Journal of the Association for Information Systems
JAIS

Research Article

Designing Collaborative Systems to Enhance Team Performance*

Xiaojun Zhang
Hong Kong University of Science and Technology
xiaojunzhang@ust.hk

Viswanath Venkatesh
University of Arkansas
vvenkatesh@vvenkatesh.us

Susan A. Brown
University of Arizona
suebrown@eller.arizona.edu

Abstract

Collaborative technologies are widely used to enable teams to function effectively in today's competitive business environment. However, prior research has been inconclusive regarding the impacts of collaborative technologies on team performance. To address the inconsistencies in prior work, this paper seeks to understand the mediational mechanisms that transmit the effect of collaborative technologies on team performance. Specifically, we theorize that there is a relationship between design features and knowledge contextualization. We further theorize relationships between knowledge contextualization and a team's capability for collaboration, specifically examining collaboration know-how and absorptive capacity, both of which are expected to influence team performance. We conduct a field study including 190 software project teams from a large organization in China. The results support our theoretical model and demonstrate that design features have an impact on performance outcomes, mediated by collaboration know-how and absorptive capacity.

***Keywords**: Collaborative Technologies, Design Features, Collaboration Know-how, Absorptive Capacity, Team Performance.*

* Ananth Srinivasan was the accepting senior editor. This article was submitted on 26th May 2010 and went through two revisions.

Volume 12, Issue 8, pp. 556-584, August 2011

Designing Collaborative Systems to Enhance Team Performance

1. Introduction

In today's complex, competitive, and dynamic business environment, many organizations use teams to sustain and prosper (Dennis, Fuller, & Valacich, 2008; Guzzo & Dickson, 1996; Sundstrom, 1999). Information and communication technologies (ICTs) are widely used to enhance team functioning (Dennis et al., 2008; Dennis & Valacich, 1994, 1999; Hsieh, Rai, & Keil, forthcoming; Martins, Gilson, & Maynard, 2004; Powell, Piccoli, & Ives, 2004). Much work has sought to understand the design features of ICTs and how they affect human-computer interaction (e.g., Hong, Thong, & Tam, 2004a, 2004b; Hu, Ma, & Chau, 1999; Rai, Lang, & Welker, 2002; Thong, Hong, & Tam, 2002; Valacich, Dennis, & Connolly, 1994; Wei, Hu, & Chen, 2002). Among the various ICTs, collaborative technologies have been most extensively used due to their ability to facilitate effective collaboration among team members (e.g., Dennis & Wixom, 2002; Easley, Devaraj, & Crant, 2003; Gallivan, Eynon, & Rai, 2003; Rai, Brown, & Tang, 2009a). Thus, organizations often leverage collaborative technologies to augment team performance (e.g., Fuller & Dennis, 2009; Walsham, Robey, & Sahay, 2007). However, prior findings related to how collaborative technologies affect team performance outcomes, such as decision quality, number of ideas generated, decision time, and users' satisfaction, have been inconclusive (Dennis & Valacich, 1994; Dennis & Wixom, 2002; Fuller & Dennis, 2009; Valacich & Schwenk, 1995). For example, Fuller and Dennis (2009) found that technology positively affected team performance when technology supported the task, whereas Malhotra and Majchrzak (2009) found that the direct effect of collaborative technology on team performance was not significant. Although prior studies have used different measures for team performance, most studies measure either team effectiveness or efficiency (Henderson & Lee, 1992; Nidumolu & Subramani, 2003). Consequently, the inconsistent results are not likely to be associated with the measurement variation in team performance. In-depth theory building is required to resolve the inconsistent findings of prior research (Lewis, 2000; Poole & Van de Ven, 1989). To understand why a relationship is not significant or why prior results have been inconsistent, we include additional variables and examine how they mediate and/or moderate the original relationships (Fairchild & MacKinnon, 2009; Fuller & Dennis, 2009; Malhotra & Majchrzak, 2009). Researchers have noted that such an approach is vital to moving research forward and making substantial theoretical contributions (e.g., Mathieu, DeShon, & Bergh, 2008; Whetten, 1989).

To identify the mediational mechanisms that link collaborative technology design to team performance, we draw from the strategy literature on organizational capabilities, i.e., capabilities that enable organizations to leverage knowledge effectively (e.g., Dosi, Nelson, & Winter, 2000; Grant, 1996; Kogut & Zander, 1992). In this work, we define team performance as effectiveness and efficiency in achieving team project objectives (Cohen & Bailey, 1997; Henderson & Lee, 1992; Nidumolu & Subramani, 2003). We conceptualize organizational capabilities at the team level, i.e., the *team's capabilities to leverage knowledge* in a distributed environment. This is consistent with prior research that develops the concept of team capabilities arising from organizational capabilities to understand the relationship between knowledge gathering and project performance (Haas, 2006). In understanding team performance outcomes in a distributed environment, prior research has indicated the importance of collaboration among team members and identified various factors that affect collaboration, e.g., familiarity (Espinosa, Slaughter, Kraut, & Herbsleb, 2007), situational awareness (e.g., Kanawattanachai & Yoo, 2007), information exchange, joint problem solving, and trust (e.g., Rai, Maruping, & Venkatesh, 2009b). One of the important findings was that effective collaboration among team members facilitates knowledge sharing and integration that contribute positively to team performance outcomes (e.g., Rai et al., 2009b). This research indicates that a team's capabilities to leverage knowledge importantly affect the team's performance outcomes. We argue that the team's capabilities to leverage knowledge are potential mediational mechanisms that link collaborative technologies design to team performance. This is because: (1) an important objective of designing collaborative technologies is to facilitate knowledge sharing and integration among distributed team members, and a team's capability to leverage knowledge is an important team behavior (Kanawattanachai & Yoo, 2007; Leonardi & Bailey, 2008; Thomas & Bostrom, 2010); (2) a team's capabilities to leverage knowledge have been found to positively affect team performance outcomes (Bresman, 2010; Robert, Dennis, & Ahuja, 2008). We identify two important mediators, i.e., *collaboration know-how* and *absorptive capacity,* that describe a team's capabilities to leverage knowledge.

For teams to function effectively, team members first need to be able to express their opinions and integrate ideas of other team members. *Collaboration know-how* describes team members' abilities to coordinate their actions and work with others (Majchrzak, Malhotra, & John, 2005). A second component necessary for teams to function effectively is the ability to learn and apply new knowledge to resolve task problems (Espinosa et al., 2007; Majchrzak et al., 2005). Prior literature in organizational learning and knowledge transfer described *absorptive capacity* as an organization's or an individual's ability to identify, assimilate, and apply new knowledge and suggested that it is a key predictor of organizational or individual performance (Brown, 2005; Cohen & Levinthal, 1990; Huber, 1999; Mitchell, 2006). Given that use of collaborative technologies to support team-based work systems is pervasive in the workplace (Easley et al., 2003), an understanding of how teams embrace such collaborative technologies in enhancing team capabilities to leverage knowledge, e.g., absorptive capacity, is critical for organizational success. By conceptualizing absorptive capacity at the team level, we extend our understanding of how this construct might affect team-level outcomes. This is consistent with prior research that conceptualizes system usage at the team level and uses team use to predict team performance (Burton-Jones & Gallivan, 2007; Easley et al., 2003). Thus, we define team *absorptive capacity* as a team's ability to identify, assimilate, and apply new knowledge. Considering the important role of *collaboration know-how* and *absorptive capacity* on team effectiveness in task completion, understanding their determinants will enable the development of a nomological network that incorporates the mediational mechanisms that can help explain the impacts of collaborative technologies on team performance.

