based on this discussion, this strategic decision had to be taken early on the research cycle to be more effective in conducting the research. However, Scudder and Hill (1998) conducted a competing study on the papers and research done in the field of operations management where project management belong s and found that over 60% of the research in the field uses surveys as a method. A survey, as discussed in Appendix 1, is a tool for empirical research, and it is used by both positivists and constructivists. However, 35% of researchers used case studies as a method for their research (Scudder and Hill 1998). Case studies are also a tool used in a positivistic approach to research. This means that PM belongs to the empirical and positivistic approaches to research.

Table 2: Data collection tools

Research Methods	**Number of articles**	**Percentage**
Survey	294	61.64%
Case Study	168	35.22%
Database	10	2.10%
Panel Study	5	1.05%

Source: (Scudder and Hill 1998)

Moreover, other dissertations in the field of project management were also considered to see what their research methods entailed in order to have a clearer idea of what to consider in the data collection methods. The dissertations developed in the field were looked at to check which research approach was used and which data collection methods were used. This will help in developing the right decision regarding which research method should be used on what application and what are the most appropriate data collection tools for this research approach. Considering the research efforts for dissertation publications before, it appeared that most of the researchers have used surveys in their data collection with the various approaches used to develop and complete their research. If researchers used another data collection method like case study analysis, they also employed a survey to collect more data about participants. Interviews and surveys were both used together in some research and complemented each other well. Interviews provide some clarification to questionnaire questions that might be vague or unclear to participants. In addition, interviews provide more explanation about the answer to the questions that the participant provided. The following figure shows the philosophical approach to this research.

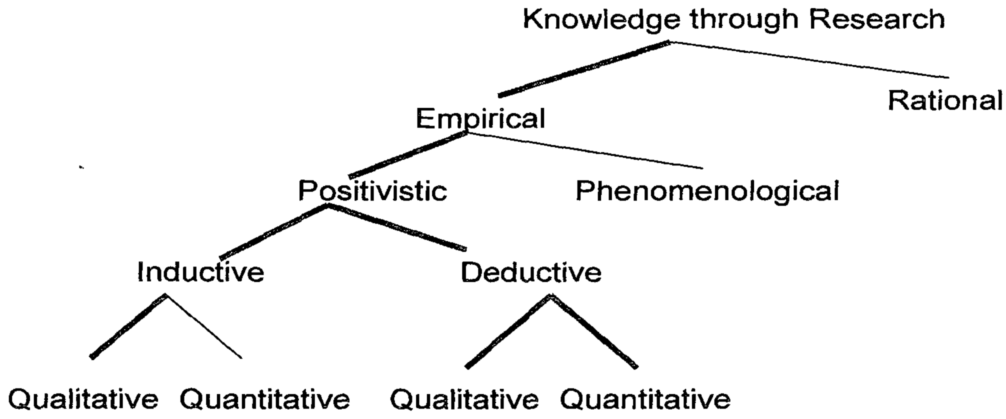


Figure 13: research approach and philosophy

Figure 13 illustrates the idea that the effort is to be qualitative inductive from a positivistic empirical approach. It is expected to mix some methods to better analyze the available data. For example, a mix between qualitative and quantitative methods would be used to develop and answer the research questions and fully analyze data after collection. Moreover, a mix between inductive and deductive research is possible. Inductive effort is used to build the hypothesis, and the deductive approach is used to test the answer to the questions and to deduce results from data analysis.

3.2 Validity

Validity is a cornerstone in any research development. Validation is the process of assessing and confirming theories posted in the research.

There are several items that need to be validated such as the data collected and the source of data used. Validation includes checking the research documents against a formal standard document to ensure that the research is valid. It also includes establishing documented evidence that ensures the validity of questions posted in this research. Verification is also about reviewing, inspecting, and testing research to ensure that it meets standards and regulations. It is also a quality assurance process to evaluate whether or not the research complies with requirements and conditions. Validity in research could be internal validity, construct validity, external validity and statistical validity, all of which are defined below:

Internal validity represents the logical relation between the dependent and independent variables (McBurney 2001). For example, experiments have an internal validity.

Construct validity is about measuring what the tool is suppose to measure and nothing else (McBurney 2001). In research, construct validity is about whether the results of the research answer the research question or solve the research problem.

External validity, on the other hand, is concerned with generalizing and applying the research results to other situations with different dimensions such as time, location, setting and subject. In other words, the research results are applied only to similar situations (McBurney 2001).

Statistical validity is similar to internal validity, where the relation between dependant and independent variables has a cause-effect relationship. A statistical test shows that only the outcome has a certain probability of happening by chance, which means that it does not confirm a cause-effect relationship ((McBurney 2001).

Face validity requires that a test should appear to test what it is supposed to test (McBurney 2001).

Content Validity is sampling the range of the behavior that is denoted by the theoretical ideas being measured (McBurney 2001).

Criterion Validity requires that a test be correlated with other measures of the same theoretical construct (McBurney 2001).

3.3 Generalizability

Collis defined generalizability as the application of research findings on other cases or situations that were not considered in the study (Collis and Hussey 2003). Research is conducted on a sample of subjects in a certain field or multiple fields. In some situations, there only needs to be a few samples to find something interesting and of value to add to the body of knowledge. However, this knowledge will be of a very limited use if it only applies to the sample under consideration. Generalizability is the concept that needs to be kept in mind and considered (Lee and Baskerville 2003) by the researcher, even before s/he starts his/her research. In order to do this, the researcher needs to avoid developing knowledge only for specific premises under study; rather s/he should generalize and apply findings to non-observed subjects. This goes along with Lee and Baskerville who argue that if the research lacks generalizability, it also loses practicality (Lee and Baskerville 2003).

Huberman and Miles (2002) looked at generalizability from a different perspective. They considered generalizability to be the most important feature of external validity across the population, setting, treatment variables, and measurement variables. They also considered the threat to external validity to also be a threat to generalizability and they limited these threats to:

- Interaction of testing and experimental treatment,
- The interaction of selection and treatment,
- The reactive arrangement ,
- Interference of multiple treatments with each other (Huberman and Miles 2002).

The most interesting aspect of their view is that they differentiate between quantitative and qualitative generalizability and have a reasonable approach towards it. They assume that generalizability, for quantitative research, is accomplished through the high number of sampling where results of the research can be generalized across the populations with the support of statistical software (Lee and Baskerville 2003). In qualitative research, however, generalizability is established through synthesis of pre-existing qualitative studies (Huberman and Miles 2002). Guba and Lincoln have a different term for generalizability in qualitative situations; they use the term "fittingness" because of the differences in time and context of each situation (Guba and Lincoln 1981). "Fittingness" means to make a fit between the situation under study and other situations where similar concepts apply (Huberman and Miles 2002).

Colllis and Hussey use a simple definition of generalizability which states that it is coming to a conclusion about one thing by knowing information about another (Collis and Hussey 2003). Generalizability also could be discussed from a paradigm perspective. In the case of a positivistic perspective, the research will build a sample to determine if the feature found in the sample can apply to the whole population from which the sample is taken. However, generalizability from the phenomenological (interpretive) research perspective is established from one setting to another where a finding in one case can be applied to another if the case under study manages to address the interaction and characteristics of the phenomenon (Collis and Hussey 2003). Finally, Lee and Baskerville came up with a framework that suggests four types of generalizability which are based on either empirical (E) or theoretical (T) statements. The four types are:

- EE generalizing from data to description: This means generalizing data to a measurement, observation, or other description.

- ET generalizing from description to theory: this means generalizing measurement, observation to theory.
- TE Generalizing from Theory to Description: This means generalizing from the theory confirmed in one setting at the discretion of other settings.
- TT generalizing from concept to theory: this means generalizing a variable or construct to a theory (Lee and Baskerville 2003).

3.4 Research in Project Management

It is clear (from the above discussion) that an extensive effort has been conducted in this field. However, some scholars claim that some phases in projects have been given more attention from scholars. For example, project planning has been extensively researched where so many papers were issued in resource allocation, portfolio management, time and scheduling -- not only papers that were developed for these phases but also some software packages that help in accomplishing good results for these phases. One of the scholars claims that project closing was given very little attention by scholars in the field of PM (Dvir 2005). The figure below shows project phases and how they are sequenced and related.

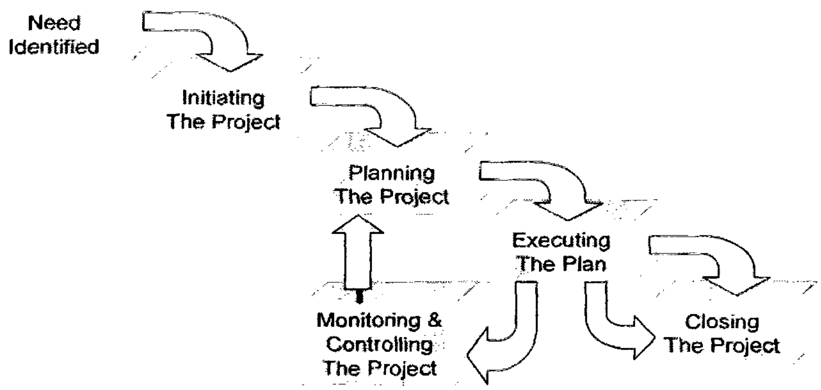


Figure14: Project phases adopted from (Kolmetz and Warner 2005)

Dvir (2005) argued that the closing phase was given little attention (Dvir 2005). Moreover, this research effort advocates that the risk propagation from a project was also given little attention from scholars, if any. In turn, the process of how to mitigate or eliminate these risks was also not well studied. The research effort in this dissertation is to investigate this phenomenon and find out if the risk from project would be transferred to the system which might lead to an undesirable event from probable risk that was undetected.

3.5 Surveys

The survey is the most common tool used by researchers for data collection. As has been mentioned in the research methods section, 61 percent of the research conducted in the field of project management used surveys and questionnaires to collect data from participants. Moreover, among the 20 dissertations reviewed in the field of PM completed in the last two years, three of them did not use surveys while the other 17 dissertations used surveys as a data collection tool.

A survey is defined as the first method that helps to learn something about a population. It is also used to meet the need for data that might be unavailable elsewhere (Fowler 2009). Surveys are developed to collect data to develop statistical information about a subject in order for the researcher to answer his research questions or to justify or refute his hypothesis.

Fowler (2009) posted three main properties of data that are collected through surveys:

- Probability sampling enables the researcher to gain confidence in the sample of data. The collected data is not biased and shows how accurate the data are.
- Standardized measurement ensures that comparable information is obtained about everyone that is targeted.
- A special purpose survey might be the only way to ensure that the data needed for a given analysis are available and can be related (Fowler 2009).

Surveys are usually conducted on a sample of participants whose opinion or feeling will be used to draw a conclusion about the population.

However, a sampling has three methodologies that have to be considered in selecting the samples:

- Sampling: Select a small subset of the population to represent the whole population. To make surveys useful, research has to learn how to sample. The most important feature of good sampling is to give all members of the population the same chance of being selected.
- Design question: The way questions are worded is very critical for participant response. The researcher should evaluate questions to ensure that they are understood and the answers are meaningful. The use of standardized questions might be useful for good survey results.
- Data collection (Fowler 2009).

Creswell claims that there are two types of surveys based on the dimensions under which the surveys are being conducted. These two types differ based on the purpose for which they are being conducted. They are either longitudinal or cross-sectional. The first is to study the behavior of an individual over a long period of time. This means that it takes a long time to complete a single study about one phenomenon. The second, which is the one utilized in this research, is cross-sectional and is used to collect data that reflect the current attitude, opinion, or beliefs of an individual or organization (Creswell 2002).

In order to avoid bias in the survey, the question has to be constructed in a way that is easily understood by all participants. Moreover, information should be collected in a standard procedure where each participant is to be asked the same question in the same way. Part of the most important confidentiality issue of surveys is that the individual who participates in the survey should not be identified when survey findings are presented or reported (Scheurn 2004).

3.6 Research Methods and Research Issues

There were two issues that have been raised from this research effort. The first issue is to *identify whether the risky initiating events within the project can extend or propagate to systems op eration after projects are completed.* This issue is to be identified and answered by questioning the participants in the survey. The questions in the survey were designed to enable identifying the answer to this issue. The questionnaire is posted in Appendix 3. There are some closed and open-ended questions to which participants can provide a reply that helps in identifying the relation between systems and the project. The answer will also help in identifying the relation between the risk management process in both projects and systems. Several questions are also listed in the questionnaire to test how effective the risk management process is in the project and how phases of the project are included in the process.

The second issue that was raised in this research is *what can be done during the project lifecycle to mitigate or eliminate any risk propagation from the project to the system?* This issue will be answered in two ways. The first is to develop the gap analysis in the literature and find out the problem in the current risk management processes of the project and system. From this gap analysis, this dissertation suggests a framework that might be applied to relate a risk management process in projects and systems to mitigate or eliminate the risks that might propagate. The second effort that will support the gap analysis and literature review is the survey. There are some questions in the survey that will help derive some reasonable suggestions from the expert participants. Experts and practitioners in the field of project and systems management would have valuable views of the problems they faced and would help in deriving some problem solving methods that can be generalized over other situations with similar contexts. Combining the literature review gaps and the practical experts' suggestions will enable suggesting a framework that will help to answer the second issue of the research efforts.

3.7 Research Methodology and Design

This research effort divided the answer to these questions into three phases. The first phase is the exploration phase where the research effort validates the existence or non-existence of the problem. The second phase is to validate the findings of this research effort in the first phase. The third phase is to suggest a solution to the problem that is addressed by this research. This is about suggesting a framework of how to handle the project risk management and system risk management processes. The following illustration provides a summary of these three phases:

Phases of the Research:

Phase 1: Problem Exploration

Research questions to be answered:

1.1 Is it true that risks can propagate from the project phase to systems operation? (What is written in the literature about risk propagation from the project phase to systems operation?)

1.2 How does the current PRM process interact with the system risk management process?

Output: A thorough literature review to find out what has been written about the stated problem.

Phase 2: Initial Problem Validation

Research questions to be answered:

2.1 Do risk initiating events propagate from the project phase to the systems operation?

2.2 What is the role of project risks in systems operations' risk events?

2.3 Does PRM fail to identify risks that might propagate to the systems operation after integration?

Output: Verification of the existence of the problem where risks propagate from project phase to systems operation.

Phase 3: Framework Building

Research questions to be answered:

3.1 What could be done during the project phase to mitigate or eliminate the propagation of risks to systems operation?

3.2 What could be done to minimize or eliminate inherited risks from projects prior to project integration?

3.3 How can project risks that might propagate to systems operation after integration be managed?

3.4 How can PRM be related with SRM to avoid failures during systems operation?

Output: Propose a framework that would require future validation and analysis.

Phase 1: Exploration: This phase is a continuous effort of investigating the available information about the issue raised in this research effort. Exploration started with a literature review of what scholars said about the risk management processes in the field of projects a nd systems management. The research also addresses how these two processes are related and how they interact with each other to avoid any major or minor risk events in the system and project. The findings from reviewing the literature pose a major research issue the limited research efforts that were conducted in the completion phase of the project compared to other phases (Dvir 2005).

PM and RM are mature fields of study and have been extensively researched. However, the issue raised in this research was not mentioned in the literature; there are only similar ideas where the scholar mentioned the propagation of risk form subsystem to another (Garvey and Pinto 2008). Garvey and pinto proved propagation of risk between subsystems using mathematical models. Nonetheless, Garvey, Pinto and other scholars did not give careful attention to how these issues are initiated or how they can be resolved. Identifying this issue in the literature might not be adequate to validate that the problem is really there. This research effort is planning to validate the finding from literature from a practical perspective. This research effort will seek the opinions and feelings of the people practicing PM and RM and who are involved in the integration of the project into systems. Various participants with different levels of knowledge and experience are expected to participate in the study to help validate the problem from different perspectives. Various levels of functional responsibility will also be included to uncover a thorough solution to the issue of this research.

Another validation process will be academic validation. This validation was conducted through presenting the proposed problem addressed in this research in academic environment. This was done by presenting this effort in conferences to observe how people in the academic world respond to the problem addressed in the research.

The tools employed in this research are surveys and interviews. The questions in the surveys were designed in a way to grasp the picture of the issue raised. The questions were either closed or open-ended questions. A sample of these questions is included in Appendix 3. Examples of the functional responsibilities that are expected to participate in this survey are project managers, engineers, timekeepers, cost analyzers, and other project team members. The survey includes a mixture of multiple choice questions and written responses. A combination of surveys and interviews will also be conducted to make sure that the survey questions are well understood and the participants give appropriate answers to the questions.

Phase 2: Initial Problem Validation: The validation process will be conducted in two ways. The first validation process is through face validation by presenting the findings of this research in creditable conferences or publishing the findings in creditable journals. The findings from the literature review were consolidated in a conference paper. The paper was submitted and presented at the Portland International Center for Management of Engineering and Technology (PICMET) 2009 conference in August of 2009 in Portland, Oregon. The paper was presented and posted in the conference proceedings. This paper covered the findings from the literature review and identified the problem and presented the gap analysis that led to problem identification. The same paper was also presented in June 2009 in the Saudi International Conference (SIC) in Guildford, United Kingdom. The paper was selected for presentation among many other papers submitted for presentation.

The third conference was the International Council on Systems Engineering (INCOSE) HRA Hampton Roads Area. The conference was held on November 2009 in Newport News, Virginia. What is good about this conference is that the academic and practical presence was available to criticize the problem and the issue addressed in this research from both perspective. The different perspective added value to this research effort.

The face validation covers the academic perspective of the research findings. The proposed surveys and questionnaire that will be conducted are to complement the academic validation and to provide practical validation of problem statements. The results or the outcome from these conferences will be presented in the result analysis chapter.

Phase 3: Framework Building: the first part was to complement the findings from the literature review and comments scholars posted in their findings. As stated, the first phase is to validate that the problem did exist. This phase is to seek a solution to the problem. The scholars, in a review of the literature, did not spot the problem to suggest a solution for it. There are a limited number of papers that even mentioned adequate research efforts in the last phase of the project which might have a lot to do with the reallocation of project resources back to their original functional areas. Dvir (2005) posted the problem in his paper, but he only addressed how to turn the project to the consumers. His emphasis was on how to handle the completion phase of the project in order to turn project output to the users. He did not discuss if there are any risks that can be transferred from the project to the system. He also did not discuss how the project management process handles the completion phase of the project.

