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Research article

Information technology project risk management: bridging the gap between research and practice

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Abstract

The gap between research and practice is strikingly evident in the area of information technology (IT) project risk management. In spite of extensive research for over 30 years into IT project risk factors resulting in normative guidance on IT project risk management, adoption of these risk management methods in practice is inconsistent. Managing risk in IT projects remains a key challenge for many organizations. We discuss barriers to the application of normative prescriptions, such as assessments of probability and impact of risk, and suggest a contingency approach, which addresses the uncertainties, complexities, and ambiguities of IT projects and enables early identification of high-risk projects. Specifically, in a case study, we examine how the project management office (PMO) at one organization has bridged the gap between research and practice, developing a contingency-based risk assessment process well founded on research knowledge of project dimensions related to project performance, while also being practical in its implementation. The PMO's risk assessment process, and the risk spider chart that is the primary tool in this assessment, has proven to be effective for surfacing inherent risk at the early stages of IT projects, thereby enabling the recommendation of appropriate management strategies. The PMO's project risk assessment process is a model for other organizations striving to engage in effective and collaborative practices in order to improve project outcomes. The case illustrates the importance of considering the practical constraints of the context of application in order to transform research findings into practices that promote attainment of desired outcomes.

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Introduction

As members of an applied, or professional, discipline, Information Systems (IS) scholars seek to advance both academic and practical knowledge in their field. A key challenge, however, is to bridge the gap between research and practice and to ensure that practice is well founded on empirical findings. Even when a research focus is profoundly applied, such as in the information technology (IT) project management arena, the goal of advancing practice with the benefits of research findings has often been difficult to achieve. This paper demonstrates the successful transfer of research to practice in the area of IT project risk assessment.

In spite of extensive research for over 30 years into IT project risk factors resulting in normative guidance on IT project risk management, adoption of these risk management methods in practice is inconsistent (Bannerman, 2008) and delivery of IT projects to required performance standards remains an elusive target (Standish Group, 2005;

Sauer *et al*., 2007). One key area that can drive improvements in IT project performance is the early identification of high-risk projects (Pennington and Tuttle, 2007). If high-risk projects are identified early, then appropriate risk management and oversight mechanisms can be implemented to mitigate the threats, and to ensure early and decisive action on problems that arise. However, early identification of high-risk projects poses many questions. What determines a high-risk project? Which risk factors should be considered? How can they best be evaluated? How can the organization get a holistic picture of the risk profile of the project? What is the best way to manage risk on high-risk projects? Given the extensive body of research on IT project risk factors and risk management approaches (see, e.g., Bannerman, 2008, for a detailed review of recent IT project risk management research; and Schmidt *et al*., 2001, for one of the most extensive surveys of IT risk factors), it might be assumed that these questions would be easily answered. It is somewhat surprising, then, that there is very little evidence that research knowledge on IT risk factors and risk management has actually been applied in the workplace (Bannerman, 2008; de Bakker *et al*., 2010). One of the biggest challenges still in the IT project domain is to convert our research understanding of IT risks and risk management into practical, usable tools that are easy to implement and effective in practice (Bannerman, 2008; de Bakker *et al*., 2010).

Our goal in this paper is to examine a successful instance of the transformation of research knowledge on IT project risk management into a solution that takes into account the day-to-day exigencies of the practical situation. In particular, we show how the Project Management Office (PMO) at a municipal government organization, CityOrg, tasked with improving the success rate of key IT projects across the organization, developed a risk assessment tool, well founded in research and also practical in its application. The risk assessment tool incorporates the extensive body of research knowledge on IT risk and uncertainty, while avoiding the practical implementation problems of traditional risk management approaches by building on the contingency approach to risk management (McFarlan, 1981; Barki *et al*., 2001).

Our presentation of an interpretive revelatory or enlightening case study (Marcus, 1997; Yin, 2009) enables us to make contributions to both practice and research. In the practice arena, the case study reported here demonstrates a substantial advance in addressing the research-practice gap in the IT project risk management area, by providing a practical implementation of the contingency approach to risk management whose effectiveness in practice has been demonstrated. From the research perspective, by exploring how and why this organization has successfully utilized research knowledge on IT project risk management, we provide insight into what is required if research findings are to be transformed into practices that promote attainment of desired outcomes.

We begin with a brief review of the literature on IT project risk to set the scene for the case study. We then present our method for examining the case study, and describe the development of the risk assessment tool over a period of 5 years. Finally, we discuss the significance of the case findings for application of research on IT project risk management in practice, and draw on research utilization and knowledge transfer literature to explore reasons why research utilization was successful in this case.

Literature review: IT project risk

The body of research examining risk in IT projects spans over 30 years, with Alter and Ginzberg (1978), Boehm (1973, 1983), Brooks (1974), McFarlan (1981) and Zmud (1980) being among the early contributors establishing a foundation of research knowledge in the area. In subsequent years, research interest in IT project risk developed primarily in two directions, risk management and risk factors, with a smaller group of researchers building on McFarlan's (1981) work to develop contingency approaches to project risk management.

In spite of this extensive and comprehensive body of research on IT risk, there is considerable evidence that the research findings and recommendations are not being applied in practice (Pfleeger, 2000; Addison and Vallabh, 2002; Kutsch and Hall, 2005; Taylor, 2005; Bannerman, 2008; de Bakker *et al*., 2010). Both the risk factor and the risk management directions draw on models of decision making based on probability and expected utility (Charette, 1996; Pender, 2001; Ward and Chapman, 2003; Kutsch and Hall, 2005), which are founded on assumptions that risks are discrete potential events and that their impact and probability can be assessed with a reasonable degree of confidence. As we will explain, these decision-making assumptions are key to understanding why prescriptions from the risk management and risk factor strands of research appear to be so difficult to apply in IT projects.

Risk management research

Risk management researchers have focused on the examination of process models that provide prescriptions for risk management (see, e.g., Boehm, 1991; Fairley, 1994; Charette, 1996; Heemstra and Kusters, 1996; Powell and Klein, 1996; Keil *et al*., 1998; Barki *et al*., 2001; Simister, 2004), typically including variations on the four processes of risk identification, assessment, response planning, and monitoring, as shown in Figure 1. Similar process models also underpin the best practice recommendations of practitioner organizations such as the Project Management Institute's PMBOK guide (2004) and the Association for Project Management's

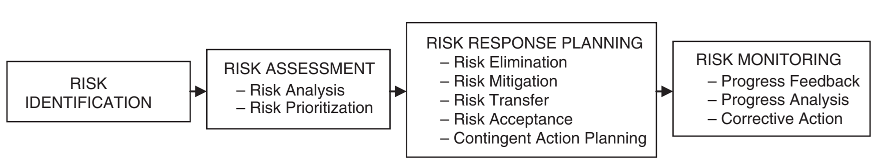

Figure 1 Project risk-management processes.

APM Body of Knowledge (2006). As noted above, these models are based on a characterization of risk as a potential discrete event, with a non-zero probability of occurrence and a quantifiable impact on the project. It is assumed that specific risks to a project can be identified, and that their probability and impact can be quantified. The recommendations also assume that project managers will, indeed, evaluate the probability and impact of each risk in order to develop a risk management plan.

In practice, the assumption that project managers will follow this decision-making process has been questioned by several researchers. For example, empirical studies in the general management field of how managers handle risk suggest that they are typically insensitive to probability estimates of risk and focus on only a few aspects of risk in a situation at any given time (March and Shapira, 1987). Similarly, there is evidence that IT project managers focus on a few factors and largely ignore others (Moynihan, 1997). Pablo (1999) observes that software development managers focus more on the impact of a possible risky event, and comparatively less on the likelihood of the event or the extent to which it can be controlled. Such failure to consider the whole risk spectrum and uneven attention between impact and probability of occurrence undermine the effectiveness of the impact–probability approach to risk management.

Risk factor research

Although the entire risk management sequence outlined in Figure 1, of risk identification followed by risk analysis and risk response planning, is not often followed in practice, the risk identification stage is commonly completed (Raz *et al*., 2002; Voetsch *et al*., 2004; Taylor, 2005; de Bakker *et al*., 2010). This stage has been supported through extensive work in the second strand of risk research, examining the range of risk factors that can impact projects. The aim of risk factor researchers has been to develop complete and comprehensive checklists of risk factors that should be considered when planning and managing an IT project. There is now a substantial body of work on the typical risk factors faced by software project managers, and also the priorities placed on these risk factors by managers (see, e.g., Alter and Ginzberg, 1978; Boehm, 1991; Barki *et al*., 1993; Heemstra and Kusters, 1996; Sumner, 2000; Schmidt *et al*., 2001; Wallace *et al*., 2004; Taylor, 2006b). The risk checklists vary in detail and emphasis – for example, the Schmidt *et al*. list contains 53 risk factors, while Moynihan identified 113 constructs grouped into 22 themes – but the risks identified all generally fall within Taylor's (2006b) categories of (i) project management risk; (ii) relationships risk; (iii) solution ambiguity risk; and (iv) environment risk.