The biggest challenge of using collaborative technologies to facilitate knowledge sharing lies in the difficulty of transferring contextual knowledge that is critical for employees working across time, space, and function to bridge differences in occupational knowledge and working practices (Alavi & Tiwana, 2002; Cramton, 2001; Leonardi & Bailey, 2008). To overcome this challenge, Majchrzak et al. (2005) described how collaborative technologies can be designed to support knowledge contextualization that is positively related to collaboration know-how (Majchrzak et al., 2005). Drawing from IS design theory (Gregor & Jones, 2007), we derive specific design features (e.g., Zhang, 2008a, 2008b) that support knowledge contextualization. We theorize how design features change users' perceptions of collaborative technologies with regard to the technology's capability to support knowledge contextualization (e.g., Leonardi & Bailey, 2008; Xu & Ramesh, 2008). Further, we theorize how knowledge contextualization affects a team's absorptive capacity and how collaboration know-how and absorptive capacity together affect team performance.

The work is expected to make several important contributions. First, this study will develop a better understanding of how collaborative technologies affect team performance by theorizing the mediational processes related to team knowledge management. Second, this study will identify principles that can be used to design and build effective collaborative technologies, consistent with the paradigm of design sciences (see van Aken, 2004, 2005). Third, this study will identify important design features that support knowledge contextualization. Thus, this work will extend IS research related to system design by incorporating literature related to strategy and knowledge management. Fourth, it will provide managers with actionable advice on how to design collaborative technologies to enhance a team's knowledge management process, with a view toward enhancing team performance.

2. Team Capability to Leverage Knowledge

The concept of team capability is rooted in the concept of capability, in general. Capability is likely to lead to intended outcomes because "to be capable of something is to have a generally reliable capacity to bring that thing about as a result of intended action" (Dosi et al., 2000, p. 2). Prior research has anchored on the team capabilities view to theorize how project teams can benefit more from knowledge gathering by developing processing, sense-making, and buffering capabilities (Haas, 2006). Such capabilities are important in any organizational context, but are especially useful for addressing the problems of knowledge gathering (Haas, 2006). The processing capability refers to a team's ability to handle a large amount of information; the sense-making capability refers to a team's ability to understand incomplete, inconsistent, and uncertain information; and the buffering capability refers to a team's capability to deal with competing perspectives, such as different ideas from multiple stakeholders (Haas, 2006). The first dimension is concerned more with information quantity, and the other two dimensions are concerned with information quality. This paper builds on the concept of the team capabilities with a focus on capabilities to leverage knowledge in a distributed environment to enhance performance outcomes. Collaboration know-how indicates a team's capability to integrate ideas among team members in a distributed environment. It is related to a team's sense-making capability because it is important to combine different ideas to make sense of incomplete, inconsistent, and uncertain information. Collaboration know-how also indicates a team's capability to develop mutual understanding. It is related to a team's buffering capability because developing mutual understanding helps resolve competing perspectives. Absorptive capacity indicates a team's capability to absorb or internalize knowledge. It is related to a team's processing and sense-making capabilities because the three capabilities indicate a team's readiness to leverage information in terms of quantity and quality.

2.1. Collaboration Know-How

The concept of collaboration know-how is derived from the idea of knowledge integration (Grant, 1996). It is the capability of an individual to communicate his or her ideas and integrate them with others' ideas so as to enhance effectiveness of team coordination and collaboration (Majchrzak et al., 2005). Prior research indicates that shared knowledge can help team members coordinate because it helps them develop more accurate explanations and expectations about task events and member behaviors (Espinosa et al., 2007).

Given that more and more organizations use IT to support team work, it is important that IT be designed to facilitate the creation of shared knowledge and enhance the awareness of task and presence. This requires IT to support the transmission of contextual information so that team members can know each other better and also be aware of progress on tasks. Researchers have sought to develop IT that can convey context (Boland, Tenkasi, & Te'eni, 1994) and incorporate contextualization into team communication strategies (Te'eni, 2001). Consistent with prior research, we examine IT support for knowledge contextualization as an antecedent to collaboration know-how (Majchrzak et al., 2005).

2.2. Absorptive Capacity

The concept of absorptive capacity has been discussed at both the organizational and individual levels in prior literature. At the firm level, absorptive capacity refers to the "ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen & Levinthal, 1990, p.128). At the individual level, absorptive capacity refers to an individual's ability to identify, assimilate, and exploit new knowledge (Brown, 2005; Cadiz, Griffith, & Sawyer, 2009). Prior research has demonstrated a positive relationship between absorptive capacity and organizational and individual job outcomes (Lane, Salk, & Lyles, 2001; Park, Suh, & Yang, 2007; Tsai, 2001).

We conceptualize absorptive capacity at the team level and explain how it is affected by IT support for knowledge contextualization. Prior research has indicated that absorptive capacity is a multilevel construct and should be studied at the individual, unit, firm, and inter-firm levels of analysis (Volberda, Foss, & Lyles, 2009). It is possible that team members can possess different absorptive capacities that negatively affect team effectiveness. For example, asymmetry in absorptive capacity can create misalignments in the speed of accomplishing various team tasks and variations in quality. Given the critical role of IT in supporting team-based structures, it is important to understand how IT can influence a team's absorptive capacity. If IT supports the transmission of relevant and contextual information, team members are likely to interact with each other more effectively. Consequently, the team's capability to absorb new knowledge is likely to be strengthened. By capturing the role of IT in affecting interpersonal interactions, we develop a better understanding of how absorptive capacity can emerge from the actions and interactions of individuals (Volberda et al., 2009).

3. IS Design Theory

IS design theory emphasizes how to design and develop an artifact that can be a technological product or a managerial intervention (Gregor & Jones, 2007; Simon, 1996). The artifact may refer to software products, such as databases, or methods, such as software development methodologies. IS design theory has been recognized as one of the five theories relevant to IS: (1) theory for analyzing; (2) theory for explaining; (3) theory for predicting; (4) theory for explaining and predicting; and (5) theory for design and action (Gregor, 2006). It lies at the intersection of knowledge of machines and knowledge of human behavior (Gregor & Jones, 2007). Design knowledge resides in products that embody design attributes (Cross, 2001). It is important to note that Hevner, March, Park, and Ram (2004) proposed a design science paradigm that is similar to the IS design theory in that both emphasize that new and innovative IT artifacts are created at the confluence of people, organizations, and technology. The differences between these two theories are that the design science paradigm places greater emphasis on the macro factors affecting design, such as how the business strategy affects organizational structure and IS strategy and how these affect information systems infrastructure (Hevner et al., 2004), whereas the IS design theory places greater emphasis on the theoretical context and related knowledge to inform design (Gregor & Jones, 2007). Our focus is on the theoretical context of design because the design features we examine are derived from our theoretical context, i.e., enhancing team capabilities to leverage knowledge, and relevant knowledge in design, i.e., design principles (Zhang, 2008a, 2008b), rather than on using macro factors such as business strategy or IS strategy to inform design. Thus, we anchor our approach to IS design theory. IS design theory identifies the principles inherent in the design of an IS artifact by drawing knowledge from both IT and human behavior (Gregor & Jones, 2007). Gregor and Jones (2007) further elaborate IS design theory to include eight components: (1) purpose and scope; (2) constructs; (3) principle of form and function; (4) artifact mutability; (5) testable propositions; (6) justificatory knowledge; (7) principles of implementation; and (8) expository instantiation. We present the explanation of each component in Table 1.

