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A framework for ex ante project risk assessment based on absorptive capacity

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Abstract

This paper explores the applicability of the concepts of absorptive capacity and "*ba*" to ex ante project risk. We develop a hybrid framework to explain knowledge transfer based on these concepts—one that proposes a hybrid transference process. We then apply this framework to develop a methodology and metric for assessing ex ante software project risk, the risk that a new technology introduced into an organization may not be used as designed or may not achieve the anticipated benefits. As a preliminary validation of these concepts, we describe three case studies, employing the framework and metric to show how examining absorptive capacity can help to assess the risk level of software projects.

Keywords: IS organizational risk; IS risk assessment; Absorptive capacity; IS implementation

1. Introduction

Assessing Information Systems (IS) project risk has been a longstanding topic in IS research (e.g., Cash et al., 1984; Keil et al., 1998; Lucas, 1974). Current approaches to IT project risk assessment essentially focus on the technology per se or on evaluating the project team's prior experience with implementing similar technologies. They may consider some organizational factors but do not explicitly consider the organization's learning capability (Senge, 1990). Most risk assessment approaches focus on *project risk*—namely issues that may prevent the team from successfully delivering the project on time and within budget (Barki et al., 2001). Such risk management frameworks tend to neglect *organizational* risk—for example, whether the system is likely to be accepted by its intended users and deployed in a manner consistent with the "spirit" (DeSanctis and Poole, 1994) of its designers and champions, as required to deliver the anticipated benefits (Chan, 2000).

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Recent empirical studies of firms' responses to the introduction of technological innovations have shown that the organization's ability to make use of such innovations varies among firms even within the same industry segment. It has long been recognized that the same innovation, when introduced into different organizations, will occasion different outcomes (Barley, 1986; Orlikowski, 1993; Robey and Sahay, 1996), depending on the context in which it is introduced, and the actions of key stakeholders during and after implementation (Markus and Robey, 1988; Ciborra, 2000). This difference in organizational dynamics occasioned by the same innovation is due, in large measure, to the firm's ability to identify, assimilate, and exploit new knowledge—what Cohen and Levinthal (1990) labeled *absorptive capacity*. When assessing project risk, it is necessary to consider not only risks related to the technology itself, but also organizational risks—specifically potential users' ability to understand, accept, and faithfully appropriate the technology in order to achieve the intended performance outcomes. In this paper, we describe a new approach to ex ante (i.e., pre-implementation) risk assessment based on the concept of absorptive capacity (AC) (Cohen and Levinthal, 1990). Moreover, we develop a theoretical metric for assessing AC and we apply it to three recent case studies of IT implementation initiatives.

2. Literature review

2.1. IT software project risk

Historically, research into software project risk has focused on areas of internal project risk or risk as associated in moving a system into production within a user organization. It has not focused on the ability of a user organization to adopt the system. In his classic work on risk assessment, McFarlan (1981) identified three dimensions of a project that influence the level of risk: size, experience with the technology and project structure. Barki et al. (1993) proposed a definition and measure for software development risk comprised of five factors: novelty aspects of the project, size, complexity, organizational environment and the project team's lack of expertise. Keil et al. (1998) identified the top three risk factors from their Delphi study as lack of top management support, failure to gain user commitment and misunderstanding the requirements. Schmidt et al. (2001) using a multi-cultural Delphi study identified 14 risk groups related to projects, including such areas as sponsorship and relationship management. Tiwana and Keil (2004) identified the following key risk characteristics: use of inappropriate technology, limited user/customer involvement, lack of project management practices, dissimilarity to other projects, complexity and requirements volatility. Wallace et al. (2004) conceptualized project risk along the dimensions of team, organizational environment, requirements, planning and control, user, and complexity. These studies have covered such organizationally related areas as sponsorship, user commitment, relationship management, and organizational environment but have not examined the area of the readiness of the organization to integrate the new system into their work processes.

2.2. Absorptive capacity theory

AC, a concept originally developed in the late 1980s (Cohen and Levinthal, 1989, 1990), has been recently re-invigorated in the management literature (Lane and Lubatkin, 1998; Zahra and George, 2002). Cohen and Levinthal (1990, p. 569) define AC as the "ability to identify, assimilate and exploit knowledge from the environment." They conceptualized AC as largely a function of the members of the organization having sufficient knowledge related to the target innovation. This concept derives from studies of individual learning and memory and is thus rooted in individual capabilities. AC is a multi-level construct, however—one that is also applicable at the level of the workgroup or organization or even at the level of interorganizational alliances or value networks (Lane and Lubatkin, 1999).

Our focus here is on the organizational level, where AC is embodied in the firm's communication capabilities—spanning both internal and

external communication (Cohen and Levinthal, 1990). Essential for such communication is the existence of an appropriate *knowledge differential* between the senders and receivers of information. According to Cohen and Levinthal, there must be an appropriate balance between knowledge sharing and knowledge diversity within the organization for optimal learning and performance to occur. Knowledge sharing is required for proper absorption of information across members, but knowledge diversity is also necessary for acquiring new sources of ideas, either from sources internal or external to the organization. Thus, AC exists as a capability that is embedded in the communication linkages among organizational members, as well as linkages across organizations (Cohen and Levinthal, 1990).

