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Objectives and Outcomes in Risk Management Education

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Objectives and Outcomes in Risk Management Education

In partial fulfillment of the requirements for the Degree of Master of Science in Technology

A Directed Project Report

By

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July 13, 2010

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Abstract

Since the advent of the Personal Computer in the 1980’s, the Information Technology (IT) industry has ballooned into one of the largest employers of people across the world. However, IT projects have constantly been plagued with low success rates. Analysis of these project failures has revealed lack of knowledge of risk management practices and tools as a key reason for unsuccessful projects.

This project focused on the development of a graduate level course in Information Technology risk management for incorporation into the graduate level curriculum at the department of Computer and Information Technology at Purdue University. A Problem learning model with a focus on constructivism was used for the design of this course. The educational materials developed as part of the project include course lectures, exercise assignments and a team-based project modeling a real-life situation in a large biomedical manufacturing organization with the use of risk analysis software Crystal Ball.
Introduction

Information Technology has experienced exponential growth across several sectors yet the rate of failure of IT projects has remained fairly constant over the years. A study conducted of 600 firms revealed that 35 percent of them had one runaway project (Boehm, 1991). Retrospective analysis of these software failures indicated that the problems could have been avoided or significantly reduced if high-risk elements were identified early in the project lifecycle (Boehm, 1991).

Research results of a more recent survey show that only one project in every eight IT projects can be deemed successful (McManus & Wood-Harper, 2008). In the research study that examined 214 information systems projects across the European Union at the same time with the period of analysis spanning the years 1998-2005, 51 (28.3%) of the initial projects were cancelled. 69 of the completed projects experienced schedule and budget overruns (McManus & Wood-Harper, 2008). Analysis of these failures has revealed insufficient risk management procedures to be one of the key reasons for project failure (McManus & Wood-Harper, 2008).

With challenges such as global IT spending being estimated to decrease by 3 percent in the year of 2009 by Forrester Research, the first time in seven years that the amount has shown a decrease as compared to previous years, the successful execution of IT projects for organizations has become extremely vital, more so now than ever (Brewer & Dittman, 2009).

A primary reason for additional complexity involved in IT projects is that IT changes rapidly; often creating a shortage of essential IT skill sets (Brewer & Dittman, 2009). A Case Study at the University of Applied Science, bfi, Vienna exposes a growing divide between academia and the corporate world (Arami, 2008). The research problem in the case study is that
“several universities in Austria invest enormous resources on Project Management courses without being certain if the training matches the needs of companies students will work for after graduation” (Arami, 2008, p. 1). Urs Fischer, vice president and head of IT governance and risk management at SwissLife (a pension and life insurance provider company) has also voiced the lack of experience of IT workforce in the latest developments in risk management and methods to quantify and evaluate risk (Ricknäs, 2008).

The solution to the rising concern about lack of knowledge about risk management practices and tools in the current IT workforce lies in narrowing the divide between the academic and corporate world by providing students and existing IT professionals in-depth knowledge and training in risk management practices, procedures, tools and methods which can help them make qualified decisions at their workplace in industry, thereby improving the success rate of IT projects.

At Purdue University, Computer and Information technology students are prepared to “plan, analyze, construct and manage information systems for existing and emerging jobs and careers in the application of information systems and technology” (College of Technology, Purdue University). It is thus imperative to render students the innovative technologies and methods of risk management that will augment their academic understanding. A student graduating from Computer and Information Technology should possess abilities to make a knowledgeable decision about risk management and quantification.

While IT project management had been identified as an important area of research and different areas of project management were being studied by graduate students at Purdue University, a course dedicated to risk management was not offered by the department of Computer and Information Technology at Purdue University.
Several tools and practices associated with risk management exist but there was a distinct lack of knowledge and implementation of them. A current analysis of the graduate level courses in project management offered by the department of Computer and Information Technology at Purdue University reveals that students are exposed to only the elementary concepts of risk management. Students were taught that risk management is extremely important for a successful project. However, there were no dedicated courses teaching processes used to identify and quantify risk. While financial implications of the absence of risk management were being emphasized to students, students were not taught how to use the tools to identify risks, create a risk management plan and perform qualitative and quantitative risk analysis to determine the optimal response strategy in a given situation. Most students joined industry without a lucid idea of what processes are involved in risk management. This project is focused on developing an advanced graduate level course in risk management for the students of Computer and Information Technology at Purdue University, a premier institution offering some of best educational facilities to its students to enable to bridge the divide between academia and industry in the field of IT risk management.

**Significance of the problem**

IT projects have been plagued with low success rates. Research results of a recent survey show that only one project in every eight IT projects can be deemed successful (McManus & Wood-Harper, 2008). In the research study that examined 214 information systems projects across the European Union at the same time with the period of analysis spanning the years 1998-2005, 51(28.3%) of the initial projects were cancelled (McManus & Wood-Harper, 2008). 69 of
the completed projects experienced schedule and budget overruns (McManus & Wood-Harper, 2008). While the patterns that emerged from the analysis of the data were multi-faceted, one of the key management reasons for project failure has been attributed to a lack of sufficient risk management training (McManus & Wood-Harper, 2008). Another independent report published by the Office of Government Commerce (OGC) in the United Kingdom also revealed insufficient risk management education to be one of the primary reasons for project failure (Office of Government Commerce, United Kingdom, 2004). With insufficient knowledge about the processes and procedures involved in risk management and without a formal risk management process in place, most organizations operate in a state of constant crisis management or firefighting; trying to determine a solution after the occurrence of a problem (Brewer & Dittman, 2009).

Traditional textbooks also emphasize the number of ways in which proper risk management processes can affect the outcome of a project favorably. These include making “aggressive risk-taking possible for an organization operating from a position of knowledge, providing minimum-cost downside protection, protecting against invisible transfers of responsibility, maximizing opportunities for personal growth and focusing both human and monetary resources where they can provide the maximum benefit to the organization” (Brewer & Dittman, 2009, pp. 245-246).

Thus, the understanding of risk management methodologies, tools and practices is extremely important for the future industry workforce to ensure better success of IT projects. With the current graduate curriculum in the department of Computer and Information Technology at Purdue University lacking a dedicated course on risk management, this study was highly significant in its importance.
Statement of Purpose

The purpose of the study was to develop a three credit, 15 week graduate level course on risk management. The course was closely aligned with the methodologies described in the PMBOK (Project Management Body of Knowledge) (Project Management Institute, 2008). These include planning risk management, identifying risk, performing qualitative and quantitative risk analysis, planning risk responses and monitoring and controlling risks. Risk management techniques for risk assessment, risk management and risk mitigation are thoroughly covered. The study also reviewed the industry best practices during risk management processes. The study investigated optimal process steps, tools and data sources to perform risk management to complement a project based on its size, complexity, longevity and strategic importance.

The course also added practical exposure for students by incorporating case studies of different organizations across the world.

Definition of Terms

- **Risk mitigation**: A situation where “an organization reduces the impact of a risk event by reducing the probability of its occurrence” (Brewer & Dittman, 2009, p. 254).

- **Qualitative Risk Analysis**: “Subjective techniques used to determine probability of occurrence and project impact of identified risks” (Brewer & Dittman, 2009, p. 251)

- **Quantitative Risk Analysis**: “Analysis based on mathematical or statistical techniques to model the behavior of a particular risk” (Brewer & Dittman, 2009, p. 252).

- **Risk avoidance**: “Avoidance entails eliminating a specific threat or risk” (Brewer & Dittman, 2009, p. 254)
• **Risk acceptance**: A situation where “an organization decides to accept the consequences of a risk without trying to control it” (Brewer & Dittman, 2009, p. 254).

• **Risk transference**: A situation where “an organization shifts the consequence of a risk and its responsibility to a third party that is internal or external to the organization or moves it to another department within the same company” (Brewer & Dittman, 2009, p. 254).

### Assumptions

The assumptions of this study are:

• One of the primary assumptions of this study was that the sponsoring professor of this study will be able to implement this course into the curriculum of Computer and Information Technology students at Purdue University.

• The study also assumed that risk management software used in the preparation of course material is available for student use.

• The study also assumed all students of this course possess adequate pre-requisite knowledge as demonstrated by experience or pre-requisite course-work.

### Delimitations

The delimitations of this study are:

• The effectiveness of the course material developed as part of the study was evaluated by the primary professor and the graduate committee at the completion of the study.
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- The content of the course was not completely exhaustive of all the available tools and methodologies in the area of Risk Management.
- The study used Crystal Ball as the primary risk management software for designing assignments for the course. Crystal Ball was chosen for its availability. This study explored no more options of Risk Management software.

**Limitations**

The limitations of this study are:

- The primary purpose of this study was to produce course content and associated course materials. The only method of validating this study was its effectiveness determined by the primary course professor and the graduate committee by looking at possible student learning outcomes.