Table 1. Explanation of the Components of IS Design Theory (Gregor and Jones, 2007)

Components	***Description***
1. Purpose and scope	What system the theory applies as well as the scope or boundaries of the theory
2. Constructs	Representations of the entities of interest in the theory
3. Principle of form and function	Principles that define the structure, organization, and functioning of the artifact
4. Artifact mutability	Degree of artifact change is encompassed by the theory
5. Testable propositions	Truth statements about the design theory
6. Justificatory knowledge	The underlying knowledge or theory from the natural of social sciences that gives a basis and explanation for the design
7. Principles of implementation	A description of processes for implementing the theory
8. Expository instantiation	A physical implementation of the artifact that can assist in representing the theory

These eight components serve as guidelines for understanding the principles underlying the form of the collaboration technology design and the act of implementing the design in the real world (Table 2). In our context, the first guideline indicates that the purpose and scope of the design is to focus on examining the application of collaboration technologies in a team environment. The second guideline indicates we need to identify constructs, i.e., design features, based on our theoretical model. In this paper, we identify design features that can be leveraged to enhance team capabilities to leverage knowledge, i.e., collaboration know-how and absorptive capacity. The third guideline indicates principles and rules used to inform the design. In this paper, we draw from literature that distinguishes between design principles and design features (Zhang, 2008a, 2008b). The fourth guideline indicates the design of the artifact should capture the dynamic of the phenomena being studied. In this paper, the design should underscore the capability of the collaboration technology to support knowledge changes that represent the evolving nature of teams. The fifth guideline emphasizes the importance of theory development to illustrate how and why the design would lead to desired outcomes. In this paper, we develop hypotheses to explain the impact of design on team functioning. The sixth guideline suggests the underlying knowledge or theory from the natural or social sciences can be used to inform design. In this case, we apply inductive theory (Locke, 2007) to inform design. The seventh guideline emphasizes that in designing the study to test the theory, we need to follow methodological rigor; and the eighth guideline indicates that the actual execution of the study should faithfully represent the theory.

Table 2. Design of Collaboration Technologies

Components	***Description***
1. Purpose and scope	Application of collaboration technologies in a team environment
2. Constructs	Identify design features that enhance team capabilities to leverage knowledge
3. Principle of form and function	Use theory of design principles (Zhang, 2008a, 2008b) to define the structure, organization, and functioning of the artifact
4. Artifact mutability	Features that support knowledge change as a result of the evolving nature of teams
5. Testable propositions	Develop hypotheses to explain the impact of design on team functioning
6. Justificatory knowledge	Apply inductive theory (Locke, 2007) to inform system design
7. Principles of implementation	Follow methodological rigor to design the study
8. Expository instantiation	Execute the study to faithfully represent the theory

In the following sections, we discuss how to identify specific design features. One important thing to be noted is that design features are generally derived from design principles that represent higher or more abstract rules (Zhang, 2008a, 2008b). For example, a design principle could be “representation of self-identify” and a specific design feature that conforms to such a principle could be “application toolbar customization” (Zhang, 2008a). Therefore, we first discuss system design principles before we illustrate specific design features.

3.1. System Design Principles: IT Support for Knowledge Contextualization

Prior literature on system design principles has discussed system design in the context of larger nomological networks. For instance, Zhang (2008a, 2008b) related system design to system effectiveness by proposing a variety of design principles based on human motivational needs that could enhance technology use. Likewise, Venkatesh and Agarwal (2006) identified various design characteristics/principles that could enhance website use and purchase behavior. Zhang and Li (2005) presented a framework that illustrates the issues and components pertinent to human interaction with technologies. The identification of important factors in the area of human-computer interaction provides a broader theoretical foundation for system design. This is particularly important given the increased focus on human-computer interaction research in IS as a result of the strong push to give the IT artifact a more central role (Benbasat & Zmud, 2003; Orlikowski & Iacono, 2001).

Prior research indicates many technologies, including collaborative technologies, do not provide adequate support for the transmission of contextual information and, consequently, impede individuals from establishing mutual knowledge, and ultimately, from sharing and integrating their knowledge (Alavi & Tiwana, 2002; Cramton, 2001; Griffith, Sawyer, & Neale, 2003; Hollingshead, 1996). To address this problem, technologies need to be designed to support knowledge contextualization. Specifically, technologies need to be configured to provide relevant contextual information to address the major challenges of distributed collaboration, such as different communication practices and interpretations of meaning (Hinds & Bailey, 2003; Maznevski & Chudoba, 2000). When knowledge is contextualized, it provides additional information about the "situation, intentions and feelings about an issue or action, as owned, evolved, and represented by each individual involved in the communication process" (Majchrzak et al., 2005, p. 11). Consequently, people working at different locations can develop a better understanding of each other, resulting in more effective communication of different ideas, integration of complex knowledge, and coordination of challenging group tasks (Majchrzak et al., 2005).

Prior research has discussed five design principles with respect to knowledge contextualization (Boland et al., 1994; Majchrzak et al., 2005). First, the IT system should let everyone know who creates a specific entry in the system, i.e., *ownership*. Second, the IT system should ease the effort of navigating across different layers of knowledge and information, i.e., *easy travel*. Third, the IT system should be able to compare different perspectives about a topic, i.e., *multiple perspectives*. Fourth, the IT system should allow for entries or knowledge that is incomplete and tentative, i.e., *indeterminacy*. Last, the IT system should support new ways of describing and organizing organizational knowledge, i.e., *emergence*.

3.2. System Design Features

We derived specific design features from the above design principles. Specifically, we identified features that are likely to support each of the five design principles, i.e., ownership, easy travel, multiple perspectives, indeterminacy, and emergence. To identify those features, we followed the guidelines of inductive theory building to choose features that are representative of the same class (Locke, 2007). First, we reviewed literature to identify relevant features. Then, we interviewed employees in different organizations about the extent to which these features were perceived to be important in supporting each dimension of knowledge contextualization. Key elements of context identified in prior research include knowing who posted the information, being able to access the information, being informed about new and changed knowledge, and having the information organized for integrated presentation (e.g., Li & Chang, 2009; Ma & Agarwal, 2007; Wagner, 2004).

The first set of features is related to the capability of the system in terms of supporting identity recognition. When employees use collaboration technologies, they are required to login to the system first before they can use various features of the technology. The feature of *user login* protects unauthorized access to and use of the system (e.g., Hwang & Li, 2000; Juang, 2004). User login is the primary control for identity recognition. Once users log in to the system, they will be assigned names so that they can be recognized by others to facilitate communication. Users may be allowed to change names assigned by the system the first time they log in to the system, e.g., change to their true names or use pseudonyms that are different from their true names. Once users choose their names, these names are less likely to be changed. The feature of *identity persistence* refers to the capability of the system to recognize and preserve the unique identity of a user (Bhatti, Bertino, & Ghafoor, 2007). Identity persistence helps users detect the behavioral patterns of others. For example, if a person actively participates in group discussions by using collaboration technologies, other people are more likely to recognize the person with his or her unique identity. Moreover, people may get to know the person better by following his or her discussions with other people. Thus, the first set of features can provide the contextual information related to user identity that can facilitate communication and collaboration among users who use the system.

The second set of features is related to the capability of the system in terms of supporting information access. Data *searchability* indicates how easily the required information can be found and *search and retrieval capability* relates to the speed and quality of information retrieval, i.e., how quickly the required information can be located and how relevant such information is (e.g., Hjelt & Björk, 2006; Revere et al., 2007). The stronger the capability of the system to support these two features, the more likely users can get access to useful contextual information that helps them better address the challenges of distributed collaboration (e.g., Leonardi & Bailey, 2008).