From a practical application perspective, the use of a comprehensive risk factor checklist seems to be a helpful tool for project managers, both in terms of identifying key risks for a project and in mitigating omissions of potential threats. However, these checklists vary considerably in the risk factors on which they focus, raising questions about which list is most applicable for a given project (Moynihan, 1997; Bannerman, 2008). Once a checklist is chosen, there may be a tendency to assume it is complete, and therefore to overlook possible risks specific to a given project that are not included in the checklist (Powell and Klein, 1996). Further, identifying risks on a checklist is only the first stage in the recommended process for management of risk. Simply identifying possible risks is not a substitute for actually taking action on the risks, and a 'checklist mentality' approach can result in undue focus on process rather than on action (Pohlmann, 2003).

A further major weakness of the risk factor strand of research lies in the assumption that project managers have complete, or even adequate, knowledge about which of the many risk factors might threaten their projects, and to what extent those risk factors are present. In reality, IT project managers face considerable uncertainty in determining the likely extent of any risk factor identified as a potential threat, and, therefore, uncertainty about possible solutions, in terms of their cost and effectiveness (Pender, 2001; Ward and Chapman, 2003; Kutsch and Hall, 2005). For example, although most IT project managers would agree that some degree of requirements risk is likely to occur in any IT project, it is difficult to decide whether the requirements uncertainty evident at the start of a project is simply the typical level for an IT project, or if there are serious hidden problems that will only surface during the course of the project. In reality, the extent of the requirements uncertainty and its impact on the progress of the project are almost impossible to assess with any degree of accuracy until the project is underway. Similarly, project managers rarely have the luxury of a generous budget or schedule, but at what stage do tight budget and schedule targets actually become a risk to project success? Rather than being discrete events with a quantifiable probability of occurrence, factors such as requirements uncertainty and tight budgets exist on a continuum as part of any typical IT project landscape.

The failure of IT project managers to use the output of risk identification processes in subsequent detailed risk analysis and response planning speaks to their uncertainty about whether, and to what extent, any given risk threatens an IT project. If the size and impact of the threat cannot be accurately estimated, or if it is impossible to even anticipate certain threats, then it is extremely difficult to decide what risk response action to take, and it is, perhaps, not so surprising that project managers often do not carry out the full risk assessment process at the beginning of their projects. In the face of such uncertainty, contingency approaches may be more appropriate.

Contingency approaches to project risk management

Contingency approaches attack the risk problem from a different angle, by providing the project manager with decision tools for deciding when to apply certain project management methods in order to achieve the best chance of project success. McFarlan (1981) was an early advocate of contingency approaches, recommending that risk resolution strategies should be based on an assessment of the project's risk in terms of size, structure, and experience with technology. Similarly, Barki *et al*. (2001) argued that the degree of formal planning, internal integration, and user participation should be matched to the level of risk exposure identified for a particular project, with high-risk projects requiring higher levels of planning and oversight, and Shenhar (2001) proposed that project leaders should consider the scope (or complexity) and technological uncertainty in the project when determining the best approaches for management and risk control.

More recently, some theorists have suggested that in the face of high levels of ambiguity, or 'unforeseeable uncertainty', project managers should not attempt to apply traditional risk management methods at all. Instead, they should operate on a basis of continuous learning and adaptation as changing situations unfold (Pich *et al*., 2002; Sommer and Loch, 2004). These researchers argue that, although traditional project risk management methods work well in contexts where the project team can reasonably foresee and understand potential threats, in situations where it is impossible to fully understand all relevant variables and interactions, the traditional methods break down. In these circumstances they recommend an approach of constant environmental scanning to recognize an unforeseen event when it arises, combined with problem solving and a willingness to modify policies in order to quickly develop an appropriate response. There is some limited evidence that this approach is taken by experienced IT project managers in practice. Taylor (2007) found that experienced IT project managers rely heavily on environmental scanning to pick up and learn from situational cues that inform adaptive responses to problems as they arise, rather than on planning actions in anticipation of possible problems.

The challenge from a practical perspective is how to decide when a project is ambiguous and/or complex enough to warrant a continuous learning and management approach, rather than the traditional probability-impact risk assessment approach. Instead of asking about the probability that a risk will occur in a project and its impact if it does occur, the question now becomes: Is this project inherently risky? In this regard, we do know that certain dimensions of a project are related to project performance. Clearly, projects with higher levels of complexity, uncertainty, or criticality have higher inherent risk (Shenhar *et al*., 2001; Howell *et al*., 2010). Size matters: project cost, project duration, the number of systems the project is connected with, the number of people on the project team, and the number of outside vendors or suppliers involved in the project are all negatively correlated with project performance (Martin *et al*., 2007). The experience of the project manager (Standish Group, 2001; Sauer *et al*., 2007), the project management maturity of the organization (Herbsleb *et al*., 1997; Jiang *et al*., 2004; Subramanian *et al*., 2007), and the active involvement of key stakeholders, particularly the executive sponsor and end-users (Wallace and Keil, 2004; Standish Group, 2005), are all positively related to performance. These dimensions can be readily assessed on a simple low-medium-high scale at the beginning of a project, and do not require probability-impact estimates. Projects with more dimensions assessed at the high end of concern (e.g., high complexity or low project manager experience) are likely to have higher inherent risk and require closer oversight, even if it is not clear exactly which of the 50 or so risks on typical checklists will actually apply.

There is a clear correspondence between these project dimensions and the risk factor categories identified earlier, as shown in Table 1. The difference is essentially one of perspective: the risk factor research views each category as containing specific discrete risk events whose probability and impact can be determined, whereas the contingency approach emphasizes that all projects should be assessed along the continuum of each dimension, resulting in a determination of the overall riskiness of the project.

Table 1 Correspondence between risk factor categories and project dimensions associated with project performance

Risk factor categories (after Taylor, 2006b)	*Project dimensions associated with project performance*
Project management risk	Project manager experience (Standish Group, 2001; Sauer *et al*., 2007) Project management maturity (Herbsleb *et al*., 1997; Jiang *et al*., 2004; Subramanian *et al*., 2007)
Relationships risk	Key stakeholder involvement (Wallace and Keil, 2004; Standish Group, 2005) Size (number of project team members; number of outside vendors and suppliers) (Martin *et al*., 2007)
Solution ambiguity risk	Complexity and uncertainty (Shenhar *et al*., 2001; Howell *et al*., 2010) Size (number of connecting systems) (Martin *et al*., 2007)
Environment risk	Criticality (Shenhar *et al*., 2001; Howell *et al*., 2010) Size (cost and duration) (Martin *et al*., 2007)

The current study: risk management and the contingency approach

The contingency approach, with its emphasis on evaluating the inherent overall risk of projects, and applying different management methods for projects with high complexity and ambiguity, could have important implications for organizations and how they approach risk management and resource allocation for the projects in their portfolio. However, to date, few tools have been available to aid organizations in the identification of projects with high levels of ambiguity. Once such high-risk projects are identified, following the contingency approach, organizations can take a more detailed, environmental scanning approach to their planning and oversight by ensuring, for example, that the project manager has the requisite continuous learning management background. As there is little research on how project managers might learn these environmental scanning and response skills, and as experienced project managers are associated with better project performance (Standish Group, 2005; Sauer *et al*., 2007), previous project experience is likely to be the best guide here. In addition, other steps may be taken to reduce the overall risk for high ambiguity projects. For example, very large projects can be split into smaller projects (Sussman and Guinan, 1999), or the requirements specification stage can be split off into a separate project (Jiang *et al*., 2002; Taylor, 2006a).

We now turn to the current study, and discuss the approach of one organization to these challenges of evaluating inherent risk in the projects in the organization's portfolio and implementing appropriate levels of project management oversight. We examine the use of a risk assessment tool – the risk spider chart – by the PMO at a large municipal government organization, CityOrg. We show how this tool enables CityOrg's PMO to apply a contingency approach to determining levels of project management oversight, by providing a mechanism to assess a project on a number of dimensions to determine its inherent risk.

Method

We present a single, particularly enlightening case study that is instrumental in providing insight to the issue of early identification of IT projects with high inherent risk and exemplifies successful transfer of research knowledge on IT risk management into the practice arena. The value of a single, in-depth case study is the insight that it can provide into complex interactions in practice (Stake, 2000; Yin, 2009). Our attention was drawn to the case because of the PMO's novel and successful approach to addressing issues of project oversight and risk management, and we wished to explore the impact of this approach.

We approached the case study interpretively, from an exploratory and collaborative practice research perspective (Zmud, 1998; Mathiassen, 2002). Collaborative practice research requires attention to twin goals. From the practice perspective, the aim is to draw on research foundations in order to implement improvements in practice, whereas from the research perspective, the aim is to collect data about practice systematically and rigorously in order to develop an understanding and interpretation of the practice in the light of research concepts and frameworks. As is typical of practice-driven research (Reynolds and Yetton, 2007), our research team comprised both academicians and practitioners, and the work reported here represents the culmination of over 5 years of engagement. The authors' different roles as researchers and practitioners in the organization provided a triangulation of researcher perspectives on the case, in addition to the more typical triangulation that was achieved by seeking several complementary sources and types of data (Miles and Huberman, 1994).