**Review of literature**

*Insufficient/Improper Risk Management: a key reason for IT Project Failure*

Information Technology has become an integral part of the global economy. Harvard University Professor Dale W. Jorgenson states that while some economists believe that Information Technology (IT) has produced a fundamental change in the U.S economy and has lead to a permanent improvement in growth aspects; economists who believe that the development of Information Technology is a temporary “shock” also believe that it has lead to a positive impact on the U.S economy (Jorgenson, 2001, p. 1).
While IT has experienced extraordinary growth in various sectors, IT projects still have extremely low success rates. A survey conducted by Bennet Lientz and Lee Larssen revealed that only 30-35% of IT projects were completed with tangible benefits (Lientz & Larssen, 2006). Insufficient understanding of risk management processes is a primary cause for failure of IT projects.

The growing importance of risk management is emphasized by the fact that in the version of PMBOK (Project Management Body Of Knowledge) published in the year 2000, the chapter on risk management was rewritten from the previous version of and higher emphasis was placed on the role of risk management in the success of IT projects (Project Management Institute, 2000) (Project Management Institute, 1996). While IT professionals have now discovered the importance of risk management in the success of a project, specific knowledge about risk management methodologies and practices eludes many. The key divide between industry and academia is apparent as determined in the Case Study at University of Applied Science, bfi, Vienna (Arami, 2008) and voiced by experts in industry and the lack of skilled IT workforce with knowledge of risk management practices is an important area of concern (Ricknäs, 2008).

The preliminary part of the literature review was concerned with emphasizing the growing gap between academia and corporate world and how the gap can be bridged by different approaches to teaching and learning as far as Project Management methodologies are concerned, with special focus on risk management. The latter part of the literature review was dedicated to understanding risk management methodologies, practices and tools. Why is IT risk management so complex? And what can be done to simplify it and enhance understanding?
Methodology of Literature Review

The literature review was performed using a variety of sources including online periodicals and reports, especially used to determine latest statistics on research studies conducted to determine the success rate of IT projects. The online portals have also been used to assess current trends and latest developments in risk management and to determine the opinions of professionals on the risk management skill-set of the current IT workforce.

The other sources include several electronic journals and conference proceedings. These have been used to determine research studies to confirm the growing divide between industry and academia in the area of Project risk management and to establish successful course design and development methodologies to enhance the effectiveness of the course material.

Traditional text books have also been heavily used in the literature review, especially to understand risk management and the best practices and processes involved, especially with a focus on IT risk management.

A variety of sources was scoured for data relevant to the study in question. Each of the relevant sources was grouped into one amongst three levels (high, medium and low) depending on their level of relevancy to the study. All the sources were recorded in a Microsoft Excel spreadsheet with a concise description of each source and their level of relevancy to the study. In addition to the soft copy of each source (other than traditional text-books) saved in a folder for easy access, the hyperlinks to each source was also recorded in a Microsoft Office Word document.
Growing gap between academia and corporate world

One of the literature sources revealing the divide between academia and the corporate world is the Case Study at University of Applied Science, bfi, Vienna (Arami, 2008). The research problem in the case study is that “several universities in Austria invest enormous resources on Project Management (PM) courses without being sure if the training matches the needs of companies students will work for after graduation” (Arami, 2008, p. 1/8). The results of the first stage analysis reveal that Universities in Austria offer traditional PM courses where basic tools like Gantt charts and network diagrams are still the primary tools used in teaching Project Management processes and methods; keeping in trend with the traditional learning the Professors received themselves (Arami, 2008, p. 2). Teaching standards and performance evaluation of students are based on the individual experience of the Professors rather than the use of PM standards and a generic design (Arami, 2008, p. 2/8). Arami (2008) thus concludes; “There is a need for introduction of generic PM standards into Universities of Applied sciences in Austria, providing more transparency in the quality of the PM courses at Austrian universities of applied sciences” (Arami, 2008, p. 2/8). With Risk Management being one of nine core areas of the PMBOK (Project Management Body of Knowledge), this case study is extremely relevant; exposing the fact that universities do not cater to the needs of the organizations students work for after their graduation. As a solution to the research problem, the research methodology involved the development of a framework to develop pilot study project management courses. The study for the design of the pilot study project management courses was divided into two stages. The first stage involved review of existing literature and analysis of project management courses
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offered at several Austrian Universities for the courses determined to be a part of the pilot study. The second stage involved Qualitative expert interviews and focus groups which were used to determine the primary success factors for Project Management courses at the University (Arami, 2008). The participants in the case study included Project Management lecturers who were first trained within a “Train a Trainer programme” where the initial course design was developed (Arami, 2008). 100 students enrolled in the pilot study Project Management courses at the University of Applied Science, bfi, Vienna where the PM courses were presented as workshops (Arami, 2008). Student centered approach with “core” and “reflective” learning subject combined was found to be successful in teaching project management theory and in helping students develop improved cognitive abilities (Arami, 2008).

The importance of understanding IT risk management to successfully complete a project cannot be emphasized enough. Urs Fischer, vice president and head of IT governance and risk management at SwissLife quoted “IT risk is really difficult to quantify, because you don't have the experience today. There is also not enough data to calculate it or even how to do it” (Ricknäs, 2008). “Everyone at the conference (referring to European Computer Audit Control and Security Conference in Stockholm in 2008) is saying it's something you have to do,” said Fischer, adding that when you ask them how to do it, no one has a good answer (Ricknäs, 2008). Fischer further says that due to the lack of real knowledge, most project managers rely on their personal judgment. This could often lead to erroneous assessments leading to increased costs and bad security. Fischer also states that there is a pent up demand for an approach to simplifying and understanding IT Risk Management (Ricknäs, 2008).

Thus, there is not only a need for implementing a graduate course in IT Risk Management in the curriculum of prospective IT professionals, especially those involved in
processes of IT project management, the design of the course should integrate theoretical concepts with practical exposure required in industry.

**How to bridge the gap between academia and industry?**

While the gap between academia and industry in understanding and implementing project management methodologies with a focus on risk management is clearly determined by industry trends and existing literature, the solution for bridging the gap lies in different instructional strategies focused at optimizing a student’s performance and equipping them to employ the theoretical concepts and classroom experience in real-life situations in industry.

While specific instruction design methodologies chosen for the design of a graduate level course in risk management and the rationale behind the choice will be discussed in the methodology section with inputs derived from the sponsoring professor of the course, the literature review section focuses on the importance of the use of project management tools to enhance the experience of a student in a project management class. A study was performed in the “context of a graduate certificate program that is intended to prepare students for careers that utilize current and emerging technologies to meet educational and training goals in various arenas including schools, communities, government agencies and corporate settings” (Rooij, 2008, p. 2). The results of the study reveal that the use of Project management scaffolding tools including Project Charter, Work Breakdown Structure (WBS), Activity list and Project Status reports during course work completion caused less frustration and improved efficiency amongst team members (Rooij, 2008). The results of the study further reveal that the use of Project Management methodology improves intra-team communication and has a positive impact on collaborative behavior (Rooij, 2008). This study had fourteen participants across two separate
course sections. “While one section was randomly designated as the test group using the project management methodology, the other section was using the traditional scaffolding tools and serving as the control group” (Rooij, 2008, p. 4). This study is extremely relevant for the development of a graduate level course on Risk Management (with Risk Management being one of the nine core areas of the PMBOK specified contents of Project Management).

This study suggests that the use of Project based learning with the use of project management tools and templates to be incorporated with instructional design strategies can have a positive impact on student interactions in a Project Management class, especially with the use of team-based assignments and activities. While this study has been performed in the context of a course delivered online, its results can be used successfully in a classroom setting. A student centered approach found successful in the Case Study at University of Applied Science, bfi, Vienna (Arami, 2008) can also be integrated with this PMBOK aligned project based approach (Rooij, 2008) and the chosen instruction design methodology.

A research paper by John Savery and Thomas Duffy attempts to correlate the theoretical principles of constructivism with the practice of instruction design and practice of teaching (R.Savery & M.Duffy, 2001). “Constructivism is a philosophical view on how we come to understand or know” (R.Savery & M.Duffy, 2001, p. 1). Savery and Duffy have classified the philosophical view in terms of three propositions (R.Savery & M.Duffy, 2001):

- “Understanding is in our interactions with the environment: This is the core concept of constructivism. We cannot talk about what is learned separately from how it is learned, as if a variety of experiences all lead to the same understanding” (R.Savery & M.Duffy, 2001, p. 1/17).
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- “Cognitive conflict or puzzlement is the stimulus for learning and determines the organization and nature of what is learned: When we are in a learning environment, there is some stimulus or goal for learning -- the learner has a purpose for being there. That goal is not only the stimulus for learning, but it is a primary factor in determining what the learner attends to, what prior experience the learner brings to bear in constructing an understanding, and, basically, what understanding is eventually constructed. (R.Savery & M.Duffy, 2001, p. 2/17)”

- “Knowledge evolves through social negotiation and through the evaluation of the viability of individual understandings: The social environment is critical to the development of our individual understanding as well as to the development of the body of propositions we call knowledge” (R.Savery & M.Duffy, 2001, p. 2/17).