While the notion of AC is well established and has been employed in the IS literature for over a decade (e.g., Attewell, 1992; Fichman and Kemerer, 1997), management scholars such as Zahra and George (2002) have recently fine-tuned and extended the notion of AC to better reflect the insights from a decade of research on organizational learning (Senge, 1990), business process reengineering (Robey et al., 1995), and knowledge management (Kogut and Zander, 1992). For instance, Lane and Lubatkin (1998) extended the original definition of AC by noting that AC is a relative concept: a firm's AC may vary not only based on the amount of related knowledge it possesses, but may also vary based on its whether its capacity to learn is high or low relative to the "teacher" firm (i.e., the alliance partner from which it seeks to acquire new knowledge). In their study of learning from interorganizational alliances, Lane and Lubatkin (1998) found that not only must the "student" firm's existing knowledge base be relevant to the knowledge they seek to acquire but, in addition, their organizational structures, and prior problem-solving experience must be sufficiently similar to those of the "teacher" firm for optimal knowledge-sharing to occur.

2.3. Determinants of absorptive capacity

Subsequent to Cohen and Levinthal, other management scholars have identified additional determinants of AC. These antecedents moderate the firm's level of AC, since they affect how new information reaches the organization as well as how it is processed. Below, we summarize research on five additional factors that moderate a firm's level of AC.

2.3.1. Combinative capabilities

Expanding on Kogut and Zander's (1992) concepts, Van Den Bosch et al. (1999, p. 556) defined combinative capabilities as capabilities that "synthesize and apply current and acquired knowledge." They identified three sets of combinative capabilities: *systems capabilities*, which are preprogrammed behaviors (e.g., policies, directions and information systems in use), *coordination capabilities* (e.g., lateral communications across the "network" of the organization) and *socialization capabilities* (mores, social rituals, and expectations for interaction within a given social milieu). Van den Bosch et al. found that coordination capabilities had a positive effect on the absorption of new knowledge, while systems and socialization capabilities exerted a negative effect (because they create rigidity to change).

2.3.2. Motivation

Research has also examined the motivational aspects of AC (Gupta and Govindarajan, 2000; Van Den Bosch et al., 1999). Van Den Bosch et al. found that the level of AC shapes the firm's expectations for the future. The higher the firm's level of AC, the greater its ability to foresee the "next big thing" (Lewis, 2000)—that is to have "industry foresight." Moreover, Gupta and Govindarajan (2000) found that three antecedents drive a firm's AC: incentives to learn, a known *lack* of knowledge on a given subject, and even coercive pressure from management.

2.3.3. Organization structure

Lane and Lubatkin (1998) and Van Den Bosch et al. (1999) argued that the flexibility of a firm's organizational structure also shapes its AC. In their respective empirical studies of interorganizational alliances and publishing firms who transitioned into multimedia publishing, these researchers found that the more flexible the

organization and the wider its scope of awareness, the greater its AC (Van Den Bosch et al., 1999; Lane and Lubatkin, 1998). Moreover, successful firms tend to migrate toward organizational forms characterized by greater flexibility and scope, in order to be able to constantly adapt to turbulent environments. Van Den Bosch et al. found that functional organizations had a negative effect on AC, while matrix forms had a positive effect and divisional forms had a neutral effect.

2.3.4. Cultural fit

Similarly, various authors have noted the importance of a cultural fit between the "student" and "teacher" organizations (Lane and Lubatkin, 1998; Gupta and Govindarajan, 2000). Lane and Lubatkin found that the student firm's knowledge processing systems and its approach to identifying and solving problems (i.e., dominant logic) should be in close correspondence with those of the teacher firms. By knowledge processing system, Lane and Lubatkin refer to employee compensation and other incentive systems that motivate employees to learn. Gupta and Govindarajan also discovered that as *homophily* (the quality of the relationship between the teacher and learner organization) increases, knowledge flows are enhanced as well.

2.3.5. Channels

Lane and Lubatkin (1998) also examined the importance of communications channels. They indicated that as the communication channel between firms becomes richer, the ability to absorb new knowledge increases. They identified three types of channels: *observational* channels (the least rich, by which a firm receives explicit knowledge from published sources), *informal* channels (conversations, email and other informal sources by which the firm receives a mix of tacit and explicit knowledge without intentionality), and *formal* channels (the richest channels, which are created by management and through which a formal relationships are created so that knowledge can be deliberately transferred). A mix of different channels is desirable, although the richer channel types require more effort to create and sustain.

2.4. Dynamic process of absorptive capacity

Zahra and George (2002) re-conceptualized the AC concept as a dynamic capability that processes knowledge through four iterative stages: *acquisition* (gaining knowledge from the external environment), *assimilation* (storing knowledge within the firm), *transformation* (recombining new information with existing knowledge to render it applicable to the firm), and *exploitation* (utilizing knowledge in new ways for the firm's processes).

2.5. Nonaka and Nonno's concept of "ba"

In a related vein, Nonaka and Nonno (1998) developed the concept of *ba* and the *SECI* model (which refers to socialization, externalization, combination, and internalization) to describe how knowledge is disseminated within organizations. Drawn from the precepts of Japanese philosophers Nishida and Shimizu, *ba* represents a "shared space that serves as a foundation for knowledge creation" (Nonaka and Nonno, 1998, p. 40). This space can be physical, virtual, mental or a combination of the above. It is characterized by a supportive context where relationships are created and nurtured so that the participants share knowledge and common experiences, thus allowing for tacit knowledge to be articulated, exchanged and absorbed.