Garvey and Pinto (2008), on the other hand, had a similar clue about the problem. They recognized dependencies between systems and subsystems. They raised the issue of ripple effects of risks. He proved mathematically that a risk in one subsystem will propagate to other subsystems. Their point is the risk that initiated in one node will propagate to another node, and the second node will carry it over to a third node and continue to a certain limit. This finding or mathematical justification will support the first phase of this project where the research claim is that risk will propagate from projects to systems even though there is a difference between the relation of subsystems (or node) and the relation of projects to systems. Garvey and Pinto's mathematical model served the objective of this research by proving that the risks do cross the boundary where they are initiated. Risk will have the tendency to cross the boundary of the subsystem where it started.

However, Dvir (2005), Garvey and Pinto (2008) did not offer any suggestions for what to do about this problem. What can be done to stop the risk from propagating from projects to systems? This phase of the research is to suggest a framework to enable project management to coordinate with systems management to resolve this issue.

From the gap analysis conducted earlier, a possible framework can be suggested to overcome the addressed problem. The section on gap analysis has discussed several gaps that might be addressed. These issues might have been considered in practice. We think that in addition to academic study and analysis, there has to be practical analysis of the issue in order to see how people in practice treat these issues. If these issues are not identified in practice, then it is suggested to seek the opinion of experts in the field of risk and project management to overcome or mitigate these problems. Interviews and surveys are to be employed to grasp the practical perspective to solve these issues.

Through combining the findings from the literature review with those from the fieldwork, the research will suggest a framework to mitigate or eliminate the problem. The application of this framework and how effective it is across various industries will need to be considered under future research.

CHAPTER 4:

4 RESEARCH INSTRUMENT AND RESULTS

Among the various research methods and instruments, this research effort used questionnaires to grasp the input of the participants regarding the issue that was addressed by this research effort. The issue that was studied under this research is to find out if the risk that was indentified and quantified during the project lifecycle or under the project timeframe could propagate to the system after it is integrated into the system. This section of the research will explain the instrument used.

Before presenting the research instrument, the research philosophy will be restated. As it has been presented in Figure 13 in chapter three, this research adapts a positivistic empirical viewpoint supported by inductive and deductive approaches. The inductive part of the research was the literature review, where fundamental ideas about the gap and eventual problem area were gathered. This part was discussed and presented in chapter one.

The deductive part is to validate the existence of the problem in practice. The idea is to deduce the existence of the problem from the response provided by the survey. The questionnaire was designed with a subjective approach, where it would be difficult to use statistical analysis on the responses. The survey has two sections, the multiple choice and the open-ended questions, both with subjective responses. The analysis of the data under this section is both subjective and qualitative. As stated in Appendix 1, the attributes of the qualitative approach are: exploration and justification of research problems, as well as seeking to understand the participants through the use of subjective text or images, limiting the number of participants to a small group, and the use of evaluative criteria. A quantitative approach was used to present the results; they were presented in percentages to show the significance of the responses, rendering them easier to understand and evaluate compared to subjective texts and images.

This means that the analysis of the surveys was done qualitatively based on the subjective responses, especially for the open-ended questions. However, the results were quantitatively presented as numerical percentages to attain a better understanding of the results, especially for the multiple choice questions.

4.1 Questionnaire Construction

The questionnaire consists of 31 questions. The questions can be classified into three types based on their textual format. There are twenty three multiple choice questions with four options to choose from. The objective of the multiple choice questions is to find out several perspectives about the participants, where some questions were used to evaluate the level of experience of participants and the type of function they are practicing in the project. This will help to anticipate the value of the answer of those participants. Another part of the multiple choice questions is designed to study the relation between the changes that occur in the project and risk process management. Some of the multiple choice questions aimed to evaluate the RM process being practiced in their organizations and how their project risk management process is executing the different phases of the process. The other questions are used to evaluate the impression of the participants towards their risk management process.

The other section of the questionnaire contains open-ended questions, designed to measure the responses and feelings of the participants towards the research issue and their experience with similar situations that might occur during their practical working experience. There were eight open-ended questions listed after the multiple choice questions. The objective of these questions is to have the participants express their reaction to the requested information by the question. A direct question about the participant's experience of any event in the system was posed as an open-ended question. Then, other questions were posed to investigate if this event was caused by long or short term risk-initiating events. Then, another direct question was posed about the relation of the event experienced to risk-initiating events from the projects that were just integrated into the system. By the end of the questionnaire, a couple questions were posed to have the participant comment on the relation of the risk management process s/he was using to the objectives of the project compared to the objective of the system.

The questionnaire was formulated initially and went through multiple revisions to ensure that it contained the right questions and addressed the right issues. Moreover, the Department of Social Science, with the help of Dr. Vandecar-Burdin, Associate Director of the Social Science Research Center in the College of Arts and Letters at Old Dominion University, offered her expertise in further refinement of the questionnaire, especially in the review and validation of the targeted survey participants. Several versions were updated upon her suggestion to meet Old Dominion University's questionnaire standards. Some of her excellent suggestions were regarding the order and the format of both open and closed-ended questions.

Nonetheless, the most important contribution from Dr. Vandecar-Burdin was her unbiased view of the problem context which enabled her to identify initial questions that may have presented unintentional bias toward certain issues of the research. Moreover, her experience helped validate the format and the wording of the questions. Her input to the questionnaire was valuable in the way to order and construct the questions themselves. She had important notes about where to place the questions and how to address the participant. Her notes also help in finding the best way to encourage participants to reply to and answer the questions, which helped in maximizing participant response.

4.2 Questionnaire Distribution

As suggested by Dr. Vandecar-Burdin, a check box was used in front of the four given options to make it easier for the participants and help in improving participant response. The open-ended questions, on the other hand, were left open to the participants to write whatever they thought as an answer to the question without any word limit, even permitting one-word responses. The participants were given two weeks to return their answers. This time period was also discussed with Dr. Vandecar-Burdin, and she suggested, from experience, that allowing a longer response time would make the participants feel relaxed about responding to the survey while a shorter response time might put pressure on them, leading them to ignore the survey altogether.

In order to get a good response to the survey, a network of people were contacted to participate, some of whom were known personally. These individuals forwarded the survey to other people that they know who have experience in either the field of project or system management. This provided a broader range of people whose responses were of great value to this research effort. Moreover, friends and colleagues who are known to be knowledgeable and interested in related fields were also asked to participate. Unfortunately, there were no risks managers who participated in this survey since there was no single respondent whose task is risk management in a project or system. Risk management is usually practiced by other engineers or employees where they have other tasks as their primary job. For example, risk management might be done by project managers themselves in addition to other tasks they have to perform as part of their duties. Moreover, risk management might be performed by more than one person in a project or system depending on who has the time to do it, even if it is assigned as a task in the system or project functionalities.

The survey was sent as a Word attachment through email to those people mentioned above. With a response time limit of two weeks, there were no responses in the first week. This required action to be taken to ensure that there were responses. Follow-up emails were sent emphasizing the time the survey was sent and the timeframe in which it should be answered. Unfortunately, there were some people who were out of the office and would not be able to respond. After the second week was over, the response was very limited. Responses were only from people who were known personally. The deadline for the questionnaire was modified and re-sent with great emphasis placed on this deadline, urging the participants to have their responses sent by the new due date. Follow-up phone calls were also made to some participants, and it was communicated to them how important their responses to the survey were. A meeting was also called with some participants to explain to them the objectives of this research effort and encourage them to respond with their perspectives on the posed issue. With these activities, the response improved and a good number of questionnaires were received. The total number of answered questionnaires was 39 from different areas of project management.

4.3 Questionnaire Responses

As mentioned in the above section, the first part of the questionnaire was to study the participants to find out more about their experience and their level of knowledge in project and project management.

4.3.1 Multiple choice questions

Question 1: What is your role/function in the project/system?

The first question in the questionnaire was to indentify the role of the participants in the project knowing that each could be the project manager, a team member, a member of the support team or have some other functionality. Most of the participants have had a relation with the project during its lifecycle or after its integration.

The majority (45%) of participants were project engineers who executed several different tasks during a project's lifecycle (see Figure 15). The next highest number of participants was project managers who know the most about the project and its relation with the system.

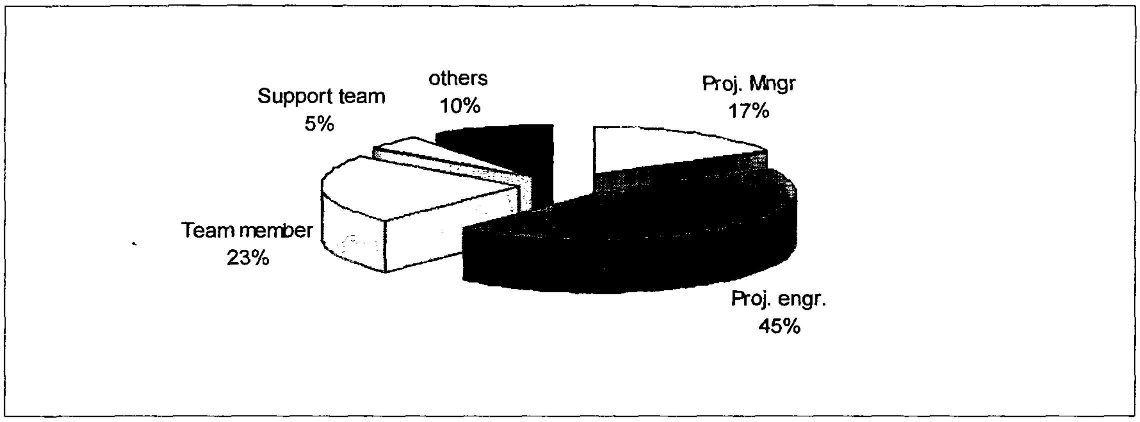


Figure 15: The percentage of participants based on their functionality

10% of the participants were from a category other than the ones indicated. They are either working at a higher level, for example as program level participants, where they manage multiple projects simultaneously or could be a participant from a systems perspective.

Question 2: How long have you been working in projects and project management?

The second area to be clarified was the level of experience (number of years) that the participants had in the project practicing project management from their functional areas. More than 50% of the participants had more than 10 years of experience in the field of project management. In addition, more than 30% had more than 5 years of experience but less than 10 years. This shows that almost 80% of the participants did have good knowledge of the terms and conditions of the project and its relation to the system. Figure 16 illustrates the percentage of each level of experience.

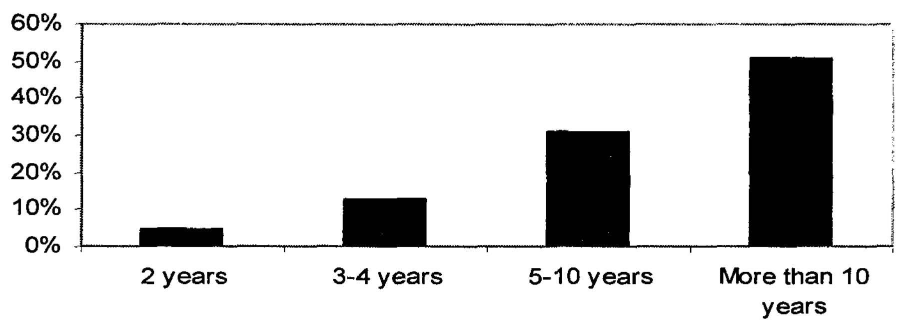


Figure 16: Level of participants experience in years

Question 3: What is the usual size of the projects you worked on?

Another important piece of information about the participants was the size of project they had worked on. This information helped indicate the responses from respondents who had more involvement in larger projects since they have a better view of the issue addressed by this research effort. The respondents looked promising, since 38% of them were working at the program level (projects with a budget of over $5 million). Participants with working experience in large and medium projects had a percentage of 23% and 30% respectively (where large < $5 million and medium < $500,000). This indicated that the responses from those participants would be significant because of their experience in the size of the projects they participated in or led. Figure 17 below shows the distribution of participants over the size of the project.

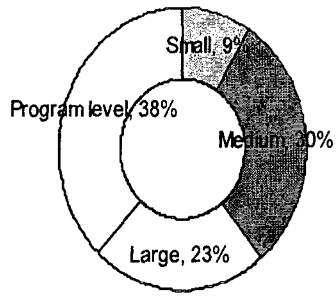


Figure 17: Percentage of participants to the size of the projects

Question 4: How often do you conduct reviews in the project per phase?

One of the most important practices during a project is to conduct reviews to support the risk management process in order to identify risk and consequently plan for it. A question about how often this is being practiced was included in the questionnaire. The response to this question was reasonable with at least one review per phase and with a total of 33% for two reviews per phase. It does not look reasonable when the participant selected the fourth option with 4 reviews per phase of the project, and they might be confused about the number of reviews during the time frame of the project and the reviewed asked for each phase.

Question 5: What may prompt a change request during a project?

Another key factor that affects the risk management process within a project or system is the change requests that are issued within the project in response to an important issue that might affect the performance, schedule, operation, quality, or the cost within the project or the system. From the response to a question in the survey (as shown in Figure 18), the participants selected the risk issues as the least cited reason for the system or project management to issue a change request.

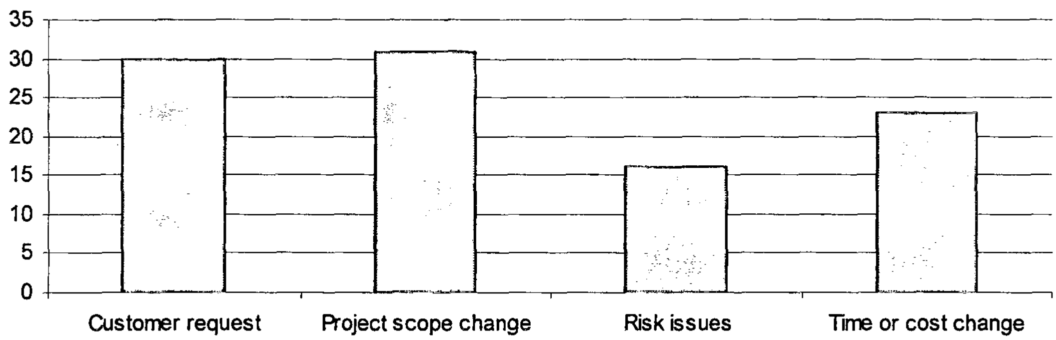


Figure 18: Number of participant reactions to different reasons for the issue of a change request

Question 6: Are change requests related to risk management?

As a confirmation to the above question about the issuance of a change request, this question was posed. The question addresses the relation between the change request and risk. The reaction was not as expected since the change request would primarily be issued to overcome a problem or a risk that might affect the success factors of the project, where 64% of the participants said they sometimes issue change requests for a risk issue. However, 13% answered "No," which indicates that the risk management process might not be an integral part of project management.

Question 7: How often do you practice risk management in your projects in each phase of the project?

When asked about the risk management process within the project, most participants (67%) expressed that they do it once during any phase of the project. This is a very high percentage which reflects the lack of care towards applying a risk management process within the project. It appears that risk is not one of the primary activities.

Question 8: How do you maintain relationships with project stakeholders?

The other issue that was also addressed in the questionnaire is the relation of the stakeholder to the project and how often they are involved during the project lifecycles. The response was mixed between the four options provided, even though the question requested that participants choose all that applied. The highest option continues to be communication with stakeholders by the participants, which means having good communication with the systems representative to avoid any project integration problems or even risk propagations from project to system. However, the participants also selected the other options (23% for the proposal phase and 22% for the design phase) which shows there is limited communication with stakeholders during a certain phase of the project, either the design or project proposal phases, which indicates that there might be confusion in understanding the question or there might be confusion in understanding the relationship with stakeholders. A very close percentage between the options might give a different indication of the involvement of stakeholders in the project.

Question 9: What are the most frequent risks in projects?

The answer to the question about the type of risks being experienced in a project gives a good indication of the factors that contribute to the project's success, which affects the completion of the project. The figure below signifies the response to the question about the risk types in projects.

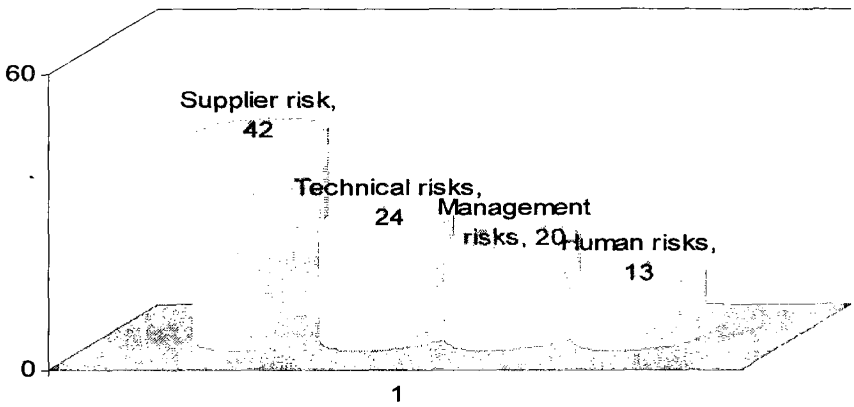


Figure 19: Risk types response

The response was 42% to the supplier risk which is a good indication that the participants pay great attention to two of the three project main success factors, which are cost and time. The supplier risk has a direct relation to delays, which will affect the project's completion date and is the greatest concern of participants. This type of risk cannot propagate to the system since it is only for the phase when a project is under construction. More analysis of this issue will be discussed in the analysis section.

Question 10: Have you been involved in projects with no risk management plans?

This question addresses the issue of the risk management process within the project. It is a direct question that asks if the participants have been involved in any project that has no risk management process.

It is true that the highest percentage was for the option "No," which means that each project will have a risk management process; however, the percentage of those who selected this option was only 36%, which means that the remaining 64% have another response to this question. The other options were "Yes," but with different specific situations during the project. The 15% who selected the "Yes, for all projects" option cannot be neglected. These responses are illustrated in Figure 20 below.

