Managing Risks in Complex Projects

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ABSTRACT

Dealing effectively with risks in complex projects is difficult and requires management interventions that go beyond simple analytical approaches. This is one finding of a major field study into risk management practices and business processes of 35 major product developments in 17 high-technology companies. Almost one-half of the contingencies that occur are not being detected before they impact project performance. Yet, the risk-impact model presented in this article shows that risk does not affect all projects equally but depends on the effectiveness of collective managerial actions dealing with specific contingencies. The results of this study discuss why some organizations are more successful in detecting risks early in the project life cycle, and in decoupling risk factors from work processes before they impact project performance. The field data suggest that effective project risk management involves an intricately linked set of variables, related to work process, organizational environment, and people. Some of the best success scenarios point to the critical importance of recognizing and dealing with risks early in their development. This requires broad involvement and collaboration across all segments of the project team and its environment, and sophisticated methods for assessing feasibilities and usability early and frequently during the project life cycle. Specific managerial actions, organizational conditions, and work processes are suggested for fostering a project environment most conducive to effective cross-functional communication and collaboration among all stakeholders, a condition important to early risk detection and effective risk management in complex project situations.

KEYWORDS: project management practices; performance; maturity; risk management; project management; complexity; high-technology companies; new product development; leadership; teamwork

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INTRODUCTION

Uncertainty is both a reality and great challenge for most projects (Chapman & Ward, 2003; Hillson, 2010). The presence of risk creates surprises throughout the project life cycle, affecting everything from technical feasibility to cost, market timing, financial performance, and strategic objectives (Hillson, 1999; Loch, Solt, & Bailey, 2008; Thieme, Song, & Shin, 2003). Yet, to succeed in today's ultracompetitive environment, management must deal with these risks effectively despite these difficulties (Buchanan & O'Connell, 2006; Patil, Grantham, & Steele, 2012; Shenhar, 2001; Shenhar, Milosevic, Dvir, & Thamhain, 2007; Srivannaboon & Milosevic, 2006). This concerns executives, and it is not surprising that leaders in virtually all organizations, from commerce to government, spend much of their time and effort dealing with risk-related issues. Examples trace back to ancient times that include huge infrastructure projects and military campaigns. Writings by Sun Tzu articulated specific risks and suggested mitigation methods 2,500 years ago (Hanzhang & Wilkinson, 1998). Risk management is not a new idea. However, in today's globally connected, fast-changing business world with broad access to resources anywhere, and pressures for quicker, cheaper, and smarter solutions, projects have become highly complex and intricate. Many companies try to leverage their resources and accelerate their schedules by forming alliances, consortia, and partnerships with other firms, universities, and government agencies that range from simple cooperative agreements to "open innovation," a concept of scouting for new product and service ideas anywhere in the world. In such an increasingly complex and dynamic business environment, risks lurk in many areas, not only associated with the technical part of the work, but also including social, cultural, organizational, and technological dimensions. In fact, research studies have suggested that much of the root cause of project-related risks can be traced to the organizational dynamics and multidisciplinary nature that characterizes today's business environment, especially for technology-based developments (R. Cooper, Edgett, & Kleinschmidt, 2001; Torok, Nordman, & Lin, 2011). The involvement of many people, processes, and technologies spanning different organizations, support groups, subcontractors, vendors, government agencies, and customer communities compounds the level of uncertainty and distributes risk over a wide area of the enterprise and its partners (Thamhain, 2004; Thamhain & Wilemon, 1999), often creating surprises with potentially devastating consequences. This paradigm shift leads to changing criteria for risk management. To be effective in dealing with the broad spectrum of risk factors, project leaders must go beyond the mechanics of analyzing the work and its contractual components of the "triple constraint," such as cost, schedules, and deliverables, and also examine and understand the sources of uncertainty before attempting to manage them. This requires a comprehensive approach with sophisticated leadership, integrating resources and a shared vision of risk management across organizational borders, time, and space. Currently, we are good at identifying and analyzing known risks but weak in dealing with the hidden, less-obvious aspects of uncertainty, and in proactively dealing with risks in their early stages (Smith & Merritt, 2002). Yet, some organizations seem to be more successful than others in dealing with the uncertainties and ambiguities of our business environment, an observation (Thamhain & Skelton, 2007) that is being explored further in this field study, resulting in actionable lessons for effective risk management, summarized at the end of this article.

What We Know About Risk Management

We Are Efficient in Identifying and Analyzing Known Risk Factors

With the help of sophisticated computers and information technology, we have become effective in dealing with risks that can be identified and described *analytically.* Examples range from statistical methods and simulations to business-case scenarios and user-centered design (UCD). Each category includes hundreds of specialized applications that help in dealing with project risk issues, often focusing on schedule, budget, or technical areas (Barber, 2005; Bartlett, 2002; Dey, 2002; Elliott, 2001). Risk management tools and techniques have been discussed extensively in the literature (Bstieler, 2005; D. Cooper, Grey, Raymond, & Walker, 2005; Hillson, 2000, 2003, 2010; Jaofari, 2003; Kallman, 2006). Examples include critical path analysis, budget tracking, earned value analysis, configuration control, risk-impact matrices, priority charts, brainstorming, focus groups, online databases for categorizing and sorting risks, and sophisticated Monte Carlo analysis, all designed to make project-based results more predictable. In addition, many companies have developed their own policies, procedures, and management tools for dealing with risks, focusing on their specific needs and unique situations. Especially in the area of new product development, contemporary tools such as phase-gate processes, concurrent engineering, rapid prototyping, early testing, design-build simulation, computer aided design/computer aided engineering/computer aided manufacturing (CAD/CAE/CAM), spiral developments, voice of the customer (VoC), UCD, agile concepts, and Scrum have been credited for reducing project uncertainties. Furthermore, industry-specific guidelines (i.e., *DOD Directive 5000.1*, 2007), national and international standards (i.e., ANSI, CSA, the International Organization for Standardization [ISO], and National Institute of Standards and Technology, 2000), and guidelines developed by professional organizations (the fifth edition of *A Guide to the Project Management Body of Knowledge* (*PMBOK® Guide*) [PMI, 2013]) all have contributed to the knowledge base and broad spectrum of risk management tools available today.

We Are Weak in Dealing With Unknown Risks

These are uncertainties, ambiguities, and arrays of risk factors that are often intricately connected. They most likely follow non-linear processes, which develop into issues that ultimately affect project performance (Apgar, 2006). A typical example is the 2010 *Deepwater Horizon* accident in the Gulf of Mexico. In hindsight, the catastrophe should have been predictable and preventable. In reality, the loss of 11 workers and an environmental disaster of devastating proportion came as a "surprise." While the individual pieces of this risk scenario appeared to be manageable, the cumulative effects leading to the explosion were not. They involved multiple interconnected processes of technical, organizational, and human factors, all associated with some imperfection and risk. Even afterward, tracing the causes and culprits was difficult. Predicting and controlling such risks appears impossible with the existing organizational systems and management processes in place.