The third set of features is related to the capability of the system in terms of recognizing and notifying users about knowledge changes that result from the team interactions. We propose to study two features that are relevant in this context. The first feature is *expert flag,* which refers to the capability of the system to allow domain experts to identify critical changes or advances in specific areas (e.g., Jan, Lin, Tseng, & Lin, 2009). The second feature is *notification,* which refers to the capability of the system to report the changes that have been made to other team members (e.g., Chao, Jen, Chi, & Lin, 2007). These features keep team members aware of important changes in knowledge. Consequently, team members are likely to use the new knowledge to collaborate. Without flags or notifications, different team members may use different knowledge, and such knowledge asymmetry may become a barrier to knowledge transfer and effective collaboration (e.g., Reagans & McEvily, 2003).

The fourth feature is related to the capability of the system for content management. *Syndication* is a feature that summarizes relevant topics and displays them to the users at one place, thus making it easy for readers to digest information (Cold, 2006; Treiber & Dustdar, 2007). One major application of this feature is RSS, i.e., really simple syndication, a family of web feed formats used to publish frequently updated work, such as blog entries, news headlines, audio, and video, in a standardized format. The major benefit of this feature is to make it easier for users to access and process the topics in which they are interested. Without syndication, users may need to go to different web pages to find relevant information that has not been summarized or synthesized, thus making it difficult for users to access and process such information, including comparing different perspectives to aid in decision making.

The last feature is related to the capability of the system in terms of supporting the evolving nature of knowledge. Employees' knowledge on certain topics is likely to evolve when they have more opportunities to access different perspectives on the topics (e.g., Cross & Cummings, 2004). *Experimental knowledge entry* is a feature that allows employees to enter incomplete knowledge entries and then make corrections to them at a later time (Majchrzak, Rice, Malhotra, King, & Ba, 2000; Malhotra, Majchrzak, Carman, & Lott, 2001). The piece of knowledge entered in the system represents an employee's level of understanding about a topic. Even though the piece of knowledge may not be fully complete or accurate at the time it is entered, one major benefit of this feature is that it can initiate further discussions on the topic. When employees have more discussions, they are likely to be exposed to different ideas or thoughts that help them develop a better understanding of the topics. Afterward, they can make changes to the system to better represent the knowledge. In this case, the system is more capable of capturing the evolving nature of knowledge.

4. Hypotheses Development

Drawing from the team capabilities perspective (Haas, 2006) and IS design theory (Gregor & Jones, 2007), we identify design features that support knowledge contextualization. We seek to understand how collaboration know-how and absorptive capacity mediate the effect of collaborative technologies that support knowledge contextualization on team performance. Figure 1 presents our research model.

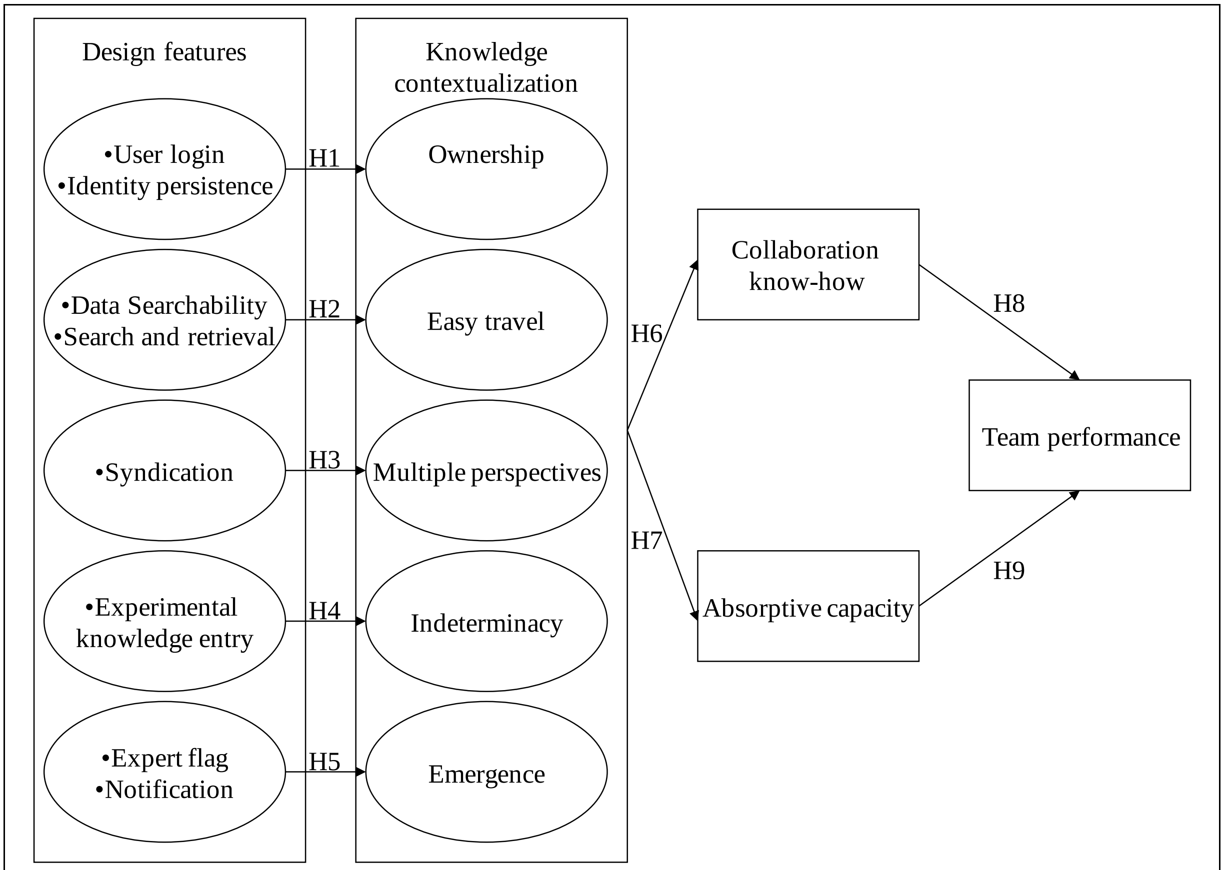

Figure 1. Research Model

4.1. Design Features and Knowledge Contextualization

4.1.1. Ownership

To make everyone aware of who has made changes to information in the system, such as creating a new entry or modifying or deleting an existing entry, the system should allow users to identify themselves by entering their names or online identities. As a result, when other users find information in the system, they know who provided it. Knowing who provided specific information in the system is likely to help knowledge seekers better assess the value of the knowledge (Borgatti & Cross, 2003; Poston & Speier, 2005). We aim to accomplish this using two design features: (1) user login; and (2) identity persistence. To enforce transparency of ownership, the system will ask users to enter their names or online identities before accepting new information or changes to existing information. The system can be designed such that all users need to log in to it before they use it, and the system will attach users' identities to all new information or changes they make to existing information. Additionally, the system should enforce unique or persistent identity, i.e., a user should have only one name or identity, and the name and identity should not change over time. Prior research indicates that if users do not change their names or identities, they are more likely to be known (Ma & Agarwal, 2007). Multiple or unstable identities will, in contrast, not allow the establishment of ownership. Thus, we hypothesize:

> ***H1:*** *System login and identity persistence will be positively related to ownership.*

4.1.2. Easy Travel

It is important for team members to navigate across different sources of knowledge or information, e.g., team's internal and external knowledge, historical connections between entries, and other summaries or details in the system (Majchrzak et al., 2005). As another dimension of knowledge contextualization, easy travel underscores a system's capability for locating relevant knowledge in a timely manner. This is consistent with prior research that emphasizes the importance of locating and applying relevant knowledge to resolve problems in a timely manner (Faraj & Sproull, 2000). Finding the knowledge in the system is a significant challenge (Wagner, 2004). A good system should not only allow users to find the knowledge, but also to filter out irrelevant information that could negatively affect the use of the knowledge. Additionally, a good system makes it easier for users to quickly retrieve the information or knowledge they want.