A study conducted in the year 2006 revealed that a “constructivist learning environment which involves students in real-world projects can motivate students in learning (Law, 2007, p. 1).” The study describes the use of a “real-world, community related project called Youth Can Do Information Technology” (Law, 2007, p. 1). This project was integrated into a class teaching “project management skills in the areas of integration, scope, time, cost, quality, human resource, communication, risk, and procurement as recommended by the Project Management Institute (PMI)” (Law, 2007, p. 1). This study is especially relevant as it was used in the realms of IT Project Management. The successful implementation of a constructivist approach to instructional design can be applied to this study to enhance student’s learning. Problem-Based Learning (PBL) was initially developed in the mid-1970’s and has found success as a instructional model and was implemented across sixty schools (R.Savery & M.Duffy, 2001, p. 7). The model has also been successfully implemented in several Business schools (R.Savery & M.Duffy, 2001, p. 7). This has prompted the choice of this model for the design of a course in management. Combined with
the constructivist approach, in a problem learning model, students are encouraged and expected
to think both decisively and resourcefully (R. Savery & M. Duffy, 2001).

Understanding Risk Management

Barry Boehm attempts to define the fundamental concept of risk management: risk
exposure (Boehm, 1991). He determines that risk exposure can be defined by the relationship:

\[ RE = P(UO) \times L(UO) \]  

(1)

where \( RE \) refers to risk exposure, \( P(UO) \) refers to the probability of an unsuccessful outcome
and \( L(UO) \) refers to the loss to the affected parties due to the unsatisfactory outcome (Boehm,
1991). Boehm attempts to define unsatisfactory outcome from a multi-dimensional point of view
taking into consideration customers, users, developers and maintainers. The most important
perspectives are obviously those of the customer and the user (sometimes the same entity) who
consider schedule and budget overruns and wrong functionality, performance and reliability
pitfalls as unsatisfactory outcome respectively (Boehm, 1991). Developers are also likely to
consider schedule and budget overruns as an unsatisfactory outcome while maintainers would be
impacted in an unsatisfactory manner by poor quality of software (Boehm, 1991). A decision tree
can be used as a paradigm to determine potential losses for probable unsatisfactory outcome
(Boehm, 1991). Risk Management consists of two important steps: Risk Assessment and Risk
Control, each of which is subdivided into three subcategories. Risk Assessment involves the
procedures of risk identification, risk analysis and risk prioritization while Risk control consists
of risk management planning, risk resolution and risk monitoring (Boehm, 1991).
The PMBOK describes six processes in Risk Management including: (Brewer & Dittman, 2009)

- Risk management planning— how to approach and plan risk management activities to reduce effect of negative outcomes and enhance opportunities and positive outcomes
- Risk identification—determining which risks might affect the project
- Qualitative risk analysis—Use of subjective techniques to assess impact of identified risks
- Quantitative risk analysis— Use of mathematical and statistical methods in measuring the probability and consequences of risks and their effects on project outcomes
- Risk response planning— developing specific response plans for each risk to enhance opportunities and reduce impact to project objectives and outcomes
- Risk monitoring and control— monitoring and tracking risks, determine effectiveness of risk responses and fallback and contingency plans

We notice a close correspondence in the processes described by the PMBOK and the risk management processes detailed by Barry Boehm. Figure 1 details Boehm’s structure of Risk Management.
Boehm also details cost drivers and the probability of impact with probability ranging from categories improbable to frequent (Boehm, 1991). Boehm’s techniques on software risk management have been found to be robust, easy to implement, apt for teaching purposes and have been deemed practical for implementation in a workplace environment (Frailey, 2006). Thus, the findings of Boehm are still relevant in today’s date.

Risk Management for IT projects varies significantly from other business projects. Cost and Risk generally go hand in hand for a standard risk project (Lientz & Larssen, 2006). The relationship between cost and risk in an IT project is more complex. Figure 2 represents the relationship between cost and risk in an IT project.
The graph indicates that in an IT project, most of the money is spent in the initial stages of the project towards elements like hardware, software and network components (Lientz & Larssen, 2006). However, risk tends to increase in the later stages of an IT project. The vertical line represents 90% completion of the project; yet only around 50% of the total risk associated with the project has been encountered (Lientz & Larssen, 2006). Thus, risk management in IT project requires a greater degree of comprehension and adequate planning to ensure a successful outcome.

Lientz and Larssen suggest tackling IT project risk by addressing issues (Lientz & Larssen, 2006). An issue impacts the performance of a project in a negative way or can lead to new opportunities for growth. Risk is caused by a single or multiple issues (Lientz & Larssen, 2006). By grouping issues and addressing the tangible issues, the likelihood of the occurrence of the risk is reduced (Lientz & Larssen, 2006). Lientz and Larssen further suggest success factors in the resolution of risk (Lientz & Larssen, 2006):
• Maintain a repository of previously encountered IT issues and opportunities realized by project teams
• Involve people to obtain support over important decisions in the project
• Identify issues early in the project lifecycle
• Involve a structured approach to re-examine issues
• Improve constantly with each project experience; especially when similar issues are encountered

The implementation of these practices not only reduces risk involved in a project and improving the chances of success of a project but also makes IT work more predictable and thereby easy to perform (Lientz & Larssen, 2006).

A recent study conducted by Odzaly and Greer attempted to study the barriers to software risk management in organizations (Odzaly & Greer, 2009). The study surveyed 18 experienced Project Managers across different organizations. The results of the survey reveal that the main barriers to performing risk management activities in an organization include the perceived large degree of effort required for performing risk management activities and the perceived lack of value of the effort. Yet, only one organization in the study responded positively to using a tool to manage risk (Odzaly & Greer, 2009). The use of risk management tools can optimize the process of documenting identified risks, analysis of the risk and providing a variety of scenarios in risk evaluation considering several variables.

While there are several resources dedicated to Risk Management and the findings of Boehm are still relevant in most IT projects, review of traditional textbooks and web-based sources for the constantly changing field of Risk Management with inputs from the primary Professor is to be used to design the content of the course.
Methodology

The methodologies used in this study were derived from educational theories, both for learning and instructional design which have been proven to be successful in the realms of conceptual adult-learning with a focus on management and decision making. The methodology section further details the model used in the study and the theories and approaches involved in enhancing the learning experience for students of the course. A complete framework for conducting the study is also illustrated.

Study Design

The course objectives were determined after detailed discussions with the course sponsor. The course objectives were then laid out for facilitating student-learning via:

- Course Lectures to be delivered by the course sponsor/instructor by using Microsoft PowerPoint Presentation slides.
- A team-based final semester project closely modeling a real-life situation associated with risk management in industry
- Exercise assignments with a focus on the study material delivered during lecture sessions to enhance and facilitate learning of concepts and general ideas discussed during lecture sessions.
- A review of case-studies to bridge the growing gap between learning theoretical concepts and their practical application in various areas in industry.
- Use of tools to identify and quantify risk.

Lecture content was sourced from several journal publications, reputed text-books and some of the latest developments in risk management techniques and methods are also sourced...
from well-established trade articles and magazines. A Problem-based learning model was used as the instructive model for course design. A Problem-learning model with a focus on constructivism was used in the design of this course. A Problem-learning model emphasizes the use of real-life scenarios and real-life projects to stimulate the learner’s experience (R. Savery & M. Duffy, 2001). Problem-based learning also focuses on the learner taking ownership of a problem and the learner is not given direct answers or data to reach a desired solution (R. Savery & M. Duffy, 2001). This encourages students to look beyond the instruction material to assimilate concepts of risk management education. The facilitator plays an important role by constantly prodding the students with questions directed at probing a student’s knowledge further (R. Savery & M. Duffy, 2001). In addition to the basic foundation of these models, using PMBOK tools and methodologies have been found to be extremely useful for students of Project Management as sourced through the literature review (Rooij, 2008). The literature review also reveals the importance of constant feedback and interaction between teacher and student in teaching courses. The teacher is to “value and challenge” the learners’s thinking and ensure that the deliverables or course activities are completed to the best of the student’s potential (R. Savery & M. Duffy, 2001). The design principles of the Problem learning model thus are to be supplemented by lectures and assignments using content and tools aligned with the PMBOK with a high degree and frequency of intelligent feedback from the course instructor. The course content has been designed by using the double-loop learning theory of Argyris (Argyris C., 2002) and Symbol systems theory by Salomon (Salomon, 1994).