We Are Getting Better Integrating Experience and Judgment With Analytical Models

With the increasing complexity of projects and business processes, managers are more keenly aware of the intricate connections of risk variables among organizational systems and processes, which limit the effectiveness of analytical methods. Managers often argue that no single person or group within the enterprise has the knowledge and insight for assessing these multi-variable risks and their cascading effects. Further, no analytical model seems sophisticated enough to represent the complexities and dynamics of *all* risk scenarios that might affect a major project. These managers realize that, while analytical methods provide a critically important toolset for risk management, it also takes the collective thinking and collaboration of all stakeholders and key personnel of the enterprise and its partners to identify and deal with the complexity of risks in today's business environment. As a result, an increasing number of organizations are complementing their analytical methods with managerial judgment and collective stakeholder experience, moving beyond a narrow dependence on just analytical models. In addition, many companies have developed their own "systems," uniquely designed for dealing with uncertainties in their specific projects and enterprise environment. These systems emphasize the integration of various tools, often combining quantitative and qualitative methods to cast a wider net for capturing and assessing risk factors beyond the boundaries of conventional methods. Examples are well-known management tools, such as review meetings, Delphi processes, brainstorming, and focus groups, which have been skillfully integrated with analytical methods to leverage their effectiveness and improve their reliability. In addition, a broad spectrum of new and sophisticated tools and techniques, such as UCD, VoC, and phase-gate processes, have evolved, which rely mostly on organizational collaboration and collective judgment processes to manage the broad spectrum of risk variables that are dynamically distributed throughout the enterprise and its external environment.

The Missing Link

Despite extensive studies on project risk and its management practices (Hillson, 2000, 2010; Jaofari, 2003; Kallman, 2006; Wideman, 1992), relatively little has been published on the role of collaboration across the total enterprise for managing risk. That is, we know little about organizational processes that involve the broader project community in a collective cross-functional way for dealing with risk identification and mitigation. Moreover, there is no framework currently available for handling risks that are either unknown or too dynamic to fit conventional management models. The missing link is the people side as a transfunctional, collective risk management tool, an area that is being investigated in this article with focus on two research questions, which provide a framework for this exploratory field study:

Research Question 1: How do contingencies impact project performance, and why does the impact vary across different project organizations?

Research Question 2: What conditions of the project environment are most conducive to dealing effectively with complex risk issues?

In addition, I state four important observations made during discussions with project leaders and senior managers at an earlier exploratory phase of this study. These observations provide a small window into current managerial thought and practice. They underscore the importance of investigating the two research questions and providing ideas for future research and hypothesis testing.

Observation 1: Contingencies in the project environment do not impact the performance of all projects equally.

Observation 2: Early detection of contingencies is critically important for managing and minimizing any negative impact on project performance.

Observation 3: Performance problems caused by contingencies (risks) are likely to cascade, compound, and become intricately linked.

Observation 4: Contingencies in the project environment affect project performance more severely with increasing complexity and high-tech content of the undertaking.

While specific hypothesis testing appears premature at this early stage of the research, the research questions together with the field observations provide focus for the current investigation, including designing questionnaires, conducting interviews, guiding data collection, and discussing results. Furthermore, the field observations could provide the basis for the development of formal propositions, hypothesis testing, and future research.

Objective and Significance

Taken together, the objective of this study is to investigate the dynamics and cascading effects of risk scenarios in complex projects, and the management practices of handling these risks. Specifically, the study aims to improve the understanding of (1) the dynamics of risk impacting project performance and (2) the human side of dealing with risks in complex project situations. Part of the objective is to look beyond the analytical aspects of risk management to examine the interactions among people and organizations and try to identify the conditions most conducive to detecting risk factors early in the project life cycle and handle them effectively. The significance of this study is in the area of project management performance and leadership style. The findings provide team leaders and senior managers with an insight into the dynamic nature of risk and its situational impact on project performance. The results also suggest specific conditions that leaders can foster in the team environment conducive to effective risk management, especially in complex project scenarios.

Key Variables Affecting Risk Management

By definition, risk is a condition that occurs when uncertainties emerge with the potential of adversely affecting one or more of the project objectives and its performance within the enterprise system (ISO, 2009; PMI, 2013). Risk can occur in many different forms, such as known or unknown, quantitative or qualitative, and even real or imaginary (Shaw, Abrams, & Marteau, 1999). Risk is derived from uncertainty. It is composed of a complex array of variables, parameters, and conditions that have the potential of adversely impacting a particular activity or event, such as a project. At the minimum, three interrelated sets of variables affect the cost and overall ability of dealing with risk, as graphically shown in Figure 1:

1. Degree of uncertainty (variables, set #1)
2. Project complexity (variables, set #2)
3. Impact (variables, set #3)

Understanding these variables is important for selecting an appropriate method of risk management, and for involving the right people and organizations necessary for effectively dealing with a specific risk situation.

1. ***Degree of Uncertainty (Variable Set #1).*** For discussion, we can divide the degree of uncertainty into four categories (rank-ordered from low to high) that may affect various segments of the project or the whole business enterprise.
   - *Variations.* These are variations of known variables, such as cost, timing, or technical requirements. The degree of risk varies with the level of uncertainty and magnitude of the expected variation, and the potential impact on the project. However, by definition, the variables are well understood and the model for project performance impact is known. This is an area where analytical methods and conventional methods of project planning, execution, and control are usually highly effective.
   - *Contingencies.* These are known events that could occur and negatively affect project performance. However, the probability of occurrence and magnitude of impact are not known. Or, the cost and effort of determining probable occurrence

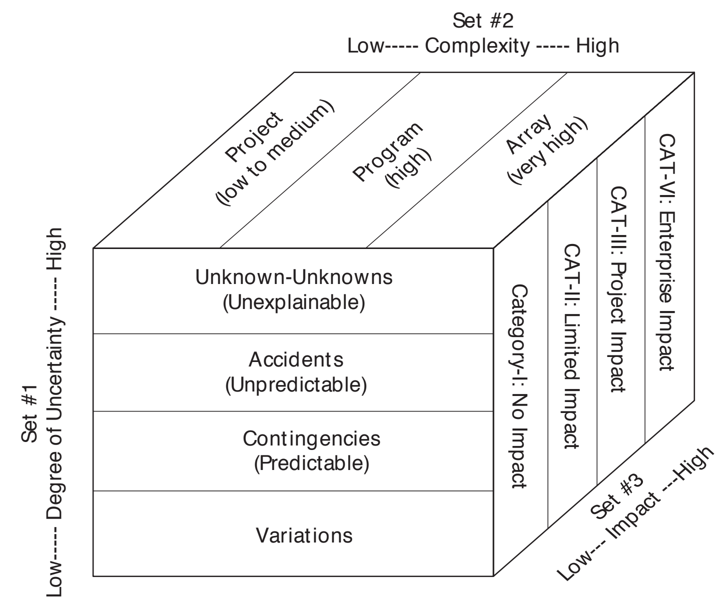

Figure 1: Dimensions of risk management.

and impact are too great, or stakeholders simply have chosen not to deal with this contingency for the time being. Examples are customer changes, design failures, and contractor issues that could have been expected but catch project leaders by surprise. This is an area where better management discipline, policies, and procedures can be effective. In addition, certain analytical methods, such as PERT and computer simulations, can help in anticipating and dealing with these risk factors.