In the *SECI* model, Nonaka and Nonno (1998) conceptualize a four-step process to facilitate the transfer of tacit knowledge via *ba.* The first phase, *socialization*, describes an opportunity for people to come together to engage in joint activities to allow the participants to achieve a common understanding and language—similar to the notion of *homophily* (Gupta and Govindarajan, 2000). The second phase is *externalization*, the conversion of tacit knowledge to external knowledge that can be transmitted to other individuals. This occurs through the "socialized" groups formed (in phase one) articulating their tacit knowledge by means of extensive use of visual symbols, dialogue and metaphor. The third step, *combination*, allows for the merging of new explicit knowledge with existing knowledge to create new forms of knowledge. In the socialized group, such externalized knowl-

edge can be more easily captured, disseminated to where it is needed, and combined with existing knowledge to render it useful. The final step is *internalization*—whereby new knowledge combinations become internalized among members to become tacit knowledge. This typically occurs in the form of practice or simulations in using the new knowledge, under the guidance of a trained mentor in order to successfully institutionalize the knowledge. If any phase of the *SECI* cycle is missing or defective, successful knowledge dissemination will be inhibited (Nonaka and Nonno, 1998).

3. Assessing organizational project risk through AC

Fig. 1 graphically depicts the concepts described above, showing the transmission of knowledge within the context of shared basic knowledge, *homophily* (attraction and trust that results from similar features), and *ba* (the shared space for knowledge exchange). We include Lane and Lubatkin (1998)'s concept of shared prior experience with problem solving (i.e., a shared "dominant logic") in the concept of *homophily*. In addition to creating the appropriate context for knowledge dissemination, there must be one or more channels through which knowledge can be transferred from "teachers" to "students." These channels may include a combination of the formal, informal, and observation channels, described above (Gupta and Govindarajan, 2000; Lane and Lubatkin, 1998).

The student organization must have in place the necessary organization structure and combinative capabilities to recognize, receive, and interpret new knowledge (Kogut and Zander, 1992; Lane and Lubatkin, 1998). Van Den Bosch et al., 1999 argued that certain organizational structures (e.g., matrix or networked structures) are more effective than other structures (e.g., functional hierarchies). The five phases of the knowledge transference process, based on Zahra and George's work, appear in Fig. 2.

4. Using the knowledge transfer model to assess organizational risk

Our model of knowledge transfer offers a set of criteria to assess the degree of organizational risk prior to implementing a technological innovation. Using the set of criteria below, we identify six areas of potential risk within a given software project initiative.

4.1. Prior related knowledge

Users must have prerequisite knowledge in order to assimilate new technologies. For example, if the technological innovation being introduced to prospective users is a networked, client-server system, users must have prior experience or

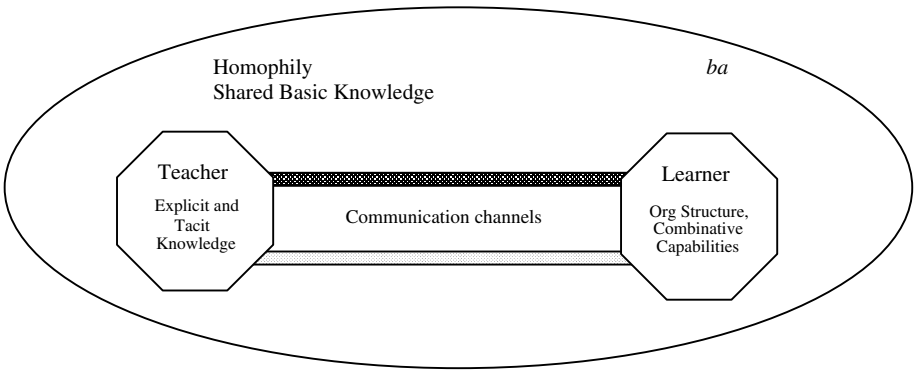

Fig. 1. Components of knowledge transference system.

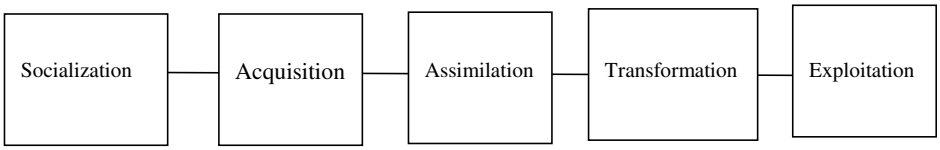

Fig. 2. Process of knowledge transfer (from Zahra and George, 2002; Nonaka and Nonno, 1998).[1]

training in using PCs, a mouse, graphical user interface, as well as to familiarity with how the network shares information with other users. If such prior, basic knowledge is lacking, hands-on training must be used to disseminate the required basic knowledge.

4.2. Combinative capabilities

Combinative capabilities (Kogut and Zander, 1992) should also exist in the organization. Management must develop such capabilities through interactions across organizational levels, as well as through lateral relationships among peers. As described above, Van Den Bosch et al. (1999) conceive of three sub-types of combinative capabilities: systems, coordination, and socialization. Such capabilities are created via training and job rotation programs, opportunities for working on participative projects within teams, and liaisons within and across different organizations (Van Den Bosch et al., 1999). Socialization capabilities are often reflected in the existence of a common culture (shared group identity, cohesion, common values, and norms for interaction among members). Systems capabilities consist of explicitly defined processes such as policies, procedures, and existing information technology in which these processes are embedded.