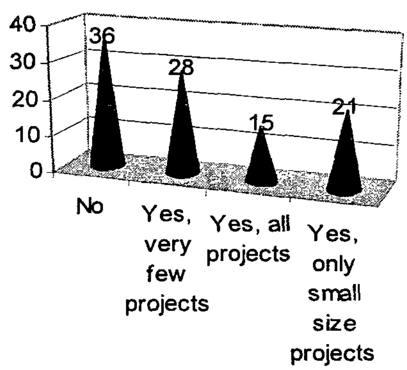


Figure 20: No risk in project response

The next part in the multiple choice questions was about the risk management process that is being used in the organizations where the participants belong. As it has been described above in the literature review section of this research, a risk management process consists of five different phases. It includes risk identification, risk assessment, risk assessment (analysis), risk planning, risk response, and control and monitoring of risk. Few questions were used to find out how participants apply this risk management processes in their projects.

Question 11: How do you identify risk in projects?

The first question addresses the identification process of risk in the respondent's project, and the highest percentage of participants (36%) chose the option of team members as the one who identify possible risks while only 28% chose brainstorming for risk identification among the various stakeholders of the project. This also raises the same issue for the relation of project and system since a team member's vision will only be valid for the lifecycle of the project and will not have any consideration for risks that might extend beyond the completion of their project.

Question 12: Who is involved in Risk identification of the project?

Moreover, when asked about who is involved in the risk identification process during projects, the participants most frequently responded by selecting the project manager and the team members as the primary individuals who are given the task of identifying the project risk with a percentage of 59%. They made this selection even though they had the chance to choose all that applies in their projects. Each is aware that when a project is completed, the project manager might be assigned to another project or a different task within the system.

In addition, project team members will go back to their functional management area after integrating the project into the system and would have no control over risk management. Risks that were not identified in the projects will have a great chance to propagate to the system and might materialize before they are even identified within the system. Luckily, 23% of the participants selected to have project stakeholders involved in the identification process which means there is a good chance the systems representative will be involved in the identification of risk and might also reduce the chance of risk propagating to the system. The identification of risk is to answer the first question in the definition of risk provided by Kaplan (1997) which is "What can go wrong?" It is the anticipation of the problems that might face the project in either the near or distant future.

Question 13: How do you assess and evaluate risks in projects?

The second question in Kaplan's definition of risk was "How likely is it?" (Kaplan 1997). The answer to this question addresses issues under the second phase of the project risk management process, which is risk assessment. This phase evaluates the risk and anticipates the possibility that the identified risk might materialize. The assessment in this phase affects how the risk management team handles the subsequent phase. 54% of the survey participants assume that project team members are the ones who assess the risk while 20% think that project managers also have a major role in risk assessment. Some projects employ consultants to assess and evaluate their risks and suggest different action plans. These three options for risk assessment (risk owner, project manager and project team) are all available before a project is integrated and will not be available when the project is closed. These three options totaled 92% which is illustrated in Figure 21. This means there is no systems perspective towards the identified risk. The assessment was mostly conducted by project personnel, and they reflect their perspective towards the success factor of the project only.

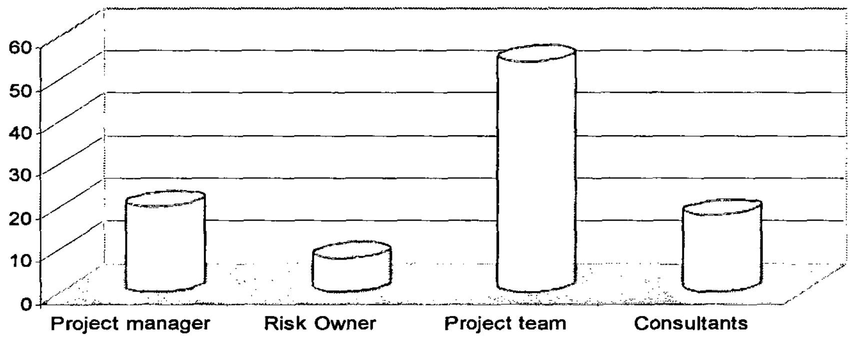


Figure 21: Risk assessment

Question 14: How do you plan for risk in projects?

The next phase in the project risk management process is to plan and respond to risks. As stated in the literature review section, risk is an anticipated problem that might happen during projects or in the system sometime in the future. Any action or plan towards these risks will be based on these anticipations. The questionnaire posed a question about how the participants plan for risk. A similar response to the assessment was provided by the survey. The greatest contributors to the plan for risk were project managers and project team members with 38% and 40% respectively. This response limits the planning for risk mostly within the project and will finish with the completion of the project. An illustration of these percentages of who plans for risk in projects is shown in Figure 22.

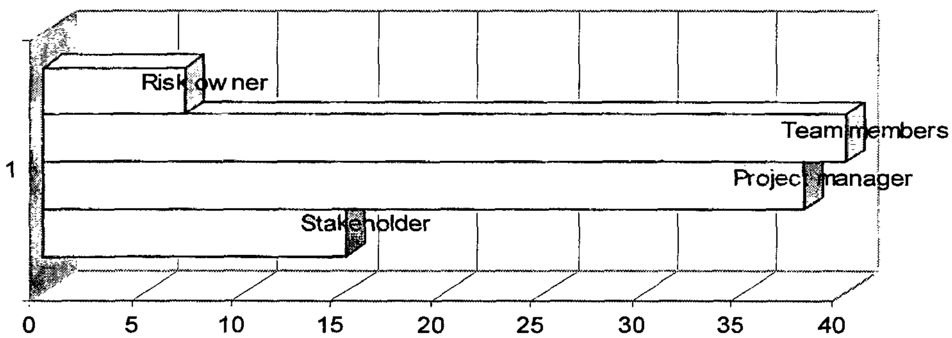


Figure 22: Planning for risk in project

Question 15: How do you prioritize or rank risks in projects?

The survey also posed a question about how identified risks are prioritized during the project time frame. This step leads us to know who contributes the most in the risk management process. Prioritization means ranking the identified risk based on certain criteria. It could be based on the risk that might affect the cost and schedule for a project and it could be those risks that affect performance in systems. It seems that participants gave reasonable responses to this question where the highest percentage was suggesting that the risk management team is the one who should be doing the prioritization with 38%. However, 35% selected the option of "project manager" as the one who should do the prioritization of risks in the project. Only 10% of responses suggested that stakeholders are to be involved, indicating that stakeholders, even if they are project owners, are barely involved in risk prioritization. Those numbers are reflected in Figure 23.

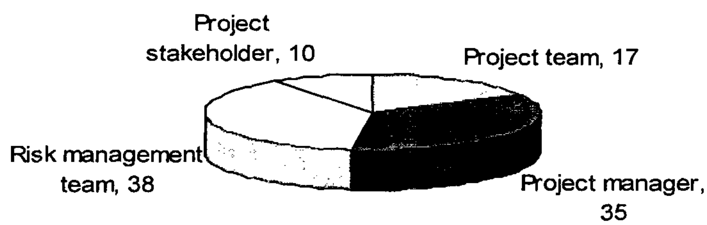


Figure 23: Risk prioritization

Question 16: What practices do you use to mitigate project risk?

The next step in risk management is to mitigate or eliminate the bad consequences of risks. There are several alternatives discussed in the literature for minimizing or eliminating the effects of risks used in the industry. The first action used in mitigating the risk is to accept it. This means that the project manager and team members will accept the risk they have identified and assign a risk owner whose task is to remove this risk or minimize its impact on the project or systems objectives. The second alternative to mitigate the risk is to transfer it, which means that the risk has been identified and accepted, but the project or system cannot eliminate it. In this case, project managers choose to transfer the risk to another project, contractors, or to a functional division within the system. The other option is to ignore it. This alternative treats the risk as if it does not exist because of several reasons: either the risk has a low probability that it could be materialized, the consequences are not severe, or both. Some project managers choose to ignore the risk but keep monitoring it, and whenever the probability of occurrence gets higher the project management start to take action. According to the survey, most participants think that the last option is the one that is mostly used in practice where they do not take any action towards risk until it starts to be more critical before the end of the project. Moreover, if the risk has severe consequences, the project management team starts to deal with this risk and tries to minimize the consequences to eliminate the risk.

As shown in Figure 24, 52% of the participants choose to monitor risk before they consider any action, while only 25% of the responses choose to accept the risk when it is identified. Moreover, 19% selected to transfer the risk to another division or project, but only 4% choose to ignore the risk from the point of identification. However, the risks under monitoring are ignored until they change during the lifecycle of the project, regardless of whether they might materialize during systems operation.

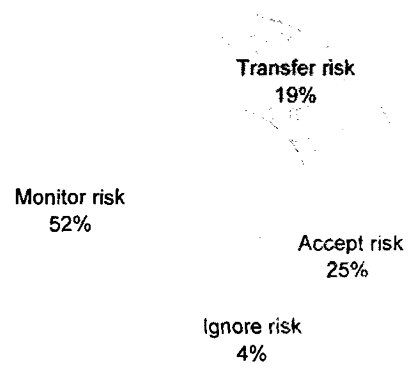


Figure 24: Risk mitigation options

Question 17: Do you ignore any type of risks? and Question 18: When would you accept risks during project?

The next two survey questions address the two extremes of risk mitigation plan solutions: accepting or ignoring risk. This is a critical decision during a project's lifecycle. As discussed in the literature review section, the project has three major dimensions that affect its success: time (schedule), cost (budget), and quality (performance). If any risk is accepted, it would have a direct effect on these three factors of the project. Accepting risk means that the project management team would take a certain action that might affect the schedule or the allocated budget for the project. However, the other extreme in this process is ignoring the risk which would have no direct effect on the current situation of the project or system. Ignored risks have no immediate effect on projects, and this is the reason they are ignored. However, this type of risk might have critical consequences when the time factor is included in the equation. With time, those ignored risks might have more factors to interact with that might have a serious impact on the projects or systems. One ignored risk might interact with another ignored risk to give a bad result that may not have been considered before. The response to the two questions about the two processes is illustrated in the following two figures.

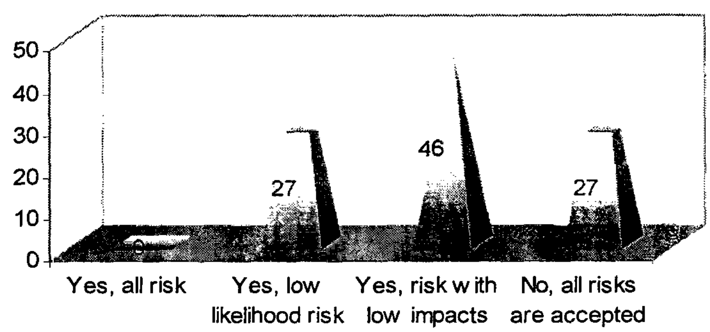


Figure 25: Response to "when to ignore risk"

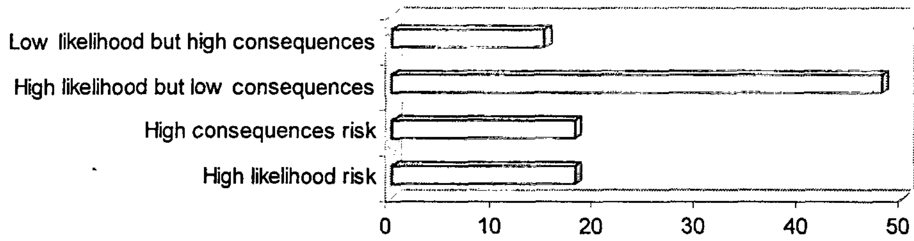


Figure 26: Response to "when to accept risk"

There is a contradiction in the responses to these two questions. In the first question, the respondents choose to ignore the risk when it has a low impact or minimal consequences, while they accept it when it has a high probability, even if it has minimal consequences. Because risk is a probable event, the respondents give more weight to the probability of occurrence rather than to the impact of the risk.

Question 19: At what phase of the project do you plan for risks?

Which phase of the project risk management is being practiced is important to the effectiveness of this process. This claim is addressed in one of the survey questions. The respondents were given the option to choose whichever applies to their projects from the four given options. The response is illustrated in Figure 27 where each of the four options has a near-equal percentage. This indicates that risk management is conducted in each phase of the risk management process.

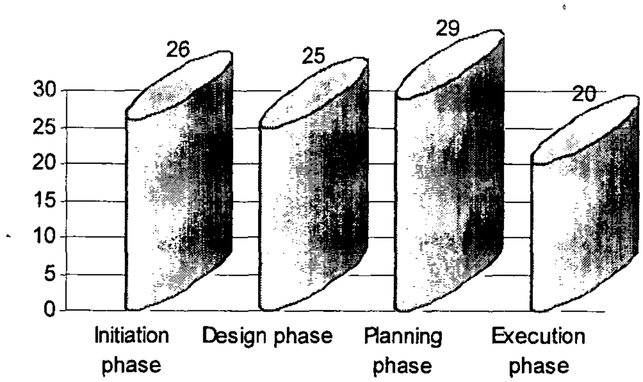


Figure 27: Response to "when to conduct risk management."

Question 20: What determines how long it takes to respond to risk events?

When to respond to an identified risk is one of the criteria that might affect the objective of this research effort since the longer it takes to respond to a risk, the more critical the risk will be. As mentioned above, time is a critical factor in the effectiveness of risks. The ignorance of risk over time might drive the risk from the project phase to the systems operation and materialize then. Based on the options that were posed under this question, responding to risk based on priority was only 17%, while immediate response or responding based on management request was only 7% each (see Figure 28). However, the highest percentage of responses was given to the option "based on risk level." This might be a good response based on the way it is understood. The respondents might consider the probability, consequences, or both for the risk level. It might not be the right option if the risk level was based on the personal perspectives towards the risks. The main indication out of this question was that the participant gave a very low percentage for the priority of risk which is one phase of PRM. This indicates that there is very little attention given to the whole risk management process.

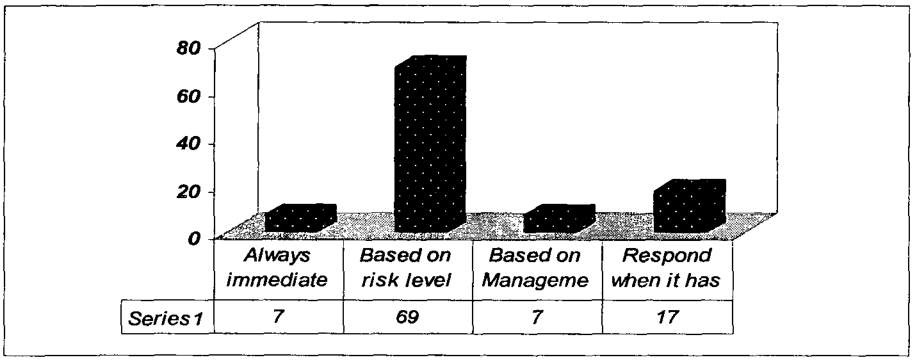


Figure 28: The time to respond to risk

Question 21: How confident are you about the risk management process used by the project?

An important question was posed in the survey about how the respondents felt about the risk management process they use in their projects or systems. This question was important because it points out how confident respondents are about the process of risk management and how safe they feel when they conduct risk identification, planning, mitigation, or even control. Only 26% of the responses indicated that the respondents feel very confident about their project while 67% (two thirds) of the respondents feel they are somewhat confident, which indicates that the risk management process is not clear enough for most of the systems or projects populations. The option of being unconfident is not of great value, which shows that the respondents trust their risk management, but it might be based on when and who conducts the risk management process.

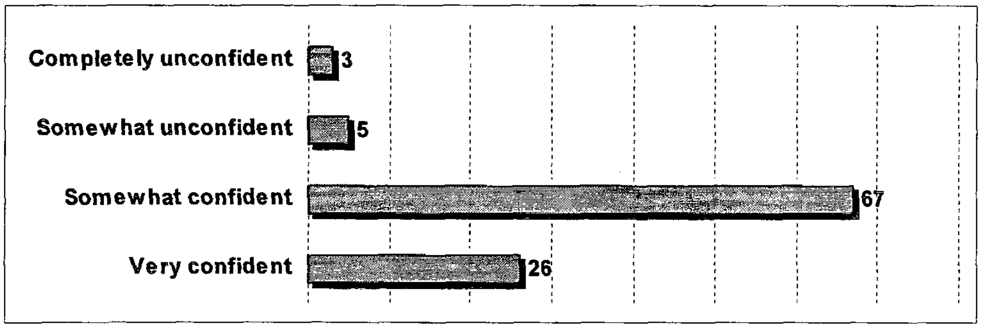
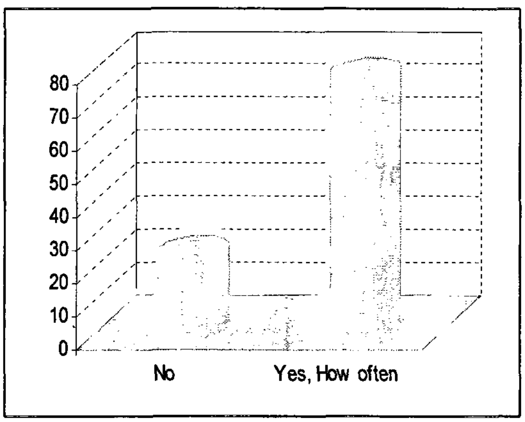


Figure 29: Confidence in the risk management process

Question 22: Do you communicate any risks to the system during project integration? Question 23: Are project's owner representatives involved in the projects made aware of risks during projects?

At the end of the multiple choice questions in the survey, two closed-ended questions were posed to measure the relation between the systems and project while the project is active. The first question addresses the issue of communications between the systems and project, especially during the integration phase. The answer was "Yes" for a percentage of 77% while 23% answered "No." The expectation was to have full communication with the system during integration, but if one quarter of the participants answered "No," then it makes a significant impression on the topic of this research.

The other question was about the involvement of the systems representative on the risk management process. This might contradict some of the answers above when it is asked who is involved in the various risk management processes. This is based on the response that 85% of systems representatives were aware of the risk during a project. If the systems representatives were aware of the risk, they might have no control over the other phases of the processes based on the answers to the above questions. The answers to these two questions are illustrated in Figure 30.



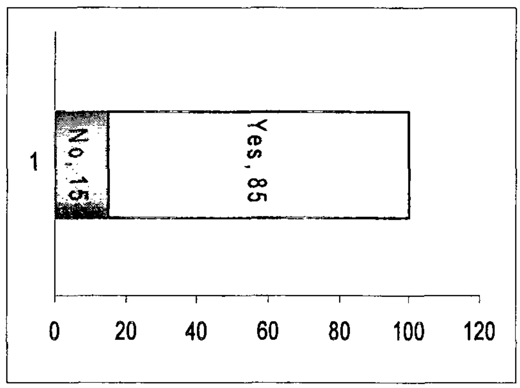


Figure 30: Closed-ended question about communications and involvement of systems.