The double-loop learning theory of Argyris is especially relevant to management education. According to this theory, Argyris describes learning as a process of “detecting and correcting error” (Argyris C., 2002). As opposed to single loop learning, double loop learning
occurs when governing values and actions are changed in the process of correcting error and enhancing learning (Argyris C., 2002). This theory encourages feedback and a high degree of interaction with others. The students are thus encouraged to constantly interact with each other and the instructor, thus affecting the course delivery to a great extent. The double loop learning theory of Argyris is especially relevant to decision-making skills as it focuses on analysis of the underlying factors in the learning process and enables individuals to take an informed decision based on valid information (Argyris C., 2002). Decision-making skills are extremely important for any student studying an area of Project Management.

The symbol theory by Salomon describes how the symbols system of media can affect acquisition of knowledge and play an important role in mental activities (Salomon, 1994, p. 222). Salomon describes how the choice of “certain coding elements can increase or decrease processing burden of the learner” (Salomon, 1994, p. 222). Salomon also describes how “different symbol systems differ to the amount of elaboration they allow or require” (Salomon, 1994, p. 222). Thus, the design of course content using visual aids and graphs and survey results was closely allied with the principles described by Salomon.

**Development of Course Material**

The process of course development involves producing the tangible deliverables of the study. The process of course development was initiated after an initial design of course objectives and outcomes. The major output of the design process was a lesson plan.

A detailed lesson plan was prepared in close alliance with the sponsoring professor of the course (Appendix A). This lesson plan included a tentative plan for 16 weeks of the span of the course including major topics to be covered as part of the course, details of
homework assignments and exams to be conducted during the course. The lesson plan also
allocated a classroom session for introduction to the use of Crystal Ball, the risk management
software to be used as part of the course. The lesson plan was a dynamic document and was
updated frequently with course content changes.

As part of the design process, a primary text-book for the course was chosen after
detailed discussions with the sponsoring professor of the course. “Identifying and Managing
Project Risk” by Tom Kendrick was identified as a suitable primary text-book for the course
(Kendrick, 2003). The text-book was chosen for its lucid and complete approach to risk
management and close alignment with principles described in the PMBOK. The author Tom
Kendrick is a certified Project Management Professional and has worked in several projects at
Hewlett-Packard and Dupont (Kendrick, 2003). He used real-world experience as a foundation
for the content of his book, thus offering ideas which are practical and effective (Kendrick,
2003). Most importantly, the book examined the areas of Information Technology, software
engineering and product development which is highly relevant to the nature of this study
(Kendrick, 2003). In addition to the primary text-book, other traditional text-books used in the
preparation of course content are “Methods of IT Project Management” by Kevin Dittman and
Jeffrey Brewer (Brewer & Dittman, 2009) and “Risk Management for IT Projects: How to Deal
with Over 150 Issues and Risks” by Bennett Lientz and Lee Larssen (Lientz & Larssen, 2006).

Course Lectures

The introductory course lecture content consisted of a detailed introduction to risk
management. The importance of risk management in the success of IT projects was presented to
students by demonstrating statistics of failure of IT projects and insufficient risk management
practices often identified as the root cause of failures. The course content also demonstrates the
special challenges faced in technology projects; they are more varied and unique, thus making them different from previous projects (Kendrick, 2003). Technology projects often have a higher degree of risk associated with them and it is important for a Project Manager to understand and plan mitigation activities accordingly (Kendrick, 2003). The course content also explains the benefits of risk management activities and how good risk management strategy can lead to realization of new opportunities for an organization. A variety of web-sources were also used to develop the course material. Several relevant videos were also added to stimulate the interest of the students.

The course lecture content further explores the topics of risk identification and risk management planning. The content includes ideas for managing risk right from the stage of project selection. Tom Kendrick utilizes a collection of previous project issues and the impact of the issues on a project in a database known as the Project Experience Risk Information Library (PERIL) as a basis for risk analysis described in his book (Kendrick, 2003). These concepts are presented to the students in the course material for this chapter along with the use of risk identification techniques like Brainstorming, Analogy, Delphi technique, interviews and SWOT analysis (Brewer & Dittman, 2009). The course material also covers detailed concepts of managing scope, schedule and resource risk. Two case studies have also been integrated into the course material to demonstrate how lack of application of specific risk management practices can negatively impact the success of a project.

Other chapters include detailed Quantitative and Qualitative risk management including the widely used Program Evaluation and Review Technique (PERT) and decision trees (Kendrick, 2003). Strategies to deal with project risks have also been addressed in great detail. Another case study was used to demonstrate how to successfully avoid and mitigate risk in an
organization. Tools used to analyze project risk have been explored comprehensively in the course material. After the analysis of risk, processes and tools to monitor risk on a regular basis are discussed in the material developed. The course material also describes how to effectively close out projects and describes activities to be performed at the end of the project so that data is collected and recorded for use by other project teams in an organization. Course lecture slides are demonstrated in Appendix D.

Course Assignments

In close alliance with the design principles of the Problem learning model with the use of constructivism, the course assignments are meant to probe the learner’s thought process in depth. Since the course is designed to be incorporated into the graduate level curriculum, the course assignments involved a mix of reading and research assignments (Appendix D). Research articles have been presented to the students for reading. In addition to this, a reading list has also been provided to students to allow them to further augment their understanding of risk management. (Appendix B) The assignments also involve a combination of homework assignments and class assignments to stimulate interest in the class. Students are also required to present their views in class so that the process stimulates enhanced discussion in class and different perspectives on the material being discussed. The research assignments involve the student to research a particular topic associated with risk management and present their findings in class. This enables the students to look beyond the presented course material to assimilate the concepts of risk management.
Team Based Semester Project

The team based semester project (Appendix C) was modeled to be similar to a real-life scenario. The scenario presented to the students involved the process of risk assessment, management and analysis in a large biomedical organization. Data about risk management in an IT project in a regulated environment was collected through unstructured interviews with managers of Information Systems (IS) teams in a large medical device firm located in the state of Massachusetts, USA. As per the determination of human subjects research at Purdue University, “Interviews of individuals where the questions focus on things not people (e.g. questions about policies or business procedures) is classified as a non research activity (Office of Research Administration; Purdue University). Thus IRB (Institutional Review Board) review and approval was not required to conduct this activity. The data collected from interviews was used to design the team based project. The project also involves the use of Crystal Ball for determining optimal solutions, predicting performance based on historical data and calculations based on optimistic, most likely and pessimistic estimates. Crystal Ball is a spreadsheet based tool by Oracle which can be used for optimizing decisions, forecasting and simulation providing insight into several factors affecting risk in a project (www.oracle.com). Integrated with Microsoft Excel, this tool provides a high degree of ease of use and efficiency in risk management processes. Links to demos to the software and instructions on use have also been provided as course handouts to be distributed to students of the course.
Evaluation of course material

The effectiveness of the developed course material was evaluated through feedback gathered from the graduate committee including the sponsoring professor of the course. The course material was reviewed and determined to be effective and thorough in its content to stimulate interest and impact learning in a positive manner for graduate students enrolled in the course.
Summary/Conclusions

IT risk management has been perceived to be complex, time-consuming and of little value to an organization. Several studies explored as part of this project emphasize the importance of risk management knowledge in the success of an IT project.

This project presents an initial step to educate students of project management on risk management processes in IT. As part of this project, educational materials to develop a graduate level course in risk management have been created. A limitation of this project is that student learning outcomes were not gauged as part of the project. Future work could include modifying or supplementing the existing material based on student learning outcomes. Future research to collect data specific to risk management processes involved in different IT organizations in both the private and public sector could be pursued. Real-time collaboration with industry on projects relevant to the scope of the course can also be pursued.
References


### Appendix A

#### Objectives and Outcomes in Risk Management Education

**Lesson Plan**

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture Topics</th>
<th>Deliverables/Weekly activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>• Introduction to Risk and Risk Management&lt;br&gt;• Why is Risk Management important?</td>
<td>Special Features: Relevant videos to be shown in class&lt;br&gt;• Assignment 1: Read and Report-“2009 CIO Challenges: Risk Management”</td>
</tr>
<tr>
<td>2</td>
<td>Risk Management Planning</td>
<td>N/A</td>
</tr>
<tr>
<td>3-5</td>
<td>Risk Identification&lt;br&gt;• Identifying Project Scope Risk&lt;br&gt;• Identifying Project Schedule Risk&lt;br&gt;• Identifying Project Resource Risk</td>
<td>• Class Exercise 1: Brainstorming&lt;br&gt;• Class Exercise 2: Dollar Bill Auction&lt;br&gt;• Share and Tell Assignment 1: Report-COCOMO, COCOMO II and function points in Risk Management&lt;br&gt;• Class Exercise 3: Delphi estimating&lt;br&gt;• Assignment 2: Read and Report-“Trust but Verify”</td>
</tr>
<tr>
<td>6</td>
<td>Managing Project Constraints and Risk documentation</td>
<td>• Share and Tell 2: Report-Quality Function Deployment</td>
</tr>
<tr>
<td>Week</td>
<td>Topic</td>
<td>Assignments</td>
</tr>
<tr>
<td>------</td>
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<td>-------------</td>
</tr>
<tr>
<td>7</td>
<td>Quantitative and Qualitative Risk Analysis</td>
<td>Assignment 3: Read and Report pgs 35-39 of “Risk Management for IT projects by Lientz and Larsen”</td>
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<tr>
<td>8</td>
<td>Midterm</td>
<td>Midterm</td>
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<tr>
<td>9-10</td>
<td>Managing Activity Risks</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Categories of Risk</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Root-Cause Analysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Managing a specific Risk</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Quantifying and Managing Project Risk</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Project level Risk</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aggregating Risk Responses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Questionnaires and surveys</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Analysis of scale</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Monitoring and Controlling Risky projects</td>
<td>Assignment 4: Read and Report “Intra-Organizational communication on serious risks”</td>
</tr>
<tr>
<td></td>
<td>Project Monitoring</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trend Analysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Project Reviews and Reassessment</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Closing Projects</td>
<td>N/A</td>
</tr>
<tr>
<td>14</td>
<td>Introduction to Crystal Ball</td>
<td>Review Crystal Ball software</td>
</tr>
<tr>
<td>15-16</td>
<td>Final Semester Project Presentation</td>
<td>Submit final report and complete oral presentation on team based semester project</td>
</tr>
</tbody>
</table>
Appendix B