- *Accidents*. These are events that can be identified in principle, but the probability of occurrence and its specific scope and impact on project performance are difficult if not impossible to predict. A somewhat simplified but graphic example might be a motorist planning for a car accident. One could make an argument that a savvy driver is proactive by carrying insurance, an emergency medical kit, a flashlight, a cell phone, and so on, and drives carefully to avoid accidents. However, the reality is that car accidents happen even to the most skilled and careful drivers. When they happen, they were not "anticipated," and a contingency plan might be of little or no value. Projecting this example to a complex project venture, such as offshore oil drilling or outer space exploration, provides the type of scenario where the possibility of accidents is certainly recognized but its scope and impact are very difficult to predict.
- *Unknown-Unknowns*. These are events that were not known to the project team before they occurred, or were seen as impossible to happen in a specific project situation. Examples might be the failure of a certified component with proven liability in similar applications, a sudden bankruptcy of a customer organization, or a competitor's breakthrough invention/innovation that undermines the value of your current project or threatens a major line of business. By definition, unknown-unknowns are not foreseeable and therefore cannot be dealt with proactively.

This classification was developed during an earlier research study (Thamhain & Skelton, 2007), where it helped in characterizing various types of uncertainties and in setting specific boundaries for various levels of uncertainty, hence establishing a conceptual framework and basis for further discussion. However, it should be pointed out that the boundaries are rather fluid, with a wide range of overlaps among the categories. In fact, these four categories of uncertainty, previously described, blend into a continuous spectrum ranging from "predictable and manageable" to "unforeseeable and unpreventable." The degree of overlay among these classifications depends on managerial skill sets, experiences, and organizational environments, which is yet another set of variables affecting uncertainty. That is, events that seem to be manageable to one team might appear as a complete surprise (unknown-unknowns) to another, an interesting reality that will be discussed further in this article.

2. *Project Complexity (Variable Set #2).* The scope and complexity of the project undertaking is yet another dimension likely to influence the ability to deal with risk issues (Geraldi & Adlbrecht, 2007; Haas, 2009; Thomas & Mengel, 2008). Formal studies of project-related complexity have focused on two aspects: "complexity *in* projects" and "complexity *of* projects" (Cooke-Davies, Cicmil, Crawford, & Richardson, 2007). The first focus aims mostly at the complexities surrounding the project organization, such as its socioeconomic and political environment and its dynamics and changes, both internal and external to the enterprise (Cicmil & Marshall, 2005; Cooke-Davies et al., 2007; Maylor, Vidgen, & Carver, 2008). The second stream of research looks more specifically at the project, trying to characterize and classify its complexity (Geraldi & Adlbrecht, 2007; Jaofari, 2003; Shenhar & Dvir, 2007; Williams, 2005; Williams & Sumset, 2010). Among the many streams of complexity research, the classifications along structural lines, such as *task-project-program-array* shown in Figure 1, seem to be most common. It is also part of the popular Diamond Model (Shenhar & Dvir, 2007), which suggests a broader scope for characterizing project complexity along four dimensions: (1) *structural complexity* (low: assembly, medium: system, high: array), (2) *novelty or innovation* (derivative-platform-breakthrough), (3) *pace* (regular-fast-blitz), and (4) *technology* (low-medium-high-super high). All these models help in establishing some metric for classifying the degree of "project difficulty," providing useful guidelines for discussing risk in the context of project complexity.

3. ***Impact of Risk on Project and Enterprise (Variable Set #3).*** Although complex projects are likely to have a larger impact on the enterprise, smaller projects or risk issues can also impact large segments of the enterprise. An example is the Toyota acceleration problem, caused by a relatively small component of the automobile. Yet, it impacted the image and financial performance of the whole enterprise. Four specific categories of risk have been suggested in prior studies (Thamhain & Skelton, 2007) as a framework for discussing the situational nature of risk and its potential impact on project and enterprise performance:
   - *Category-I risks: Little or no impact on project performance.* Category-I risks are potentially harmful events that can be identified and dealt with before affecting project performance.
   - *Category-II risks: Potential for limited impact on project performance.* These risk issues can be dealt with at a lower level of project activity, such as a task or subsystem, before they impact overall project performance. Examples are technical issues that can be solved "locally." The impact on cost, time, quality, and other performance parameters is limited to a subset of the project.
   - *Category-III risks: Potential for significant impact on project performance.* The contingency is expected to impact the project significantly, affecting overall project performance, such as causing critical schedule delays and budget overruns.
   - *Category-IV risks: Potential for significant irreversible impact on project and overall enterprise performance.* The effects could be immediate or cascading, as we have seen in Toyota's "accidental acceleration issue," which started out as an "unknown-unknown" risk factor that appeared to be limited to some technical issues but eventually affected overall enterprise performance extensively.

The significance of establishing categories of risks with defined impact boundaries is for describing and comparing the impact of a specific contingency. These four categories are being suggested as a measure for communicating the degree of risk impact. As an analogy, this is similar to the categories established for storms or earthquakes to describe the potential for damages resulting from the events. Similarly, risk categories identify the degree of potential problems caused in projects and enterprise systems. In this context, the article contributes a building block of knowledge on project risk management. Furthermore, the four risk categories will be used later in the Results section of this article to build a model explaining the dynamics and cascading effects of risk events impacting projects and their enterprise systems.

Method

The work reported here is the continuation of ongoing research into risk management practices and team leadership in complex project situations (Skelton & Thamhain, 2006, 2007; Thamhain, 2007, 2008, 2009, 2011; Thamhain & Skelton, 2006, 2007). This article summarizes four years (2008–2011) of this investigation, focusing on the risk management practices of 35 major product developments in 17 high-technology, multinational enterprises.

The current research uses an exploratory field study format with focus on four interrelated sets of variables: (1) risk, (2) team, (3) team leader, and (4) project environment. All these variables, plus the components of risk management, product development, teamwork, technology, and project management, are intricately connected, representing highly complex sets of variables with multiple causalities. Researchers have consistently pointed at the nonlinear, often random nature of these processes that involve many facets of the organization, its members, and environment (Bstieler, 2005; Danneels & Kleinschmidt, 2001; Elliott, 2001; MacCormack, 2001; Thamhain, 2008, 2009; Verganti & Buganza, 2005). Investigating these organizational processes simultaneously is not an easy task. Simple research models, such as mail surveys, are unlikely to produce significant results. Instead, one has to use exploratory methods, casting a wide net for data collection, to look beyond the obvious aspects of established theory and management practice. I used my ongoing work as a consultant and trainer with 17 companies to conduct discussions, interviews, and some surveys, together with extensive observations, all helping to gain insight into the work processes, management systems, decision making, and organizational dynamics associated with project risk management. This method, referred to as *action research,* includes two qualitative methods: *participant observation* and *in-depth retrospective interviewing.* It also provided access to some conventional questionnaire-based surveys to about one-half of the field study population characterized in Table 1. This *combined method* is

Project Environment	Metrics
Total sample population	560
Companies	17
Product development projects	35
Project managers	35
Team members[a]	489
Product managers	9
R&D managers	6
Senior managers and directors	21
Average project budget	$4.6M
Average project life cycle	18 months

[a] 5 Total team sample – project managers – product managers – R&D managers – senior managers.

Table 1: Summary of field sample statistics.