4.3.2 Open-Ended Questions Survey

The next section of the survey contained open-ended questions. The purpose of these questions was to get a better understanding of how the participants feel about the research issue by having them express their feelings in words, regardless of how much they might write. Unfortunately, there were fewer responses to the open-ended questions than the multiple choice questions. 17% of the responses do not have answers to some or all of the open-ended questions. One possible reason for this response might be the time it takes to answer the open-ended questions. The other possible reason might be the participants might not understand the questions. The way the questions were worded might not be clear enough for the participants. However, the other response to those questions is summarized in the following sections.

The first question in this section addresses an important issue for this research which asks if the participants experienced any risk events within the systems or projects. The purpose is to bring the participants' attention towards the possibility of having a risk-initiating event materialize. If they have experienced events in projects or systems, the next question that might be asked is if this event could be avoided. This could lead to another question, which is whether the risk management process was properly practiced before the events. Did they have the right response to the risk? Did the project or system identify the risk? Did they monitor the risk? All these questions will be addressed at the time of the event. The response was good to serve the purpose of this report. 76% of participants who responded to this question did experience an event during their working experience (see Figure 31). This is a good percentage for the validity of this dissertation and shows that the participants did have a good level of experience to answer the survey questions.

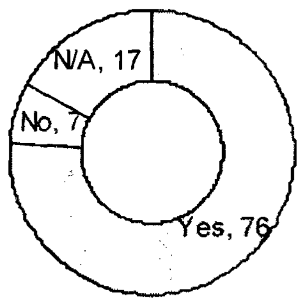


Figure 31: The response to the event experience question

The subsequent question listed in the survey as an open-ended question about the factors that the participants think caused the event. The respondents gave many reasons: uncertainty, planning, technical problems, cost and time change, scope change, lack of data about the system and historical data, lack of information, material delay, lack of resources, human negligence, the reduction of project material inventory, and the change in dollar value. More analysis will be conducted in the next section.

The survey posed two questions about the risk-initiating events that cause the events and separate them into short or long term risk-initiating events. The participants are to list the short-term and long-term risk-initiating events that they think might have caused the event. Under the short-term risk-initiating events, the participants suggested the following: conflict of interest, bad management, SW development, procurement delay, PM change, human errors, bad design, lack of manpower and equipment, change in market conditions, improper workmanship, security, change in oil price, communication issues, and lack of good preparation. However, participants either agree or disagree with the existence of long term risk-initiating events; however, some think that the long term risk-initiating events cause an accumulation of other risk-initiating events, which might cause the event, while others think that it depends on the project and the situations surrounding the project.

A direct question was posed in the survey about the topic of this research which questions if the risk-initiating event could propagate from the project to the system. The answer to this question was analogous to assumptions made in this research, where risk-initiating events during the project timeframe could cause a risk-initiating event during systems operations. However, 36% of the participants did not answer this question for unknown reasons. This high percentage could be caused by several reasons, one of which is a lack of understanding of the question. Those who did not give an answer might not understand the question's wording or simply preferred not to give an answer. The other reason could be the politics that the project management team goes through while they are executing their project; those who work in a project do not want to admit that they may have caused some risk-initiating events to propagate to the system. Their admission means that they might not have done a good job during the project's execution. Comparing the percentage of those who said "Yes" to those who said "No" shows that participants overwhelmingly support the idea that risks do have a good possibility of propagating to the system, where the total percentage of both are 54% and 10%, respectively. However, if we ignore those who did not give an answer, the percentage of people who support propagation will be 84% while only 16% do not. These percentages are illustrated in Figure 32.

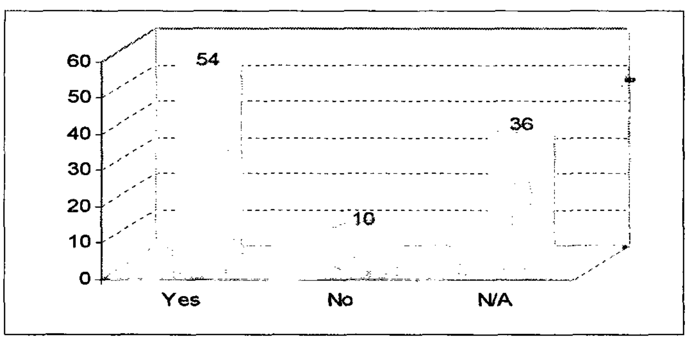


Figure 32: Response to propagation of risk

A follow-up question was also provided in the survey to identify those risks that might propagate to the system. This question serves the purpose of assuring that the participants do understand the above question by listing some of those risks that have the tendency to materialize with time and after the project is completed. Some of the responses to this question are poor handling, developing the project's scope, poor system performance, lack of man power and equipment, failure in relief valve, design errors, material selection, job execution, scope change, modification to existing design, and wrong decisions made by the project manager, team members or stakeholders.

The last two questions of the survey inquire about the relation of the risk management process to the project objectives and the second question with the system's objective. These questions were posed to help develop a solution to the issue raised in the report. There were mixed feelings observed in the answers to these two questions; however, most commented that the objective of the projects and systems should be closely related to the risk management processes. Some argue that the risk management processes are only related to short term project objectives, therefore ignoring the long term ones. More analysis of this issue will be discussed in the analysis section.

CHAPTER 5:

5 SURVEY RESULTS' ANALYSIS

The analysis of the survey was divided into two sections. The first part is based on objective one of this research and the five questions listed under it, while the second part is based on the second objective and the four questions listed under it. This section will discuss and analyze the response in both sections based on the purpose of this research which is, as stated in the first chapter of this research, *to investigate whether risk-initiating events during the project lifecycle could be transferred to the system after the project is completed and integrated into the system.*

5.1 Research Objective One

The purpose is supported by two objectives that are to validate the propagation of the risk-initiating events from the projects to the systems after integration and to propose a solution to mitigate or eliminate any risk propagation. In order to achieve the objective, five questions were raised to address the issue more clearly:

- Is it true that risks can propagate from the project phase to the systems operation? *Based on the literature review and survey* *results, the answer to this question would be yes, the risk will have a chance to propagate from project to system*

- How does the current PRM process interact with the system risk management process? *Based on the survey, there is little interaction between the PRM process and the risk management process in the system.*
- Do risk-initiating events propagate from the project phase to the systems operation? *Based on the survey responses, 84% of the responses support this question and believe that risk-initiating events could propagate from the project to the system.*
- What is the role of project risks in the systems operation's risk events? *Based on the responses to the survey, the systems' events could be traced back to the risk-initiating events from the project.*
- Does PRM fail to identify risks that might propagate to systems operation after integration? *A good percentage of the respondents to the survey agreed with this argument and believe that poor application of PRM could lead to some risks being misidentified or some risks being ignored if they do not have a relation to the project objective.*

The first question was addressed in the literature review section under the gap analysis section. After discussing the three major entities in this project (project, systems, and risk), the relation of the risk in the system and the risk in the project were presented; a gap was indentified that drives the purpose of this research.

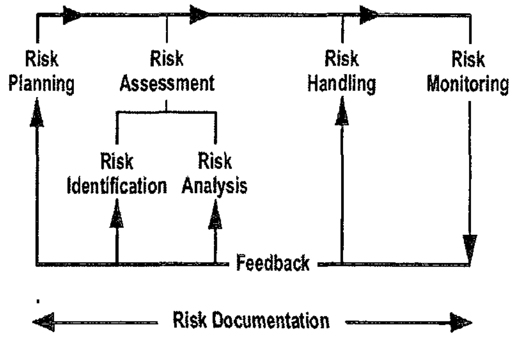
The first three questions were posed to gather information about the participants: their function in the project, years of experience, and the size of the project they worked on. This information gives insight about who is answering the survey questions. The survey results showed that most participants had a good level of experience and work as a project manager or project engineer. This gives the survey more validation due to the number of times that participants went through the event of integrating a project to a system and knew where they would have had or experienced a problem after a project is completed.

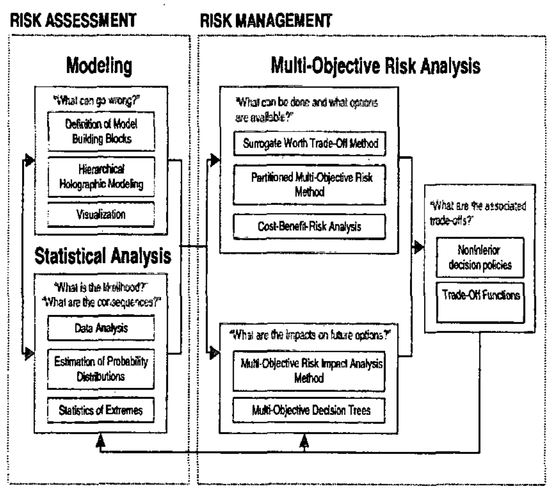
Most of the projects issue a change request to overcome changes or problems they might face during a project's timeframe without stating that there is a risk to the project's or system's success. These change requests are actually part of the risk management plan phase of the risk management process. However, the participants are not firm that these change requests are based on risk-initiating events, and most respondents think that some might have a relation to risk. Before the start of any project, the project proposal goes through multiple reviews. Project designs also go through similar or even more reviews before they are approved. The purpose is to minimize changes and reduce possible risks during project execution. It seems that participants are very well aware of change requests compared to risk management. Two or more change requests occur 64% of the time during a project compared to conducting risk management practices once during a project's phases. This shows that participants are very familiar with change requests compared to risk terms. Rather than using academic terms for managing their probable future issues, they are using practical terms that have all been agreed upon.

There are many stakeholders for each project such as contractors, consultants, users, customers, media, environmental effects, society, systems and subsystems they belong to. The most influential stakeholders are the systems and sub-systems. The relation with stakeholders will affect the risk management process in both. Various perspectives towards risk will yield different results. The participants believe that there should be a good relationship with the stakeholder with various mechanisms presented in the survey. This answers question two of the first objective.

One of the most important questions in the survey asks if the participants got involved in projects without risk management plans (question 10 in the survey). This question also provides a response to the fifth question, supporting the first objective, which addresses the issue of unidentified risks before a project is completed. Even though most respondents say "No," there is a high percentage who answered with a conditional "Yes." This means that there a possibility of not conducting a risk management process in a project depending on the perception of the project manager and team. This is a critical issue where risk might not be an issue for project management resulting in having the risk propagates to the system when integrated. This validates the purpose of this research which questions if the risk could propagate to the system. A supplemental question to the one above was also posted to find out if there are risk-initiating events that could be ignored. The responses justify the issue of risk ignorance which, in turn, increases the possibility of a risk's propagation to the system. The participants accept ignoring risks with low probabilities or low impact at the time of evaluation. If these risks are not monitored, they could be a source of future risk-initiating events. These risks might not be a threat to the projects but could be one for the system where conflicting objectives may be present.

Further presentation of the risk management process was addressed in a few questions in the survey to measure the response of participants to various stages of the risk management process. This also provides a response to the second question that addresses the current PRM, which supports the first objective of the research. The practices and activities used in the current PRM will help identify the behavior of participants towards the risk-initiating event to figure out if there is a gap that might cause a propagation of risks to the systems after project completion. This research effort does not analyze or study the process of risk management and how it is conducted. It also does not have the objective of modifying or improving the current practices of project risk management processes. Its objective is to find out if risk-initiating events could propagate from project to system for reasons that might not be clear to the current risk management teams. Risk identifications, assessment, planning or handling and monitoring are the most common phases of risk management processes. Figure 33 illustrates the relation between these processes according to Conrow (2005) and Haimes & Horowitz (2004).





(Conrow 2005) (Haimes and Horowitz 2004)

Figure 33: Risk management processes

Few questions about the phases of risk management in a project or systems were posed in the survey. The response was typical from those who are project members of any function. Most of the participants believe that the planning, identification, handling and monitoring of risk are to be conducted by the project manager or project team members with few participants choosing to include stakeholders in these processes. The project manager and team members tend to pursue the objective of the project they are executing rather than consider the systems objectives. Project objectives are narrow and limited in time and budget while systems objectives are wider and open in time and budget. This contradiction in the objectives of those who will conduct the risk management process will yield different results from the process. A risk that might go unidentified by project members and managers could have a large impact on systems. Those risks that were not identified by team members might only be identified if they involve the stakeholder, especially a representative of systems. Moreover, risk plans during a project will vanish by the completion of the project and would not be recognized after the project is integrated into the systems. On the other hand, systems do have their own risk management processes. These processes include the same phases of the projects. The plan for the risk during the system's lifecycle does not include the projects and their output. The integration of projects into the system might cause some risk-initiating events to propagate from the project to the system. What supports this argument is the response to the survey question about how confident the participants are in the risk management process they are using. Two thirds of the participants expressed that they are somewhat confident. This means that they are either completely unaware of the RMP or they do not trust the results of their risk management process.

The response to this question also supports the issue addressed in the fifth question under the first objective. Not being fully confident in the risk management plans indicates that the process yields inaccurate results. This means that there might be some risks that were not identified or were identified very late in the project timeframe. This increases the probability of the risk and also makes the impact of the event more severe.

The most important question of the ones listed under the first objective was question number three. This question directly addresses the issue under investigation by this research, which is whether or not the risk could propagate from the project to the system. A similar question was posed in the survey to assess and validate the objective of this research effort. The question was open-ended in order to give the participants room to comment or provide more details in their answers. Unfortunately, a percentage of the participants did not answer the question. However, 64% of the participants did answer. Among those who provided answers, 84% believe that there are some risks from projects that could cause a risk-initiating event in the system after it is integrated. This is a good percentage among those who participated in the survey. If the ones who did not answer the question were included in the analysis, the percentage will be 54%. This is still a good number compared to the ones who rejected the idea that the events in the systems could be caused by risk-initiating events in the project, which represents only 10% of the total number of participants. One of the participants commented on this question by adding the words *"of course,"* when he answered with "yes" to the question. This strongly supports the claim of this research. Projects are not an isolated activity during their lifecycle. A projects has so many stakeholders, the most important being the system.

The survey went further and questioned the participants about reasons that might cause the risk-initiating events to propagate to the systems. There were several reasons provided; some are completely practical and some are general. Those reasons are:

- Technical Reasons:
    - Poor system performance
    - Failure in relief valve
    - Material selection
    - Job execution
- Management Reasons:
    - Scope change
    - Modification to existing design
    - Wrong decision
    - Lack of man power and equipment
    - Incorrect estimate of the cost and schedule
    - Neglecting proper planning and risk distribution
    - Design does not satisfy stakeholder requirements

  - o Design Error
- Risk Management Reasons:
  - o Not considering some risks which might be discovered during the construction or design stages
  - o The external type of initiating events
  - o The type of events that don't follow the anticipated sequence or order of events

5.2 Research Objective Two

The above discussion covered only the first objective. The second one, however, is addressed to find a solution to the issues raised in the first objective. The second objective is to propose a process or a framework to mitigate or eliminate any risk propagation from the project to the system. This framework is based on the literature review gap analysis results and some questions addressed in the survey, in addition to the utilization of the risk management processes proposed by some scholars (Haimes, et al. 2002, Conrow 2005, Chapman 1997, and Perera and Holsomback 2005). To satisfy the requirements of this objective, the research addressed the following questions:

- What could be done during the project phase to mitigate or eliminate propagation of risks to systems operation? *Supported and answered by the suggested framework*

- What could be done to minimize or eliminate inherited risks from projects prior to project integration? *Supported and answered by the suggested framework*
- How are projects' risks that might propagate to the system's operation after integration managed? *This risk supposed to be managed before its propagation to the system by close coordination between PRM and SRM and by pursuing the systems and projects objectives while applying PRM. The survey respondents strongly supported close coordination and communication between PRM and SRM.*
- How to relate PRM with SRM to avoid failures during systems operation? *Supported and answered by the suggested framework*

Some of these questions were discussed in the survey and respondents replied to them. These responses helped in developing the framework suggested in the following sections. The first question in the survey used under the second objective is about the participation of the stakeholder (systems) during the lifecycle of the project. Fortunately, most of the respondents stated that they do have regular or continuous communications with stakeholders, which represents a good project and systems behavior to apply to risk management processes. The survey also addressed another question that was used to measure the involvement of the project stakeholder in the most important phase of the risk management process which is risk identification. The responses to the survey questions indicated only 23% stakeholder involvement, which shows that risk was not one of the primary objectives for systems representatives during the project timeframe.

A discussion of the relation between systems and projects was presented in the literature review section and showed that this research effort only considers a specific relation that is applicable to this research. This relation is an ownership relation, which means that the system issues and owns the project, even during its lifecycle. However, the projects are executed away from the systems operations and have their own risk management process. Only 8% of the participants choose to involve the project owners in risk assessment. This percentage is too low to have the systems representative express his/her impression of the identified risk. Moreover, there were also low percentages given for system participation in the risk management process, which includes planning and prioritization of risks (15% and 10%, respectively). This answers the fourth question under the second objective, which addresses the relation of the PRM and SRM. These low percentages are a good indication that the PRM and SRM are viewed as separate processes, and involvements of systems in PRM are very limited. This gives a good indication of what to consider in suggesting a framework to overcome this issue.

Furthermore, the first two questions under the second objective could be answered under the suggested framework. The third question under the second objective, which addresses the practices that need to be considered to avoid risk propagation from project to system, will be answered by the suggested framework. Simply, the framework recommends that the risk management process, which includes planning, identification, assessment and mitigation, would have to be conducted by both project and system team members. Project members will pursue the project objective in their identification or assessment of risk while systems members will assure that the system's objectives are well considered in these practices. The framework presented the ultimate relation between projects and systems and the practice of risk management in both. Risk management in a project should not only address the objective of the projects that are mostly limited to the sides of the triangle in the literature review section, but should also address the objective of the systems. The project ultimately will be part of the system after integration, and when identifying risk, the system's objective should be considered too. Likewise, with the other phases of risk management processes (assessment, planning, mitigation and prioritization), the system's objectives have to be considered during its application. Current practices, as shown by the survey, show that a system's objectives are barely considered when implementing risk management processes based on the percentage given by the participants.