4.3. Motivation

Motivation considers the aspirations or expectations of organizational members. This refers to the following questions: Are members satisfied to perform their tasks according to the *status quo*, or do they have an expectation of ongoing improvement? Do they examine their interactions with external stakeholders to identify new sources of knowledge? Additionally, are members incented to search for new knowledge and if so, how?

4.4. Organization structure

Both formal and informal structures must be in place to support knowledge transfer within the organization during implementation of a technological innovation (e.g., from software developers-to-users and vice-versa). Prior empirical research by Van Den Bosch et al. indicate that a 'matrixed' organizational structure maximizes AC, while the traditional, functional structure is least effective in facilitating AC, with other structural forms supporting moderate levels of AC.

4.5. Cultural match

The primary concern is that there must be cultural fit between the sender of new knowledge (the "teacher") and the recipient (the "student"). These roles may exist within a given firm (i.e., "teacher" and "student" may work for different business units in the organization), or may exist across organizational boundaries—as in the case of learning from alliance partners (Lane and Lubatkin, 1998), or external consultants. Prior research has defined that the level of cultural "match" or fit helps to facilitate knowledge transfer, thus maximizing a firm's AC. This refers to the

[1] Zahra and George (2002) do not include a socialization stage in their model, but we have added this as the first stage to our model. The remaining stages of Zahra and George's model are analogous to Nonaka and Nonno's model, although not in a perfect one-to-one match. For instance, Nonaka and Nonno's externalization phase includes both Zahra and George's acquisition and assimilation phases, as well as including the step of turning tacit information into explicit information. Nonaka's combination phase and internalization phases correspond to Zahra and George's transformation and exploitation phases.

degree to which the values of and methods employed by the knowledge sender and recipient are compatible. Lane and Lubatkin (1998) operationalized cultural match in terms of individuals or organizations pursuing similar kinds of business, having and similar incentive systems and "dominant logics" for framing and solving business problems. The underlying assumption is that a stronger cultural match will facilitate development of attraction and trust among members who will share knowledge with each other (i.e., *homophily*) (Gupta and Govindarajan, 2000).

4.6. Creation of Ba and communication channels

Both *ba* and extensive, rich communication channels should exist between the implementers of the technological innovation and the target users, including both formal channels (e.g., steering committees, working groups, and training classes) and informal learning and help-giving behavior (user-driven testing and training, informal question-and-answer sessions). Management must not only intentionally establish, but also nurture formal mechanisms to facilitate knowledge transfer on an ongoing basis, while condoning (or at least not discouraging) additional, informal channels. We should also see processes that embody the four steps of the SECI cycle (Nonaka and Nonno, 1998), providing extensive opportunities for socializing among members, as well as for the target adopters to combine the new skills and knowledge that they seek to learn with their prior knowledge.

5. Toward a theory of assessing organizational risk

Prior research using the concepts of AC have been either conceptual in nature (Cohen and Levinthal, 1990; Kogut and Zander, 1992; Zahra and George, 2002) or empirical studies that focus on learning within interorganizational alliances (Cohen and Levinthal, 1989; Lane and Lubatkin, 1998; Gupta and Govindarajan, 2000). To date, however, there has been little attention to issues of AC within the context of software project implementation, project risk assessment, or with regard to the macro diffusion of new technologies across organizations (with the exception of Fichman and Kemerer, 1997). Given the lack of attention to AC within the IT software project literature, as a first step toward understanding the feasibility of these concepts as a lens for understanding technology adoption, we have developed a "quick and dirty" evaluation metric for applying the notion of AC to understanding the level of organizational risk inherent in IT projects.

5.1. A "quick and dirty" evaluation metric

The use of "quick and dirty" metrics is not new to the IS literature. Tiwana and Keil (2004) have developed a similar type of metric for assessing software project risk. Their metric allows the user to specify levels of six determinants of software project risk and to receive a "back of the envelope" estimate of project risk. Tiwana and Keil argue that such simple calculations are useful for conducting intuitive "what-if" assessments of proactive actions that can be taken to reduce risk. We have developed a similar metric for assessing organizational risk which we believe provides similar benefit to practitioners and which can be used to operationalize our theory and point the way to development of more rigorous metrics for assessing organizational risk in subsequent research.

Using the six antecedents of AC described above (see Fig. 1), we created a simple evaluation matrix to provide a quick-and-dirty assessment of the level of organizational risk within an IT project scenario. Each attribute is evaluated on a three-point scale (ranging from low to high) and then a simple arithmetic sum can be calculated to assess the overall level of organizational risk. We assign the following values, where "5" represents a high level of AC and "1" represents a low level of AC, summing all six attributes to achieve a total AC score. The maximum total possible score is 30, representing a very high level of AC (and conversely, low organizational risk), whereas the minimum score is 5 (representing a very low level of AC, and conversely high organizational risk). Table 1 shows a sample score. In this example, most of the determinants of AC exhibit a low-to-medium score of 1–3 points. The total score, 13,

Table 1
Example metric table

Determinant of absorptive capacity	Level	Point total
Prior related knowledge	High	5
Combinative capabilities	Low	1
Motivation/aspirations	Medium	3
Organizational form	Functional	1
Culture match with "teacher" firm	Low	1
Channel/*ba*	Informal channels only	2
Total AC score	Moderate–low	13

indicates fairly low AC, and conversely a high level of organizational risk.