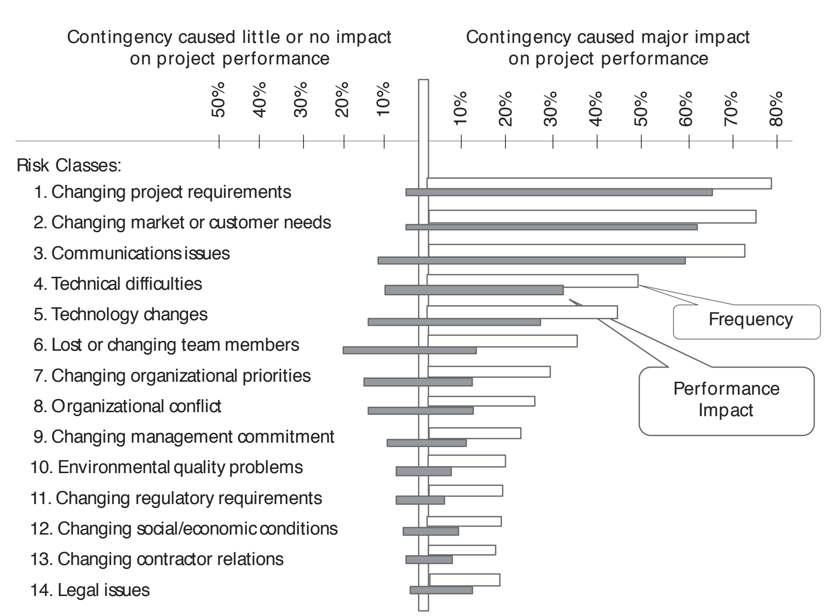

Figure 2: Risk classes, frequency, and impact on project performance.

particularly useful for exploratory investigations, such as the study reported here, which is considerably outside the framework of established theories and constructs (Eisenhardt, 1989; Glaser & Strauss, 1967). However, the method also has limitations and weaknesses, especially the dependence upon the observer's experience and the observer's biases, which are recognized.

The questionnaire was designed to measure (1) risk factors, (2) frequency of risk occurrences, (3) impact on project performance, and (4) managerial actions taken to deal with contingencies (risks). To minimize potential misinterpretations or biases from the use of social science jargon, each of the 14 risk classes (summarized in Figure 2) was defined specifically at the beginning of the questionnaire. For example, class #7 (changing organizational priorities) was defined as "changes of priorities in your organization that affected resource allocations, schedule, or support of your project." For each risk class, participants were asked to indicate frequency, impact, and managerial actions. Regarding frequency, participants indicated on a 3-point scale (never, somewhat, definitely) whether the situation occurred during the project life cycle. Regarding impact, participants indicated on a 4-point scale (no impact, little impact, considerable impact, and significant/major impact on project and enterprise performance) the impact of the contingency on the project and its performance. Regarding managerial actions, participants indicated the specific actions taken by managers and project leaders in dealing with the contingency, and the degree of success achieved by the action. Questionnaires were coded to track the responses from team members, project leaders, support personnel, or senior management, respectively.

The 14 classes of risks used in the questionnaire were identified during interviews and discussions with more than 100 managers during an exploratory phase of an earlier field study, investigating risk management practices for large projects (Thamhain & Skelton, 2005, 2007). Managers were asked: "What types of risks and contingencies do you experience in managing your projects, and where do these risks originate from? What are their causes?" The discussions resulted in more than 600 situations and conditions related to project risk, all seen with potential for significant impact on project performance. Using content analysis of these 600 factors, 14 classes of risks were developed for use in this study, as shown in Figure 2.

The questionnaires were personally introduced to 230 team members, 35 team leaders, and 36 senior managers, yielding an overall return of 83% and resulting in data describing risk categories, frequency, and impact such as summarized in Figure 2 of the Results section. The selection of the 230 team members from the total of 489 followed the project leads' recommendation, judging team members' expertise (competence) of answering the questionnaire properly. The 35 team leaders and 36 senior managers represent the total number identified in the sample, as shown in Table 1.

Data

The unit of analysis used in this study is the project. The field study, conducted from 2008 to 2011, yielded data from 35 project teams with a total sample population of 535 professionals such as engineers, scientists, and technicians, plus their managers, including 7 supervisors, 35 project team leaders, 9 product managers, 6 R&D directors, 5 marketing directors, and 9 general management executives at the vice presidential level, as summarized in Table 1. Together, the data covered more than 35 projects in 17 multinational companies in the Fortune 1000 category. Project team members had, on average, 10 years of professional experience in their field of specialty and four years of tenure with their current employer. The 35 project leaders had an average of six years of project management experience and five years of tenure with their current employer. Approximately 25% were Project Management Professional (PMP®) (or equivalent) credential holders. Virtually all of the project leaders completed some formal training in project management, ranging from seminars and workshops to certificate programs and degree programs in project management. However, none of the project leaders had any formal training in project risk management. Of the sample population, 90% had bachelor's degrees, 50% held master's, and 15% had PhDs.

The projects observed in this study involved mostly high-technology product- and service-oriented developments and roll-outs, such as information system, financial services, automotive, airplane, computer, and pharmaceutical products. Project budgets averaged $1.4M and project life cycles of 18 months. All project teams saw themselves working in a high-technology, multinational, and culturally diverse environment. The data were obtained from three sources (*questionnaires, participant observation,* and *in-depth retrospective interviewing*), as discussed in the previous section. The information obtained during *retrospective interviewing* with the team leaders, line managers, product managers, marketing directors, and general management executives was especially useful in gleaning additional, deeper insight into the processes, challenges, and best practices of risk management, and helped to support the risk cause-effects model presented in Figure 3 of the Results section.

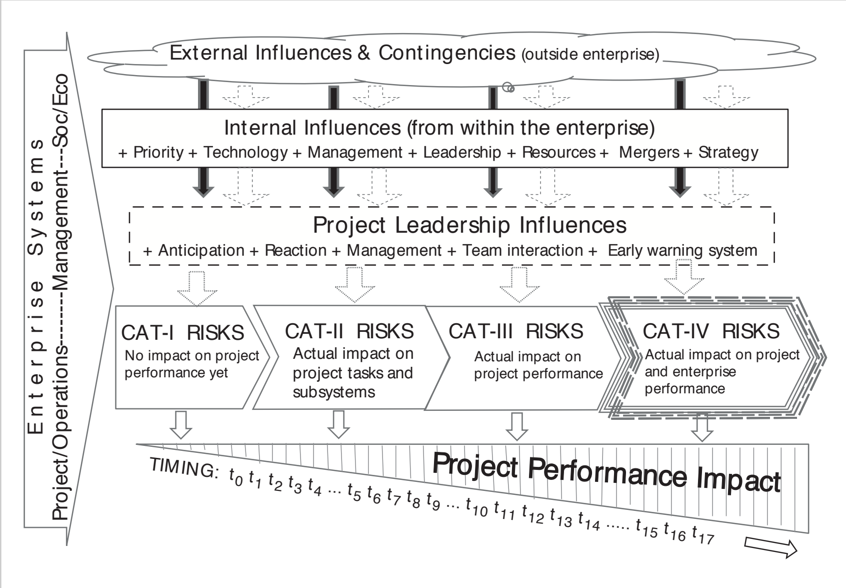

Figure 3: Model of actual risk impact on project performance.