Both practice and research questions drove the study. From the practice perspective, the question was, quite simply, how can CityOrg increase the success rate of its complex IT projects? In particular, it was conjectured that improvements in CityOrg's project oversight and risk management processes would result in improved project success rates. In addressing the practice question, the second author led CityOrg's PMO through three practical action research cycles of diagnosis, planning, action implementation, and evaluation and reflection (Susman and Evered, 1978; Creswell, 2008), over a period of 5 years. The first action research cycle began with a review of relevant project management literature and observation of CityOrg's current risk management and project oversight processes, followed by the development and implementation of a new risk assessment process. For each cycle after the first, feedback from participating project managers, review of uptake of recommendations arising from the risk assessment processes in the previous cycle, and consideration of subsequent project performance, all fed into the next planning stage, together with fresh input from the research literature. During these action cycles, the risk assessment process has been refined and now incorporates a risk spider chart that supports discussions of a project's inherent risk and management approaches with the local project manager.

From the research perspective, we were motivated by the substantial evidence of lack of effective uptake of risk management research knowledge in IT projects in practice (Bannerman, 2008; de Bakker *et al*., 2010) and we sought to understand how and why CityOrg's risk management initiatives were effective. In particular, knowing that CityOrg had tracked its project performance and could demonstrate improvements over time and that sound research evidence on IT project risks had been a key driver in the action research initiatives, a key question related to why these initiatives were successful – what was different? In order to support the research perspective question, we examined literature on research knowledge transfer and transformation to understand why the initiatives in the first action research cycle, which reflected more traditional presentations of risk assessment, were less successful. By comparing the early and late action research initiatives in the light of knowledge transfer research frameworks, we were able to shed light on the question of why the transfer of research knowledge to practice in this area of IT project risk management was successful in this instance.

Data for analysis of the research perspective question was collected from several sources, in order to provide triangulation of sources and data (Miles and Huberman, 1994). Publically available documents were reviewed for background information on the events leading up to the establishment of CityOrg's PMO and its activities since establishment. Organizational records provided historical data on the process improvement actions and records of project performance within the organization over the 5-year time period of the action research cycles. The second author provided detailed reflections and comments on the development and refinement of the risk assessment tool, and its use on over 100 projects through the action research cycles. We examined in-depth detailed data on 11 projects, in eight different departments, assessed with the tool including project details, risk assessment and recommendations, and outcomes (a summary of these projects is provided in the Appendix, Table A1). Finally, we conducted brief semi-structured interviews with the project managers of those projects seeking feedback on their experiences with the risk assessment process and the risk spider chart.

Our final analysis of the overall action research process and the data collected followed an interpretive pattern, iterating between the data and research literature on both IT project risk management and research knowledge transfer (Walsham, 2006). Our process followed three key stages (Miles and Huberman, 1994; Wolcott, 1994): description (i.e., summarizing what happened during the action research cycles); analysis (i.e., systematically identifying key factors and relationships); and interpretation (i.e., iterating between theory and our descriptions and analysis of data to draw interpretations and conclusions). As an exploratory and interpretive study, our conclusions are propositional and provide the foundation for further investigations.

The case study

The case organization is a large municipality, CityOrg, comprising about 34 departments and municipal offices. CityOrg has about 10,000 employees, and supports an estimated 600,000 constituents and customers. The organization has a federal governance mode (Sambamurthy and Zmud, 1999), with most of the 34 departments supported by a centralized computing infrastructure and centralized financial and personnel software applications, but each department being responsible and accountable for the success of its unique business software application projects. The Chief Technology Officer (CTO) leads the PMO and is jointly accountable with each department for the success of its IT projects. Joint accountability increases the need for visibility and oversight of IT projects and the need for collaboration and cooperation between departments and the office of the CTO.

The impetus for establishing the PMO came from a critical IT project that ran substantially over schedule and budget, garnering extensive negative media attention regarding waste of money and public resources. Thus, in 2001, reacting to the negative publicity, the CTO established the PMO to implement project management processes supporting a set of core competencies that would facilitate the completion of CityOrg's IT projects on time, within budget, and according to performance requirements. The PMO was initially staffed with a single senior, highly skilled project manager, who had a track record of successfully delivering required project performance and was well versed in project management methodologies. In 2002, a second staff member was added, with skills in project auditing and rescuing troubled projects. The current staffing level for the PMO is three.

The development of the risk assessment process

A primary goal of the PMO was to increase the success rates of complex IT projects and provide project status visibility to high-level stakeholders and sponsors, and the initial policy requiring project oversight on certain key projects was established in 2001. At this stage, a very blunt contingency approach was taken, with the requirement for independent project oversight being determined by the CTO, based primarily on the assumption that high-cost projects are more risky and therefore require more centralized oversight. For all other projects, risk assessment was left to the individual departments, where individual project managers either did no risk assessment, or followed the traditional impact–probability approach to risk management. The introduction of the oversight requirement for high-cost projects was not well received by most departments: if independent project oversight was mandated by the CTO, it was generally perceived by the project department as a non-value added expense, with only a few departments acknowledging some benefits of the process.

In spite of the initial resistance from most departments, the oversight policy was seen centrally as beneficial, and in 2004, the PMO worked to expand the process by introducing more formal risk profile reviews to determine the degree of risk associated with all projects in CityOrg's portfolio. The first step in developing the risk assessment process was to determine how to classify the projects in the portfolio, in order to decide what level of centralized oversight was required. Four levels of oversight could be applied: (i) *No Oversight Required* – the project department is solely responsible for project outcomes; (ii) *Dashboard Reporting* – a monthly written status report is prepared by the department project manager and reviewed with PMO staff; (iii) *Checkpoint Reviews* – an independent quality assurance consultant conducts in-progress audits of the project at key project milestones or phase exits; and (iv) *Formal Quality Assurance* – an independent quality assurance consultant provides continuous review throughout the project life cycle. It was at this point that CityOrg began to move from a traditional impact–probability approach toward a contingency approach of determining levels of inherent risk in projects according to an assessment of a number of project dimensions. The PMO drew on both the extensive experience of the founding PMO staff and various research publications (including, e.g., Standish Group, 2001, 2005 on IT project risks; and Wysocki *et al*., 2000 on classifying projects) in order to determine a set of measurable and defensible attributes that could be used to categorize projects according to their levels of inherent risk. (We discuss these attributes in more detail in the next section.)

These risk profile reviews provided project departments with broad-based information about the characteristics used by the PMO staff to make an expert-level judgment about the risk and corresponding appropriate oversight level for each project. Although some departments welcomed this more structured approach, generally the assessments were met with mixed reviews from project departments, and overall, some rather stiff resistance was observed. The risk profile findings were presented to departments in a narrative format, and although the intent was to determine overall project risk, the main focus remained on the assessment of individual attributes, with little emphasis on the holistic risk picture for the project. This presentation often resulted in challenges to the PMO findings regarding the overall level of inherent risk, because department project managers focused on individual attributes, and argued about whether each attribute, individually, was a threat to project success.

Reflecting on the departmental reactions to their oversight decisions, PMO staff recognized the need to do more to move the focus of the discussion onto a project's overall degree of uncertainty, in order to avoid a negative spiral of debate with project department staff about whether or not specific individual risks existed. At this stage they experimented with different approaches for presenting their analysis, with a goal of finding a more visually impactful approach that would provide a synthesis of the holistic risk picture of the project. In 2007, drawing on ideas for graphical models in Boehm and Turner (2004) and Wysocki (2001), the second author developed a risk spider chart (or radar diagram) that incorporated 12 dimensions that, together, could be used to assess a project's overall risk and also highlighted that these factors existed on a continuum for all projects. The PMO continued to refine the risk spider chart as they gained more experience with the process, and reflected on their assessments and the final outcomes of completed projects. The current version, shown in Figure 2, includes 18 dimensions that together enable the PMO staff and the department project manager to build a detailed picture of the overall risk of a project and particular areas that may require close attention.

The chart provides a visual representation of aggregate risk that is accessible and easy to discuss, providing specific measurable points along a continuum for each dimension and showing the points where the dimension (e.g., cost estimate) becomes a high, moderate, or low concern. The discussion with the department project manager became more focused on the overall risk for the project, and when an individual factor or dimension was examined, the question was not whether or not it existed, but whether it was sufficient to be a threat and how best to manage it. The introduction of the risk spider chart into the assessment process minimized the challenges about the reality of the risks in a given project, as the dimensions represent measurable attributes of all projects (Figure 2).