The last two questions in the open-ended questions section of the survey are related to the development of the framework. These two questions address the relation of the risk management process to the objective of the project in the first question and its relation to a system's objectives in the second question. The response to the first question was intuitively expected since the risk will have a strong rel ation to the project objectives. Some types of risk do affect the objectives of the project, especially when they are related to the project cost or schedule such as equipment delivery or cost overrun. Some of the responses claim that the relation of the risk process with project objectives is critical and some see it as part of the project processes. PMI (2004) considers the risk management process as part of the overall project management process. However, other responses look at PRM to "*be a very useful and effective tool in project management if it is used and practiced properly and wisely.*" This response represents the level of confidence of the application of the process and not in the process itself. Some believe that the relation of PRM and the project's objectives is "*very much related and has a great impact on the project objective on all dimensions like scope, budget and time.*" This response is most logical. PRM exists to help in achieving a project's objectives. One of the responses mentioned if the project scope, design, planning, and operations are managed well, then the PRM will not be needed; however, because of careless management and external risk factors, PRM is an integral part of risk management and directly affects a project's objectives. This is illustrated in the framework.

The second open-ended question that helps in developing the framework was the one addressing the relation of the risk management process to the system's objectives. Most of the responses provided a positive response in terms of whether they are in favor of a strong relation between PRM and a system's objectives, as illustrated by the following terms: "*critical,*" "*very related,*" "*immediate impact,*" and "*highly related and dependant on the system quality and execution.*" Some other respondents gave a more detailed response where they expressed their feelings about this relation. "*They are related and it is very crucial to ensure that risk factors are monitored to avoid impact on the system objectives*". This response illustrates the view that there is a direct connection between the risk in the project and the impact on the system which is the issue studied through this research. Another response contained a comment that was illustrated in the suggested framework, which relates a project and system's objectives with the risk management process, which states that "*risk management should make sure the project and systems objectives are met.*"

However, the last two questions of the multiple choice section of the survey presented a direct question about the relation between project and system to measure what the participants believe about them. The first question addresses the issue of risk communication during the integration process and the results were supported by a high percentage of 77%. The other question asked about the communication of risk issues during the project timeframe to the systems representatives. The percentage in favor of this question was 85%, which means that the systems representatives are well aware of risk during the project's lifecycle. However, this contradicts the results of the other questions mentioned above. These answers show a close correlation between projects and systems in regards to risk while the above answers show a poor involvement of a system's representative in the risk management phases. The likely reasons for this contradiction could be summarized by the following:

- The way the participants understand the questions,
- The difference in the practical and academic wording of the questions,
- The simplicity of the last two questions compared to the other question about the risk management phases,
- "Yes" or "No" answers seem to be more direct and easier to make the decision compared to the multiple choice questions.

However, these answers will not affect the results of the survey or the proposed suggested framework since communicating the risk to systems might not mean their involvement in the process itself. Moreover, if the representative is made aware of the risk in the project, it does not mean that s/he will eliminate it or mitigate it. Decision makers in projects are very sensitive to the project objectives and communications of risk might be limited to those identified by project management and those risks that will not affect a project's objectives.

5.3 Proposed Framework

Prior to presenting the framework as a solution to the stated problem under objective one, a few clarifications would have to be made in order to have a better understanding of the framework. The framework will consist of three major entities: project, risk, and system. The definition of these three entities will be restated but with the one that best suits or applies to the framework. Several definitions from different scholars were provided for each of these entities in chapter two. However, this section will present the definition that applies to the framework inferred from the ones presented by the scholars. The following are the definition of important terms used in the framework:

Project - *a unique task, that is initiated by the system to close a gap or add some expansion to the system, which has to be completed in a limited time with a limited budget, achieve certain quality and performance and use certain people and other systems' resources.*

Risk - *any undesirable or probable events that might occur over the timeframe of the project.*

Risk management process - *the process used to study all characteristics of the risk including its initiating events. It has five phases to manage the risk including risk planning, identification, assessment, mitigation/handling, and monitoring.* The process is illustrated in Figure 34.

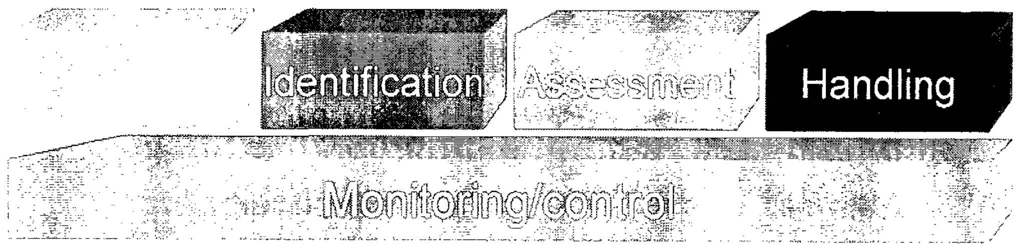


Figure 34: Risk management process

The system - *a collection of organized parts or subsystems that interact with each other to form a complex unitary whole and produce a unique output.*

It is not only the specific definition of the entities forming the framework that is important but also the relation between project and system that is crucial since projects might have different relations with the systems where the framework is developed based on the relation illustrated in Figure 35. As shown in the figure, the projects and systems relation considered in the framework is ownership, where the systems initiate the projects and are integrated back into the system after they are completed. That is why there is a chance for the ignored or misidentified risk to propagate to the system.

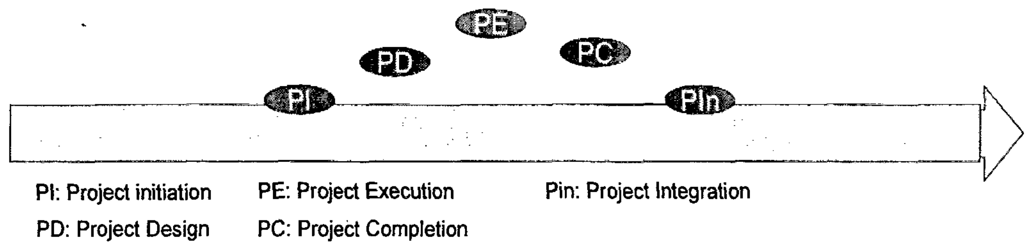


Figure 35: Project systems relation

The suggested framework is primarily intended to propose a solution to the issue raised under objective one of this research. There are some concepts in the framework that were derived from different areas. Some concepts were derived from the existing risk management processes in projects and systems. However, others were derived from the gap analysis discussed in chapter two. The gap analysis presented several scenarios and issues. Relating these scenarios with the way current risk management processes are being applied supports the development of the framework.

Others were driven by the responses from the survey and how the participants express their experience. The third source of concepts to develop the framework is from the responses that were provided at the conferences where the paper was presented. These ideas can be summarized in the following list:

- The commonality of risk management processes being practiced in academic papers and in practical life experience. These risk processes include the main five phases of risk management that include: planning for risk, indentifying risk, assessing the risk, handling the risk and controlling it (Perera and Holsomback 2005, Haimes and Horowitz 2004, and Conrow 2005). This is shown in Figure 34.
- The other concept to develop the framework was the response from the survey that indicates that there is little interaction between the risk management processes in projects and systems.
- The other concept was also derived from the survey response where there was good evidence of minimal involvement of systems in the development of the risk management process of the project.
- Respondents to the survey also indicated that there are risks that are ignored when they do not have any effects on a project's objectives, which are the three main constraints: schedule, budget and performance (Leung et al. 1998).
- Survey results also pointed out that there is a poor and inconsistent application of risk management processes during the project's lifecycle.
- The validation of the existence of risk-initiating events propagating by the responses from the conferences, which indicate that there

are problems in the relation between a project during its time frame and the system's lifecycle.

- The communication between the project management team and the system's management was one of the issues that can be inferred from the responses in the survey.
- An unclear system's objective to project management is one of the reasons to develop the framework where they should be well communicated during the initiation phase of the project.
- The communication between project and systems during the integration phase is unclear and sometimes vague, which may cause miscommunication of important risk issues in the project.
- Survey responses have also indicated that risk control during the project's timeframe is mainly managed by the project manager or project team where systems have very little involvement. The framework suggests more involvement of systems representatives in project risk control.

Figure 36 illustrates the suggested framework. It is divided into three main sections. The first, which is on the left side of the figure, is for the project and its objectives. The second is in the section on the right of the figure and represents the system part of the framework. The third section is for the risk management and its various phases. The risk management process is located in the center of the figure. Risk management phases are itemized because they are the main target of this framework. Risk monitoring was separated into two sides, one for project risk management and the other for systems risk management. This indicates that the risk in a project is to be monitored by both the system and the project. There are two arrows branching off of the system and the project, where each phase of the risk management plan received an arrow from both the system and the project. This indicates that both should participate in each phase of the risk management process: planning, identification, assessment and handling or mitigation of risks. The top arrow boxes show the project box arrow in the system's box arrow, which means that the systems are the initiator and the owner of the project over its lifecycle. There are two circles in the figure. The one on the right illustrates the system's authorities and responsibilities. However, the one on the left shows the limitation of the project's authorities and responsibilities. The two circles overlap in the middle area where the risk management process exists. The framework explains the difference in objectives for projects and systems and also shows the boundaries of responsibilities for projects and systems. It also designates that PRM is not only managed by a project team but also by a systems management team, which has to be involved to avoid any propagation of risks to the system. In the worst case, systems will be very well aware of those risks that might have the tendency to propagate to the system and will be controlled before they have the possibility of materializing.

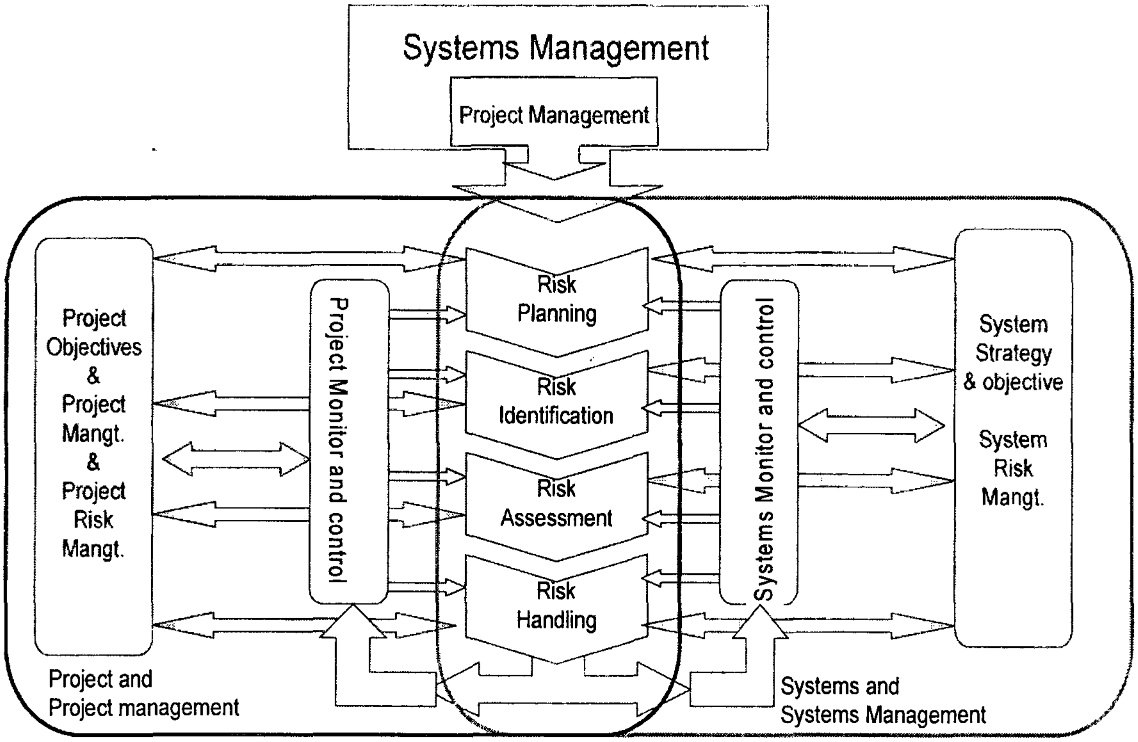


Figure 36: Suggested Framework

5.3.1 Detailing the Framework

The suggested framework presented in Figure 36 shows three main sections. The risk management process (RMP) is at the center of Figure 36 with arrows going from both sides to the project strategy and objectives on the left side and to the systems strategies and objectives on the right side. This section will discuss tasks, inputs, outputs and tools used in each phase, as well as the contribution of the projects and systems, demonstrated by the arrows going to each phase of RMP.

Planning phase:

The primary objective of the planning phase in the RMP is to create a plan for risk management during the lifecycle of the projects or systems that will ensure an acceptable level of risk over the life of the project or system (INCOSE 2004). Some of the tasks in the planning phase are:

1. Develop strategies for conducting the other RMP phases (i.e. identification, assessment, handling and monitoring),
2. Identify or develop tools or methods to be used for risk identification, assessment and handling (Conrow 2005),
3. Gather historical information from other comparable projects or systems to help in conducting the RMP phases,
4. Set up the required resources (time, budget and human resources) to conduct the RMP.

PMI (2004) describes four inputs to the planning phase, namely :

1. Project management (PM) plan ,
2. Project scope statement ,
3. Organizational process assets, and
4. Environmental factors.

On the other hand, the output of the Planning Phase is the Risk Management (RM) plan (which includes strategies of risk process). The RM plan describes roles and responsibilities, methodology of risk management, timing and budgeting, risk categories, risk breakdown structure, and more tracking information of risk. One of the tools used during this phase is probability and impact matrix, also known as a *risk matrix*. This output represents the arrows in Figure 36 from the project sides to the RMP phase, which is the planning phase.

It is notable that based on the PMI's project risk management framework; a system's contribution to this phase is not explicit. This indicates that the planning phase of the RMP, as per PMI, is focused on the pursuit of project objectives. This is clear from probability and impact tool where the objectives of the project on the columns sides and the ranking on the row side. The value given in each box is only for those affecting the objectives of the project but not for the systems.

The framework suggests that the systems have to have their inputs into risk planning phase. The contribution of the system will be similar to those of the project except that systems strategies and objectives are to be considered, namely:

1. Enterprise environment factors ,
2. Organizational Process assets ,
3. Systems' object ive,
4. Systems management strategy ,
5. Systems' risk management plans .

These contributions of the system are represented by the arrows from the system side to the planning phase of the RMP. Details of the RMP are illustrated in Figure 37.

Figure 37: Planning phase of RMP

Risk definition phase:

The main objective of this phase is to identify the risk and their levels (e.g. low, medium, or high) by monitoring the project structure and requirements. Conrow (2005, p. 8) defined this phase of RMP as "the process of examining the program areas and each critical technical process to identify and document the associated risk." PMI (2004) suggested that the participants in this phase are project manager, project team, users, consultants, stakeholders, and other project managers.

PMI (2004) describes inputs to this phase, namely

1. Environment factors ,
2. Organizational process assets ,
3. Project management plan ,
4. Risk management plan (from planning phas e),

5. Project scope statement,
6. Risk register which includes list of identified risks and their potential responses, root causes of risks, and risk categories.

Most of these inputs are contained in the work breakdown structure (WBS) which is a main input to this phase. The tools used in this phase are either document reviews or information gathering techniques, brainstorming, interviewing, Delphi technique, and root cause identification, in addition to using strength, weaknesses, opportunities and threat (SWOT) analysis technique (PMI 2004).

This represents the project side of the framework shown as arrows going from the project box to the identification phase in Figure 36. PMI indicated that stakeholders and users (as systems representatives) are to participate in this phase of RMP which is a good indication and is in line with the suggested framework. However, the framework considers the participation of the systems should be more effective. The systems representative should participate in the decision process conducted during this phase. This participation ensures that systems objectives and strategies are well considered in identifying the risk that may propagate to the system, such as:

1. Enterprise environment factors ,
2. Organizational Process assets ,
3. System's objective,
4. Systems management strategy ,

5. Systems risk management plan .

This is represented in the framework by the arrows that goes from the systems box on the right to the identification phase in Figure 36, and detailed in Figure 38.

Figure 38: Risk identification phase

Risk Assessment Phase:

The primary objective of the Risk Assessment Phase is to assign the probability and the value of the impact of the risk if it occurs (INCOSE 2004) and can be described as a process of evaluating identified risks or to refine the description of the risk in term of identifying the causes and effects of each risk (Conrow 2005). PMI (2004), however, separated the assessment phase into two parts, namely qualitative and quantitative analysis of the identified risks. The qualitative analysis entails prioritizing the risks based on the probabilities and their impact on project objectives. Quantitative analysis considers the numerical effects of the identified risks on project objectives.

PMI deems that the inputs to the Risk Assessment Phase are as follows:

1. Environnem ental factor (qualitative analysis),
2. Process assets (qualitative analysis) ,
3. Project scope statement (qualitative analysis) ,
4. Project and risk management plans (qualitative analysis) ,
5. Risk register (quantitative analysis) ,
6. Cost and time management plans (qu antitative analysis).

The tools used under qualitative assessment are: documentation reviews, information gathering techniques (listed under the above phase), check list analysis, and assumption analysis, in addition to the techniques using diagrams for analysis that include: cause and effect diagrams, process flow charts, and influence diagrams. On the other hand, the tools used for quantitative analysis are: sensitivity analysis, expected monetary value, decision trees, assessment matrix models, risk profile models, and modeling and simulation. The output of both assessments (qualitative and quantitative) is an update to the risk register that includes the identified risks in the project (PMI 2004).

These inputs, outputs and tools of the Risk Assessment Process correspond to the project is left side of the framework in Figure 36. These are the current practices during the project lifecycle. It was proved that these assessments are effective in the success of the project and good implementation provided a better chance of project completion and success. However, these research efforts look after the success of the project which is to be completed with the assigned budget, time and quality. This research discusses the propagation of the risk-initiating events from the project to the systems after they are completed. Therefore, the framework suggests a better involvement of the system in the assessment of the indentified risks. This was symbolized by the arrow from the systems on the right to the assessment phase in the center of Figure 36. The participation of the system management in the assessment phase should be a mirror of what was done in the project side or can be coordinated in another way where the participation of the systems is part of the decision process during this phase, as shown in Figure 39.