Data Analysis

The data collected via questionnaires were evaluated and summarized via standard statistical methods, while content analysis was used to evaluate the predominantly qualitative data collected via work process observation, participant observation, and in-depth retrospective interviewing.

Results

The findings of this field study are organized into three sections. First, a simple risk assessment model for tracking the effects of risk on project performance is presented. Second, the types of contingencies that typically emerge during project execution are identified and examined regarding their impact on project performance. Third, the managerial implications and lessons learned from the broader context of the quantitative and qualitative parts of this study are summarized in two separate sections of this article.

A Simple Model for Risk Assessment

"Risks do not impact all projects equally." This observation from earlier phases of this research is strongly supported by the formal results of this field study. The managerial actions of dealing with the event, such as eliminating or working around the contingency, greatly influence the ability of minimizing the magnitude of problems caused and the cascading effects that propagate through the organization. The dynamics of these processes are being illustrated with the Risk Impact Model in Figure 3, showing the influences of the external and internal business environment. The model is a conceptual development based on observations and interviews conducted during this field study. Its framework dates back to a 2007 study (Thamhain & Skelton, 2007), which suggests that contingencies affecting one part of a project have the tendency to cascade throughout the project organization, with increasingly unfavorable impact on project performance, eventually affecting the whole enterprise.

Based on the performance impact, the model identifies *four distinct risk categories*:

- *Category-I risks: No impact on project performance.* Two types of risks fall into this category. First are events that might occur in the external or internal project environment with potentially harmful impact on project performance in the future. These contingencies, such as a delayed contract delivery, labor dispute, technical issue, or priority change, are lurking in the environment, whether they are anticipated or not. But they have not yet occurred, and therefore have not yet impacted project performance. By anticipating these contingencies, management can take preventive actions to mitigate the resulting impact if the event occurs. Second, events that actually occurred were identified and dealt with before they affected project time, cost, or other performance parameters.
- *Category-II risks: Impact on task or project subsystems only.* The risk events have occurred in the external or internal project environment with potentially harmful impact on project performance. However, by definition, these risk issues occurred at a lower level of project activity, such as a task or subsystem, and have not yet affected overall project performance. Examples are delayed contract deliveries, labor disputes, technical issues, or priority changes that can be solved "locally." Although the resolution might require extra time, it is not part of a critical path, and therefore the performance impact is limited to a subset of the project. A similar situation exists for issues that affect cost, quality, or other performance parameters at the local level only. Thus, while these risks are expected to impact the whole project, they have not yet affected overall project performance. Therefore, timely managerial actions could minimize or even avoid such performance impact.
- *Category-III risks: Impact on project performance.* Events that occurred in the external or internal project environment did impact project performance, such as schedules, budgets, customer relations, or technical issues. The impact on project performance could have been a direct result of a contingency, such as a failure to obtain a permit, or resulting from an issue at a lower level but propagating to a point that affects total project performance. Examples are test failure on a critical activity path, or problems caused at a lower level propagating to a point where they affect total project performance. However, by definition, the impact is still contained "within the project," without affecting enterprise performance. Proper timely management actions can lessen the impact on overall project performance, and possibly minimize or avoid any harmful impacts on the enterprise.
- *Category-IV risks: Impact on project and enterprise performance.* Events have occurred and have already significantly impacted overall project performance and the performance of the entire enterprise. Similar to Category III, the effects could be immediate or cascading (i.e., Toyota's "accidental acceleration"). Proper management actions can lessen the final impact on both project and enterprise performance, but by definition, a certain degree of irreversible harm has been done to the project and the enterprise.

An Example Illustrating the Dynamics and Cascading Effects of Contingencies. Using the model shown in Figure 3, we can follow the cascading effects of a contingency through a time cycle. Let us assume that an original equipment manufacturer (OEM) runs into shipping issues now (time t_0) that *could* affect the delivery of a critical component to your system five months from now. However, you learn about the supply issue one month after it occurred and decide on a remedial action at month 2. That is, the contingency with potentially undesirable consequences (Category-I risk) occurs at time t_0 and is recognized at t_1 5 month 1. Its actual impact of the contingency on project performance (occurring at t_5 5 month 5) will depend on the managerial actions of dealing with the event at time t_2. These actions could range from (a) eliminating the risk issue (e.g., switching to an alternate supplier) to (b) project re-planning or (c) innovative work-around. Hence, depending on the effectiveness of the project team and its leadership, the contingency occurring at t_0 may or may not impact project performance at time t_5. However, if it does, the situation is classified as a Category-III risk. Assuming this situation is being recognized at t_6, the managerial actions taken between t_7 and t_{14} will determine whether the risk is contained within the project or escalates further, affecting enterprise performance, such as cash flow and future business between t_{15} through t_{17}. If such impact on enterprise performance occurs, the situation would be classified as a Category-IV risk. Depending on the type of contingency, the complexity of the project and the managerial interventions, the cascading of impacts may continue further. These cascading effects of contingencies propagating through the work process and compounding at higher project breakdown levels have been clearly identified and verified during participant observation and interviewing as part of the field study. It also supports Observation 3, stated earlier in this article, that performance problems caused by contingencies are likely to cascade, compound, and become intricately linked.

Significance. The model underscores the importance of recognizing risk factors and their potential performance impact early in the project life cycle, consistent with the earlier Observation 2. It also points to the people side of risk management. That is, the attitude and sensitivity of team members toward early warning signs and first-order effects is critically important. The model further provides a framework for integrated enterprise risk management (ERM) by highlighting the importance of collective cross-functional involvement toward risk identification and impact assessment, emphasizing the benefits of cross-organizational collaboration for early risk detection and effective treatment. The model also supports the need for strategic alignment of the project with the enterprise objectives. Only with the help of senior management is it possible to see the potential impact of evolving risk on overall enterprise performance and long-range mission objectives. On the operational side, the model provides a guideline for assessing the project execution process regarding its workflow, interfaces, transparency, and effectiveness of providing useful downstream results and upstream guidance, consistent with well-established models, such as VoC, quality function deployment (QFD), and stage-gate processes.

Robustness and Limitations. While the risk-impact model is relatively simple in comparison to the complexities, dynamics, and nonlinearity of today's project undertakings, it provides critical insight into the dynamics of risk propagation and its effects on project performance, as well as a framework for tracking risk issues impacting project performance and analyzing risk management effectiveness. Some of the positive features of the risk-impact model are its simple construct, clarity, and robustness, which should be helpful for work process analysis and improvement. However, further research is needed to validate and fine-tune the model for assessing enterprise risk management performance and for extending the model toward managerial leadership-style development.