In designing a system that supports easy travel, two features are critical: (1) data searchability; and (2) search and retrieval capability. Data searchability means knowledge needs to be organized as searchable data. Searchability is a key prerequisite for fast access to relevant information and knowledge. When data, information, or knowledge is created, it should be stored in a format that supports retrieval and multiple views. If data, information, or knowledge is created in a non-searchable format, it will be very difficult to retrieve, i.e., less easy travel. Advanced database technologies can be used to create data definitions and structures to facilitate data retrieval. Orphan page design is a specific feature used in Wikis, a technology that supports dynamic knowledge creation and sharing (Wagner, 2004). Orphan page is a directory function that supports more cohesive organization of existing knowledge and creation of more contexts for multiple users to make it easier for them to track and connect different sources of knowledge (Wagner, 2004). In other words, orphan page facilitates data searching.

Second, the system needs to increase the capability to search and retrieve data. One such capability is fast retrieval of information by using optimized search algorithms. If a system can search for a piece of information quickly, more information can be retrieved. Consequently, users can compare and interpret more information to gain a more complete understanding of their problems and possible solutions. Another aspect of search and retrieval is the quality or relevance of the information that is retrieved. If the knowledge retrieved provides more relevant information, users are likely to gain more contextual knowledge from it. For example, use of versioning or page history in Wiki technology helps users to better understand the evolution of knowledge and hence, increases their contextual knowledge of a problem domain. Thus, we hypothesize:

> ***H2:*** *Data searchability and search and retrieval will be positively related to easy travel.*

4.1.3. Multiple Perspectives

This dimension of knowledge contextualization relates to a system's capability to manage information content. While ICTs can serve as a repository for a large amount of information, they also create difficulties for users who need to locate and process needed information. Syndication is a system feature designed to improve the quality of content management. Specifically, syndication enables the system to synthesize relevant topics and put them in one page so as to facilitate information access and processing. Without syndication, users may spend a lot of time and effort trying to find relevant information from different pages and processing the voluminous information that has not been filtered or presented in a summarized format. In contrast, syndication speeds up information retrieval and reduces the effort used to process the information because information related to similar topics has been summarized or aggregated in a succinct format and grouped together (e.g., Tremblay, Fuller, Berndt, & Studnicki, 2007). This makes it easier for users to evaluate multiple perspectives or different approaches to solving problems, based on the information they obtain. Thus, we hypothesize:

> ***H3:*** *Syndication will be positively related to multiple perspectives.*

4.1.4. Indeterminacy

The indeterminacy dimension of knowledge contextualization indicates a system's capability to accommodate the evolving nature of knowledge. Given that many times employees may not be able to fully understand certain topics, at least initially, it is important that the system can accept uncertain or ambiguous knowledge on such topics and allow for modifications at a later time (Majchrzak et al., 2000; Malhotra et al., 2001). Experimental knowledge entry is a feature that allows employees to enter knowledge into the system even though the knowledge has not been fully developed. Once the knowledge has been entered, the employees who create the entries can modify the knowledge if they find out something is incorrect or incomplete. In addition, other employees can make changes to the entries, such as adding missing information or providing alternative solutions. Using this feature, employees are likely to believe the system supports the evolving nature of knowledge. Thus, we hypothesize:

> ***H4:*** *Experimental knowledge entry will be positively related to indeterminacy.*

4.1.5. Emergence

Another dimension of knowledge contextualization relates to a system's capability to detect and identify the knowledge changes that represent the evolving nature of teamwork. Two system features that can be developed to fulfill this objective are (1) expert flag and (2) notification. The system should allow experts, appointed by the organization, to review knowledge in their domains on a regular basis so as to detect critical changes or advances in the knowledge. When an expert finds important knowledge, he or she can create a flag in the system to indicate the change. Domain experts are more capable of capturing the evolution of domain knowledge as well as explaining the changes to other employees. Therefore, the system should be designed such that only the domain experts can certify critical knowledge changes. However, it may not be sufficient for experts to indicate knowledge changes in the system, because other employees may not be aware of the changes. To make the new changes visible, organizations can use different notification methods. For example, when an expert flag is placed on new knowledge, it could trigger a system notification to announce this to all employees by notifying them via the main web pages of the organization. Alternatively, the system could inform employees of the changes via email, an approach that could be more effective if employees seldom check organizational web pages. Thus, we hypothesize:

> ***H5:*** *Expert flag and notification will be positively related to emergence.*

4.2. Collaboration Know-How

Collaboration know-how is the capability of individuals to communicate and integrate their ideas with others' ideas (Patnayakuni, Ruppel, & Rai, 2006) and is particularly relevant for distributed teams (Boland et al., 1994). An important element for developing collaborative know-how is knowledge contextualization (Brown & Duguid, 1998; Majchrzak et al., 2005). Specifically, ownership provides the context necessary to evaluate the quality or credibility of information. For example, the reputation of a knowledge owner is likely to be an indicator of the quality of the knowledge posted by the owner (e.g., Alavi, Kayworth, & Leidner, 2005; Kankanhalli, Tan, & Wei, 2005). Easy travel enables information to be found and connected, greatly reducing the time and effort spent on information retrieval and processing. Multiple perspectives allow users to assess different alternatives to reach the optimum decision. Indeterminacy permits tentative knowledge entries that are likely to initiate further discussions or knowledge sharing during which employees can learn how to better interact with others and integrate others' ideas. Emergence provides a mechanism for keeping up with changes in information such that team members do not have a large degree of knowledge asymmetry that would negatively affect knowledge integration (Landry, Amara, & Rherrad, 2007; Reagans & McEvily, 2003). Together, these elements provide the contextual information necessary for individuals to integrate their ideas with others' ideas. Thus, we hypothesize:

> ***H6:*** *Knowledge contextualization (ownership, easy travel, multiple perspectives, indeterminacy, and emergence) will be positively related to collaboration know-how.*

4.3. Absorptive Capacity

Absorptive capacity is the ability to identify, assimilate, and exploit new knowledge (Cohen & Levinthal, 1990). In order for individuals, teams, or organizations to develop absorptive capacity, knowledge and communication structures need to be established so that the knowledge is contextually relevant and can be shared efficiently. Knowledge contextualization provides an important mechanism for doing this, as it makes the knowledge easier to absorb (Te'eni, 2001). Specifically, emergence, easy travel, multiple perspective, indeterminacy, and ownership provide elements of the context that are important for absorptive capacity. Emergence is focused on notifications regarding new and changing knowledge. This notification enhances employees' ability to identify new knowledge as it is presented in the organization. Because emergence is focused on changes, it aids in knowledge assimilation given that the new knowledge is presented in the context of prior knowledge, a critical aspect of absorptive capacity (Cohen & Levinthal, 1990). Easy travel further enhances the identification and assimilation aspects of absorptive capacity by enabling connections to be made among existing pieces of knowledge. These connections, or combinative capabilities, are essential for enabling the exploitation of knowledge (Van den Bosch, Volberda, & De Boer, 1999). Ownership enables employees to know the source of knowledge, thus providing a basis on which they can decide to use (i.e., exploit) the knowledge or not. Indeterminacy triggers employees to share ideas and thoughts on incomplete or tentative knowledge entries (Majchrzak et al., 2000; Malhotra et al., 2001) so as to refine and improve employees' knowledge level on certain topics. Finally, multiple perspectives allow employees to compare the pros and cons of different pieces of knowledge. In the process of comparing, evaluating, and appraising different pieces of knowledge, employees are likely to strengthen their capability to combine, assimilate, or absorb various them. Thus, we hypothesize:

> ***H7:*** *Knowledge contextualization (ownership, easy travel, multiple perspectives, indeterminacy, and emergence) will be positively related to absorptive capacity.*

4.4. Performance

Performance is a commonly measured outcome of individual, team, and organizational behaviors. Much of the work in collaboration know-how and absorptive capacity has been conducted at the firm level. For example, Simonin (1997) examined collaborative know-how among organizations and found that it was associated with positive outcomes. Likewise, it has been argued that firm-level absorptive capacity is associated with improved performance (Cohen & Levinthal, 1990; Park et al., 2007; Rothaermel & Alexandre, 2009). While researchers have alluded to the applicability of these constructs to finer-grained levels of analysis, little empirical work has been done to examine them at the team level. We expect that the same benefits that accrue to organizations will accrue to teams. Essentially, the importance of collaborative know-how at the firm level is due to its ability to enable knowledge sharing among members of different organizational units or teams. Likewise, absorptive capacity accrues to the firm level through similar interactions.