6. Case study illustrations

Below, we employ secondary case study analysis to illustrate our framework and our quick-and-dirty metric for assessing AC, using existing case studies of URF, MANCO and Medinet. As noted by prior management and IS researchers (Jarvenpaa, 1991; Jauch, 1990), there are considerable benefits to be gained from secondary case studies, as opposed to primary case study research. Similar to other studies in the IS literature that relied upon secondary resources (e.g., Keil and Montealegre, 2000; Lee, 1989; Oz, 1994; Scott and Vessey, 2002), we employed secondary sources, namely case studies that have been published in the IS academic literature.

6.1. Case study 1: Implementing BATON at university research foundation

Wang and Paper (2005) describe the case of an IT-related change process in a university-owned research foundation (URF). At the time of the project, URF was a 40-year-old foundation overseeing scientific research, with three separate research units and a Commercialization Office (to oversee the patent application process). In recent years, URF had experienced significant growth that caused it to be spun out from the university to become a freestanding entity performing government research. The slowdown of the global economy and subsequent decrease in research funding and greater oversight of contracts impacted URF's ability to compete. URF therefore initiated a large-scale transformation to ensure its ongoing viability in the future. A new system, BATON, was envisioned as a facilitator of this transformation. This system was designed to improve the management of URF's intellectual property through implementing new support systems. Two external IT consultants were hired to manage BATON's implementation, starting in mid-2002.

URF's internal IT department, which would later assume responsibility for maintaining BATON, is best characterized by a low level of AC. While its software developers and IT support staff had high levels of general technical knowledge, they were not organized for—and lacked experience in—developing and implementing new software applications. Each IT staff member was responsible for maintaining his existing application systems as their own personal fiefdom—with little interaction with their peers or with URF management. These IT staff members had no systems or coordination capabilities for being able to handle the set of tasks associated with implementing new systems. Moreover, their socialization capabilities were grounded in "technology intimidation" (Wang and Paper, 2005, p. 47), which meant that they used their technical expertise to intimidate users into accepting the service they wanted to provide. They were focused on solving problems in the here-and-now, rather than on replacing existing systems with new functionality or optimizing the performance of the current system portfolio. It is not surprising that their expectations for improvement were extremely low, in part because they perceived that the status quo to be acceptable. Moreover, the internal IT staff members regarded the external consultants hired by URF management as over-selling the BATON system. One IT staff member remarked that:

> ...it's hard for [the internal IT staff] to take [the consultants] seriously, because [one consultant] often said the [BATON system would] basically replace all [other] IT tools. And their experience was that they had never seen anything [that] would do this ... So, it's hard to take [the consultants] seriously (Wang and Paper, 2005, pp. 46–47).

While the level of AC among URF's internal IT staff was low, this might, in principle, be remedied by hiring external consultants with complementary knowledge and skills that were lacking in-house. However, unfortunately, the external IT consultants hired to assist with this project did not exhibit good cultural fit with the IT staff members. The consultants had a different agenda than the internal IT staff, as well as very different reward structures and communication styles. Similar gaps between the incentives and rewards of consultants and technology specialists have been noted in other field studies of failed implementation projects (Orlikowski, 1992). Table 2 provides a summary of the URF project scenario prior to implementation of BATON.

In 1999, URF hired a new CEO with the mandate to propel URF into the future. He articulated a radical new vision, signaling that URF must change its business practices. He envisioned the use of BATON as not only facilitating more efficient practices but also assisting in revitalizing URF and propelling its growth. Despite the breadth of the CEO's new vision, he did not widely disseminate or seek to "enforce" his vision on other URF managers or staff employees. Nor did he place the BATON project as his top priority.

As the BATON project began in 2002, there was no effort to increase the level of AC among either the target users or the internal IT staff. The CEO did not initiate any new organizational structures or communication channels to provide opportunities for members to develop a shared understanding of the future system (i.e., *ba*), nor did he seek a leadership role in overseeing BATON's implementation. The IT manager, perhaps as a result of the CEO's inaction, similarly neglected to make any changes within the IT organization or to mobilize his own staff around the BATON effort. Finally, the external consultants also neglected to create any communication channels (i.e., *ba*) with the IT department until after they had gained the support of the URF business unit managers. Failure to get the IT department engaged until later served to delay and ultimately caused the project to fail, because of continual delays and problems with data conversion and operation of the system.

Table 2
URF's IT organization's ratings on determinants of absorptive capacity

Determinant of absorptive capacity	Level	Value
Prior related knowledge	High	5
Combinative capabilities	Low	1
Motivation/aspirations	Low	1
Organizational form	Functional	1
Cultural match with "teacher" firm	Low	1
Channel/*ba*	Informal channels only	2
Total AC score	Low	11

The results of the BATON implementation are fairly predictable, in light of our AC analysis. The internal IT staff rejected the new technology, obstructing efforts to implement it. Paper and Wang note that "IT specialists simply did not care about the project [and were . . .] not willing to carry out their given responsibilities to make the project a success" (Wang and Paper, 2005, p. 45). Not only did the IT staff resist the new system, but they "induced obstructions of some kind" at every juncture (*ibid*). Due to their failure to develop a shared understanding and appropriate communication channels for transferring their tacit and explicit knowledge about BATON, the external consultants lost the support of the business managers by early 2003, and the project subsequently stalled, and was eventually cancelled, causing URF to return to its traditional systems and processes.