Contingencies Versus Project Performance Impact

Using content analysis of the survey data from interviews and questionnaires, managers in this study identified more than 1,000 unique contingencies or risk factors, which have the potential of unfavorably impacting project performance. These contingencies were grouped into 14 sets, or classes of risks, based on their root-cause similarities. A graphical summary shows the 14 classes in Figure 2, ranked by average frequency as observed over a project life cycle. Typical project performance impact includes schedule slippage, cost overruns, and customer dissatisfaction. In addition, risks also affected broader enterprise performance, such as market share, profitability, and long-range growth. On average, project leaders identified six to seven contingencies that occurred at least once over the project life cycle. However, it should be noted that not every contingency or risk event seems to impact project performance, as discussed in the previous section. As a most striking example, project managers reported "the loss or change of team members" (cf. Figure 2, class #6) to occur in 38% of their projects, an event described as a major risk factor with *potentially* "significant negative implications to project performance." Yet, only 13% of these projects actually faced "considerable" or "major" performance issues, while 22% experienced even less of an issue, described as "little" or "no" impact on project performance. Hence, 60% of projects with lost or changed team members experienced little or no impact on project performance. For most of the other 13 sets of contingencies, the statistics are leaning more toward a "negative performance impact." On average, 61% of the contingencies observed in the sample of 35 projects caused *considerable or major impact* on project performance. The most frequently reported contingencies or risks fall into three groups: (1) changing project requirements (78%), (2) changing markets or customer needs (76%), and (3) communications issues (72%). These are also risk areas that experience the highest negative impact on project performance. They include approximately 80% of all projects with "considerable" or "major" performance issues. The specific statistics observed across all contingencies or risks recognized by project leaders in all 35 projects, is as follows: (1) 9% of the contingencies had *no impact* on project performance (Category-I risks), (2) 16% of the contingencies had *some manageable impact* on project performance (mostly Category-II risks plus some Category III), (3) 14% of the contingencies had *substantial but still manageable impact* on project performance (Category-III risks), (4) 49% of the contingencies had a *strong, irreversible impact* on project and enterprise performance (Category-IV risks), and (5) 12% of the contingencies resulted in *project failure* (mostly Category-IV risks).

Mixed Performance Impact. Although the number of risk occurrences (frequency) was approximately equally observed by all 35 project leaders, the reported impact distribution was more skewed, with 20% of the project leaders reporting 71% of all considerable and major performance problems. This again provides strong support for Observation 1, stated earlier, that contingencies in the project environment do not impact the performance of all projects equally. It is interesting to note that although all projects (and their leaders) reported approximately the same number of contingencies with normal distribution across the 14 categories, some projects were hit much harder on their performance (i.e., those 12% in the project that failed). This suggests differences in organizational environment, project leadership, support systems, and possibly other factors that influence the ability to manage risks.

Senior Management Perception. When analyzing the survey responses from senior managers separately, we find that senior managers rate the performance impact on average 30% lower than project managers. That is, senior management perceives less of a correlation between contingencies and project performance. Additional interviews with senior managers and root-cause analysis of project failures strongly confirms this finding. While senior managers and project leaders exhibit about the same statistics regarding (1) the number of contingencies and risks occurring in projects and (2) the distribution of risks across the 14 categories (as tested by the Kruskal-Wallis analysis of variance by rank), senior managers perceive fewer performance issues directly associated with these risks. That is, they are less likely to blame poor performance on changes or unforeseeable events (risks) but more likely are holding project leaders accountable for agreed-on results, regardless of risks and contingencies. The comment made by one of the marketing directors might be typical for this prevailing perspective: "Our customer environment is quite dynamic. No product was ever rolled out without major changes. Our best project leaders anticipate changing requirements. They set up work processes that can deal with the market dynamics. Budget and schedule problems are usually related to more conventional project management issues but are often blamed on external factors, such as changing customer requirement." This has significance in three areas: (1) perceived effectiveness of project management performance, (2) conditioning of the organizational environment, and (3) enterprise leadership. First, project leaders should realize that their performance is being assessed largely because of project outcome, not the number and magnitude of contingencies that they had to deal with. Although overall complexity and challenges of the project are part of the performance scorecard, they are also part of the conditions accepted by the project leader at the beginning of the project, and therefore not a "retrospective" performance measure. Second, less management attention and fewer resources might be directed toward conditioning the organizational environment to deal with risks that specifically affect projects, because senior managers perceive less of a linkage between risk and project performance. This connects to the third area, the overall direction and leadership of the enterprise that affects policies, procedures, organizational design, work processes, and the overall organizational ambience for project execution and control, an area that probably receives less attention from the top but could potentially influence project performance significantly, and an area that should be investigated further in future research studies.

Discussion and Implications

Seasoned project leaders understand the importance of dealing with project risks and take their responsibility very seriously. However, foreseeing contingencies and effectively managing the associated risks is difficult and challenging. It is both an art and a science to bring the effects of uncertainty under control before they impact the project, its deliverables, and objectives. Given the time and budget pressures of today's business environment, it is not surprising that the field observations show project managers focusing most of their efforts on fixing problems after they have impacted performance. That is, while most project leaders understand the sources of risks well, they focus their primary attention on monitoring and managing the domino effects of the contingency rather than dealing with its root causes. It is common for these managers to deal with problems and contingencies only after they have impacted project performance, noticed in schedules, budgets, or deliverables, and therefore have become Category-II or Category-III risks. Only 25% of these managers felt they could have foreseen or influenced the events that eventually impacted project performance adversely. It is further interesting to note that many of the organizational tools and techniques that support early risk detection and management—such as spiral processes, performance monitoring, early warning systems, contingency planning, rapid prototyping, and CAD/CAM-based simulations—readily exist in many organizations as part of the product development process or embedded in the project planning, tracking, and reporting system. It is interesting to note, however, that project managers, while actually using these project management tools and techniques extensively in their administrative processes, do not give much credit to these operational systems for helping to deal with risks. Although this is an interesting observation, it is also counterintuitive and needs further investigation.

Decoupling Risks From Projects: Cause-Effect Dynamics

The field study provides an interesting insight into the cause and effect of contingencies on project performance, including their dynamics and psychology. Whether a risk factor actually impacts project performance depends on the reaction of the project team to the event, as graphically shown in Figure 3. It also seems to depend on the judgment of the manager whether or not a particular contingency is blamed for subsequent performance problems. Undesirable events (contingencies) are often caused by a multitude of problems that were not predictable or could not be dealt with earlier in the project life cycle. During a typical project execution, these problems often cascade, compound, and become intricately linked. It is also noticeable that the impact of risk on project performance seems to increase with project complexity, especially technology content of the undertakings. From the interviews and field observations, clearly even small and anticipated contingencies, such as additional design rework or the resignation of a key project team member, can lead to issues with other groups, confusion, organizational conflict, sinking team spirit, and fading commitment. All these factors potentially contribute to schedule delays, budget issues, and system integration problems that may cause time-to-market delays and customer relation issues, which ultimately affect project performance. Realizing the cascading and compounding effects of contingencies on project performance, the research emphasizes the importance of identifying and dealing with risk early in the project life cycle to avoid problems at more mature stages. The study also acknowledges the enormous difficulties of actually predicting specific risk situations and their timing, root-cause, and dysfunctional consequences, and to act appropriately before they impact project performance.

Differences in Assessing Performance Issues Between Project and Senior Managers

Project leaders and senior managers differ in their "true cause" assessment of performance problems, as was shown in the statistical analysis of Figure 2. Yet, there are additional implications to the perception of what causes performance issues. These perceptions affect the managerial approaches of dealing with risk. Specifically, we learn from the discussions and field interviews that project leaders blame project performance problems and failures predominantly on contingencies (risk situations) that originate outside their sphere of control, such as scope changes, market shifts, and project support problems, while senior management points directly at project leaders for not managing effectively. That is, senior management blames project managers for insufficient planning, tracking and control, poor communications, and weak leadership. Additional field investigations show an even more subtle picture. Many of the project performance problems and failures could be root-caused to the broader issues and difficulties of understanding and communicating the complexities of the project, its applications, and support environment, including unrealistic expectations for scope, schedule and budget, underfunding, unclear requirements, and weak sponsor commitment.