At the team level, knowledge sharing is important to bridge departmental differences. By enabling a shared understanding, knowledge transfer among team members will be easier (Reagans & McEvily, 2003). In addition, shared understanding is likely to facilitate effective collaboration among team members, resulting in performance enhancement (Nelson & Cooprider, 1996). The value of absorptive capacity at the firm level is based on the exploitation of knowledge that is shared in the institutional environment (Volberda et al., 2009). Likewise, as members of a team share knowledge, they need to recognize the value of the knowledge, assimilate it, and exploit it to reap performance benefits. Thus, we hypothesize:

> ***H8:*** *Collaboration know-how will be positively related to team performance.*
> ***H9:*** *Absorptive capacity will be positively related to team performance.*

5. Method

5.1. Settings and participants

Software developers in a large corporation in China working on different small, team-based projects participated in our study. There were a total of 336 project teams, and 190 of them provided usable responses, resulting in a response rate of 56 percent. These projects lasted no more than 100 days and were completed by different software development teams, each of which had 12 people or less. Among the developers who participated in this study, 706 (38 percent) were women. The average age of participants was 28.18 (S.D = 4.39). We checked for non-response bias and found no significant differences in demographic characteristics between respondents and non-respondents. A total of 1,860 unique developers participated in this study.

5.2. Measurement

We adapted existing scales to fit the context of the current study, with data being analyzed at the team level. We justified the aggregation of individual-level scores to form the team-level construct (Bliese, 2000) by reporting the within-group agreement index ($r_{wg(j)}$), and intra class correlation coefficients (ICC) where relevant. The $r_{wg(j)}$ indicates the extent to which group members' responses to the survey converge greater than would be expected by chance (James, Demaree, & Wolf, 1984). The ICC(1) reflects between-group variance in individual responses, and the ICC(2) indicates the reliability of the group-level means (Bliese, 2000). We found all values were within the acceptable ranges in that r_{wg} values were greater than .70, ICC(1) values were between .15 and .20, and ICC(2) values were greater than .70, thus indicating that it was appropriate to aggregate individual responses to a team-level score.

We used an 11-item 7-point scale adapted from Majchrzak et al. (2005) to measure each of the four components of knowledge contextualization. We did not include indeterminacy given that the specific organizational settings would not allow us to examine this dimension. We used a 4-item scale adapted from Majchrzak et al. (2005) to measure collaboration know-how. An example item in our 4-item scale to measure absorptive capacity is: "Our team knows the necessary steps to learn knowledge." We provided items for four components of knowledge contextualization, collaboration know-how, and absorptive capacity in Appendix A. We assessed team performance as bug severity. This was computed as the product of the number of bugs and the number of hours required to fix them. The number of bugs and the number of bug-fixing hours are objective metrics that we obtained from project archives. In the final measure, lower bug severity indicates higher IT project quality. In order to improve the interpretability of the results relating to bug severity, we reverse-scored the measure such that large values indicated high project quality and small values indicated low project quality. We included two control variables. First, we controlled for project duration—i.e., the number of days spent completing the project—which has been associated with performance (Sauer, Gemino, & Reich, 2007). Second, we controlled for team size because increasing size has been associated with coordination problems and, consequently, decreased performance (Barry, Kemerer, & Slaughter, 2006). We also included experience of the developers, the type of software development project, the proportion of time spent in the requirements and design phase, and the software development methodology used (e.g., agile programming, waterfall, spiral) as control variables to test our model, but we found they were not significant. Therefore, we exclude them from the model.

5.3. System Design and Data Collection Procedure

We made two different systems available to the teams, and each system had different design characteristics. The first design did not provide for any of the features—i.e., user login, identity persistence, data searchability, search and retrieval capability, syndication, expert flag, or notification. The second design specifically provided for each of these features. For example, the identity persistence feature was enforced by not allowing the users to change their names once they were created. The teams used one of the two systems that was randomly assigned (made available) to them. Ninety-two teams used the system with no features, and 98 teams used the system with the specific features. We used one item to assess the manipulation for each design feature to make sure the respondents referred to the specific feature in the survey (see Appendix B). The means for the treatment group were statistically significantly higher than the means for the control group on the manipulation check.

We collected the data via surveys and from project documentation. At the beginning of each IT project, team members were asked to fill out a survey regarding their demographic information. As the IT project teams worked on their respective projects, they were required to record various IT project-related metrics, such as number of bugs and man hours. Bug severity data were then obtained from project archives at the end of the projects. At the end of each IT project, team members were asked to fill out questionnaires related to knowledge contextualization, collaboration know-how, and absorptive capacity. The use of different sources and types (i.e., survey responses and archival project metrics) of data are strengths of our design.

6. Results

We used SmartPLS 2.0 (Ringle, Wende, & Will, 2005), a partial least squares (PLS) tool that utilizes a component-based approach to maximize the variance estimation in the specified model.

6.1. Measurement Model

To assess the psychometric properties of the scales, we examined item loadings, internal consistency, and discriminant validity of the constructs. Results of the confirmatory factor analysis (CFA) indicated that the loadings of multi-item scales with reflective indicators (i.e., ownership, easy travel, multiple perspectives, emergence, collaboration know-how, and absorptive capacity) were adequate, because loadings are greater than .70 and cross-loadings are less than .30, suggesting internal consistency and discriminant validity. Table 3 presents the means, standard deviations, internal consistency reliabilities (ICRs), average variance extracted (AVE), and inter-construct correlations. ICRs were greater than .70 for these scales, thus supporting reliability. Also, there is further evidence of internal consistency and discriminant validity because no inter-construct correlations were greater than the square root of the AVE. On examining the means and standard deviations, we can see substantial variance in the different variables. Also, collaboration know-how and absorptive capacity were positively correlated with team performance. Note the correlations among the different design features are 1 because they were simultaneously manipulated and the variable values were either 0 or 1. In other words, if the set of features is manipulated, the value for each of the variables was 1, if they are not manipulated, the variable values were 0.