Objectives and Outcomes in Risk Management Education-Reading List

Primary text books:

• Identifying and Managing Project Risk: Essential Tools for Failure-Proofing Your Project (Tom Kendrick)

• Risk Management for IT Projects: How to Deal with Over 150 Issues and Risks (Bennet P Lienz and Lee Larssen)

Additional reading materials:

• The Failure of Risk Management: Why It's Broken and How to Fix It (Douglas W. Hubbard)

• Waltzing With Bears: Managing Risk on Software Projects (Tom DeMarco, Timothy Lister)

• Against the Gods: The Remarkable Story of Risk (Peter L. Bernstein)

• Project and Program Risk Management: A Guide to Managing Project Risks and Opportunities (R. Max (Editor); Dawson, Rodney J.(Foreword by); Dawson, Rodney J.(Author) Wideman)

• Risk Management, Tricks of the Trade for Project Managers (Rita Mulcahy)
Appendix C

Objectives and Outcomes in Risk Management-Final Semester Project

Instructions:
This is a team-based activity. The project is designed to be completed in different phases modeling different risk management activities to be completed during the project lifecycle in an organization.

Scenario
You are an employee of a large manufacturing organization. The organization primarily focuses on manufacturing medical devices. While the organization manufactures and supplies products globally, the corporate headquarters of the organization is located in the United States of America (USA) and most product development research for the organization is conducted within the USA. The organization has around 40,000 employees globally and is a market leader in most medical device markets. You are involved in a project which involves the release of software which is used to print labels for medical device products in your organization.

Consider the following situations:

- The software needed for the project can be developed in-house. However, similar software has never been developed in-house and this approach would be completely new to the organization
The software needed for the project can be acquired from a vendor. This vendor is based within the United States. The vendor has a good reputation for delivering reliable and efficient products and services; however there is a greater cost associated with the use of this software. Further, consider the additional costs associated with customization of the software for use in your organization. Also consider that increased customization also leads to additional risk and lag times with support activities from the vendor.

The software needed for the project can be acquired from a vendor outside the country and a part of the project activities can be outsourced. This approach would lead to lower costs. However, consider all risks associated with outsourced projects. Also consider possible regulatory barriers and other environmental factors which can contribute to complexity of the project.

1. Use the approach of brainstorming to arrive upon all possible risks associated with each scenario. Document each risk and create a risk register for each situation. Rank each risk according to priority in the register. Also document what the team assumes is the probability of occurrence of each risk and initial risk response strategy.

2. Based on risk assessment from step 1, select an approach for the project amongst the three situations described above. Develop a Risk Management Plan for the approach to be followed by your project team.

Include the following details:

- Document risk categories that will be used in the project. Make sure that you include the following categories for the project based on the nature of the business of the organization:
  i. Safety
  • Consider safety associated with human, environment and property
  ii. Business
  • Consider regulatory and legal compliance issues
  iii. Technology
  • Consider complexity of the technology and how new/emerging the technology is
  • Assign each risk documented in the risk register a specific category.
• Perform high-level assessment of each risk assigned to each category.
• Compute the Risk Complexity index
• Use the risk complexity index formulae described by Tom Kendrick shown below.

Index = (Technology+Architecture+System)* Scale

*Use the following categories for Technology assessment:*
0-Only existing technology to be used
1-Minor changes to existing technology
2-Significant changes to existing technology
3-Innovation needed in some areas
4-feasible but innovation needed in several areas
5-Completely new technology; doubtful feasibility

*Use the following categories for Scale assessment:*
0.8-upto 12 people
2.4-thirteen to forty people
4.3-forty-one to hundred people
6.6-More than one hundred people

Consider large impact factors such as a life-threatening condition or serious damage to an individual, large monetary loss produced by damage to environment and property and serious compliance discrepancies with FDA, Sox, HIPAA and OSHA regulations during the process of risk management.

• Document risk acceptance criteria
  o What severity level for the software is acceptable?
• Document the type of risk response strategy to be followed for each risk
  o Are you going to be dealing with causes or with effects?
  o Which risks do you have to passively accept?
  o What kind of contingency planning can be included for each risk?
• Document details of risk re-assessment timelines
• Document details of how status meetings should be conducted based on nature of approach chosen
• Document all other information specific to planning activities in the risk management plan
• Document how to deal with confidential risk in the plan.
• Document a list of intangible information like problems between members of a team and restructuring which might impact the success of the project.

3. Assume that the total budget allocated to the project is $2 million. Create a project plan with individual costs associated with the project depending on the approach chosen. For example, if the software was to be acquired from a vendor, the individual project costs would include
  • Cost of software to be paid to the vendor as determined by the statement of work
  • Testing costs of testing the software in-house
  • Cost of customization
  • Cost of support/maintenance activities to be performed by the vendor

Determine tentative costs for each item on the project plan. Ensure that the sum of these costs adds up to 2 million. Using the risks determined before, determine how these risks can impact the cost of each individual item on the plan. Use an optimistic and pessimistic value of cost for each item. Use Crystal Ball to compute the range of the total cost of the project. Use both a triangular and normal distribution.

4. Assume that this project produces a cost savings of 3 million to the organization. The organization is considering a portfolio of projects with the following cost savings:

<table>
<thead>
<tr>
<th>Project</th>
<th>Cost savings (in millions of dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project A</td>
<td>3</td>
</tr>
<tr>
<td>Project B</td>
<td>2.5</td>
</tr>
</tbody>
</table>
Project C | 2.7
---|---
Project D | 2.9

However, the organization has a total budget of 10 million only for new projects in this calendar year. Use Crystal Ball to determine the optimal mix of projects for the organization with a 95% confidence rate that the projects will not go over-budget.

5. Consider the data below:

<table>
<thead>
<tr>
<th>Month</th>
<th>Cost Savings (in dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100,000</td>
</tr>
<tr>
<td>2</td>
<td>98,000</td>
</tr>
<tr>
<td>3</td>
<td>89,000</td>
</tr>
<tr>
<td>4</td>
<td>77,000</td>
</tr>
<tr>
<td>5</td>
<td>84,000</td>
</tr>
<tr>
<td>6</td>
<td>115,000</td>
</tr>
<tr>
<td>7</td>
<td>92,000</td>
</tr>
</tbody>
</table>

Assuming that these values represent the cost savings the software leads to in the organization in the months after release. Predict the cost savings of the project for the next 12 months using Crystal Ball. Using these predictive metrics, analyze when the cost savings will exceed the initial investment of 2 million in the project.
Appendix D

Slides for the course are attached below.
The PMBOK® defines four processes in Risk Management:

- Risk identification
- Risk analysis
- Risk response planning
- Risk monitoring and control

Risk identification focuses on identifying potential risks and their causes. Risk analysis involves assessing the probability and impact of identified risks. Risk response planning involves developing strategies to mitigate, transfer, or accept risks. Risk monitoring and control involves tracking risks throughout the project and adjusting plans as needed.