The use of the risk spider chart enabled the PMO staff to maintain the focus on assessing the overall inherent risk of the project and appropriate management approaches instead of getting caught up in debates about the existence of particular risks. The visual

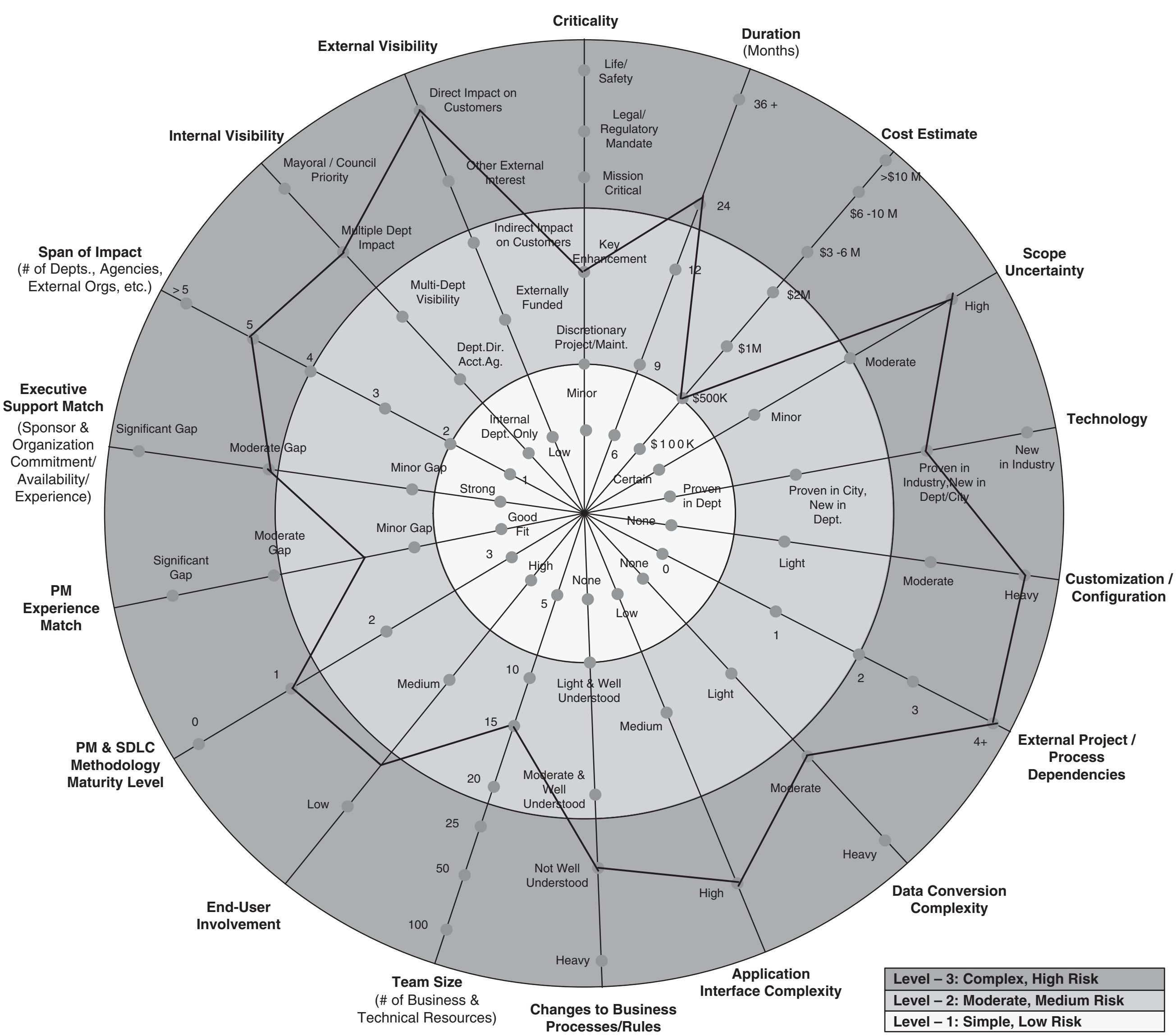

Figure 2 Example completed risk spider chart with 18 risk dimensions (for Project F in Appendix Table A1).

presentation and holistic approach were particularly appreciated:

> It [the spider chart] helped to synthesize the whole picture to see all the risks together. [PM I]

> It [the spider chart] made it easier to see the 'red-flagged' areas. [PM J]

> It [the spider chart] really helps show where the focus needs to be. [PM C]

Additional project department support for the process grew as project managers realized they could leverage the risk assessment process to get additional support from their own senior managers to resolve ongoing issues:

> It would have been difficult to persuade management to add budget for contingency funds without [the chart]. [PM H]

PM E used the chart to emphasize a point with executives and commented:

> It [the spider chart] had an influence on the decision to break up the project and helped them [the executives] focus on getting agreement on the scope.

As CityOrg's project managers gain more experience with the risk assessment process, it is becoming embedded in their own personal project management methods:

> It [the risk assessment process] has really helped improve [our] perspective and use of risk management disciplines in [our] day-to-day- activities. The real test is, if it [the spider chart] gets posted on a wall as a ready reference, [then] it has value. I see a lot of these posted. [PM G]

> We have adapted to use [the process] internally …, even for projects that aren't under official oversight. [PM B]

Risk dimensions

As shown in Table 2, the dimensions address the range of factors, identified earlier in the literature review, that have been linked to project performance: criticality; uncertainty; complexity; size; project management experience; and stakeholder involvement. These 18 dimensions provide a measurable way of assessing the overall level of inherent risk in a project, without assuming that risks are discrete events, present or not, and without requiring any assessment of probability and impact of given factors. Instead, the risk assessment is underpinned by the knowledge that the high end of these dimensions is typically associated with poorer project performance. For example, instead of attempting to assess the extent of a project's requirements uncertainty, and its impact and probability, CityOrg uses specific dimensions of scope and technology uncertainty, and changes to business processes, evaluated on simple low to high scales, as part of an overall assessment of the project and then determines recommendations for an appropriate management approach based on the overall inherent risk.

Criticality dimension

The three attributes of criticality – *safety/mission criticality*, *external visibility,* and *internal visibility* – are used as 'red flag' attributes, because the consequences of adverse events on these types of project are so severe (Shenhar, 2001; Howell *et al*., 2010). High levels on these attributes prompt a careful assessment of other dimensions to ensure that the riskiness of the project is not compounded by problems in other attributes. For example, projects with *safety/mission criticality* assessments involving life and safety require high levels of *project management maturity* to ensure that all appropriate safeguards are in place and to minimize the probability of adverse consequences. Projects with *safety/mission criticality* involving legal and regulatory mandates are frequently driven by an externally imposed *duration* and inflexible *scope*, which minimize project management trade-off capabilities. Projects with high *external visibility* are of particular concern because of possible negative attention from the public, whereas high *internal visibility* projects are often subject to internal political attention. High levels on the criticality dimension typically lead to recommendations of the highest levels of oversight, combined with efforts to ensure that the project manager has a proven track record with projects of this type.

Uncertainty dimension

Three aspects of uncertainty are considered: *scope uncertainty, technology uncertainty,* and *changes to business rules.* High levels of both *scope uncertainty* and *technology uncertainty* are frequently associated with poorer project performance (Shenhar, 2001), and it is often difficult to resolve these uncertainties until considerable progress on the project has been made (Ward and Chapman, 2003). Moderate to high levels of *changes to business processes/rules* are associated with more difficulties and greater resistance from users, and, again, the full extent of these difficulties is often not understood until well into the project. For projects with high levels of uncertainty, the PMO works with the project manager to clarify scope and resolve technology and business uncertainties before exiting the initiation stage.

Complexity dimension

The complexity attributes – *customization/configuration, data conversion complexity, application interface complexity, external project/process dependencies,* and *span of impact* – are related to the uncertainty attributes, in that high scores on complexity are also likely to be associated with increased uncertainty about scope and technology (Shenhar, 2001). The *span of impact* measures complexity in terms of the number of different organizations, such as other departments, vendors, agencies, and other external organizations, that are involved in the project. Similarly, *external project/process dependencies* introduce the complication of greater collaboration and coordination with other project teams and departments. A key challenge in the complexity area is accurate estimation of the effort required; these attributes are frequently initially underestimated both because of lack of experience with the application and also uncertainty about the extent of complexity of the various attributes (Sommer and Loch, 2004).

Table 2 Risk spider chart dimensions

Factor	*Dimension*	*Measurement Range (lowest concern–highest concern)*	*Rationale*
Criticality (Shenhar, 2001; Howell *et al*., 2010)	Safety/mission criticality	Minor maintenance – life/safety	Life/safety projects require most rigorous project management disciplines to minimize adverse consequences
	Internal visibility	Internal department only – mayoral or city council priority	Projects that interest senior executives are more likely to be subject to political complexities
	External visibility	Low – direct impact on customers	Projects that are visible to the general public can attract negative publicity if problems arise
Uncertainty (Shenhar, 2001; Ward and Chapman, 2003)	Scope uncertainty	High certainty – high uncertainty	Increases likelihood of cost/schedule over-runs and quality shortfalls
	Technology uncertainty	Proven in department – new in industry	New, unfamiliar technology creates uncertainty
	Changes to business processes/rules	None – heavy	High-to-moderate levels of business change are associated with more difficulties and greater resistance
Complexity (Shenhar, 2001)	Customization/ configuration	None – heavy	Higher levels can be under-estimated and often involve unanticipated problems
	Data conversion complexity	None – heavy	Frequently underestimated and increases likelihood of cost and schedule over-runs
	Application interface complexity	Low – high	Number and complexity can be under-estimated and often involve unanticipated problems
	External project/process dependencies	0–4+	Project complexity increases as number of dependencies increases
	Span of impact	1– > 5	Complexity increases as number of affected organizations increases: user requirements become more diversified and gaining consensus becomes more difficult
Size (Martin *et al*., 2007; Sauer *et al*., 2007)	Duration	6 months – 36+ months	Risk increases as duration increases
	Cost estimate	US$100 thousand – > US$10 million	Project success diminishes as cost increases
	Team size	5–100	Organizational and communication complexity increases as team size (business and technical resources) increases
Project management maturity (Herbsleb *et al*., 1997; Jiang *et al*., 2004; Sauer *et al*., 2007; Subramanian *et al*., 2007)	Project Manager & Systems Development Lifecycle (SDLC) Methodology Maturity Level	3–0	Risk increases as maturity levels decrease
	Project Manager Experience Match	Good fit – significant gap	Highly proficient project managers reduce project risk
Stakeholder involvement (Wallace and Keil, 2004; Wallace *et al*., 2004)	End-user involvement	High–low	Risk increases as end-user involvement decreases
	Executive support match	Strong – significant gap	Strong involvement reduces project risk

Size dimension

Project size, as measured by the attributes of *duration, cost estimate,* and *team size,* has been shown to be negatively associated with budget and quality performance (Martin *et al*., 2007; Sauer *et al*., 2007). There is overlap between the complexity and size dimensions, in that longer and costlier projects tend to be more complex, and larger teams typically involve greater communication and organizational complexity. Thus, higher ratings on the size attributes are likely to be associated with higher complexity ratings, and, conversely, actions taken to reduce one of the size attributes, such as splitting a very long project into shorter sub-projects, are likely to also result in reduced complexity ratings.