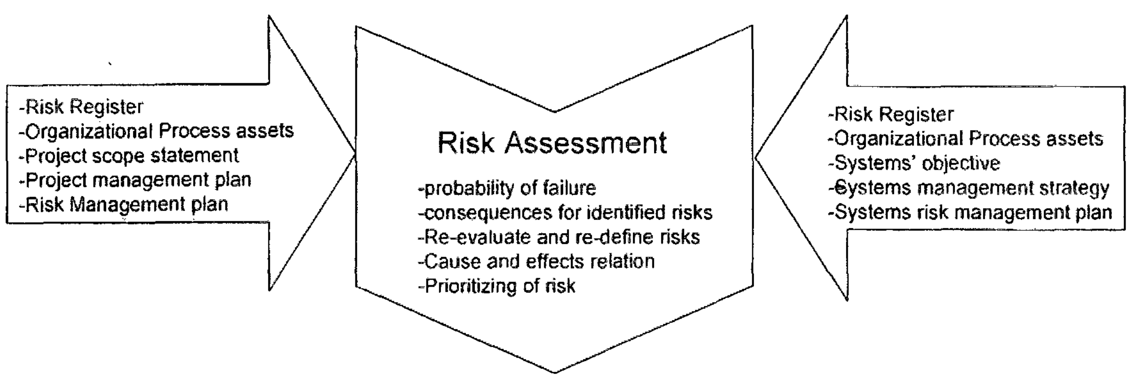


Figure 39: Risk Assessment Phase

Risk Handling Phase:

The primary objective of the Risk Handling Phase of the risk management process is to take proper action to mitigate or eliminate the identified and assessed risks. This phase is essentially a process of identification, evaluation, selection and implementation of tools to reduce the risk to acceptable levels within the pre-set constrains of the projects (Conrow 2005). This will consist of what action should be taken, how long it should take, who is assigned to do it, and what are the impacts on time and budget. There are several options to handle risks that include assumptions, avoidance, mitigate, and transfer. The issue of available resources is an important issue for project management and has to be available to mitigate those identified risks. Risk handling could start during the design phase of the project where the design can be developed based on low risk solutions. Moreover, recovery planning is also a good option to consider to help make the right handling decisions (INCOSE 2004).

PMI consider only two inputs to this phase:

1. Risk management plan and
2. Risk register.

Risk management plans have the roles and responsibilities of the project management team and also have the levels of risk for low, moderate or high. In addition, they have the requirements of time and cost to mitigate the identified risks. Risk register was initiated during the identification phase, and it contains the prioritize risks based on the assessment phase input. It also contains root causes of risks, anticipated responses, owners of risks, symptom, and warning signs to initiate an action to resolve the risk. In addition to the two inputs suggested by PMI, It is ultimately understood that the project scope statement and project management plans are supposed to be inputs to this phase too. However, the outputs of the handling phase are to update the risk register for those risks that have been handled and those that have been ignored. The other output of this phase is to update the project management plan and a list of any contract used to mitigate the risks. The tools and techniques used in this phase are avoidance (avoiding the risks), transfer (transfer the risk impacts to a third party), mitigate (reduce the probability or the impact of the risk), acceptance (accept to eliminate the risk or take any other action that will not affect project's objectives).

The steps developed above are for the project perspective to handle risk during project lifecycle. These correspond to the arrow coming to the handling phase of RMP from the project box as shown in Figure 36. These are used to ensure that the project is successful and to be completed within the pre-assigned constraints of time, cost and quality. Which strategy to use to handle risk was based on project objectives and choose the one that will not dramatically affect the schedule or the budget of the project. These notions are used in most of the literature concerning project and risk management. The framework, in order to resolve the stated problem under the first objective of this research, suggests entailing systems management in choosing which strategies to handle the risks. This is represented by the arrows from the systems objectives and strategies box to the handling phase box in Figure 36.

Participation of systems in choosing the strategies to handle the risk will help the system to avoid some risk impacts by using a certain handling strategy. The participation of systems management should be to the level that it reflects similar activity that was conducted in the project side. The idea of systems participation in this phase is to have the system fully aware of the risk-initiating events in the projects and how they were handled to be ready to accommodate those processes when the project is to be integrated, as shown in Figure 40.

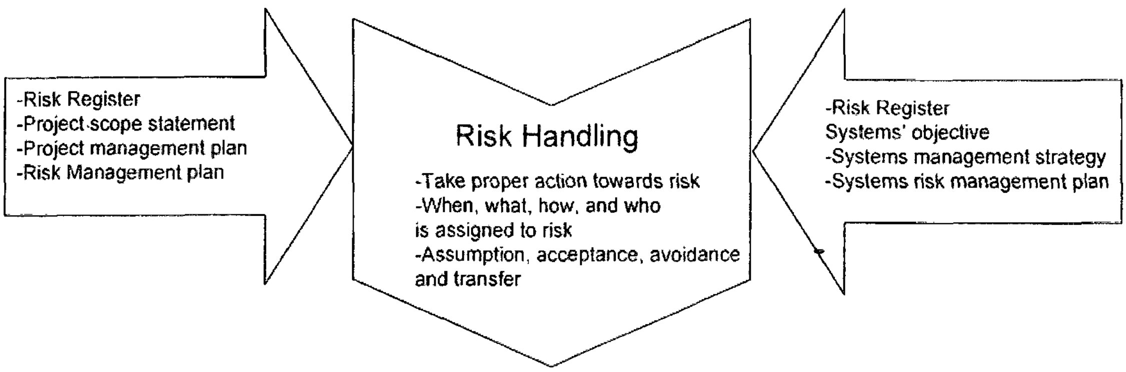


Figure 40: Risk Handling Phase

Risk Control and Monitoring Phase:

The objective of this phase is to monitor the whole RMP and provide feedback to the other phases of the process. This phase is a process of tracking and evaluating the performance of the handling strategies to do the necessary updates and provide a feedback information to the other phases of the process (Conrow 2005). Monitoring and control may suggest changing the current handling strategy, closing the risk, invoking a contingency plan or just continue with the original plans (Perera and Holsomback 2005). PMI looks at the monitoring and control phase as feedback process of reevaluating, based on recent tracking information, what actions to take concerning a particular risk, and implementing those decisions. Actions may include changing the current action plan, closing the risk (accepting the residual risk), invoking a contingency plan when the original plan is found to be ineffective or continuing with the original plan and continuing to track the risk. Each of the risks identified, analyzed, planned, and tracked should be periodically reviewed to make sure that decisions made are effective and that relate actions remain valid (PMI 2004). The inputs that considered by PMI to this phase are

1. Risk management plan ,
2. Ri sk register,
3. Approved change requests ,
4. Performance report ,

5. Work performance information .

However, the outputs are updates to risk management documents and project plans, in addition to requested changes, recommended corrective and perspective actions (PMI 2004). The tools and techniques used during controlling and monitoring phase are risk reassessment, risk audit, variance and trend analysis, technical performance measurement, reserve analysis, and status meetings (PMI 2004).

The framework positioned the monitoring phase of RMP different from the other phases, shown in Figure 36. Monitoring and control affects each phase of the process. It monitors the identified and assessed risk in the first two phases. Moreover, it monitors and controls the handling strategy and assesses its efficiency and whither it needs to be updated or even changed. There are arrows from the monitoring and control phase to each phase of the process providing a feedback on the performance of the process to each phase to take the proper corrective actions. Currently, the corrective action is based on current risk management process outputs and project objectives.

The intervention of the project is to reflect any changes in scope or objectives presented by the arrow from the project box to monitoring phase. The framework also suggests that similar intervention has to be implemented from the systems perspective to reflect any change in systems structure, objectives and strategies. The arrow from the system box to the control and monitoring phase depicts systems participation as illustrated in Figure 41.

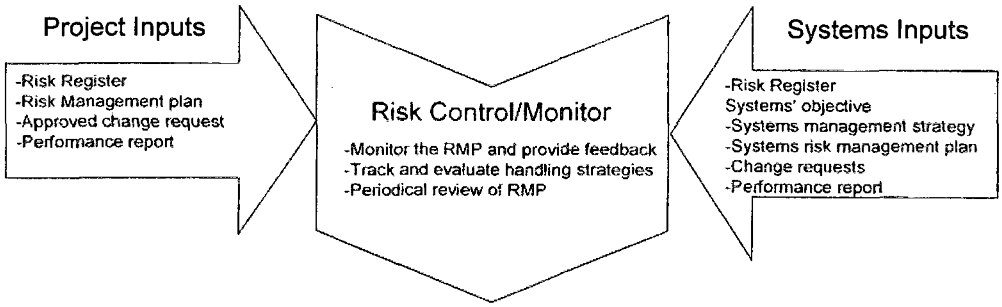


Figure 41: Risk Control and Monitoring Phase

The following section provides an example of risk propagation and the application of the framework.

5.3.2 Example

The example used to test the application of the framework is the collapse of terminal 2E (the project) of Charles de Gaulle airport (the system) on May of 2004 where five people died and several more were injured. The collapse occurred just 11 months into the airport's operation. Jonson (2008) related this collapse to the implementation phase of the project. He claimed that it could be caused by the implementation of the project completion and integration phase. The primary reason is that the accident occurred soon enough from project commissioning.

The consequences of the accident were enormous on the system - the Charles de Gaulle Airport - namely the huge financial loss due to closure of the terminal for several months; significant business disruptions as airline traffic was rerouted to other terminals and lost credibility of the airport and its management. Overall, the total consequences, including intangible matters were much more than the cost of the project itself.

The iterature provided various contributing reasons for the collapse of the terminal, including:

- The enormous number of project stakeholders (400) and contractors each in charge of a part of the project (Greenway 2004). This requires huge coordination and extensive management.
- The design using a newly structured tunnel-like terminal (Reina 2004).
- The material used for construction was a mix between concrete, carbon material and glass.
- A hole in the vault of the concrete roof was made to install metal support.

How can the suggested framework help in reducing the probability of terminal collapse? Some of the contributing reasons can be traced back to the project, which is consistent with the assumption of the framework. Consider the first contributing event - the huge number of stakeholders in project execution. This is a definite source of problems since this requires extensive coordination among the stakeholders. In particular, the competing objectives between the contractors may result in critical tradeoffs in the construction of the project. It is a project management decision to choose multiple contractors for construction and design. The possible objective of this decision was to reduce cost and time of the project. The involvement of systems in this issue will demand to minimize the contractors to a better manageable number which in turn will reduce risk possibilities. In other words, systems will demand a more controllable project execution. This will be part of a risk management plan which is set early in the project lifecycle. The contribution of the system in this phase is illustrated in Figure 37. Systems objectives and strategy are inputs to this phase which will enable the system to modify the project risk management plan. This in turn will affect the number of the contractors executing the project since there might be a conflict with systems strategy and objectives.

The second contributing reason was the more complex methods of tunnel-like construction of the terminal. Will systems involvement affect this level of complexity? Systems are primarily looking for a competitive advantage to improve their profits by minimizing the operational cost. Complex design would have to be weighed against those objectives and may be re-evaluated if it has any effects on systems' objectives. The project design phase is an early phase of the project execution and this means that the system inputs to this phase have to be early in the risk management process. The participation of systems in mitigating this issue will be in the first two phases of RMP namely planning and identification phases. System management can provide inputs to these phases to have the design complexity as a risk that might affect system performance and have it listed in the risk register. Moreover, the system can also add the type of the structure as another risk initiating event. The system can have its influence in the first two phases of RMP during project through their inputs to both phases illustrated in Figures 37 and 38 particularly systems objectives and strategy as well systems risk management plans.

Material selection is the third contributing reason. The main factors that affect material selection are the cost and the delivery time. Both of these factors are main constraints to the project. Systems participation will have an effect on this source of risk during project lifecycle. The framework implementation may have some influence on material selection especially if they have a long anticipated life. The project will be a subsystem of the whole system and material selected during project lifecycle has to meet the system's standards. Implementing the framework will enable systems management to affect material selection. This type of risk might not be added to risk register if the systems are not involved in risk identification. Involvement of systems in the assessment process is also necessary to assure that this risk is not ignored or cancelled. Moreover, they can guarantee that material types and qualities meet systems standards. This can be accomplished if the systems established their inputs to risk identification and assessment phases as illustrated in Figures 38 and 39.

The fourth contributing reason is the hole that caused damage to the concrete roof and consequently caused the collapse of the terminal. Having the system more aware of airport structural risk would play a major role in eliminating the collapse of the terminal. Applying the framework would make systems management aware of this risk and systems people aware of the type of the structure and would not make holes in this type of concrete. Systems management awareness of risk perceived from project would help them create the right procedure to eliminate the propagation of the risk or reducing its probability to materialize. Therefore, the application of the framework would be effective in making systems personal well aware of the right practices when the project is integrated within the system. This risk can be related with the second and third risks. Figure 41, which shows control and monitoring phase, clearly explains the participation of systems in this phase. The monitoring phase in the framework has a two sided arrow that shows systems input to RMP and the phase output to the system. The continuous monitoring of the risk will help building good awareness of projects' risks and project structure as well.

CHAPTER 6:

6 FACE VALIDATION (RESPONSES FROM CONFERENCES)

The topic of this research was presented at three different conferences with different types of audiences.

6.1 Saudi International Conference

The issue discussed in this research was presented at the Saudi International Conference that was held in Guildford, United Kingdom, in June of 2009. The paper was selected for presentation after a careful review by PhD holders from various British universities joined by professors from King Abulaziz University in Saudi Arabia. The selection of the paper for presentation indicates that it presents a valid topic of research and could open a new area of research. It has been selected from among a few hundred papers submitted for review. The paper was presented under the title **"Project, Systems and Risk Management."**

The paper only presented the problem of propagation of risk from project to systems (the first objective of this research). Most of the audience who attended the presentation was from academic backgrounds; they were professors, associate professors, assistant professors or graduate students. There were a good number of attendees, even though the presentation was late in the afternoon. There were few interruptions during the presentation for some clarification about project, systems and their relation to risk. One professor gave positive comments on the presentation after it was completed. There were few clarifications on the presentation topic and no negative comments about the topic or its validity. One perspective in favor of the validation of the existence of the problem is that there were no negative comments on the presentation or on the issues addressed. This indicates that the problem stated in this research report is one of the issues that have to be researched, and it also opens up more research opportunities in the field of systems and project management. The audience members, who came from a variety of backgrounds, admitted that this is an area of research that will have a contribution to the body of knowledge in project management.

In summary, the participation in this conference contributes to the face validation of this research effort in the following observed ways:

- Accepting the paper to be presented in the conference gives credit to the addressed problem.
- The reviewer's comments on the submitted paper were minimal and limited to formatting and editing issues. This also supports the issues and suggestions presented in the article and contributes to the validation of this research.
- Having high attendees during the presentation indicates that the topic is of high interest in the academic area.

- Supporting comments on the presentation from the audience were considered a support to the paper and its addressed problems.

6.2 PICMET Conference (Portland International Center for Management of Engineering and Technology)

A derivative paper was submitted to PICMET conference for presentation in August of 2009, which was held in Portland, Oregon. The paper was submitted under the title "**Project, Systems and Risk Management Processes Interactions.**" PICMET is an international conference where papers are submitted from all over the world, especially from Japan, Korea, and China. This means that the papers have to compete with many other papers in order to pass the reviews that have to be conducted before the paper is accepted for presentation. The derivative paper that was submitted based on the concepts developed under this research was submitted for review and evaluation to be presented at the conference. The proposed concept of the paper was appreciated and received minor comments from reviewers regarding some formatting issues.

During the presentation of the paper, there were few comments about the topic and idea presented. However, most of those comments did not reject the topic presented by this paper. Actually, most of the comments supported the idea and presented some examples where it could be applied or noticed. The first comment was about the existence of the problem across different industries such as constructing, consulting, and manufacturing. The second comment pointed to a very critical issue, which was considered during the development of this research. The comment addressed the application of the systems-of-systems ideology for this problem. This comment was considered when the framework was developed where some systems-of-systems principles were used. Examples of those principles are the unity principle, modularity principle, darkness principle, and system holism principle (Clemson 1991).

Another comment complimented the idea presented by comparing it with the way physicists look at the concept called "heap." This concept means that a collection of seemingly unrelated objects have emergent relationships. The only answer to this comment is that there is a strong relation between a project and a system, but still there is a high tendency of emergent behavior after project integration into the system. The last comment was completely supportive and mentioned that the issue presented under this research very much bridges both the engineering and business or management fields.

In conclusion, the comments provided in this conference were also supportive and can be considered as part of the validation of this research. The first supportive indication from this conference is when it was accepted and passed the reviewer comments without any comments on the topic and problem stated in the paper. The second indication is the supportive comments from the audience who showed great interest in the topic and aided in identifying different possible applications of the idea. Moreover, a month after the presentation, the paper got invited by the management committee of PICMET to be published in a special edition of the Engineering Management Journal. The paper was submitted for review and publication.

In summary, being part of such an international conference gave recognition to the paper and the ideas stated. The following points contribute to the face validation of the research problem:

- Acceptance of the derivative paper to be presented in the conference is a validation of the stated problem
- The paper passed reviewers with minimal comments that only addressed some formatting issues. Moreover, the paper was invited to be part of the special edition of Engineering Management Journal. This is an excellent sign that the problem stated in the paper is original and legitimate.
- The topic of the paper attracted a good number of attendees which is an indication of how important and original the topic was in the field of project and systems management. The contribution from PICMET also contributes to the face validation of this research topic.

6.3 INCOSE Conference (International Council on Systems Engineering) HRA Hampton Roads Area,

The conference was held in Newport News, VA on November 17, 2009. The paper was submitted under the title "**Risk Management between Projects and Systems.**" The audience at the conference was a mix between academia and practical fields. This combination means there is a good chance that various perspectives on the concept addressed in this research are represented. There were a few comments on the topic. The first one made an argument comparing risk management with lessons learned. These lessons were learned from the event after which many regulations and rearrangement occurred to avoid such consequences in the future. The individual who made this comment gave the example of Hurricane Katrina; when it hit New Orleans and caused major damage, the state had less damage because of the preparations made to protect their system. The reply to this comment was that this is a very good example of what is presented in this research since there was a very low probability that such a hurricane would occur, the ignorance of this small possibility from the system caused the devastating damage as there was not any plan to consider this risk and take proper action before its occurrence. The other reply was also about the difference between lesson learned and risk. The first is to learn from events that have already occurred, which means after the fact that the damages did happen. However, risk is to anticipate the problem that might happen in the future and take proper actions to mitigate or eliminate its occurrence.