Case Study / Hypothesis
- Company faced financial problems due to unexpected increases in project costs.
- Executive management believed increasing project costs were due to an increase in the number of risk events.
- Audit of the project identified that 10% of the total project budget was affected by high-risk events.
- The company invested in risk management training and processes to reduce future risks.
- Results showed a 25% reduction in project costs compared to previous projects.
Risk Management Planning

Risk Management Planning (Cont.)
- Risk management plan should contain risk management information
  - Approaches to performing risk management
    - Risk Acceptance
    - Risk Avoidance
    - Risk Transference
    - Risk Mitigation
  - Identification of risk management processes
  - Communication strategies
  - Risk Identification
  - Project risks identified
  - Risk Mitigation
  - Risk Acceptance
  - Risk Transference
  - Risk Mitigation plan

Requiring documentation and training

Components of a Risk Management Plan

Risk Identification

- Analogy
  - Using experience from similar projects to identify similar risks
  - Using previous team members who have worked on similar projects to identify similar risks

A Sample Risk Report

Risk Identification Techniques

- Analogy
  - Using experience from similar projects to identify similar risks
  - Using previous team members who have worked on similar projects to identify similar risks

Brainstorming

- Brainstorming is a fast and efficient method of identifying potential risks
- Each team member discusses the potential risks identified by others
- Collectively, the team identifies potential risks and develops strategies to mitigate or eliminate them

Characteristics of brainstorming techniques

Brainstorming

- Uses collective expertise to generate ideas
- Encourages creative thinking and encourages team members to build on each other's ideas
- Helps to identify potential risks and develop effective strategies to mitigate them

Brainstorming

- Brainstorming is a method used to generate a large number of ideas in a short amount of time
- Helps to identify potential risks and develop effective strategies to mitigate them
In this technique, high emphasis is placed on technology being used in the project. This technique was used in several companies with better results than other project teams. The project team's ability to deliver project deliverables.

Risk Framework
- Risk Analysis: Risk Techniques
  - Procurement
  - Marketing
  - Manufacturing (production and delivery)
  - For each factor, assessment is detailed
    - Change is either small or large
    - Change correlation with risk
    - Use context-dependent measurement

Any change to the team's performance or output, the series of changes required by the project is assessed. For example, for technology, the project team is asked about the number of people expected to leave the organization. For the organization, this is an important factor in assessing the team's performance. For the other factors, the team's performance and how they view the project are assessed.

Any project is a success when the project team is able to deliver the project deliverables. How successful is a project when the project team is asked to deliver the project deliverables. The project team is expected to deliver the project deliverables. The project team is expected to deliver the project deliverables. How successful is a project when the project team is asked to deliver the project deliverables.

Risk Assessment Grid

<table>
<thead>
<tr>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk</td>
<td>Medium risk</td>
<td>High risk</td>
</tr>
</tbody>
</table>

A sample Risk Assessment grid as demonstrated by Tampicam.

The use of the risk assessment is a method to manage risks. Often the decision is made by the project team. The project team is expected to deliver the project deliverables. How successful is a project when the project team is asked to deliver the project deliverables. The project team is expected to deliver the project deliverables. How successful is a project when the project team is asked to deliver the project deliverables. The project team is expected to deliver the project deliverables. How successful is a project when the project team is asked to deliver the project deliverables. The project team is expected to deliver the project deliverables. How successful is a project when the project team is asked to deliver the project deliverables.
Marked Risk
- Tied to be on the "asset" side of the business balance sheet
- Risk to greater for longer and more complex projects
- Project completion with technical means is vital
- Activities
  - R&D
  - Market research
  - Engineering
  - Operations and maintenance
- Organizational challenges are necessary steps to be
  competed with similar efficiencies

Confidentiality Risk
- This risk refers to knowledge or ideas used by better-funded organizations in creating and producing first
- Meeting data risk potentially increases market risk due to
  limited methods of identifying data
- Need to know data used within the project team
- Fixing how the data is used
- Make all appropriate measures non-reproducible
- Use legal protections such as copyrights and patents

Delays Risk
- Planned over 60% of individual risks
- Impact form today's risk to future for these risks
- Poor business planning
  - Inadequate and unnecessary resources
  - Defective hardware
  - Times required to replace or replace critical parts
  - Other requirements
  - Lack of education
  - Limited "human" labor

Dependency Risk
- Most serious category of individual risks
- Most common list is the list
  - Depending on other plans projects
  - Technical issues
  - Interruption of hardware services such as computer systems and networks
  - Unavailable access to resources such as help desks and system support
Calibration Risks

- Most visible amongst schedule risks
- Marginal change in work creates difficulty in estimating projects
- Most visible include
  - Supply chain issues
  - Overestimation estimates
  - Leasing issues
  - Work class outside the project especially with technical projects with aggressive timelines

Problems with estimation risk

- Ambiguity
- Uncertainty
- Lack of Information
- Granularity

Calibration process

- On the basis of historical data, effort estimates are derived by combining project-specific circumstances
- Project-specific factors include
  - Complexity of project specifications
  - Likelihood of specification change
  - New technology involved
  - User-defined tolerance or iteration necessities
  - Demographic and cultural differences
  - Infrastructure and environmental factors

Duration estimates and resource factors

- Effort and resource utilization with project information on people and tasks provides a basis for duration estimates
- Resource factors include
  - Amount of time required for a project member to allocate for project work
  - Number of people contributing to task variability
  - Skill set and experience of each project team member
  - Time lag and overlapping elements
  - Capital time of staff during project
  - Human requirements
  - More project interdependencies

Duration estimates and resource factors (Cont.)

- Amount of time a project plan revision can happen on a project is often the source of duration estimates
- Probability is not the important parameter of variability
- Duration estimates are used for most schedule analysis of projects
- Often are required inputs to computer scheduling tools

Calendar estimates and nonproject factors

- Final stage of estimating translates duration estimates into project estimates
- Non-project factors include
  - Lack of
  - Vacations
  - Weather
  - Other projects
  - Other nonproject work
  - Fluctuation in materials
  - Interactions and overlaps
  - Delays in or subtle delays

Department of Computer and Information Technology (DIT)
### Estimation Techniques

- **Historical data**
  - Build empirical data in the most useful historical information
  - Data sources include:
    - Projected impact of past work
    - Lessons learned from past projects
    - Inputs from previous reports or project requests
    - Notes from peers and colleagues
    - Engineering or other published historical data
  - Environmental factors
  - Governmental or technical standards

### Share and Tell Assignment

Research and develop a report on COCOMO, COCOMO II, and the use of Hundson points in software projects. How have those tools proven to be useful in estimating project risks? What are the limitations of using these parametric formulas?

### Delphi Estimation

- **Process**
  - Minimization of error and maximization of feasible people involved
  - A small sample group will be selected as the estimating team
  - Process starts when each individual has some experience at selecting in group
  - Accuracy of the project estimates that need estimates to be provided
  - Maximize first by not expressing opinions but have estimates with no help
Debrief estimation

• All estimates are collected and sorted into three groups
  • Short
  • Medium
  • Long

• Eliminating processes in extensive unstructured cycles of discussion: collecting data and sorting till a consensus is reached

• It is often described as a "group intelligence" way to tap into the subconscious, historical data, which is often unavailable.

Class exercise

You are to develop a graduate-level course in Risk Management. List the project activities involved in the project, use UCP's bottom-up estimating to come up with estimates for each project activity. Arrive upon a consensus on the approximate time taken to design the course.

Project Level Estimation

• All project phases may fall into three broad categories:
  • Tasks: All initial work is project-oriented planning, analysis, review, and decision-making. It will be defined and proposed by the task force, and
  • Project: the work that is usually defined and reviewed in the project plan:
    • Development of project milestone, review and statements, and sometimes tasks from the project plan:
  • Amount of time spent in each phase of the project at highly dependent on project tasks.

Estimates adjusted for uncertainty

- PERT (Program Evaluation and Review Technique) is used
- Developed in the late 1950's by US Navy
- Three estimates for each activity are used
  - Optimistic estimate
  - Pessimistic estimate
  - Most likely time
- Used to calculate an expected activity duration

where:

- t is the calculated 'expected' duration—time mean
- τ is the optimistic duration
- τ is the most likely duration
- τ is the pessimistic duration
Problems with PERT

- Time and effort required for analysis
- PERT uses percent completion to estimate completion time
- Estimations are based on historical data, but it lacks an overall assumption
- Data quality is difficult in determining the exact outcomes with any accuracy
- Difficult to back out

Activity Sequencing

- Critical Path methodology combines activity estimates with precedence information and includes a discussion for the critical path
- This process can be automated manually or can be automated
- All activities, dependencies, and durations are entered into the database
- Software evaluates the resulting project network and locates the sequence of activities with a longest duration
- A path where that makes up the longest sequence are termed critical

Summary Key Issues for Identifying Subtractive Risks

- Clear and concise notations of all concerns
- Identify all estimates not based on historical data
- Now dependencies that pass away next, including all interfaces
- Find any differences between project effort requirements and baseline
- Identify any activities included it aren't ready to the project
- Activities not associated with multiple critical or near-critical paths
- Note risks associated with lengthy projects

Identifying Resource Ramps

- Representation less than one-third of records in PERT database
- There's a lack of resource risk
- Resource
  - People
  - Tools
  - Software
  - Tools and software outside the project team
  - Training, system training issues
  - Notion how reported problems are prioritized about funding issues

People Issues

- Most businesses allocate resources issues
- Primarily related to staff instability issues
  - Staffing project permanently
  - Extending the project temporarily
  - Staffing the project later
  - Planning resources in smaller episodes and how to evaluate risk project
  - Conflict around staff turnover

- Market issues
  - Good brand and low cost, keeping the product sustainable project participation.
Geese Study - Fauxy Manufacturing
- Slower employees now rest the company
- Decreased employee retention
- Lower morale among employees
- Higher turnover rates among employees
- Reduced customer satisfaction
- Increased risk of errors in products
- Higher overall costs

Please ensure full documentation.