Project management maturity dimension

Both the *project management maturity level* of an organization (Herbsleb *et al*., 1997; Jiang *et al*., 2004; Subramanian *et al*., 2007) and the *project manager's experience* (Standish Group, 2001; Sauer *et al*., 2007) have been linked to project performance. In CityOrg, the project management maturity level varies across departments, and while some departments have highly experienced project managers on their teams, others have relatively inexperienced managers. The aim when evaluating this dimension is to ensure that the department has assigned a project manager with sufficient experience for the type of project and that the project manager is able to select and scale a project management methodology well suited to the type of project. High concern measures on the attributes in this dimension result in recommendations such as assigning a more experienced project manager or introducing an experienced mentor into the process.

Stakeholder involvement dimension

Given strong research evidence of the importance of key stakeholder involvement for project success (Wallace and Keil, 2004; Wallace *et al*., 2004), two aspects of stakeholder involvement are considered. Indicators of strong *executive support match* include the executive's availability and active involvement, and the adequacy of commitments for funding and resources, as well as the extent of the sponsor's experience with projects of a similar scope and complexity. For the *end-user involvement* attribute, project plans are assessed to determine whether adequate involvement of key end-users has been built in throughout all project stages, but especially the early requirements stages. Where gaps are identified in involvement of either type of key stakeholder, remedial efforts are initiated to minimize the shortfalls.

Applications of the risk spider chart

The 12-point spider chart has been used in approximately 70 projects, and the recently introduced 18-point version has been used in over 30 projects, most of which are still under way. A typical process involves the local project manager completing a questionnaire about the proposed project. A PMO staff member then completes the uncertainty assessment of the project, and prepares the risk spider chart and oversight recommendation for review with the local project manager. An example chart is shown above in Figure 2, and Table A1 in the Appendix details assessments for a representative selection of projects in the last 2 years.

In addition to the oversight recommendations, PMO staff work with the local project manager to suggest methods of reducing the overall inherent level of risk. These methods include splitting large projects into separate smaller sub-projects (i.e., reduction in project *size* and *complexity*); assigning a more experienced project manager or bringing in a senior project manager to act as a guide and mentor (i.e., increasing the *project management experience*); implementing standard project management techniques such as labor tracking, budgeting, and detailed schedules and work-plans (i.e., increasing the *project management maturity level*); for multi-department projects, taking steps to obtain departmental buy-in to the project, including a memorandum of agreement between departments and a steering committee of representatives across departments (i.e., addressing *stakeholder involvement*); and clarifying scope, roles and responsibilities, reevaluating proposed solutions, and holding risk workshops (i.e., addressing *uncertainty*). In addition, high-risk projects, with high levels of *criticality*, are typically assigned the highest levels of oversight requirement.

The PMO recommendations are not mandatory. From the PMO's perspective, some less successful projects have resulted when their recommendations have not been followed by the project department. However, even though the PMO's recommendations are not always adopted by the project departments, CityOrg's project performance has improved, in terms of key project metrics. Of the 14 projects carried out in 2006, 57% were completed within 10% of budget, and 36% were completed within 10% of the planned schedule. While there is still substantial variation from project to project, of the 46 projects carried out from 2007 through the first half of 2010, 76% were completed within 10% of budget – a 19% improvement over the 2006 benchmark – and 43% were completed within 10% of planned schedule – a 7% improvement over the 2006 benchmark. These improvements cannot be attributed to any single factor, owing to concurrent efforts to improve many aspects of project management practice within the organization, but the enhanced visibility provided by the risk spider chart and corresponding growth in project management maturity and awareness of risk are likely to have played a substantial role in project performance improvements. The oversight provisions have raised departmental awareness of the importance of project management methodologies and performance monitoring, while the risk spider chart provides a focus for discussion and coaching, both with the project department sponsors and the project managers:

> I used the chart with the steering committee to show areas of risk we need help in resolving and helped the steering committee understand how they can help manage obstacles. [PM C]

Discussion

Real life IT project management is messy, and CityOrg's experience is no exception. Faced with public concern about their project performance, they launched many initiatives to try and improve project management across the organization, including the introduction of a centralized early risk assessment process for their IT projects. Over the last 5 years, CityOrg has moved from a very blunt oversight approach based simply on project cost to a much more nuanced method, which takes into account a holistic view of a range of project dimensions, providing better support for early detection of risky projects and allowing for mitigation actions. CityOrg has been able to demonstrate a steady improvement in key project metrics, and while there are likely many factors that have contributed to this improved performance we have chosen to focus on one major initiative, the risk assessment process and associated risk spider chart, because of its originality and practicality, and its strong foundation in IT risk management research.

In keeping with the twin research and practice goals of collaborative practice research, we begin by discussing the insights that this case provides into overcoming the barriers to utilization of research knowledge in practice, and then turn our attention to the implications of the case for practice. Finally, in this section, we discuss limitations of the study.

Overcoming barriers to use of IT risk management research knowledge in practice

Understanding how research can successfully advance practice in a given field has been an on-going challenge for scholars in professional disciplines (Van de Ven, 2007). Within the IS discipline, the relevance of research has received considerable attention over a number of years (Marcus, 1997; Benbasat and Zmud, 1999), although most recently Straub and Ang (2011) have challenged long-standing concerns that IS topics are not useful and that IS knowledge transference is not occurring. Certainly, in the IT project management arena, neither of these concerns seems to be applicable; the topics of IT project management research are clearly very relevant, and the findings have been widely disseminated through practitioner-oriented outlets such as PM Network© and have been incorporated into best practice prescriptions promoted by professional organizations such as the Project Management Institute in the United States and the Association for Project Management in the United Kingdom. Yet we still have strong evidence that IT project risk management research findings are not being applied (Bannerman, 2008; de Bakker *et al*., 2010), suggesting that the problem is deeper than failure of researchers to investigate relevant topics or failure to transfer research knowledge to practitioner-oriented media. Strangely though, there has been little attention to the question of *why* these findings and best practice prescriptions are not being applied in practice.

Researchers in other disciplines, such as management and public policy, have argued that simply producing relevant research is not enough; research knowledge must be transformed or reconstructed to meet the idiosyncrasies and constraints of practice contexts in order to make it managerially useful (Nutley *et al*., 2003; Rasche and Behnam, 2009; Markides, 2011). Most typically, such transformation requires the active participation of practitioners, who can convert research findings into action through the operation of their expertise in particular settings (Desforges, 2000; Markides, 2011). In addition, knowledge produced in the research context is often presented in a prescriptive, text-based format that works well in communicating to other academics, but is less effective than visual representation formats in conveying meaning and providing cognitive support to managers (Desforges, 2000; Worren *et al*., 2002). The case study described in this paper illustrates how research knowledge transformation can be achieved in practice through these two key aspects – active participation of practitioners and visual presentation of research knowledge.

First, the PMO staff at CityOrg were research-oriented, so they began from a starting point based in the substantial body of knowledge on IT project risk management and used a rigorous approach to developing and evaluating the initiatives in each action research cycle. At the same time, the PMO brought a practitioner perspective, founded in the practical realities of the organizational context, to the conceptualization of the problem and the evaluation of the outcomes of each action research cycle. The practical action research supported field experimentation in context and allowed an emerging understanding of the situational constraints that can obstruct effective application of any proposed problem solution, resulting in the development of a risk assessment process that was both research-based and able to be utilized effectively in the practice context.

In particular, the action research approach used here surfaced a practical solution that addresses concerns that, in practice, managers tend to focus on only a few risks and to place more weight on impact than on probability of occurrence of these risks (Moynihan, 1997; Pablo, 1999). As shown in Tables 1 and 2, the project dimensions used by CityOrg in their risk assessment process are associated with different categories of risk from the research literature. By focusing on measurable dimensions of projects that are known to be linked with project performance, CityOrg addresses risks indirectly, based on the assumption that higher measures on the dimensions are associated with higher risk. This indirect approach allows CityOrg to ensure that all risks are covered in the assessment without having to identify individual risks. CityOrg's process also shifts the focus away from the uncertain ground of estimating probability and impact for each risk, and onto measurements of project dimensions that can be more easily and accurately determined even with the relatively incomplete information typically available at the beginning of a project.