The second comment was supportive of the idea being studied under this research and gave an example of what the audience's company faced when they had a completed project commissioned and turned on to the system. However, several problems started arise in the system. The risk-initiating events of these problems could have been from the project or from the integration process. They also could have been from the system as an emergent issue after integration because of the interaction of the new subsystem (the project) with the existent sub-systems.

The response from this conference was positive and supportive. This research has a practical application. It would be helpful if there were methodologies to apply it in practice. Projects and systems are considered everywhere across related industries, and there will be some applications of the framework suggested by this research.

CHPTER 7:

7 CRITIQUE AND RECOMMONDATIONS

The previous chapters presented two main points. The first stated the research problem statement, which is about the propagation of risk-initiating events from the project lifecycle to the system's operation after the project is completed and integrated. The second point was the proposal of a solution to the problem, a framework that would be applied with the participation of project and systems management.

In this chapter, the framework will be critiqued and discussed, and recommendations will be suggested for future research work and practical application. The objective of this chapter is to reveal some characteristics (e.g. assumptions and properties) of the framework and describe its importance for academic research and practical applications.

The application of the framework will require additional time, to which project and systems managers may not be accustomed. Having systems management involved in every phase of the risk management process will take more time than they may typically spend. This time will be needed to coordinate and evaluate every phase of the project. This additional time may be critical for project management since it may affect one of their primary objectives: the completion schedule. In this situation, project management might resist the application of the framework.

The framework only addresses the specific relation between the project and the system, as shown in Figure 35. This means that there are other relations between projects and systems not addressed by the framework.

The framework was meant to generalize various industries, making it widely applicable; however, each industry has different characteristics that might cause a change in the way the framework might be applied. As such, if it is applied to different industries, then the output of the framework might vary based on the way it was applied and the relation between a project and system in that particular industry.

The framework suggests a close coordination between project and systems management to pursue their objectives in the application of the risk management process. This will add another dimension to the already complex interaction between those managing the project and the system. This may result in another political and organizational issue between systems management and project management.

The suggested framework is the first of its kind to be suggested and might face resistance from project and systems managers. The framework is now in its theoretical stage, and some of these unfavorable factors in the application of the framework can be attenuated through further evaluation, possibly through pilot-testing, prior to full-scale application. This will assist in making the framework more favorable among project and system managers.

The proposed framework bridges the difference in the inherent objectives between systems and project management; therefore, there has to be a way to manage conflicts that may arise from these differences in objectives. This can be accomplished by establishing a methodology clearly describing the roles and responsibilities of both the project and systems management.

The framework assumes that the coordination between project and system in the application of the risk management process will make the risk-initiating events more controllable during the project and the system's lifecycle. The framework was built on this concept where the risk-initiating events might propagate during the project lifecycle under the control of risk managers. However, when risk-initiating events propagate from the project to the system, the sequence of events might not be clear, predictable or controlled.

The framework was developed based on the current risk management processes being practiced in systems and projects (e.g. Haimes et al. 2002, Perera and Holsomback 2005, and Conrow 2005). The framework assumes that the current risk management processes produce good results based on publications when practiced in projects and systems. However, the framework may provide insights to further refine these current risk management processes in light of the roles of systems management in projects.

The framework tries to capture both project and systems objectives. The framework may play a significant role even early in the requirement management phase of a project development in order to guarantee better results in assessing the requirements and the risks that might emerge during a project's lifecycle. Furthermore, the framework emphasizes the required close relation between projects and systems and for each to pursue its objectives and strategies. Therefore, the project's initial requirements might also be affected by the application of the framework since there is a real emphasis on the effects of project and systems objectives on the framework.

There will be a potential effect of the framework on the current systems development process. Even though the framework primarily deals with risk, it emphasizes the required close relation between projects and systems and for each to pursue its objectives and strategies. As a potential result, the acquisition of particular systems or development standards or practices, e.g. MIL-STD, IEEE, INCOSE, etc. may be affected by the application of the framework.

The framework significantly re-defines the correlation between project and systems. Even though the Project Management Institute (PMI) has firm and well-established project management processes, the framework may affect the PMI standard for a better way of looking into the relation between project and systems risks.

The application of the framework might help to minimize and reduce the risky events within the systems, other than those propagated from the project. Because of the close interaction between project and systems management, other risk in the system might also be mitigated. The project will be part of the system and will interact with the other subsystems.

The application of the framework might require some resources in term of budget and time. Therefore, there has to be preparation for the application of the framework from the initial phase of the project. This will help project management be ready for systems input and consider their requirements.

Participation of systems management in the framework will have several advantages besides identifying and assessing risk. A systems representative will be able to communicate the dynamic strategies and objectives of the system to and from the project.

Another benefit of system's involvement in the framework is to participate in evaluating external sources of risk caused by the changing environment. Systems management might have a better experience with environmental issues compared to the projects. The same idea applies when there are changes in the government's roles and regulations.

As shown in the framework, the risk management process consists of five phases. It will be much safer to move from one phase in the PRM to another with the participation of the systems, as suggested by the framework. For example, when the assessment phase is being conducted, the participation of systems management will give a more accurate assessment compared to limiting the assessment to project management only.

There is a risk of over-utilization of the framework when both project and systems management overstate their objectives. For example, systems management might introduce risks that might not have any effect on the system. These risks might apply to project management when they ignore risks that might have some impact on the system.

It is not advocated by this research that all or even most risks within projects be propagated to the system as this will lead to frequent crises in all systems. The idea is that there are risky events that take place in systems. Can these events be caused by risk-initiating events from the project? Is it possible that the events be mitigated if the risk-initiating events in the project were accepted and mitigated?

There were many accidents in the systems, but it was never considered that any of them were caused by the projects. This is because the effects of the risk-initiating events from the project are not clear to systems management, especially if it takes a long time for their integration.

The results of section 5.3.1 "Detailing the Framework" can further be used to support engineering managers in their tasks to avoid emerging risks as observed in the literature analysis and the evaluation of the questionnaire described in this thesis. So far, we assumed that system and project phases are conducted in parallel and derive the need for alignment and orchestration. The detailed framework enumerates the inputs needed for both participating sides to support an effective and efficient risk management process. Each input identified and displayed in Figures 37-41 under project inputs is required to support system risk management processes. Furthermore, each input identified and displayed in Figures 37-41 under system inputs is required to support project risk management processes. As the examples show the missing of even one of these input parameters can lead to the observed emerging risk within the system.

For the engineering manager this result leads to having to extend the system and project risk documentation respectively ensuring that the information needed is documented for the system as well as for the project side in an appropriate and accredited form. Using the planning phase of the risk management process as depicted in Figure 37 as an example, each project must evaluate and document data regarding its project management plan, the project scope statement, organizational process assets, and environmental factors. If these data are available for each project in the scope of the system, the system engineer can conduct all tasks identified for the planning phase of the risk management process efficiently and effectively. Accordingly, the system risk managers provide the system's enterprise environment factors, the system's organizational process assets, the system's objective, the system's management strategy, and the system's risk management plans as input for each participating project.

It goes beyond the scope of this dissertation to recommend more detailed structure and content for derived engineering management documents, checklist and supporting procedures, but the framework can be used as a guideline for further investigations.

CHAPTER 8:

8 CONCLUSION

The first section of this dissertation presented the problem statement upon which this research effort was developed: to investigate whether the risk-initiating events that develop during the project phase could propagate to the systems after integration before the project mitigates or eliminates it.

An extensive literature review was developed to find out what scholars discussed about the issue raised in this research. In support of the idea presented in the literature review that the project risk management process only considers the objectives of the project, Leung et al. (1998) developed a definition for risk management in projects, which stated that it is an "undesirable event which diminishes the chance of achieving these project objectives namely schedule, budget, and technical and operational performance" (Leung et al. 1998, p. 628). This means that PRM is only concerned with the project objectives, which have been addressed by the suggested framework. Other scholars, on the other hand, mentioned or have indicated similar issues addressed in this research. For, example, Garvey and Pinto (2009) looked at the problem from a different perspective; they looked at the propagation of risk between subsystems within a system and developed their mathematical models to justify their argument. In addition, they only looked at the capabilities of those subsystems and their interactions for the risk to propagate. Another scholar (Johnson 2008) mentioned the issue but without any discussion. He gave a good example from the construction industry where he mentioned that a roof of one recently built terminal in Paris' Charles De Gaulle Airport collapsed one year after project completion and integration. Five people died and many more were injured (Johnson 2008). This is validation of the problem's existence. However, the discussion was not about risk or risk propagation; rather, it emphasized project completion (Johnson 2008). The idea of continued communication for risk management, as highlighted in the framework, was also emphasized by Yin and Li (2007) who presented a model showing the continuous communication among the risk management processes. On the other hand, Wu et al. (2008) studied the relation of risk to project performance and found a good correlation between the two (Wu et al. 2008). However, they did not mention anything about the propagation of risk to the system (Wu et al. 2008).

Based on the problem statement, this research set out to address two objectives. The first objective was to confirm that the issue raised in the problem statement is true. This means that there is a need to investigate whether the risk-initiating events developed during the project will propagate to the system after integration. Two paths were used to confirm this issue. The first path surveyed the project and project teams to find out what they think about this issue. The result of the survey, as discussed above, shows good support of the issue. Most of the respondents believe that risk-initiating events could propagate from project to system. Moreover, they listed several reasons that might cause the propagation, some of which are technical, such as material selection, system performance or job execution. However, they also listed managerial reasons for risk propagation such as multiple scope change, wrong decision, incorrect cost and time estimates, poor planning, and design errors. The third category that might cause the propagation is the risk management process being used in the systems and projects. The reasons given by participants under this category include ignoring risks during the construction or design stage, external types of risk-initiating events, and irregular risks that do not follow the anticipated order of events.

The other issue addressed under the first objective of the research was the relation between the PRM and SRM. The survey revealed that there is a poor interaction between the two processes because the risk processes (PRM and SRM) are conducted based on the project objectives for PRM and based on systems objectives for SRM. The difference in objectives causes the isolation of each process. This is why the participants reinforced that there is a role of risk-initiating events from projects in systems events. The last issue addressed under the first objective was the failure of PRM to identify risks that tend to propagate to the system. The survey results were in support of this issue because of the ignorance of the risk management process itself and failure to involve the main stakeholder in the risk management process.

As part of the second objective, a solution to the problem in the form of a framework was developed that considered the survey results. The suggested solution also considered the literature review gap analysis. Moreover, it takes into consideration the current project risk management and systems risk management processes. The type of relation that exists between the system and project was also considered to avoid any confusion with other situations that might not be considered under this research effort. The framework emphasized consideration of the project and system's objective in conducting the different phases of the PRM and SRM. The framework also emphasizes the extensive communications between the risk management team in both projects and systems. This highlights the notion that risk monitoring should not only be the responsibility of the project team in PRM but also the systems team.

The next progression of this framework will be its application to different industrial contexts for refinement. This will bring about more reliability and better applicability. The application of such a framework will be of great benefit to the industries since it may reduce total risk management costs because it proposes the elimination of risk-initiating events before the event materializes. If the event had a chance to occur, the consequences might not be predictable, which means that the impact will be huge damage to the systems. As such, catastrophic events could be avoided or mitigated if a risk management process is properly performed.

8.1 Research Significance & Contributions

This dissertation contributes to the body of knowledge and practice of Engineering Management in ways that it:

1. Identified key issues in integrating project risk management to systems risk management concepts and approaches,
2. Investigated the notion and effects of risk-initiating events that occur in the project and propagate in the system after the project is integrated,
3. Addressed from the System of Systems Engineering (SoSE)-perspective the issue of a risk event emerging from a risk-initiating event during a project lifecycle,
4. Developed a framework to adopt systems approaches to project risk management toward a holistic approach of ultimately being part of a whole system that peruses a system's objectives.

8.2 Potential Research Agenda

The objective of this section is to present an agenda for future research based on the findings of this dissertation, especially research on the contribution of the framework in both academic and practical fields. The area of research that relates the objectives of the systems and projects is still a promising area for research, and the following is a research agenda that could further contribute to the body of knowledge:

1. Develop a method to assess and analyze the sequence of events that tend to propagate to the system. Using the framework will help the system to monitor the sequence of events when it had the chance to cross the boundary of the project to the systems and eliminate it before it leads to a risk scenario.
2. Apply the framework to real case studies from different industries such as the auto, oil and construction industries. Application of the framework will help in identifying the weaknesses and strengthes of the framework and how to modify it accordingly.
3. Build on this strategy to find out how the framework can be used in the project development process. The framework suggests an extensive relation between project and systems in coordinating and communicating their objectives during the application of the risk management process. The framework can be customized to accomplish the project's specific requirements.

4. Develop quantitative and qualitative tools for SoS based on established and generally accepted methods, e.g. those developed by Kaplan (1997), Haimes and Horowitz (2004), and others. In particular, adapt Hierarchical Holographic Modeling by Haimes and Horowitz (2004) as it applies to the proposed framework.
5. Use the concepts developed under this research, including the framework, to identify gaps in other processes in project management and use the suggested framework in this research to propose proper solutions to the those gaps.
6. Consider each phase of the project risk management process and propose ways that systems can contribute or provide input to each phase. The framework considers the participation of project and systems management in each phase of the risk management process. For example, future studies can consider the risk identification phase of the process and give a thorough analysis of the involvement of systems and projects management.

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10 APPENDICES

10.1 Appendix 1: (brief discussion)

Research philosophy, approaches, paradigms and data collection methods

We have to keep in mind that research is conducted for the purpose of finding knowledge; it is a tool to develop more knowledge in the subject under study.

1 Knowledge and research

Plato defined knowledge as JTB which is Justified True Believe. This is called the traditional view of knowledge which is interpreted as

"S knows P if (a) S believes P

(b)S's belief in P is justified

(c) P is true." (Sturgeon, 1993)

Gettier argued that traditional interpretation does not represent knowledge since it does not include the scope or the context of the situation it is applied to. This means it is not universal since you might believe in something and it is true but it is not knowledge; Sturgeon (1993) discusses th is issue in more detail. Therefore, the traditional interpretation has been modified to JTB+. Where the + refers to the context and scope of the situation. Then, in order to convert beliefs into knowledge, it has to be true and justified within a certain scope or context.

Knowledge looks, from this view, in different way. A belief is knowledge within the individual mind, so the person who believes in something has knowledge in himself within a context. However, in order to make this belief knowledge for others, it has to be justified. Therefore, the purpose of justification in the definition above is to transfer the knowledge from the individual mind to others and to be considered public knowledge.

In the situation here, for the research or the dissertation to develop knowledge or add to the body of knowledge through theorems, issues or problems have to be justified and proved within their context for the public to consider those theorems as knowledge. The research has to justify the theorems in order for them to provide knowledge.

2. Research Philosophy

Part of the efforts in conducting the research is to decide on the philosophy that should be used. The philosophy behind the research should decide which methods have to be used. However, there are several perspectives of research philosophy. The research could be approached from rational or empirical perspectives. It also can be approached from the positivistic or constructivist approach. Well known terms in research are whether it should be deductive of inductive research; consequently, we consider whether to use a quantitative or qualitative approach towards the research.

This part of the research include a brief explanation of the above approaches to enable us to view the method of this research more clearly.

2.1 Rational Vs. Empirical

Rationality is defined by McBurney as "the world is understandable by way of logical thinking" (McBurney, 2001). However, Bernard stated that "Rationalism is the idea that human beings achieve knowledge because of their capacity to reason" (Bernard, 2002). This means that reasoning is the basis of solving problems. He also stated that if the world is not understandable by logic then it will make no sense to try to understand it by any other means. Logic is behind Mathematical calculations as well as modeling and simulations and then considered means of rational thinking. Rationality can be considered deductive and inductive techniques.

McBurney also looks at empirical methods as any knowledge that can be gained through experience (McBarney, 2001). However, Bernard stated that empiricist philosophy is "we see, and hear and taste things, and, as we accumulate experience, we make generalization" (Bernard, 2002). Therefore an empirical approach is descriptive in nature. It focuses on tools and means of gaining knowledge. An empiricist can be positivist or constructivist which we will discuss next. The tools used in empirical research are observations, interviews, case studies and action research.

2.2 Positivist vs. constructivist

According to Lee, positivists are usually called objectivists or quantitative while constructivist are called subjective or qualitative (Gable, 1994). He had the following argument about constructive or interpretive methods: which is "the social scientist must collect facts and data describing not only the purely objective, publicly observable aspects of human behavior, but also the subjective meaning this behavior has for the human subjects themselves" (Gable, 1994). Lee also argued that a positivist method is the use of natural science and these are the only methods for acquiring knowledge. This opposes the constructivist approach, for which methods are not part of natural science (Gable, 1994).

2.3 Inductive vs. Deductive

Collis defined deductive research as “a study in which a conceptual and theoretical structure is developed and then tested by empirical observation” (Collis, 2003). Therefore, deduction deduces a specific concept from general information or knowledge. As Collis also states, deduction moves from the general to the particular.

However, he defined inductive research as "a study in which theory is developed from the observation of empirical reality" (Collis, 2003). This means that an observation is generalized which is the opposite of deduction that is moving from general to specific. However, Feibleman made several distinctions between induction and deduction. He first stated that induction serves three main objectives: discovering hypotheses, offering evidence support and telling us about the future. The other distinctions of induction compared to deduction are that induction:

- starts with data,
- requires less data compared to deduction,
- is not self corrective,
- seeks timeless generality,
- discovers new ideas as a hypothesis for testing,
- is always accidental while deduction is always necessary (Feibleman, 1954).

2.4 Qualitative vs. Quantitative

This topic relates back to Collis who defined the quantitative approach as "involve collecting and analyzing numerical data and applying statistical tests" (Collis, 2003). However, he defined the qualitative approach as "it is more subjective in nature and involves examining and reflecting on perceptions in order to gain an understanding of social and human activities." (Collis, 2003) The decision of being qualitative or quantitative in the research is very critical and affects how a researcher will approach his/her research. The approach affects what to observe and what data to collect for analysis and derivation of theory or justification of a hypothesis. Regardless of which type of data would be collected, the following are the most important concerns about data:

- Sample size: positivistic approach use more samples compared to constructivist ones;
- Type of Data: Positivistic approaches use precise data (quantitative) while constructivist ones are concerned with qualitative and depth of data;
- Data measurement is an essential element of data collection;
- Location: where the data is collected, environment and culture;
- Reliability: if the research finding could be repeated then it is reliable;
- Validity: if research findings accurately represent the actual situation;
- Generalizibility: application of research findings to other cases not considered in the study (Collis, 2003).