The significance of these findings is in several areas. First, the polarized perspective between project leaders and senior managers creates a potential for organizational tension and conflict. It also provides an insight into the mutual expectations. Senior management is expected to provide effective project support and a reasonably stable work environment, while project leaders are expected to "manage" their projects toward agreed-on results. The reality is, however, that project leaders are often stretched too thin and placed in a tough situation by challenging requirements, weak project support, and changing organizational conditions. Moreover, many of the risk factors have their roots outside the project organization and are controlled by senior management. Examples are contingencies that originate with the strategic planning process. Management, by setting guidelines for target markets, timing, return on investment, and product features, often creates conflicting target parameters that are also subject to change due to the dynamic nature of the business environment. In turn, these "external changes" create contingencies and risks at the project level. Existing business models do not connect well between the strategic and operational subsystems of the firm, and tend to constrain the degree to which risk can be foreseen and managed proactively at the project level (Hillson, 2003; Shenhar et al., 2007). It is therefore important for management to recognize these variables and their potential impact on the work environment. Organizational stability, availability of resources, management involvement and support, personal rewards, stability of organizational goals, objectives, and priorities are all derived from enterprise systems that are controlled by general management. It is further crucial for project leaders to work with senior management, and vice versa, to ensure an organizational ambience conducive to cross-functional collaboration.

Lessons for Effective Risk Management

Despite the challenges and the inevitable uncertainties associated with complex projects, success is not random. One of the strong conclusions from this empirical study is *risks can be managed.* However, to be effective, especially in complex project environments, risk management must go beyond analytical methods. Although analytical methods provide the backbone for most risk management approaches, and have the benefit of producing an assessment of a known risk situation relatively quickly, including economic measures of gains or losses, they also have many limitations. The most obvious limitations are in identifying potential, unknown risk situations and reducing risk impact by engaging people throughout the enterprise. Because of these limitations and the mounting pressures on managers to reduce risk, many companies have shifted their focus from "investigating the impact of known risk factors" to "managing risk scenarios" with the objective to eliminate potential risks before they impact organizational activities. As a result, these companies have augmented conventional analytical methods with more adaptive, team-based methods that rely to a large degree on (1) broad data gathering across a wide spectrum of factors and (2) judgmental decision making. In this field study, I observed many approaches that aimed effectively at the reduction or even elimination of risks, such as simplifying work processes, reducing development cycles, and testing product feasibility early in the development cycle. Often, companies combine, fine-tune, and integrate these approaches to fit specific project situations and their people and cultures, to manage risks as part of the total enterprise system. An attempt is being made to integrate the lessons learned from both the quantitative and qualitative parts of this study. Especially helpful in gaining additional perspective and insight into the processes and challenges of risk management, and in augmenting the quantitative data toward the big picture of project risk management, was the information obtained while working with companies on specific assignments (action research). This includes discussions and interviews with project leaders and senior managers and the observations of project management practices. Therefore, within the broader context of this study, several lessons emerged that should stimulate thoughts for contemporary risk management practices, new tool developments, and future research.

- *Lesson 1: Early recognition of undesirable events is a critical precondition for managing risk.* In addition, project leaders must not only recognize potential risk factors in general, but also know when they will most likely occur in the project life cycle. Recognizing specific issues and contingencies before they occur or early in their development is critical to the ability of taking preventive actions and decoupling the contingencies from the work process before they impact any project performance factors. Examples include the anticipation of changing requirements, market conditions, or technology. If the possibility of these changes is recognized, their probability and impact can be assessed, additional resources for mitigation can be allocated, and plans for dealing with the probable situation can be devised. This is similar to a fire drill or hurricane defense exercise. When specific risk scenarios are known, preventive measures, such as early warning systems, evacuation procedures, tool acquisitions, and skill developments, can be put in place. This readiness will minimize the impact, if the risk situation actually occurs. While the field study clearly shows the difficulties of recognizing risk factors ahead of time, it is fundamental to any risk management approach. It is also a measure of team maturity and competency and gives support to the observation made during this field study that "contingencies do not impact performance of all projects equally."
- *Lesson 2: Unrecognized risk factors are common in complex project environments.* Contingencies (even after affecting project performance) often go unrecognized. In our field study, more than half of the contingencies that occurred were not anticipated before causing significant performance issues (Category-III risks or higher). Most commonly, the impact is on cost, schedule, and risk escalation. "Delayed risk recognition is more difficult and costly to correct than contingencies treated early in their development" was a remark often heard during field interviews and in group discussions. To minimize these problems, more collective, team-centered approaches of monitoring the project environment are needed. This includes effective project reviews, design reviews, focus groups, action teams, gate reviews, and "management by wandering around (MBWA)." All these approaches are "catalysts" toward making the project organization more transparent, agile, and alert to changes and issues in the work environment.
- *Lesson 3: Unchecked contingencies tend to cascade and penetrate wider project areas.* Contingencies occurring anywhere in a project have the tendency to penetrate into multiple subsystems (*domino effect*) and eventually affect overall project performance. Many of the contingencies observed in this field study, such as design rework of a component, a minor requirements change, or the resignation of a team member, may initially affect the project only at the subsystem level. These situations might even be ignored or dismissed as issues of no significance to the project as a whole. However, all these contingencies can trigger issues elsewhere, causing workflow or integration problems, and eventually resulting in time-to-market delays, missed sales opportunities, and unsatisfactory project performance. Moreover, surprises, no matter how small, often have psychological effects on the organization, leading to confusion, organizational conflict, sinking team spirit, fading commitment, and excuses to change prior agreements. All these issues eventually translate into reduced organizational efficiency and lower performance. Recognizing the cascading nature and multiple performance impact of contingencies provides a starting point for devising an effective risk management strategy. It also helps in conditioning the team toward collective monitoring of the potential problem areas and effective early intervention.
- *Lesson 4. Cross-functional collaboration is an effective catalyst for collectively dealing with threats to the project environment.* The project planning phase appears to be an effective vehicle for building such a collaborative culture early in the project life cycle. The active involvement of all stakeholders—including team members, support functions, outside contractors, customers, and other partners—in the project planning process leads to a better, more detailed understanding of the project objectives and interfaces, and a better collective sensitivity where risks lurk and how to deal with the issues effectively. Collaboration is especially essential for complex and geographically dispersed projects with limited central authority and limited ability for centrally orchestrated control. Throughout the project life cycle, collaboration is a catalyst for identifying risks early. It helps to create transparency throughout the organization, unifies team members behind the requirements, and enhances the team's ability to collectively recognize and deal with risks in the broader project environment.
- *Lesson 5: Senior management has a critical role in conditioning the organizational environment for effective risk management.* Many risk factors have their roots outside the project organization, residing in the domain of the broader enterprise system and its environment. Examples are functional support systems, joint reviews, resource allocations, facility, and skill developments, as well as other organizational

components that relate to business strategy, work process, team structure, managerial command and control, technical direction, and overall leadership. All these organizational subsystems have their locus outside the project organization, controlled to a large extent by senior management. In addition, a natural "impedance barrier" seems to exist between the enterprise systems and the project organization, which makes external risks less recognizable and manageable in their early stages. Since early risk detection and mitigation depend to a large degree on the collective multifunctional involvement and collaboration of all stakeholders, it is important for management to foster an organizational environment conducive to effective cross-functional communications and cooperation. In addition, senior management can unify the project community behind the broader enterprise objectives by clearly articulating business strategy and vision, a contemporary process that is known as strategic alignment (Shenhar et al., 2007). Taken together, senior management—by their involvement and actions—can develop personal relations, mutual trust, respect, and credibility among the various project groups, its support functions, and stakeholders, a critical condition for building an effective partnership among all members of the project community. This is an ambiance supportive to collective initiatives and outreach, conducive to early risk detection and management.