The second critical aspect of the case was the recognition by the PMO staff of the need to develop a better means of communicating their risk assessments to local project managers and other stakeholders. A simple change in presentation, from a text-based to a graphical format, played a major part here in making relevant research useful in practice. Although radar diagrams such as CityOrg's spider chart are of course not new, and have been promoted for many years as an effective means of condensing information on many variables into an intuitively understood format (Tufte, 2001, is the classic work), this particular implementation for the purpose of holistic risk assessment is new and worthy of wider dissemination. The risk spider chart, with its easily assimilated graphical presentation of risk assessments, provides a quick and impactful reference and summary of the project characteristics, and acts as a boundary spanning object (Levina and Vaast, 2005), enabling the PMO staff to develop effective working relationships with local department project managers. Project managers use the spider charts on an on-going basis, pinning them on their office walls as a visual reminder of the likely problem areas in their projects and using them to aid communication with sponsors, steering committees, and other stakeholders.

Implications for practice

The contingency approaches to IT project risk management recommended in the research literature have provided little guidance for practical implementation. CityOrg's approach demonstrates how to take a research-based recommendation to use contingency approaches to manage uncertainty and turn it into a practical solution. The recommended actions arising out of the risk assessment process revolve around reducing uncertainty and complexity in the proposed projects. In particular, following the contingency approach, high-risk projects are subject to higher levels of planning and oversight, with project management strengthened through the application of project management methodologies and the assignment of more experienced managers and mentors. Although CityOrg's PMO does not explicitly advocate use of situational awareness approaches to project management, as recommended by researchers in the contingency strand of risk management research, their approach does set the stage for a continual awareness of the high complexity and ambiguity dimensions.

The implementation of many concurrent initiatives to improve project management practices at CityOrg precludes the attribution of performance improvements to any one of these initiatives. However, aspects of the successful implementation of risk management practices in this case can provide insights that may help other organizations to apply research-supported risk management practices in their IT projects. As de Bakker *et al.* (2010) note, many of the risks in IT projects are epistemic rather than probabilistic, and risk mitigation decisions in such circumstances depend on the availability of sufficient information. In addition, each project is likely to have context-specific problem areas that must be addressed. In these situations, traditional probability-impact risk management approaches break down, but, as this CityOrg case shows, organizations do have practical alternatives to address and manage risks in their projects.

The risk assessment process and risk spider chart described in this case study comprise a useful toolkit for organizations struggling to get to grips with their IT project performance. CityOrg's typical process involves a PMO staff member working with the local project manager at the start of the project to capture details of various project dimensions. These dimensions are well founded in research as being significantly related to project performance, and are easy to assess at the early stages of any project. The project dimensions are used to determine oversight recommendations for the project, and are displayed on a risk spider chart, which is used for discussions on appropriate risk mitigation and management approaches with the local project manager and with various project stakeholders. The visual presentation on the risk spider chart provides an easy-to-use and impactful display both for discussion and collaboration about the project challenges and for quick reference throughout the course of the project. Together, the assessment process and chart form a powerful tool for the application of the contingency approach to IT project risk management and deserve wider adoption in the business world.

Limitations

Practice-driven research such as this study, involving a series of action research cycles at a single site, is clearly limited in terms of its generalizability. Action research is an emergent process in a fluid and constantly changing environment. Each planned intervention changes the situation under study and feeds into a new cycle of evaluation and action. The research takes place on-site and, as with all field studies, opportunities to control exogenous variables are limited or non-existent. The researcher is a participant in the process and hence the objectivity of reporting may vary depending on the level of researcher involvement. We have taken a number of steps to mitigate these limitations, using triangulation of researcher perspectives to mitigate potential bias from our participant involvement in the action cycles and triangulation of informants and data sources to provide complementary perspectives on the case. Viewing the findings in the context of two contrasting perspectives of risk management theory – probability-impact and contingency – provides a theoretical triangulation (Patton, 2002) to support our interpretation of the outcomes of the action cycles.

We do not claim any generalizability from a single case, as every organization will operate within a different set of environmental and contextual constraints. However, we do believe that examining the circumstances of this case and interpreting them within the framework of the risk literature reviewed earlier can provide insight into the practical realities of successful risk management and project oversight of IT projects, and into issues related to successful transfer of research knowledge into practice. Such insight can provide a foundation for further studies to elaborate on the challenges of utilizing research knowledge in practice, and can also provide practical suggestions for other organizations facing similar IT project risk management issues.

Conclusion

In this paper we have sought to address the gap between IT project risk management research and practice by demonstrating how one organization has embedded research knowledge in a practical and effective application. Instead of attempting the traditional probability-impact method of assessing project risks on a risk-by-risk basis, the PMO at CityOrg has taken a contingent and holistic approach, categorizing projects on their level of overall inherent risk by evaluating key dimensions known to be associated with project success. Drawing on a foundation of research knowledge and extensive project management experience, the PMO has developed a risk assessment process and associated risk spider chart that have proven to be effective tools in practice for surfacing inherent risk at the early stages of IT projects and enabling appropriate management strategies to be recommended. The project risk assessment process is a model for other organizations striving to engage in effective practices in order to improve project outcomes.

In summary, the case study reported here provides an illustration of how research can be effectively utilized in practice. We believe the successful application of research in this instance had three key features:

- Active participation of research-oriented practitioners who have a detailed understanding of the constraints and ambiguities of the practice context.
- Synthesis of an overwhelming checklist of risk factors, which are difficult to assess accurately at the start of a project, into a manageable set of project dimensions that can be measured at the start.
- Presentation of the information in a format that allows easy visualization of the interaction of individual details, displays information holistically, and supports discussion among multiple stakeholders.

It is essential for researchers interested in improving practitioners' uptake of research findings to consider the practical constraints of the context of application. In particular, it is important to recognize that research findings, often developed with 20–20 hindsight from retrospective examination of facts, can only be effectively utilized in the workplace if they are transformed to incorporate the ambiguities, uncertainties, and incomplete information typically faced by practitioners attempting to manage future scenarios.

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References

Addison, T. and Vallabh, S. (2002). Controlling Software Project Risks – An Empirical Study of Methods Used by Experienced Project Managers, in Proceedings of the Annual Conference of the South African Institute of Computer Scientists and Information Technologists (SAICSIT) (Port Elizabeth, South Africa, 16–18 September).

Alter, S. and Ginzberg, M. (1978). Managing Uncertainty in MIS Implementation, *Sloan Management Review* **20**(1): 23–31.

Association for Project Management. (2006). *APM Body of Knowledge*, 5th edn, London: Association for Project Management.

Bannerman, P.L. (2008). Risk and Risk Management in Software Projects: A reassessment, *Journal of Systems and Software* **81**(12): 2118–2133.

Barki, H., Rivard, S. and Talbot, J. (1993). Toward an Assessment of Software Development Risk, *Journal of Management Information Systems* **10**(2): 203–225.

Barki, H., Rivard, S. and Talbot, J. (2001). An Integrative Contingency Model of Software Project Risk Management, *Journal of Management Information Systems* **17**(4): 37–69.

Benbasat, I. and Zmud, R.W. (1999). Empirical Research in Information Systems: The practice of relevance, *MIS Quarterly* **23**(1): 3–16.

Boehm, B.W. (1973). Software and its Impact: A quantitative assessment, *Datamation* **19**(5): 48–59.

Boehm, B.W. (1983). Seven Basic Principles of Software Engineering, *Journal of Systems and Software* **3**(1): 3–24.

Boehm, B.W. (1991). Software Risk Management: Principles and practices, *IEEE Software* **8**(1): 32–41.

Boehm, B.W. and Turner, R. (2004). *Balancing Agility and Discipline: A guide for the perplexed*, Boston: Addison-Wesley.

Brooks Jr., F.P. (1974). Mythical Man-Month, *Datamation* **20**(12): 44–52.

Charette, R.N. (1996). The Mechanics of Managing IT Risk, *Journal of Information Technology* **11**(4): 373–378.

Creswell, J.W. (2008). *Educational Research: Planning, conducting and evaluating quantitative and qualitative research*, 3rd edn, Upper Saddle River, NJ: Pearson Merrill Prentice Hall.

de Bakker, K., Boonstra, A. and Wortmann, H. (2010). Does Risk Management Contribute to IT Project Success? A Meta-Analysis of Empirical Evidence, *International Journal of Project Management* **28**(5): 493–503.

Desforges, C. (2000). *Putting Educational Research to Use Through Knowledge Transformation*, Keynote lecture presented at the Further Education Research Conference (Coventry, England, 12 December).

Fairley, R. (1994). Risk Management for Software Projects, *IEEE Software* **11**(3): 57–67.

Heemstra, F.J. and Kusters, R.J. (1996). Dealing with Risk: A practical approach, *Journal of Information Technology* **11**(4): 333–346.

Herbsleb, J., Zubrow, D., Goldenson, D., Hayes, W. and Paulk, M. (1997). Software Quality and the Capability Maturity Model, *Communications of the ACM* **40**(6): 30–40.

Howell, D., Windahl, C. and Seidel, R. (2010). A Project Contingency Framework Based on Uncertainty and its Consequences, *International Journal of Project Management* **28**(3): 256–264.