6.2. Case study 2: Implementing ERP at MANCO

Sarker and Lee (2003) describe the implementation of ERP software at MANCO, a manufacturing subsidiary in the air-pollution and dust-collection markets. The order management process, which was the target for improvement, was organizationally fragmented between staff that reported to the Vice Presidents of engineering, sales, and operations. Immediately prior to the decision to implement ERP, the organization had become dysfunctional due to the existence of a "'territorial' culture created and encouraged by the . . . VPs" (Sarker and Lee, 2003, p. 818). There

was little information sharing among members of various business functions, which led to poor customer service and overall firm performance. The CEO determined to resolve the problem by the implementing an ERP system to ensure higher levels of integration and coordination.

Prior to initiating the ERP system, MANCO can be characterized by low levels of AC. While we lack sufficient information regarding the level of prior related knowledge to the ERP system, based on the case itself (Sarker and Lee, 2003), we do know that the firm's combinative capabilities were low, as evidenced by the lack of communication and information-sharing among members of different functional units. MANCO displayed a traditional, functional organization structure, characterized by a culture of territorialism and mistrust which led (not surprisingly), to a focus on each unit's individual performance rather than optimizing performance across business units for the benefit of its customers. The very low level of AC is summarized in Table 3.

MANCO's CEO, in contrast to his counterpart at URF, moved decisively to bolster MANCO's level of AC prior to implementing its ERP system. He dismissed the former VPs of engineering, sales, and operations, replacing them with a single Senior VP of Operations, who oversaw all three functional areas, while seeking to streamline the order management process. The CEO also took steps to foster a cooperative culture, and personally involved himself in monitoring the implementation of these culture change programs. His dedication resulted in the creation of a new organizational climate within MANCO. Coordination combinative capabilities increased as a result of increased collaboration among the engineering and production planning managers. The motivational level of MANCO's staff also increased as the prior focus on sub-optimizing each business function independently was replaced by a more integrated customer orientation and greater interdependence among units. The organization structure changed from a functional form to a more collaborative, networked-typed structure. The results of these structural and cultural changes at MANCO are summarized in Table 4.

As MANCO began ERP implementation, a formal communication channel was created for the implementation team members, which took the form of a cross-functional team whose members were carefully chosen by the MIS Manager based on nominations from all functional areas. Members were chosen based not only on their knowledge of their own functional area, but moreover based on the quality of their relationships with other divisions and their ability to collaborate with other members. This ERP implementation team collaboratively identified the detailed process changes required to implement ERP in a way that respected the existing members and the processes to be affected. MANCO's senior managers supported the team's decisions as well, thus empowering the team to take whatever actions they believed necessary. Lastly, the CEO strongly supported the implementation team's activities. Team members cheered when the CEO vowed to metaphorically "kill" anyone who hindered the ERP system implementation.

Table 3
MANCO's ratings on determinants of absorptive capacity (before reorganization)

Determinant of absorptive capacity	Level	Value
Prior related knowledge	Unknown	1
Combinative capabilities	Low	1
Motivation/aspirations	Low	1
Organization form	Functional	1
Cultural match with "teacher" firm	Unknown	1
Channel	None	2
Total AC score	Low	7

Table 4
MANCO's ratings on determinants of absorptive capacity (prior to implementation)

Determinant of absorptive capacity	Level	Value
Prior related knowledge	Unknown	1
Combinative capabilities	Moderate to high	4
Motivation/aspiration	Moderate to high	4
Organization form	Matrix	5
Cultural match with "teacher" firm	High	5
Channel/*ba*	Formal	5
Total AC score	High	24

Thus, the steps taken preemptively by the CEO to create the right environment for the implementation team, including the necessary communication channels (*ba*) among team members, and between team members and the target users helped to maximize the level of AC prior to implementing ERP. As a result of taking these steps early in the project's lifecycle, the ERP system was widely supported by the upper-, middle- and lower-levels of management at MANCO, as well as the target users, and was successfully implemented and received.

Following shortly after the successful implementation of the ERP systems' core modules, a subsequent follow-on project was identified: to implement a bolt-on *product configurator* module to "transform order processing by facilitating the configuration of products on-line and the generation of bills-of-material and routings pertaining to the configured order" (Sarker and Lee, 2003, p. 820). Despite being a much smaller project, relative to implementation of the core ERP modules, this subsequent project was much less successful, in part, because, the CEO (who had overseen the earlier phases) left the company and was replaced by the Operations VP who did not immediately hire a successor to serve as Operations VP. As a result, no one filled the gap created by his promotion, and there was a lack of hands-on managerial involvement in the product configurator's design and implementation. This leadership gap was exacerbated by the fact that oversight of the configurator implementation was assigned to two low-level engineers who lacked prior involvement in the ERP implementation, while also lacking prior relationships with business managers in the functional areas that were to be affected by the configurator.[2]

[2] Moreover, based on the early success of implementing the ERP core modules, the MIS manager had been promoted to corporate MIS manager and thus, he became responsible for ERP implementation in the parent company. He was thus, unavailable for the same level of involvement in overseeing the product configurator as he had exhibited during implementation of the ERP core modules.