- *Lesson 6: People are one of the greatest sources of uncertainty and risk in any project undertaking, but also one of the most important resources for reducing risk.* The quality of communications, trust, respect, credibility, minimum conflict, job security, and skill sets, all these factors influence cooperation and the collective ability of identifying, processing, and dealing with risk factors. This field study found that many of the conditions that stimulate favorably risk management behavior are enhanced by a professionally stimulating work environment, including strong personal interest in the project, pride, and satisfaction with the work, professional work challenge, accomplishments, and recognition. Other important influences include effective communications among team members and support units across organizational lines; good team spirit, mutual trust, respect, low interpersonal conflict, and opportunities for career development and advancement; and, to some degree, job security. All these factors seem to help in building a unified project team that focuses on cross-functional cooperation and desired results. Such a mission-oriented environment is more transparent to emerging risk factors and more likely to have an action-oriented, collaborative nature that can identify and deal with emerging issues early in their development.
- *Lesson 7: Project leaders should have the authority to adapt their plans to changing conditions.* Projects are conducted in a changing environment of uncertainty and risk. No matter how careful and detailed the project plan is laid out, contingencies will surface during its execution that require adjustment. Project managers and their teams should not only have the authority to adapt to changing conditions, but also be encouraged to identify potential contingencies and propose plan changes for eliminating risks before they impact the work process.
- *Lesson 8: Testing project feasibility early and frequently during execution reduces overall project risk.* Advances in technology provide opportunities for accelerating feasibility testing to the early stages of a project life cycle. Examples are system integration, market acceptance, flight tests, and automobile crash tests that traditionally were performed only at the end of a project subphase or at a major integration point. However, with the help of modern computers and information technology, many of the companies in our study were able to reduce risks considerably by advancing these tests to the front end of the project or to the early stages of a product or service development. Examples are CAD/CDE/CAM-supported simulations and product/service application modeling. A simulated jet flight or automobile crash test is not only much less costly and less time-consuming than the real thing, but also yields valuable information for the improvement and optimization of the product design at its early stages, long before a lot of time and resources have been expended. Technology also offers many other forms and methods of early testing and validation, ranging from 3-D printing, stereo lithography, and holographic imagery for model building to focus groups and early design usability testing. These technology-based methods also allow companies to test more project and product ideas, and their underlying assumptions for success, in less time and with considerably fewer resources than with traditional "end-of-the-development" test methods.
- *Lesson 9: Reducing work complexity and simplifying work processes will most likely reduce risk.* Uncertainties originate within the work itself. The observations from this field study show that the project work, together with its complexities and processes, contributes especially heavily to the uncertainties and risks affecting project success. Whatever can be done to simplify the project and its scope, deliverables, and work process will minimize the potential for problems and contingencies, make the project more manageable, and increase its probability of success. Work simplification comes in many forms, ranging from the use of prefabricated components to subcontracting, snap-on assembly techniques, material choices, and high-level programming languages. Any innovation that reduces

complexity, development time, resource requirements, testing, production setup, or assembly also reduces the risk of contingencies to occur over the development cycle. In addition, risk and uncertainties can be reduced by streamlining the work processes. Contemporary project management platforms, such as concurrent engineering, stage-gate processes, or agile/Scrum, in their right setting, can simplify the work process, reduce development time, and enhance organizational transparency.

Conclusion

Risks do not affect all projects equally is one strong conclusion from this field study. Actual risk impact depends not only on the risk event, but also on the managerial actions of dealing with the contingency and its timing, which influence the magnitude of problems caused by the event and the cascading effects within the project organization. The risk-impact-on-performance model developed in this article contributes to the body of knowledge by providing a framework for describing the dynamics and cumulative nature of contingencies affecting project performance. The empirical results show that effective project risk management involves a complex set of variables, related to task, management tools, people, and organizational environment. Simple analytical approaches are unlikely to produce desired results but need to be augmented with more adaptive methods that rely on broad data gathering across a wide spectrum of the enterprise and its environment. The methods also have to connect effectively with the organizational process and the people side of project management. Some of the strongest influences on risk management seem to emerge from three enterprise areas: (1) work process, (2) organizational environment, and (3) people. I observed many approaches that effectively reduced risks by simplifying the work and its transfer processes, shortening development cycles, and testing project feasibility early. The best success stories of this field study point to the critical importance of identifying and dealing with risks early in the development cycle. This requires broad scanning across all segments of the project team and its environment and creative methods for assessing feasibilities early in the project life cycle. Many risk factors originate outside the project organization, residing in the broader enterprise and its environment. Therefore, it is important for management to foster an organizational environment conducive to effective cross-functional communications and collaboration among all stakeholders, a condition especially important to early risk detection and risk management.

Although no single set of broad guidelines exists that guarantees project success, the process is not random! A better understanding of the organizational dynamics that affect project performance, and the issues that cause risks in complex projects, is an important prerequisite and catalyst to building a strong cross-functional team that can collectively deal with risk before it impacts project performance.

Recommendations for Future Research

By its specific design and objective, the current research is exploratory. Investigating organizational processes and managerial practices toward project risk identification and mitigation is a relatively broad, new, and multidimensional area that reaches far beyond a journal article but is holding many opportunities for future research, some of them suggested in this section:

1. *Testing of specific propositions and hypotheses.* While it was premature in this article to test specific hypotheses, the research questions identified at the beginning (e.g., impact of contingencies on project performance and organizational conditions that are most conducive for risk management) could be expanded into more formal propositions for future research and hypothesis testing.
2. *Risk perception by senior management and impact on resource allocation.* Because senior managers seem to perceive less of a linkage between risk and project performance, less management attention and resources might be directed toward conditioning the organizational environment to deal with risks that specifically affect projects. This could potentially influence the ability of managing project risk significantly, an area that should be investigated further.
3. *Influence of policies and organizational environment.* Senior managers seem to believe that overall policies and organizational ambience have no significant influence on risk management at the project level. However, the analytical findings of this study produced mixed results, sometimes even suggesting that *policies and organizational environment* have significant impact, a controversy that should be more formally investigated in future research.
4. *Effective use of risk management tools and techniques.* Although project managers widely use analytical risk management tools, they do not seem to give much credit to the effectiveness of these tools and techniques for dealing with risk. It would be interesting to formally investigate why project managers do not value these tools as much as claimed by the literature, and how these risk management tools could be better leveraged in the field. ■

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