However, Kerlinger stated three major weaknesses in qualitative studies:

- The inability to manipulate independent variables,

- The risk of improper interpretation, and
- The lack of power to randomize (Gable, 1994).

Nonetheless, researchers develop their research to build theories from available information and prove them through data analysis and results. Other papers use hypotheses to develop their research. Therefore, it is also important to state the difference between hypothesis and theory: *A Theory* is "a statement or a set of statements about relationships among variables to explain there relationships" (McBurney, 2001), while a *hypothesis* is: "a statement that is assumed to be true for the purpose of testing its validity" (McBurney, 2001). Table 3 summarizes the attributes of both qualitative and quantitative approaches.

Table 3: Qualitative and Quantitative approches

Quantitative	Qualitative	Source
Description and explanation oriented	Exploratory and understanding oriented	(Creswell 2002)
Literature play minor role	Literature play a major role	(Creswell 2002)
Positivist paradigm	Interpretive Paradigm	(Downs 1999)
Justify for the research	Justify for the research	(Creswell 2002)

problem and support needs for the study	problem	
Research purpose is specific and narrow	General and broad	(Creswell 2002)
Seek measurable and observable data	Seeks to understand the participants	(Downs 1999)and (Creswell 2002)
Collecting data on predefined instilments	Collecting data on protocols developed during study	(Creswell 2002)
Objective numerical data	Subjective, text or image data	(Downs 1999)and (Creswell 2002)
Collect data from large number of people	Small number of people Or sits	(Creswell 2002)
Statistical data analysis	Test analysis	(Creswell 2002)
Research reports use standard, fixed structure and evaluative criteria	Reports use flexible emerging structure and evaluative criteria	(Creswell 2002)
Objective and unbiased approach	Reflexive and biased approach	(Creswell 2002)

Can randomize	Lack of power to randomize	(Gable 1994)
Numeric interpretation	Risk of improper interpretation	(Gable 1994)
Well defined independent variables	inability to manipulate independent variables	(Gable 1994)

3 Data Collection methods

In this part, I will discuss and present most of the methods that have been used in developing research in the field of PM. The list of methods below was collected through a literature review and also reviewing previous published dissertations in the project/operation management field.

3.1 Historical data

Historical information is a source of data that is usually searched and analyzed first since it is available and provides some insight about the performance of the organization or the system. Single or multiple case studies in addition to the other methods will benefit the available historical data. These data are a good start for researchers to assess and evaluate a situation and help in developing questionnaires and interview questions. There is no bias in the archival data since there were no observations or interviews or any intention at the time of events to be biased towards any position in respect to the research. Historical data might not be the effective source of data for theory validation since it might be considered a secondary data and might not be considered reliable (Flynn 1990)

3.2 Interviews

Interviews can be used by both positivists and constructivists. As the name indicates, interviews are a method of collecting data based on asking questions to interviewees about their experience, functions, feelings and the way they think about the posted research question. Interviews could be face-to-face, teleconference or video conference. Interviews could be structured (closed questions) or ethnographic (unstructured). Structured interviews are based on a script from which specific and structured questions were asked to the interviewee; the questions are prepared beforehand. Structured interviews could be compared for validation and verification. Ethnographic interviews, on the other hand, are used for the purpose of discovery of a certain concept. In this type of interview hierarchal questions are asked based on the response of the interviewee to the previous question which means that questions are not prepared beforehand. These can be used to indicate where improvement is needed and used to validate and differentiate among a number of concepts and hypotheses based on interviewee experience (Flynn 1990).

It seems very promising and very advantageous to collect data through interviews, but there are problems with interviews:

- time consuming,
- expensive,
- pose confidentiality issues,
- access to interviewee especially if there is a need for a large number of them,
- for good results, questions have to be asked in the same way for all interviewees,
- interviewer personality affects the results of the interview,
- interviewee response to the interview might be affected by some issues (internal politics) which will guide his/her response to the questions,
- event might affect the response of the interviewee. (Collis and Hussey 2003).

3.3 Observations

observations could be used by the positivist as well as the constructivists to collect data to support their research. Observation could be part of lab experiment or social observation of phenomena. Observation could be external (non-participant) or internal (participant) (Collis and Hussey 2003 and Flynn 1990). External or non-participant observation is to document and observe a participant without any involvement of the researcher. Flynn looks at the external observation as it is being conducted by an observer external to the research efforts. Internal observation is to collect information about a participant and the issue under research with the involvement of the researcher. It is more effective in building theories and formulating hypotheses. Researcher involvement in observation will give a different view of the problem and the answers to the research question compared to external observation. (Collis and Hussey 2003 and Flynn 1990)

However, there are still some problems with observation. First, there is no control over variables of the participants. The other issue with observation is an ethical one. There will be problems with recording or observing participant. Next is the issue of the effect of the observer on the participant especially on the internal observation. People usually behave or act differently when they are being watched. Not all observers are unbiased while observing; the bias position of the observers will affect the validity of the data collected. Another problem with observation is that not everything can be observed which means a lack of some part of the activities that might affect the outcome of data collection efforts (Collis and Hussey 2003).

3.4 Surveys and Questionnaires

Questionnaires and surveys are the most commonly used research methods. Questionnaires are the tools used to perform surveys. A questionnaire is a list of carefully prepared questions developed by researcher based on the research problem and research question (Collis and Hussey 2003). It is to be applied to a selected sample of participants in the designated location of the research (Collis, 2003). This tool is used by both the positivists and the constructivists, but each use different questions in the questionnaire. Positivists use closed-ended questions while constructivists use subjective, open-ended questions. Designing questions is a major issue for the survey to provide useful data that support the research problem (Creswell 2002). Surveys using a questionnaire could be the least expensive tool used to collect data which is why it is more popular in research. The main issues when using questionnaire are listed by Collis as follows:

- Sample size,
- Type of questions,
- Wording of the questions and how to assure that they are intangible and unambiguous,
- Instructions of the questions,

- Methods of distributing and returning questionnaires,
- Test of validity and reliability of responses,
- Methods of classifying and analyzing the data from questionnaires (Collis and Hussey 2003and Creswell 2002).

Surveys and questionnaires are an extensive effort and need a lot of management in order to keep track of the questionnaires and their responses. Therefore, it is important to have a mechanism to track each questionnaire to know who replied and who did not. The other issue in questionnaire design is arrangement of the question and the supporting information about the participant. Piloting the survey on a small number of participants is important to test whether the questions and arrangement are perceived as intended by the participants. The cost factor involved in this effort has to be kept in mind. It is decided based on which methods are used to distribute the questionnaires (Collis and Hussey 2003).

Like other data collection methods, there are some problems with surveys and questionnaires. The first and most important problem in surveys is the large amount of non-respondent. Several PhD. holders, who conducted their research based on surveys, complained about the low rate of response to their questionnaires. Reasons for this low response could be ambiguity of the questions, lack of interest, irrelevant to participant area of interest, lack of interest in generalizing participant ideas and thought of the situation. Another problem with responses is that sometimes not all questions are answered. Some questions might be answered incorrectly. If certain questions were dominantly unanswered, altimetry will be ignored by the researcher. Design of the questionnaire will play a major role in deciding the number of expected responses. Moreover, choosing the participants will also affect the percentage of respondents. Little attention to a questionnaire's preparation, including ignoring reliability and validity of questions, affects response to the surveys (Collis and Hussey 2003and Flynn 1990).

3.5 Single/Multiple Case Study

A case study objective is to document and examine, in detail, a phenomenon with a certain boundary or a single plant where the researcher has no control over the event. (Yin 2003), and (Voss et al. 2002). In research, the case study is used to validate or formulate a new theory.

The case study provides the clearest possible picture about a phenomenon by gathering a large volume of data from within the organization or system. A case study concentrates on the current condition. It is similar to the internal observation where the researcher got involved in the organization. The case study provides detailed information about how and why an event occurs. A case study, as a methodology for research development, is considered an empirical approach used to better understand real world events. With multiple case studies, a causal relationship among events could be developed which simulate the quasi-experiment methods.

Because of their detailed and in depth analysis of a situation, case studies are used for:

- Exploration: the case study is used to develop research ideas and identify the problem and establish research questions;
- Theory development: cases are used to identify dependant and independent variables of the research problem. In addition, cases can be used to identify the relations among those variables and how and why these relations exist (Voss et al. 2002),
- Theory testing: some researchers build theories in early stages of the research and they use cases to test and validate their theories. The study tests the survival of the theory after testing it compared to data collected. It also tests the behavior of the theory after data collection to check if it is as predicted by the theory or if there will be unpredicted behavior (Voss et al. 2002);
- Theory extension/refinement: based on results or observation in the cases, theories could be re-tuned to better represent the right behavior and reflect the right knowledge. The case also shows how the theory could be generalized and where it could be applied.(Voss et al. 2002).

Gable, however, looked at case study methodology in adifferent way, he argued that the case study uses multiple methods in a limited number of organizations or systems. A case study uses:

- participant observation,
- detail interviews,
- longitudinal studies.

He stated that a case study is used to understand the problem being investigated (research problem). It also give a chance to ask critical questions to grasp the organizational behavior However, the problem is that the outcome might not be generalized.

On the other hand, Bengast (1987) suggested that case study methodology has three main strengths compared to other methods:

- The researcher can develop theories from practice because case study is a natural setting,
- Better understanding of the nature and the complexity of the system,
- Good insight can be learned for new emerging topics in fast changing technology (Gable 1994).

Gable compared survey methods to the case study method with respect to some rigorous features. See table 2.

Table 2: Relative Strength of Case Study and Survey Methods

	Case Study	Surveys
Controllability	Low	Medium
Deductibility	Low	Medium
Repeatability	Low	Medium
Generalisability	Low	High
Discoverability	High	Medium
Representability	High	Medium

Source: Gable (1994)

3.6 Panel study/focus group

A panel study collects expert responses to certain questions to define terms and make predictions. The written response is distributed to the members of the panel who can revise their responses accordingly. The round continues until a consensus is reached. This process is used heavily in operation management research. A focus group, on the other hand, is the same as the panel study, but the group attends at a meeting and the response is communicated orally rather than in writing. The objective is consensus as in the panel study. The group is given a set of questions to answer prior to the meeting. A facilitator manages the meeting to allow every member to express his/her own opinion and allow discussion to come up with an agreed upon decision about the topic (Flynn 1990 and Collis and Hussey 2003).

10.2 Appendix 2: Topic Area of Literature

Reference	Sys	Proj	Risk	ResM	SM	PM	RM
Systems Guide (1997)	x						
(Abraham 1936)				x			
(Arthur 1994)				x			
(Atkinson 1999)		x				x	
(Blanchard 2004)	x				x		
(Blanchrad and Fabycky 2006)	x				x		
(Bouchard 1976)				x			
(Brill 1999)	x				x		
(Cervone 2006)		x				x	x
(Chapman 1997)		x	x			x	x
(Checkland 2000)	x				x		
(Collis and Hussey 2003)				x			
(Covello and Mumpower 1985)			x				x
(Creswell 1998)				x			
(Creswell 2002)				x			
(Creswell 2008)				x			
(Creswell et al. 2007)				x			
(Downs 1999)				x			
(Duncan)		x				x	
(Dvir and Lechler 2004)						x	
(Dvir 2005)		x	x			x	x
(Eisenberg and Goodall 1993)	x				x		
(Feibleman 1954)				x			
(Finne 2000)							x
(Forza 2002)				x			
(Gable 1994)				x			

(Garvey and Pinto 2008)	x					x	x
(Garvey and Pinto 2009)	x					x	x
(Guba and Lincoln 1981)				x			
(Haimes 1991)			x				x
(Haimes et al. 2002)			x				x
(Huberman and Miles 2002)				x			
(Kaplan 1997)			x				
(Kast and Rosenzweig 1972)	x						
(Keating et al. 2001)	x						
(Keating et al. 2005)	x						
(Kossiakoff and Sweet 2003)	x						
(Leach 2000)		x				x	
(Lee and Baskerville 2003)				x			
(Lister 1997)		x	x			x	x
(Meredith and Mantel 2003)						x	
(Merriam-Webster.com)	x						
(Mihram 1972)				x			
(SB et al. 1992)			x				x
(Palomo et al. 2007)						x	x
(Perera and Holsomback 2005)			x				x
(Perminova et al. 2008)		x				x	x
(Phadke 1995)	x		x				
(Pmi 2000)		x				x	
(Raz and Michael 2001)		x	x				x
(Rhodes and Hastings 2004)	x						

(Risk Filtering 2002)			x				x
(Robinson 1951)				x			
(Salmon 1976)				x			
(Seiler 1991)		x	x			x	
(Skelton and Thamhain 2006)		x				x	
(Stephan and Badr 2007)				x			
(Sturgeon 1993)				x			
(Tah and Carr 2001)		x				x	x
(Voss et al. 2002)				x			
(Ward and Chapman 1996)		x	x			x	x
(Williams et al. 1997)			x				x
(Williams 1995)		x	x				x
(Williams 1996)		x				x	x
(Wu et al. 2006)			x				x
(Yin 1989)				x			
(Yin 2003)				x			

Sys = Systems
Proj. = Projects
SM = Systems management
ResM = Research Methods
PM = Project management
RM = Risk Management

10.3 Appendix 3: *Questionnaire*

Project, Systems and Risk Management Interaction Survey

This survey is part of a doctoral dissertation research effort to investigate the effects of risk management process during project on the process of the systems (organizations) after the project is integrated into the system. The purpose is to identify if there are any risks that can propagate into the system after the project is completed and commissioned. This research effort will also suggest some procedures to mitigate or eliminate these risk propagations if any.

Responses will remain confidential and no individual results will be presented – all results will be reported in aggregate form and will not be able to be traced back to any one person or event.

Please complete this survey on or before: 8/18/2009

Please choose your response to the following questions:

1. What is your role/function in the project/system?
a. Project manager
b. Project engineer
c. Project team member
d. Project support team
e. Other ____________

2. How long have you been working in projects and project management?
a. 1-2 years
b. 3-4 years
c. 5-10 years
d. More than 10 years

3. What is the usual size of the projects you worked on?
Small<$50,000 Medium < $500,000 Large <$5 Million, Program>$5 Million
a. Small
b. Medium
c. Large
d. Program level

4. How often do you conduct reviews in the project per phase?
a. 1 time
b. 2 times
c. 3 times
d. 4 or more times

5. What may prompt a change request during a project? (check all that apply)
a. Customer request
b. Project scope change
c. Risk issues
d. Time or cost change

6. Are change requests related to risk management?
a. Yes
b. No
c. Sometimes
d. When there is risk of change on time and cost

7. How often do you practice risk management in your projects in each phase of the project?
a. 1 time
b. 2 times
c. 3 times
d. More than 3 times (continuous)

8. How do you maintain relationships with project stakeholders? (check all that apply)
a. Regular meetings
b. During project proposal phase
c. During design phase
d. Continuous communications with project stakeholders

9. What are the most frequent risks in projects?
a. Supplier risk
b. Technical risks
c. Management risks
d. Human risks
e. Other(?): ___________

10. Have you been involved in projects with no risk management plans?
a. No
b. Yes, very few projects
c. Yes, all projects
d. Yes, only small size projects

11. How do you identify risk in projects? (check all that apply)
a. Brain storming
b. Project manager identify risks
c. Consultant identify the risks
d. Team members identify the risks

12. Who is involved in Risk identification of the project? (check all that apply)
a. Project manager
b. Project team
c. Project stakeholder
d. Contractors and suppliers

13. How do you assess and evaluate risks in projects?
a. Project manager assess the risk
b. Risk owner
c. Project team
d. Consultant

14. How do you plan for risk in projects? (check all that apply)
a. Stakeholder issue plans
b. Project manager initiate plans
c. Team members initiate plans
d. Risk owner plan for his project

15. How do you prioritize or rank risks in projects?
a. Project team
b. Project manager
c. Risk management team
d. Project stakeholder

16. What practices do you use to mitigate project risk?
a. Transfer risk
b. Accept risk
c. Ignore risk
d. Monitor risk

17. Do you ignore any type of risks?
a. Yes, all risk
b. Yes, low likelihood risk
c. Yes, risk with low impacts
d. No, all risks are accepted

18. When would you accept risks during project?
a. High likelihood risk
b. High consequences risk
c. High likelihood but low consequences
d. Low likelihood but high consequences

19. At what phase of the project do you plan for risks? (check all that apply)
a. Initiation phase
b. Design phase
c. Planning phase
d. Execution phase

20. What determines how long it takes to respond to risk events?
a. Always immediate
b. Based on risk level
c. Based on Management request
d. Respond when it has high priority

21. How confident are you about the risk management process used by the project?
a. Very confident
b. Somewhat confident
c. Somewhat unconfident
d. Completely unconfident

22. Do you communicate any risks to the system during project integration?
a. No
b. Yes, How often

23. Are project's owner representatives involved in the projects made aware of risks during projects?
a. No
b. Yes

24. In your own words, please write a short answer to the following questions:

25. Have you experienced any risk events?

26. What do you think are the reasons for this event?

27. What are the short term initiating events that might cause the event?

28. Do you think that there is a long term initiating events for the event?

29. Do you think that there are some initiating events from projects?

30. What initiating events during project that might cause an event in the system?

31. How would you relate risk process with project objective?

32. How would you relate risk process with systems' objectives?

Thank you for your valuable contribution to this survey.
It is highly appreciated if you can respond to this survey by 08/18/2009.

11 VITA

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  - Doctoral of Philosophy (Engineering Management) August, 2010
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PhD. Dissertation

POST-PROJECT RISK PERCEPTION AND SYSTEMS MANAGEMENT

REACTION

A practical study of the propagation of risk initiating events form the project execution phase to the system after project is completed and integrated into the system. Framework was proposed to over the problem by relating project to system with respect to risk to eliminate propagation.

Certification and Training

- ATM LAN Engineer Certification, Fore Systems 3/98 Pittsburg, USA
- ATM WAN certified engineer, 8/98 Pittsburg, USA
- Interconnecting Cisco Network Devices, 2005 Dhahran, KSA
- Designing Telecommunications Distribution Systems
- High speed networking over copper cable with Pairgain DSL equipment, 9/97, Lugano, Switzerland