Table 5
MANCO's ratings on determinants of absorptive capacity (before configurator)

Determinant of absorptive capacity	Level	Value
Prior related knowledge	High	5
Combinative capabilities	Low to moderate	2
Motivation/aspirations	Low to moderate	2
Organization form	Matrix	5
Cultural match with teacher	Low	1
Channel/*ba*	Informal	2
Total AC score	Low	17

Following this new turn of events, the lack of trust and communication that had existed prior to the original ERP system's implementation returned. The new CEO and the new VP he eventually hired did not sufficiently prioritize the importance of the product configurator project. The successful cross-functional implementation teams had been disbanded after completion of the ERP core modules, but prior to the configurator project and hence, the two low-level engineers were left to complete implementation of the product configurator on their own. These various changes caused the level of AC to decrease between the time the ERP core modules were implemented and when the product configurator was adopted, as summarized in Table 5.

Not surprisingly, the configurator implementation became viewed as "engineering's project" and was ignored by other members in the organization, who lacked knowledge of and enthusiasm for the project. As a result, implementation of the configurator encountered a variety of delays and design problems (Sarker and Lee, 2003).

6.3. Case study 3: Implementing an H/R system at a Dutch hospital

Bondarouk (2004) provides a case study of the implementation of a human resource (H/R) management system named "Beaufort" at Medinet, a large Dutch regional hospital. Medinet was formed in 1990 by the merger of three smaller hospitals and two clinics with the goal of achieving economies of scale and improving service within the region. In 2003, the merged entity had 1070

beds and 3800 employees, which were dispersed across four locations situated within 10 miles of the main city in which most members of the workforce resided. While the company sought to move toward a united Medinet culture, each location still retained its own local culture to some extent—"especially concerning management processes and task divisions" (Bondarouk, 2004, p. 253). The functions of H/R management were originally centralized, but in 1998 they were decentralized in order to allow H/R managers in each location to interface with employees regarding their specific concerns.

To support this new, decentralized structure, Medinet sought a new H/R system to replace the older centralized system that no longer supported hospital's needs. The new Beaufort system was selected because it allowed decentralized processing (at multiple locations) and information sharing across the organization. Two types of users were targeted for the system: first, Personnel and Salary Administration (PSA) employees for whom the system would support their primary job functions. and second, the local H/R managers and secretaries for whom the use of the system provided ancillary HR functions, which were outside of their day-to-day job duties. Implementation of "Beaufort" was planned to take place over 15 months, with the PSA employees being the first "wave" of adopters, followed later by the decentralized, local H/R managers and secretaries. Due to differences in the conditions affecting them, we consider the level of AC among each set of target adopters separately.

The level of AC among the PSA employees was high. These employees had significant prior related experience with another system, *Prigem*, an older system designed by the same vendor as Beaufort. The PSA staff also had high combinative capabilities due, in part, to their substantial experience working together (ranging from 5 to 12 years). Every morning, the staff had 30-min coffee breaks where they discussed problems and solutions, providing an opportunity for socialization to occur informally. The PSA staff thus did not focus on narrow job duties, but rather worked in a team-like, networked manner. PSA management was diligent in keeping these employees informed regarding Beaufort's progress, so they had clear expectations of what the new system would do. We assess the level of AC for the PSA staff as shown in Table 6.

Table 6
PSA's ratings on determinants of absorptive capacity

Determinant of absorptive capacity	Level	Value
Prior related knowledge	High	5
Combinative capabilities	High	5
Motivation/aspirations	High	5
Organization form	Network	5
Culture match with "teacher" firm	High	5
Channel/*ba*	Formal core team, dialoging, systematizing, exercising *ba*	5
Total AC score	High	30

The implementation schedule allowed PSA employees significant time for training and hands-on practice and experimentation, which allowed them to become comfortable with the system. One-third of the PSA employees were designated as *key users*, who received four days of training at the software vendor's office, followed by additional training in-house. These key users then assisted in training the remaining PSA staff, each of whom received approximately four hours of training for each module they were intended to use. All PSA users had their own PCs and could practice using Beaufort before the official "go live" date, under the guidance of the key users. The Beaufort system was implemented on target and was successfully integrated with the PSA staff's operations.

The situation was very different for the decentralized H/R managers and support staff, however. While these members also had high expectations for the new system, the level of prior related knowledge varied dramatically within this group. While most users (16 of 19) had experience using a computerized H/R system; some had no prior computer experience at all. Additionally, these employees were not accustomed to working together: in fact, most of these target users did not know each other, in part because they were distributed across the four satellite locations. Most had

Table 7
Decentralized users' ratings on determinants of absorptive capacity

Determinant of absorptive capacity	Level	Value
Prior related knowledge	Low/high	3
Combinative capabilities	Low	1
Motivation/aspirations	High	5
Organization form	Divisional	3
Culture match with "teacher" firm	Medium	3
Channel/*ba*	Informal	1
Total AC score	Low	16

been trained to work independently and develop their own H/R policies that suited their specific locations and needs. These individuals operated within their own divisional structure and thus, they had little opportunity to interact with their peers at other locations. This lack of familiarity and support among these users led to low levels of combinative capabilities. As shown in Table 7, their level of AC was low on all dimensions, with the exception of motivation level (which was high).