Jiang, J.J., Klein, G. and Discenza, R. (2002). Pre-Project Partnering Impact on an Information System Project, Project Team and Project Manager, *European Journal of Information Systems* **11**(2): 86–97.

Jiang, J.J., Klein, G., Hwang, H.-G., Huang, J. and Hung, S.Y. (2004). An Exploration of the Relationship Between Software Development Process Maturity and Project Performance, *Information & Management* **41**(3): 29–288.

Keil, M., Cule, P., Lyytinen, K. and Schmidt, R. (1998). A Framework for Identifying Software Project Risks, *Communications of the ACM* **41**(11): 76–83.

Kutsch, E. and Hall, M. (2005). Intervening Conditions on the Management of Project Risk: Dealing with uncertainty in information technology projects, *International Journal of Project Management* **23**(8): 591–599.

Levina, N. and Vaast, E. (2005). The Emergence of Boundary Spanning Competence in Practice: Implications for implementation and use of information systems, *MIS Quarterly* **29**(2): 335–363.

March, J.G. and Shapira, Z. (1987). Managerial Perspectives on Risk and Risk Taking, *Management Science* **33**(11): 1404–1418.

Marcus, M.L. (1997). The Qualitative Difference in Information Systems Research and Practice, in A. Lee, J. Liebenau and J.I. DeGross (eds.) *Information Systems and Qualitative Research*, London: Chapman & Hall, pp. 11–27.

Markides, C. (2011). Crossing the Chasm: How to convert relevant research into managerially useful research, *Journal of Applied Behavioral Science* **47**(1): 121–134.

Martin, N.L., Pearson, J.M. and Furumo, K. (2007). IS Project Management: Size, practices and the project management office, *Journal of Computer Information Systems* **47**(4): 52–60.

Mathiassen, L. (2002). Collaborative Practice Research, *Information Technology & People* **15**(4): 321–345.

McFarlan, F.W. (1981). Portfolio Approach to Information Systems, *Harvard Business Review* **59**(5): 142–150.

Miles, B.M. and Huberman, A.M. (1994). *Qualitative Data Analysis: An expanded sourcebook*, 2nd edn, London: Sage.

Moynihan, T. (1997). How Experienced Project Managers Assess Risk, *IEEE Software* **14**(3): 35–41.

Nutley, S., Walter, I. and Davies, H.T.O. (2003). From Knowing to Doing: A framework for understanding the evidence-into-practice agenda, *Evaluation* **9**(2): 125–148.

Pablo, A.L. (1999). Managerial Risk Interpretations: Does industry make a difference? *Journal of Managerial Psychology* **14**(2): 92–107.

Patton, M.Q. (2002). *Qualitative Research & Evaluation Methods*, 3rd edn, Thousand Oaks, CA: Sage.

Pender, S. (2001). Managing Incomplete Knowledge: Why risk management is not sufficient, *International Journal of Project Management* **19**(2): 79–87.

Pennington, R. and Tuttle, B. (2007). The Effects of Information Overload on Software Project Risk Assessment, *Decision Sciences* **38**(3): 489–526.
Pfleeger, S.L. (2000). Risky Business: What we have yet to learn about risk management, *Journal of Systems and Software* **53**(3): 265–273.
Pich, M.T., Loch, C.H. and De Meyer, A. (2002). On Uncertainty, Ambiguity, and Complexity in Project Management, *Management Science* **48**(8): 1008–1023.
Pohlmann, T. (2003). *How Companies Govern their IT Spending*, Cambridge, MA: Forrester Research.
Powell, P.L. and Klein, J.H. (1996). Risk Management for Information Systems Development, *Journal of Information Technology* **11**(4): 309–319.
Project Management Institute. (2004). *A Guide to the Project Management Body of Knowledge (PMBOK Guide)*, 3rd edn, Newton Square, PA: Project Management Institute.
Rasche, A. and Behnam, M. (2009). As if it were Relevant: A systems theoretical perspective on the relation between science and practice, *Journal of Management Inquiry* **18**(3): 243–255.
Raz, T., Shenhar, A. and Dvir, D. (2002). Risk Management, Project Success, and Technological Uncertainty, *R & D Management* **32**(2): 101–109.
Reynolds, P. and Yetton, P. (2007). Building Theory from Practice: Opportunities in IS Project Management, in AMCIS 2007 Proceedings. Paper 428, http://aisnet.org/amcis2007/428.
Sambamurthy, V. and Zmud, R.W. (1999). Arrangements for Information Technology Governance: A theory of multiple contingencies, *MIS Quarterly* **23**(2): 261–290.
Sauer, C., Gemino, A. and Reich, B.H. (2007). The Impact of Size and Volatility on IT Project Performance, *Communications of the ACM* **50**(11): 79–84.
Schmidt, R., Lyytinen, K., Keil, M. and Cule, P. (2001). Identifying Software Project Risks: An international Delphi study, *Journal of Management Information Systems* **17**(4): 5–36.
Shenhar, A.J. (2001). One Size Does Not Fit All Projects: Exploring classical contingency domains, *Management Science* **47**(3): 394–414.
Shenhar, A.J., Dvir, D., Levy, O. and Maltz, A.C. (2001). Project Success: A multidimensional strategic concept, *Long Range Planning* **34**(6): 699–725.
Simister, S.J. (2004). Qualitative and Quantitative Risk Management, in P.W.G. Morris and J.K. Pinto (eds.) *The Wiley Guide to Managing Projects*, Hokoben: John Wiley & Sons, pp. 30–47.
Sommer, S.C. and Loch, C.H. (2004). Selectionism and Learning in Projects with Complexity and Unforeseeable Uncertainty, *Management Science* **50**(10): 1334–1347.
Stake, R.E. (2000). Case Studies, in N.K. Denzin and Y.S. Lincoln (eds.) *Handbook of Qualitative Research*, Thousand Oaks, CA: Sage, pp. 435–454.
Standish Group. (2001). *Extreme CHAOS*, West Yarmouth, MA: Standish Group International.
Standish Group. (2005). *Chaos Rising*, West Yarmouth, MA: Standish Group International.
Straub, D.W. and Ang, S. (2011). Rigor and Relevance in IS Research: Redefining the debate and a call for future research, *MIS Quarterly* **35**(1): iii–xi.
Subramanian, G.H., Jiang, J.J. and Klein, G. (2007). Software Quality and IS Project Performance Improvements from Software Development Process Maturity and IS Implementation Strategies, *Journal of Systems and Software* **80**(4): 616–627.
Sumner, M. (2000). Risk Factors in Enterprise-Wide/ERP Projects, *Journal of Information Technology* **15**(4): 317–327.
Susman, G.I. and Evered, R.D. (1978). An Assessment of the Scientific Merits of Action Research, *Administrative Science Quarterly* **23**(4): 582–603.
Sussman, S.W. and Guinan, P.J. (1999). Antidotes for High Complexity and Ambiguity in Software Development, *Information & Management* **36**(1): 23–35.
Taylor, H. (2005). Congruence Between Risk Management Theory and Practice in Hong Kong Vendor-Driven IT Projects, *International Journal of Project Management* **23**(6): 437–444.
Taylor, H. (2006a). Critical Risks in Outsourced IT Projects: The intractable and the unforeseen, *Communications of the ACM* **49**(11): 74–79.
Taylor, H. (2006b). Risk Management and Problem Resolution Strategies for IT Projects: Prescription and practice, *Project Management Journal* **37**(5): 49–63.
Taylor, H. (2007). An Examination of Decision-Making in IS Projects from Rational and Naturalistic Perspectives, in ICIS 2007 Proceedings. Paper 30, http://aisle.aisnet.org/icis2007/30.
Tufte, E.R. (2001). *The Visual Display of Quantitative Information*, Cheshire, CT: Graphics Press.
Van de Ven, A.H. (2007). *Engaged Scholarship: A guide for organizational and social research*, Oxford, UK: Oxford University Press.
Voetsch, R.J., Cioffi, D.F. and Anbari, F.T. (2004). *Project Risk Management Practices and their Association with Reported Project Success*, Paper presented at the IRNOP VI Conference, 25–27 August, Turku, Finland.
Wallace, L. and Keil, M. (2004). Software Project Risks and their Effect on Outcomes, *Communications of the ACM* **47**(4): 68–73.
Wallace, L., Keil, M. and Rai, A. (2004). How Software Project Risk Affects Project Performance: An investigation of the dimensions of risk and an exploratory model, *Decision Sciences* **35**(2): 289–321.
Walsham, G. (2006). Doing Interpretive Research, *European Journal of Information Systems* **15**(3): 320–330.
Ward, S. and Chapman, C. (2003). Transforming Project Risk Management into Project Uncertainty Management, *International Journal of Project Mana-gement* **21**(2): 97–105.
Wolcott, H.F. (1994). *Transforming Qualitative Data: Description, analysis, and interpretation*, Thousand Oaks, CA: Sage.
Worren, N., Moore, K. and Elliott, R. (2002). When Theories Become Tools: Toward a framework for pragmatic validity, *Human Relations* **55**(10): 1227–1250.
Wysocki, R.K. (2001). *Building Effective Project Teams*, New York: John Wiley & Sons.
Wysocki, R.K., Beck Jr., R. and Crane, D.B. (2000). *Effective Project Management*, 2nd edn, New York: John Wiley & Sons.
Yin, R.K. (2009). *Case Study Research: Design and methods*, 4th edn, Thousand Oaks, CA: Sage.
Zmud, R.W. (1980). Management of Large Software Development Efforts, *MIS Quarterly* **4**(2): 45–55.
Zmud, R.W. (1998). *Conducting and Publishing Practice-Driven Research*, Paper presented at the IFIP Working Groups 8.2 and 8.6 Joint Working Conference on Information Systems: Current issues and future changes, 10–13 December, Helsinki, Finland.