Real lessons for People Issues
- "Talking Deadstock" syndrome
- Parts left project management projects that don’t fit into the timeline
- Key people work on finishing one prior project causing a lag in new one
- Too many projects
- Lack of clear responsibilities
- Lack of communication and coordination
- Insufficient resources

Scarcity of certain relevant skills
- Use of spreadsheet expertise on multiple projects causing "spreading"
- Customer problems, reorganization, illness, resignations, etc.
- Many inequities among the projects.

Homework Assignment
Read the article "Taxes on the Way" by IBM Taxman Security. Discuss the implications of taxes on outsourcing. Write a one-page summary of the ideas presented in the article. Where does the approach of tax avoidance increase risk for an outsourced project?

Quick Help: "Quick Help" is used to help customers find solutions to problems. It is a comprehensive system designed to provide fast and accurate answers to common questions. The system is designed to be user-friendly and accessible, with a user interface that is easy to navigate.

Money Risks
- Not commonly used in the MTS database
- Average impact is highly variable
- However, lack of funding create challenges and delays in projects

Note: A copy of the article is attached as a pdf for the course professor.


**Collaboration Planner**
- Develop a Request for Proposal
- Ensure that at least one member of the project team is involved with planning and billing, and that line item numbers are used.
- RFP includes a very clear, unambiguous definition of work.
- Finalistic, realistic, workable, meaningful.
- Reference past experience is often important to avoid outsourcing risks.

**Source Selection**
- The following risks are involved in bringing subdivision to a project:
  - Scheduling Risk
  - Interrelated analysis
  - Technical analysis
  - Preparation of resources
  - Scope:
    - Strongly resist projects with softening of specifications.
    - Never contract or let contracts with risks.
    - Contracting
      - Unreliable subcontractors must be handled
      - How to clearly define Statement Of Work.

**Outsourcing**
- Staffing and outsourcing costs
- Replication and software costs
- Time
- Other costs
  - Videoconferencing technology
  - Teleconferencing
  - Courses
  - Setup and maintenance of a secure public domain repository of information available to everyone.

**Summary for Identifying Resource Risks**
- Identify all required skills you need for each task.
- Namely, estimated lab time.
- Determine all situations in the project plan where people or other resources are overstressed.
- Find all activities with insufficient resources.
- Identify cost and quality effort measures.
- Notice interdependency charts.
- Plan funding approval early for needed training, equipment, personnel, and other tasks.
- Ascertain all expected project costs.
Opportunity Management

- Opportunity management can project the number of possible changes
- This is done
- The project is influenced by a set of criteria
- It involves a wide range of activities and is influenced by the project
- I am confident in my analysis and can determine the effectiveness of the model

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Share and Tell assignment

Write a one-page report on QFD (Quality Function Deployment), areas of application, and practical application in an IT project.
Revelling Resource Planning

- Resource analysis
  - The analysis work converses between in deductible effort and effort likely needed.
  - Providing team members with resources which enable them to work faster.
  - Providing task with resources which enable them to work faster.
  - Training additional staff.
  - Defining alternatives.
- Generally used when schedule is more important than budget.
- Defining tasks, resource assignment, solicitation of technical activities.

Revelling Schedule Planning

- Using fluid
  - Fluid plan on non-critical activities
  - This process consumes project risk.
- Handling activity uncertainty:
  - Rewriting or redlining work by using a more compact work flow.
  - Revising critical path activities that key to create schedule activities can be enacted in parallel.
- Next batch
  - Overuse of work
  - "Push it" for short deadlines when the resources had to adapt the task during the work.

Revelling the Schedule:

- Allocating additional resources to gain speed
  - All activities cannot be crashed.
  - Crashing adds cost and risks.
- Advanced communications, purchase and training.
- Software is often used to manage most complex activities.
- Typical methods used in shorter projects durations include:
  - Working overtime
  - Paying the premium.
  - It may involve taking on subordinate tasks virtual facilities.
  - Upgrading equipment.

Geek Missions Scope Risks

- Disagreement uses of own technology and feasibility issues.
- Personal responsibility for key task.
- Levels of technical complexity.
- Unclear scope at project scoping.
- Poorly defined acceptance or testing criteria.
- 10-12% overestimate strength of risk or uncertainty.
- Loss of proprietary information.
- Larger problem on individual.

Geek Missions Schedule Risks

- Very large several major activities
  - Identified high outstanding critical activities
  - Multiple critical point
  - Extreme dependencies
  - Excessive optimism
  - Increasing over summary risk skills.
  - Examine with non-rgb colors.
  - Constraints in project uncertainty.
  - Integrated activities.
  - Practical training problems.

Geek Missions Resource Risks

- Activities that require larger staff.
- Activities that require costs.
- Geocaching or functional expansion.
- Activities with insufficient resources.
- Package directly required for software or hardware.
- Training and start development requirements.
- Technical staff on project experience.

Geek Missions Project Risks

- Emphasis on a detailed plan.
- Need for the project.
- Activities can be resource.
- Question whether the project.
- Critical activities that require resources.
- Training and development requirements.
- Technical staff on project experience.
**Additional methods for identifying potential problems**
- Root Cause Analysis
  - Identification of the root cause of issues
  - Possible areas for improvement
- Brainstorming
- Delphi Technique
- FMEA (Failure Mode and Effect Analysis)
- Fault Tree Analysis
- Fault Tree Analysis

**Key Ideas for Constraint Management and Risk Discovery**
- Minimize differences between project plans and objectives
- Use recent project history to identify areas for improvement
- Evaluate and consider alternative solutions
- Develop criteria and compare alternatives
- Evaluate budget impact of proposed project changes
- Identify and manage project risks

**Quantitative and Qualitative Risk Analysis**
- Quantitative analysis
  - Use probability and impact assessment
- Qualitative analysis
  - Use qualitative techniques

**Qualitative vs. Quantitative Risk Analysis**
- Quantitative analysis
  - Baseline analysis
  - Risk assessment
- Qualitative analysis
  - Risk identification

**Risk Probability**
- Quantitative: Risk measurement assigns each risk a value between 0 and 1
- Qualitative: Risk is described in qualitative terms
- Introduction of risk into the project budget
- Risk response planning
- Review and update the risk register
Risk Impact
- Qualitative assessment assigns each risk to one or more non-overlapping categories.
- Categorization is important because risks are compared within the same category.
- Each category can be further divided into subcategories.
- Important to note that non-measurable project risks are
  - Sometimes difficult to quantify
  - Do not affect the project's overall success.

Quantitative Risk Analysis
- Identifies the likelihood and impact of each risk.
  - Risk = Likelihood x Impact
  - Likelihood can be modeled by a probabilistic distribution.
  - Impact can be measured using decision tables.

Risks in Project Management
- Risks are identified and assessed, and strategies are developed to mitigate or avoid them.
- Risk management is an integral part of project planning and execution.

Risk Assessment Table
- Categorization of both probability and impact provides insight into the overall risk.
  - High: Risk is high, and mitigation strategies are required.
  - Medium: Risk is medium, and monitoring is necessary.
  - Low: Risk is low, and a contingency plan is recommended.

Risk Assessment Matrix
- Risks are evaluated based on their likelihood and impact.
- The matrix is used to prioritize actions required to address each risk.

Quantitative Risk Analysis
- Probability analysis
  - Identifies the probability of occurrence of risks and their impact on the project.
  - Allows for a more accurate estimation of risk management strategies.

Key learning points:
- Quantitative risk assessment is crucial for effective project management.
- Identifying and mitigating risks can help ensure project success.
- Risk management strategies should be developed based on the severity of the identified risks.
**Probability density functions**
- PERT uses a continuum of possibilities rather than a single point, deterministic estimate
- Beta-distributed functions are more commonly used
- Other distributions include
  - Normal
  - Lognormal
- The shape of the distribution is relatively uncertain
- Risk assessment depends on the model and should be reviewed with the person responsible for decision-making and summarizing the figures.

**Decision trees**
- It is common practice to use this technique only when a small number of options or potential outcomes are possible
- Usually used to evaluate several options before selecting one to execute
- When several outcomes are possible in a project, each can be assigned a probability
- An "expected" estimate for both duration and cost can be derived by weighing the estimates and summing the figures.

**Homework assignment**
Read pages 36-39 of "Risk Management for IT Projects by Lichten, and Larson". Identify the problems faced with standard measurement techniques. How do the management control path help in identifying project risk?
Managing Activity Risks

Heat Police Analysis:
- The first step in heat response planning depends on the cause of the risk.
- Effective risk cause analysis depends on thorough understanding of project risks.
- Multi-disciplinary techniques can help understand this cause.
- Analysis can be divided into categories of approaches.