The Beaufort system required these H/R managers and support staff to change the methods by which they performed their tasks, enter different content into the system, assume responsibility for the financial aspects of the job and to work more collaboratively with other users.

During implementation, this group of users received virtually no training. One user received training at the vendor's location and was then expected to train the remaining 18 users. These 18 users received just one hour of instruction from one of the PSA specialists, with little time to practice using the system before the "go live" date. Following training, they were required to start using the system immediately. Not surprisingly, they encountered difficulties and ultimately rejected the system, which they found difficult to use. In part, this was because the system required them to perform tasks and enter information which they were not accustomed to doing. These employees, thus, lacked familiarity with the changes and lacked the communication channels needed to learn and share collaboratively with each other.

7. Discussion

From the case studies above, we can see that, in the absence of internal project related issues, assessing the AC of the organization and the channels to be used to implement the system can predict organizational risk issues in a project situation. Table 8 summarizes the results from the case studies with their associated AC metric score. These results show that the software projects that were subsequently successful exhibited higher scores on the "Total AC Score" metric than the unsuccessful sites. This is consistent with our theory that higher levels of AC translate to lower organizational risk which, in turn, enhances the likelihood of successful project implementation.

Table 8
Summary of results from case studies

Absorptive capacity determinant	Baton	MANCO ERP	MANCO configurator	Medinet PSA users	Medinet decentralized users
Prior related knowledge	High	Unknown	High	High	Low/high
Combinative capabilities	Low	Moderate to high	Low to moderate	High	Low
Motivation/expectations	Low	Moderate to high	Low to moderate	High	High
Organization	Functional (low)	Matrix (high)	Matrix (high)	Network (med-high)	Divisional (med-low)
Cultural match with "teacher" firm	Low	High	Low	High	Medium
Channels used	Informal/few	Formal/few	Informal/few	Formal/many	Informal/few
Total AC score	11	24	17	30	16
System implementation outcomes	Failure	Success	Failure	Success	Failure

It also shows that the effect of prior related knowledge on AC is significantly moderated by other determinants such as cultural match between the ''student'' and the ''teacher,'' the presence of formal and informal communication channels, and the existence and levels of combinative capabilities. These additional, moderating factors are important to articulate, since nearly all the projects exhibited high levels of prior related knowledge (the first row) and hence, prior knowledge does not help to discriminate between those projects exhibiting high versus low organizational risk.

It appears that combinative capabilities and channels seem to have the greatest effect on AC. The implementations with the highest scores had high levels of both of those determinants. Where they were low, the AC scores were low. The cultural match determinant seemed to follow this pattern with the exception of the Medinet distributed users where we rated it as medium. It seems to have a lesser impact. The other determinants appear to be not as highly correlated.

The cases that we used had only one situation where prior related knowledge was low (Medinet Decentralized Users) and that not for all users. This might be the determining factor as to why the implementation did not succeed as opposed to the low level of the determinants of AC. It might also explain why despite high levels of anticipation and motivation, this implementation did not succeed. Further research will be needed to assess the interaction of these elements.

8. Conclusion

In this paper, we developed a novel theory and metric for IS organizational risk assessment. The case studies that we examined seem to show that AC has an effect on the ability of an organization to adopt systems. The implication of this conclusion is that management must not only ensure that the system is delivered successfully to be implemented but also take steps to ensure that organizational members are ready to assimilate the changes implied by the new system and that appropriate structures and processes are in place to facilitate system absorption. Specifically, it would appear that management must ensure that prior related knowledge exists within the organization and that the organizational culture is such that the new technology is anticipated in a positive light. Care should be taken to align the measurement/reward mechanisms of the implementers and target users to ensure that they work together. Rich channels and knowledge transfer processes should be established to create *ba* and allow both explicit and tacit knowledge to be shared between developers and users. Users should be allowed sufficient time to work with the system in a test mode to gain experience and confidence and thus, internalize use of the system. The metric that we propose provides a way to measure whether suitable structures and processes are in place to facilitate the firm's AC.

For researchers, our study points the way to a method to measure AC and project risk that can benefit from subsequent, more rigorous development and validation. The metric needs to be rigorously developed with additional, primary source data in order to identify the interactions and levels of influence of various antecedents on a firm's AC. Practical methods and instrumentation for field measurement should also be developed to assess the level of AC in situ. Our model complements the existing literature on software project risk (Barki et al., 2001; Keil et al., 1998; Lucas, 1974; Scott and Vessey, 2002; Schmidt et al., 2001; Wallace et al., 2004), but additional research should be conducted to ensure that the items used to operationalize the constructs from these two bodies of literature are consistent with each other.

For practitioners, our study offers a ''quick-and-dirty'' measure to allow them to assess whether the organization is ready to absorb the changes associated with a new software application and, if not, what specific interventions should be undertaken to prepare the target users and members of the internal IT staff (as in the URF case scenario). Analogous to a ''one-minute risk assessment tool'' recently introduced to the literature (Tiwana and Keil, 2004) for examining technical project risk, our study seeks to provide a useful and easy-to-use method and metric for assessing *organizational* risk.

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