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Appendix

Table A1 Representative selection of projects evaluated with the risk spider chart process, and assessments, recommendations, and actions

Project	*Project description*	*Assessment summary*	*Recommendations*	*Actions*	*Results*
A	Central IT implementation of a software tool on all client workstations across all departments, affecting more than 10,000 users	Significant risk of going over schedule and budget owing to high span of impact, new technology, and being led by a relatively inexperienced project manager	Monthly dashboard reporting. (i) Get departmental buy-in as early as possible to minimize the risk of going over schedule. (ii) Use a signed charter agreement to document buy-in. (iii) Use a labor-tracking tool to track internal labor to measure costs and progress against planned work	Buy-in was documented via a signed charter, but only after lengthy negotiations. Labor tracking tool was implemented	Schedule duration was 260% over its initial estimate, because of time taken to get agreement on the project schedule from multiple departments
B	New business application implementation in a single department	Significant risk of losing focus owing to very long duration combined with high business and technical uncertainty and complexity	Monthly dashboard reporting. (i) Split the project into multiple smaller projects in order to manage duration and allow for pilot test of business and technology changes. (ii) Supplement the team with a mentor with experience in the management of IT projects	The project was broken into a series of smaller projects starting off with a pilot effort in a low-risk business area. A more experienced project manager was assigned as a mentor to work directly with the project manager on specific deliverables	Completed on time and on budget, delivering all required scope. Won an industry award for excellence in business performance/strategic planning and the organization's annual award for Project Management Excellence
C	Replace all manual work order management processes with automated enterprise-level Commercial-Off-The-Shelf (COTS) application using a single shared database and workflow application system	Several higher risk attributes that could compromise the outcome of the effort. However, the visibility of the project was largely contained to the department. Scope could be reduced if necessary to offset unexpected cost increases. The department did not have experience with large complex IT projects	Monthly dashboard reporting. (i) Conduct a risk identification workshop to help expose what the team and stakeholders did not know and help align stakeholders on pitfalls and strategies to reduce risk	Recommendation adopted. Department hired a knowledgeable project manager to guide them	Still in progress and positioned for completion ahead of schedule and under budget overall
D	Change manual processes for receiving, reviewing, and approving documents and plans to online submission, review and approval	The project had high levels of internal and external visibility and a number of uncertainties that were likely to lead to schedule expansion, increased cost, and the potential for issues with cultural changes. The project sponsor and project manager had experience on projects of similar size, scope, and complexity	Monthly dashboard reporting. Owing to the project sponsor and project manager's experience and the Department's success with similar projects, no specific recommendations were made		The project delivered all scope and successfully achieved the project objectives. The project was delivered on budget, but was 15 weeks (−30%) later than planned, due to a key resource being diverted to a higher priority project. As expected, some of the in-house development was more complex and took longer to develop than originally estimated

E	Add enhancements and functionality to a previously implemented Software as a Service (SaaS) application that was deployed to fulfill a legal mandate	This project exhibited a moderate risk profile with high external and internal visibility, broad span of impact, some new technology, business process reengineering, moderate cost and duration. Some aspects were critical in order to meet the legal mandate. User acceptance of the previous release of the application was challenged. Some high-risk factors were offset by the sponsor's and the team's prior experience implementing the initial project and the application of lessons learned from that project	Monthly dashboard reporting. (i) Restructure the project into smaller chunks to address existing user issues first. (ii) Defer deployment of optional functionality pending improved user acceptance of the already deployed application. (iii) Develop distinct budgets and schedules for all project work. (iv) Clarify roles and responsibilities to increase understanding about ownership and accountability	The recommendations were not adopted due to a lack of buy-in from the Executive Steering Committee. Project work and daily operational work and budgets became intermingled so it became difficult to manage the effort as a project. These problems became apparent in the monthly dashboard reporting process and led to the project being rated unhealthy and at-risk by the PMO	The recommendation to restructure the project was adopted after the Executive Committee failed to come to agreement on the scope and detailed roles and responsibilities and the project received an at-risk rating from the PMO. The first stage of the restructured project has proceeded successfully
F (see Figure 2)	A CityOrg department will partner with a State agency to provide a web-based universal internet portal that makes it easier for individuals to apply for and access a variety of vital services and benefits	The project exhibited a high-risk profile. Much of the technical and project management risk would be owned by State. The City portion of the project required considerable collaboration with internal City organization and the City had very limited input and control of the final solution. The roles, responsibilities, accountabilities, and commitments with the partner agency were vague. If the project failed to achieve grant requirements, grant funding could be at risk and the department would be required to cover expenses	Monthly dashboard reporting and independent oversight of partner agency. (i) Assign a project manager who has experience with projects of similar size and complexity. (ii) Implement a Memorandum of Agreement to clarify roles, responsibilities, commitments, authorities and accountabilities between all partners. (iii) Clarify scope and re-estimate cost, duration, and risks to be sure the constrained budget will be sufficient to complete the project	All recommendations adopted except independent oversight of partner agency	The project has been placed on hold by the sponsors until the City's participation in the project is more clearly defined and they are confident the partner agency can fulfill its commitments
G	Replace the City's messaging and calendar application with a different technology. The project was initiated out of an earlier project that developed the project and implementation plans, architecture design, and cost estimate. The project represents a significant technical shift of a highly visible, mission critical application used on a daily basis by City staff	The project showed several high-risk factors in critical areas due largely to its size and span of impact and therefore presented a high-risk profile. Although a plan that called for staged deployment of the application helped reduce the risk, strong project management disciplines would be required to improve the likelihood of success.	Monthly dashboard reporting and independent project oversight by an outside consultant	The project used highly experienced consultants to develop the implementation plan	The project completed on time and 28% under budget, and delivered all identified scope
H	Departmental mission critical project to replace two MS Access-based applications with a Commercial Off-the-Shelf (COTS) web-based software application to improve the department's ability to evaluate data and track business needs. Original proposal was to implement a pre-release version of the vendor software package, requiring considerable configuration	The project presented a moderate risk profile owing to its internal and external visibility, the proposed use of pre-release software that would require considerable configuration by staff who have little experience with that type of technology, and the long duration and the project manager and sponsors lack of experience with projects of this size and complexity	Monthly dashboard reporting. (i) Consider solutions that were already proven in the industry. (ii) Add an experienced advisor to the team to guide them through creating a Statement of Work for the vendor and the planning stage of the project	Both recommendations were adopted	The project is still in the Planning Phase. With planning and procurement activities underway, the project currently exhibits a healthy profile

Table A1 Continued

Project	*Project description*	*Assessment summary*	*Recommendations*	*Actions*	*Results*
I	Custom build an employee self-service portal and upgrade a major Commercial-Off-The-Shelf (COTS) application to a supported version of the same vendor's software. The application is used by all City employees and departments	The project exhibited a medium-to-low overall risk profile. While this project was highly visible across the City, it maintained a low profile external to the City. A governance structure was in place with three key stakeholders as Steering Committee members. The custom development component posed the most significant technical risk but would re-use some modules from another application to minimize risks. The project team was small and was familiar with the technology and earlier upgrade approach. The project manager and team had successfully performed earlier upgrades. This new version of the vendor software had been proven in the market for about 1 year. Very little customization of the software was required	Monthly dashboard reporting. (i) Assign one of the three key sponsors as the 'final authority.' (ii) Implement simple practices for Project Portfolio Management and Resource Management to help reduce exposure to ongoing issues with frequent unscheduled work, and serious resource contention. (iii) Develop detailed work plans that provided a minimum of a 90-day look-ahead, and milestone level plans for the project and resource load these work plans	Recommendations (i) and (ii) were not adopted. The 90-day look-ahead was adopted but only sporadically implemented. Use of resource planning was not adopted	This project is nearing completion but is 38% behind the original schedule and 8% behind a re-baselined schedule. The department does not practice Project Portfolio Management and is subject to frequent and unexpected new high priority projects that delay work-in-progress. The project managers assigned at the time of the Risk Profile Review did not come onto the project as planned. The project was then assigned to an internal project manager
J	Replace an existing technology platform because the old platform was no longer supported by the vendor, migrating a portion of existing application functionality from the old platform to the newer technology system	The project presented a moderate risk profile owing to the criticality of the functionality delivered, the long duration, citywide visibility, and multi-department nature	Monthly dashboard reporting. (i) Owing to the multi-department nature of the project, form a steering committee of representatives from affected departments to provide input to the strategic direction of the project	Recommendation adopted	The project is complete with very good performance on scope, budget, and schedule. All objectives were achieved. After adjustment for change orders, scope was delivered for 4.6% less than planned cost and the 16-month project was delivered 4.6% beyond the planned completion date