Multidisciplinary analysis techniques help understand the cause.
- The cause may be, for example, market factors, technology, market forces.
- Often a risk analysis can identify potential causes of risk.

Mitigation diagrams are also commonly used to graphically display and cause of risk allowing deeper understanding of source and prevention of problems.

Citation of Major Risks:
- Controlled business risks
- Possible environmental risks
- Uncertain known risk
- Unknown risks
- Other, especially planning is of no use

Risk Responses Planning:
- Risk responses are available.
- Dealing with success
  - Risk reduction
  - Risk mitigation
  - Risk transfer
  - Risk acceptance

Mitigate with efforts
- Risk management
- Decision making
- Dealing with conflicts

Strategies for avoiding risks:

Avoiding Known Risk:
- Avoid overlap.
- Incoherent and document all internal and external sources of risk to other projects.
- Avoid common and unstructured technology.
- Leverage work done by others.
- Risk avoidance of resources.

Avoid planning risks:
- Critical path risk
- Network activity dependencies
- Schedule high, uncertainty/estimates early.
- Decompose lengthy activities even further.
- Avoid having many critical activities end early.
Avoiding Resource Risks
- Automate mundane work
- Hire hard people for most critical activities
- Maximize use of overloaded resources
- Develop available skills and then relocate
- Limit commitments to other project activities
- Publicly increase risk
- Minimize dependencies on a single individual
- Use experts to cover skill gaps not available on project team

Risk Mitigation Strategies
- Physically visible project scope and all deliverables
- Use a clear change management process
- Build model, evaluate, and simulate
- Test often and early with users
- Keep all plans until requirements are updated
- Tackle external and environmental problems in consideration

Scheduling Mitigation Strategies
- Schedule high priority work first
- Schedule progress forecasts
- Schedule project reviews
- Partition large projects into a sequence of smaller ones
- Send shipments early
- Have communication indicators for visibility and feedback
- Reduce rework by working with known technology or other major contracts

Resource Risk Mitigation Strategies
- Automated processes
- Manage resources (skilled or otherwise)
- Negotiate and manage outsourcing
- Increase team size in increments to join project
- Build teamwork
- Avoid overloading one employee
- Specify and address issues in project objectives

Case Study: Focused Systems
Exceeds the required level of excellence
- Extremely successful especially after a major project from a particular client
- They made the following serious errors
- Rejected a project in one client
- They had a lack of communication with the client
- They missed bids for another international work
- They projected too large of an amount of work

Case Study: Focused Systems
Exceeds the required level of excellence
- They continually altered their plans
- Fortunately, the owners put in effort and expanded their project and eventually offered a large contract to the company
- They maintained their business for more than 5 years with the original team
- This case study illustrates that a proper risk strategy should have been chosen by the company by using or implementing an adequate strategy
Risk Mitigation Plan (RMP) vs. Audit Trail:
- RMP: A proactive approach towards risk management
- The plan for RMP (RMP 1000)
  - Recommendations
    - Risk Management
  - Responsibilities
  - Timing
  - Workshops
  - Monitoring and Reporting
- Monitoring and Performance measures are not a part of RMP plan

Risk Transfer:
- Ideal effective when dealing with risk whose impact is severe
- Risk transfer allows division of probability and reduce nonfinancial impact of risk
- Risk is accepted irrespective of its occurrence
- Any methodology implies that risk is calculated in the project
- Any methodology implies that risk is calculated in the project

Dealing with Risk Effects:
- Contingency Planning
  - Developing alternative strategies in case that minimizes impact to project
  - Identifies sources and resources
  - Reduces cost
deadline
- Identifies key resources and stakeholders
- Monitors resources from other low priority projects
- Modification of project objectives to provide most of the value of project objectives agreed with resource and schedule constraints

Passive Acceptance:
- Only used for issues whose severity impacts are not an option
- For a sufficiently serious risk, abandoning the project might be the best course of action
- For less severe risks, the project team can choose to:
  - Introduce some project countermeasures to minimize risk as much as possible
  - Introduce some project countermeasures and accept resources to be used in managing these risks

Analyzing Project Risk:
- Helps prioritize resources, potential projects, and enable process of selection
- Can lead to elimination of high risk projects
- Useful for managing a portfolio of projects
- Reduce fall of individual projects
- Data on trend analysis of project into parts of project infrastructure
- Use to make structural changes
- Provides input to model existing and resource constraints
- Useful for assessment of risks
- Enables effective understanding between managers and stakeholders

Uses of Project Risk Data:
- Helps prioritize resources, potential projects, and enable process of selection
- Can lead to elimination of high risk projects
- Useful for managing a portfolio of projects
- Reduce fall of individual projects
- Data on trend analysis of project into parts of project infrastructure
- Use to make structural changes
- Provides input to model existing and resource constraints
- Useful for assessment of risks
- Enables effective understanding between managers and stakeholders
**Analysis of Goals**
- The process of assessing risk based on the overall size of the project.
- Projects are generally classified into low, medium, and high risk.
- The assessment is based on the size of the project, and additional risk management may be required.
- Risk assessments always include both financial and non-financial aspects.
- Quantitative and qualitative measures are essential for identifying risks.

**Project Metrics**
- **Predictive Project Metrics**
  - Trend analysis: Identifies trends over time.
  - Forecasting: Predicts future values.
  - Sensitivity analysis: Evaluates the effect of changes in input variables.
  - Monte Carlo simulation: Simulates the probability of various outcomes.

- **Diagnostic Project Metrics**
  - Cost overruns: Identifies discrepancies between budgeted and actual costs.
  - Schedule delays: Identifies deviations from the planned schedule.
  - Resource allocation: Evaluates the efficiency of resource utilization.
  - Risk management: Identifies and mitigates potential risks.

**Project Management**
- Monitoring and controlling: Ensures that the project stays on track.
- Change management: Manages changes to the project scope.
- Quality assurance: Ensures that the project meets quality standards.
- Risk management: Identifies and mitigates potential risks.

**Conclusion**
- The project management process requires ongoing monitoring and control.
- Effective communication is key to successful project management.
- Continual improvement is essential to ensure project success.
Measurement Reserve
- Method of managing project risk that reduces uncertainty
- Can be thought of as a generic contingency plan for overall project
- Reserve is spent first before money from budget contingency
- Reserve is allocated to overall project
- Must be spent or released at end of project
- Reserve can be increased or decreased

Scheduling Reserve
- Methods to determine schedule reserve
- Grapple the aspects of schedule reserve and examine the project timeline to estimate further project completion by that amount
- Three different techniques: Earned Value Method, Time Management Study
- Schedule estimates can be used as a resource
- Use data from contemporary plans
- Use MVA for similar historical analyses
- Avoid using contractor magnitudes at unknown risk
- Avoid making decisions during periods of scope creep and Parkinson's law

Change Management
- Change Process
- Change Control System to manage change by keeping and building a system to help manage changes, ensure the mapping of changes, and ensure that all changes are documented
- Request for change must be closely documented
- Should include information about how the change is needed, additional benefits, impact, and consequences
- Change requests should include impact assessments and condition-specific responses to be performed by the project team
- After method of disposition is decided, the decision should be made in a written and communicated to the affected people
More Importa... 
- Change related summations
- Gravity reports
- Testing and test results
- Personnel report
- Contract status reports

Best Practices for Monitoring projects
- Conduct effective and well-structured status meetings
- Measure that affect the internal communication is being used and in situations of the project team
- Provide regular updates to the team for better communication and to enable a lesson learned session for future projects
- Conduct a periodic project review to be able to address project problem mitigation
- Follow-up after the project review with a documented summary of findings

Closed Project

Test case acceptance decision
- Final acceptance criteria for all project deliverables
- All criteria met
- Close out of all contracts, documents, and agreements
- Acknowledgment of all contributors to the project team members
- Test case analysis
- Latest changes
- Celebration

Formal Acceptance
- Final acceptance criteria for all project deliverables
- Frequent communication with people who will evaluate and accept the project deliverables
- Engage the users/clients in discussions and evaluations of project deliverables
- Provide a list of actions to be taken to accept deliverables
- Ensure detailed and validated success definition

Retrospective Analysis
- This analysis is conducted
- Final evaluation of deliverables
- Postive results
- Recommendations for future projects
- Control changes
- Identifies the next project and project improvement
- Prioritize recommendations
- Final thoughts
- Blueprint use of specific examples by colleagues to demonstrate their points of view
• Conduct an retrospective analysis meeting
• Document the meeting minutes in a comprehensive manner
  – Top recommendations
  – Key findings
• Distribute the report to participants for review
• Give a copy of this document in relevant archived archives
• Discuss key recommendations to management and obtained support for implementing the changes
• Discuss alternatives if recommendations are not accepted
• Final version and keep as the future reference for similar audits.