Table 3. Reliabilities, Descriptive Statistics, and Correlations

	Mean	SD	ICR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Project duration in days (control)	94	28.5	NA	NA															
2. Team size (control)	6.80	3.30	NA	.22[c]	NA														
3. Ownership-user login	NA	NA	NA	.08	.03	NA													
4. Ownership-identity persistence	NA	NA	NA	.07	.03	1	NA												
5. Easy travel-data searchability	NA	NA	NA	.06	.04	1	1	NA											
6. Easy travel-search and retrieve capability	NA	NA	NA	.02	.01	1	1	1	NA										
7. Multiple perspectives-syndication	NA	NA	NA	.04	.03	1	1	1	1	NA									
8. Emergence-expert flag	NA	NA	NA	.04	.06	1	1	1	1	1	NA								
9. Emergence-notification	NA	NA	NA	.04	.08	1	1	1	1	1	1	NA							
10. Ownership	5.10	1.22	.75	.13[a]	.15[a]	.37[c]	.38[c]	.30[c]	.35[c]	.22[c]	.29[c]	.34[c]	.70						
11. Easy travel	4.45	1.30	.77	.10	.08	.40[c]	.29[c]	.40[c]	.30[c]	.21[c]	.28[c]	.50[c]	.31[c]	.71					
12. Multiple perspectives	3.98	1.40	.73	.08	.07	.14[a]	.08	.14[a]	.22[c]	.30[c]	.07	.13[a]	.24[c]	.20[b]	.70				
13. Emergence	4.52	1.28	.80	.07	.04	.41[c]	.34[c]	.44[c]	.31[c]	.25[c]	.31[c]	.43[c]	.32[c]	.38[c]	.23[c]	.74			
14. Collaboration know-how	4.88	1.30	.70	.14[a]	-.14[a]	.26[c]	.31[c]	.25[c]	.37[c]	.24[c]	.24[c]	.25[c]	.26[c]	.28[c]	.30[c]	.31[c]	.75		
15. Absorptive capacity	4.36	1.44	.73	.16[a]	-.15[a]	.25[c]	.28[c]	.26[c]	.31[c]	.26[c]	.33[c]	.29[c]	.34[c]	.22[c]	.33[c]	.28[c]	.32[c]	.80	
16. Team performance	29.01	8.40	NA	-.19[b]	-.13[a]	-.19[b]	-.22[c]	.25[c]	.31[c]	.28[c]	.32[c]	.33[c]	.28[c]	.24[c]	.28[c]	.33[c]	.41[c]	.44[c]	NA

Notes: n = 190. ICR: Internal consistency reliability. Diagonal elements are the square root of the shared variance between the constructs and their measures; off-diagonal elements are correlations between constructs. [a] $p < .05$; [b] $p < .01$; [c] $p < .001$.

6.2. Structural Model

The structural model results are shown in Tables 4 and 5. Tables 4 and 5 show how the R-square of team performance changed after adding the control variables. We found a significant and positive relationship between design features and knowledge contextualization. Specifically, user login and identity persistence were significantly and positively related to ownership, thus supporting Hypothesis 1. Data searchability and search and retrieval capability were significantly and positively related to easy travel, thus supporting Hypothesis 2. Syndication was significantly and positively related to multiple perspectives, thus supporting Hypothesis 3. Expert flag and notification were significantly and positively related to emergence, thus supporting Hypothesis 5. We also found a significant and positive relationship between knowledge contextualization and collaboration know-how, thus supporting Hypothesis 6. Specifically, ownership, easy travel, multiple perspectives, and emergence were all positively and significantly related to collaboration know-how. Similarly, the relationship between knowledge contextualization and absorptive capacity was positive and significant, thus supporting Hypothesis 7. Specifically, ownership, easy travel, multiple perspectives, and emergence were all positively and significantly related to absorptive capacity. Our last two hypotheses were also supported in that collaboration know-how and absorptive capability were significantly and positively related to team performance. A main effects model that incorporated control variables (i.e., team size and project duration) and main predictors (i.e., knowledge contextualization, collaboration know-how, and absorptive capacity) explained 25 percent of the variance in team performance. Also, contextualization explained 31 percent of the variance in collaboration know-how and 37 percent of the variance in absorptive capacity.

Table 4. Results of Predicting Knowledge Contextualization and Knowledge Capabilities

	Knowledge contextualization				Knowledge capabilities	
	Ownership	Easy travel	Multiple perspectives	Emergence	Collaboration know-how	Absorptive capacity
R^2	.14	.20	.09	.17	.31	.37
Control variables						
Project duration in days					.13*	.13*
Team size					.10	.12*
Design features						
Ownership-user login	.22***					
Ownership-identity persistence	.24***					
Easy travel-data searchability		.33***				
Easy travel-search and retrieval		.30***				
Multiple perspectives-syndication			.30***			
Emergence-expert flag				.26***		
Emergence-notification				.28***		
Knowledge contextualization						
Ownership					.26***	.28***
Easy travel					.23***	.20**
Multiple perspectives					.19**	.20**
Emergence					.12*	.28***

Notes:
1. If the area is in grey, variables are not included in the model test.
2. *p < .05; ** p < .01; *** p < .001.

Table 5. Results of Predicting Team Performance		
	Model 1	Model 2
Project characteristics (controls)		
Project duration in days	-.15*	-.10
Team size	-.12*	-.11
Knowledge contextualization		
Collaboration know-how		.32***
Absorptive capacity		.30***
R^2	.06	.25
ΔR^2		.19***

Notes:
1. n = 190.
2. If the area is in grey, variables are not included in the model test.
3. * p < .05; ** p < .01; *** p < .001.

As a robustness check, we tested the entire model using the manipulation check variable values (instead of using the dummy variables). The pattern of correlations (see Appendix C) is similar. Note the correlations among the different design features are not 1 because they were replaced by actual manipulation check values. The effect of design features on knowledge contextualization is shown in Appendix D. The pattern of findings is the same overall, with all differences being < .05. Given that the results for knowledge capabilities and team performance were not affected, we do not report them again. As a post-hoc analysis, we tested the mediating role of team capabilities to leverage knowledge, i.e., collaboration know-how and absorptive capacity, by following Baron and Kenny's (1986) guidelines. We examined the relationships between: (1) knowledge contextualization and collaboration know-how and absorptive capacity; (2) knowledge contextualization and team performance in the absence of collaboration know-how and absorptive capacity; and (3) knowledge contextualization and team performance in the presence of collaboration know-how and absorptive capacity. Results indicate that team capabilities (i.e., collaboration know-how and absorptive capacity) to leverage knowledge partially mediate the relationship between knowledge contextualization and team performance.

7. Discussion

This research seeks to enrich our understanding of the impacts of collaborative technologies on team performance. We use IS design theory to develop a model that relates system design to team performance. Specifically, we examine how design features are related to knowledge contextualization and how collaboration know-how and absorptive capacity mediate the impacts of knowledge contextualization on team performance. We find support for our theoretical model. All design features are positively related to knowledge contextualization that, in turn, positively affected collaboration know-how and absorptive capacity. This suggests certain design features support knowledge contextualization with respect to allowing users to retrieve relevant and contextual information easily and quickly. Such knowledge contextualization enabled by collaborative technologies will, in turn, improve teams' ability to collaborate and assimilate knowledge. Also, collaboration know-how and absorptive capacity positively affect team performance, indicating the important role of team collaboration and knowledge integration in affecting team performance.

7.1. Theoretical Implications

Our work makes several contributions. First, this study helps us gain a better understanding of how to leverage collaboration technologies by drawing from IS design theory (Gregor & Jones, 2007). Although IS design theory makes useful suggestions for how to develop an IS artifact, limited research has actually leveraged this theory. Following the guidelines outlined in the IS design theory, this study develops and empirically tests a model that relates design of collaboration technologies to team performance. Our study indicates that IS design theory provides a sound theoretical foundation for developing the IS artifact and understanding its impacts on major outcomes, e.g., team performance.

Second, our study contributes to IS research in both design science and behavioral science by integrating them to understand the impacts of collaborative technologies on team performance (Gregor & Jones, 2007; Hevner et al., 2004). This study demonstrates how technologies can be designed to affect employees' thought processes and behavior outcomes, thus extending prior research on how to improve system design to achieve better results from human-computer interaction (e.g., Hong, Thong, & Tam, 2007; Hong et al., 2004a, 2004b; Hu et al., 1999; Wei et al., 2002). The paradigm of design sciences seeks to identify field-tested and grounded rules (van Aken, 2004, 2005). Consistent with that goal, our work presents important design principles that can be applied to improve the design of collaborative technologies. Table 6 summarizes these principles. Our research demonstrates that simply focusing on technology design or on employees' behaviors is not adequate. It is the integrated view of design science and behavioral science that sheds light on our understanding of the phenomenon. Drawing from IS design theory, our study provides evidence that manipulating design features may change team perceptions of collaborative technologies with respect to support of knowledge contextualization. Such change of perceptions has an effect on a team's behavioral processes, i.e., collaboration and knowledge assimilation, which play an important role in affecting team performance. By integrating design science and behavioral research, we gain a better understanding of human-computer interaction and how it affects a team's development of collaboration and knowledge assimilation skills, which are likely to affect team performance.

Table 6. Principles for Designing and Building Collaborative Technologies
1. Support ownership by incorporating features that allow single user login and identity persistence.
2. Support easy travel by incorporating features that facilitate searchability and retrieval of data.
3. Support multiple perspectives by incorporating features that facilitate integration and synthesis of data.
4. Support emergence by incorporating features that facilitate expert flag and notification.

Third, this research adds to the body of knowledge related to collaborative technologies (Dennis & Wixom, 2002; Dennis, Wixom, & Vandenberg, 2001). Although prior research has sought to understand the performance impacts of collaborative technologies from different theoretical perspectives--e.g., human information processing theory (Norman, 1976) and task-technology fit theory (Goodhue & Thompson, 1995; Zigurs & Buckland, 1998)--limited research has examined the mediational processes that link design of collaborative technologies to team performance. This work, thus, captures the important team processes that transmit the effect of collaborative technologies on team performance. We identify two important team processes related to team knowledge management--i.e., collaboration know-how and absorptive capacity--and examined their roles in the nomological network that relates system design to team performance. Team processes are important in understanding team functioning, and future research should identify those processes that are critical for various specific contexts.

Fourth, drawing from IS design theory and knowledge management literature, this research identifies key design features and theorizes how they affect team perceptions of collaborative technologies' capabilities to support knowledge contextualization. Our findings indicate a significant relationship between design features and perceptions of knowledge contextualization. Future research should examine different design features, e.g., posting, rating, related to ownership, easy travel, multiple perspectives, and emergence. In addition, future research should examine design features related to other mediational mechanisms that were not examined in this study, e.g., knowledge conversion (from tacit to explicit or from explicit to tacit, Alavi & Leidner, 2001; Nonaka, 1994). Moreover, future research should enrich our understanding of the role of design features by incorporating potential contingency factors, e.g., personality. For instance, extroverts may be more willing to reveal their identities to others than introverts would be, such that the effect of identity persistence on ownership could be stronger for extroverts than it is for introverts.

7.2. Limitations and Future Research

We acknowledge a few limitations of this study. First, due to constraints imposed by the research setting, we were unable to examine indeterminacy. Given the positive results for the remaining characteristics, we expect that this dimension will also be highly relevant. Future work should examine indeterminacy via experimental knowledge entry. Second, we did not incorporate task characteristics in our research model. It is important to capture this factor because it affects effectiveness of use (Majchrazk et al., 2005). Given that the software development teams in this study were responsible for similar software development projects, the severity of the problem of not capturing task variety was reduced. Nevertheless, future research should incorporate task characteristics to understand the impact of collaborative technologies on team performance. Third, although we have identified some design features in this study and we based our selection of the design features on theories (Locke, 2007; Zhang, 2008a, 2008b), future research should examine these features in more rigorous experimental settings. For example, each feature should be examined independently to reduce the possibility of confounding effects. In addition the features should be examined with participants who perform different types of tasks. The effects of these features over time should also be examined. There could be other features, such as using online avatars to represent self-identity (Zhang, 2008a), that support knowledge contextualization but were not covered in our study. Therefore, future research should examine more design features so that we can develop a better understanding of how collaborative technologies affect team performance.

7.3. Practical Implications

As organizations rely more and more on teams that use collaborative technologies, especially for distributed work, they must leverage collaborative technologies effectively and maximize the benefits they can bring, such as enhancing team performance. Our research identifies some specific features that can be incorporated by companies in developing collaborative technologies to improve a team's knowledge management processes as they relates to better collaboration and knowledge assimilation. For example, companies can enforce the feature of identity persistence in developing collaborative technologies such that users clearly know who authors messages. Having such information may help users better assess the value of knowledge.

In addition to identifying system features, our study finds that team performance is driven by team members' capability to collaborate and assimilate knowledge. Managers should, thus, develop interventions to achieve this objective. One approach discussed in this work is to leverage collaborative technologies by configuring them to support access to relevant information easily and quickly. There are other approaches to increase team collaboration, e.g., creating interdependent tasks to offer opportunities for interactions or relationship building among team members or using team-based rewards so team members pay more attention to collaboration and team outcomes. Also, formal training sessions could be provided to make team members develop better skills to leverage the collaborative technologies or encourage informal knowledge sharing.

Finally, this study indicates that team absorptive capacity is positively related to team performance. While organizations have been focusing on developing absorptive capacity at the organizational level, our study suggests they should also facilitate the development of absorptive capacity at the team level, especially given that team-based structures are widely used in today's organizations. When teams enhance their absorptive capacity, they are likely to extend such capacity to a large unit, such as a business unit or even the whole organization. This study suggests that team members can leverage collaborative technologies to develop their team's absorptive capacity. Organizations should provide training to employees so that they can become familiar with the specific features of the collaborative technologies that support knowledge contextualization--e.g., syndication, expert flag--an important antecedent of team absorptive capacity.

8. Conclusions

The work furthers our understanding of the impact of collaborative technologies on team performance. Drawing from literature on team capabilities and IS design theory, we developed a model that relates design features to team performance. We argued that collaborative technologies could be designed to support knowledge contextualization that would lead to enhanced team capability with respect to collaboration and knowledge assimilation that, in turn, would positively influence team performance. The results supported the proposed model. Further, based in a design sciences paradigm, our study identified four important design principles for collaborative technologies. Thus, we provide insights about how to integrate behavioral and design science research to enrich our understanding of the impacts of collaborative technologies on team functioning and performance.

References

Alavi, M., Kayworth, T. R., & Leidner, D. E. (2005). An empirical examination of the influence of organizational culture on knowledge management practices. *Journal of Management Information Systems, 22*(3), 191-224.

Alavi, M., & Leidner, D. E. (2001). Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly, 25*(1), 107-136.

Alavi, M., & Tiwana, A. (2002). Knowledge integration in virtual teams: The potential role of KMS. *Journal of the American Society for Information Science and Technology, 53*(12), 1029-1037.

Baron, R., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173-1182.

Barry, E. J., Kemerer, C. F., & Slaughter, S. A. (2006). Environmental volatility, development decisions, and software volatility: A longitudinal analysis. *Management Science, 52*(3), 448-464.

Benbasat, I., & Zmud, R. (2003). The identity crisis within the IS discipline: Defining and communicating the discipline's core properties. *MIS Quarterly, 27*(2), 183-194.

Bhatti, R., Bertino, E., & Ghafoor, A. (2007). An integrated approach to federated identity and privilege management in open systems. *Communications of the ACM, 50*(2), 81-87.

Bliese, P. D. (2000). Within-group agreement, non-independence, and reliability: Implications for data aggregation and analysis. In K. J. Klein and S. W. J. Kozlowski (Eds.), *Multilevel Theory, Research, and Methods in Organizations* (pp. 349-381). San Fransisco, CA: Jossey-Bass.

Boland, R., Tenkasi, R., & Te'eni, D. (1994). Designing information technology to support distributed cognition*. Organization Science, 5*(3), 456-475.

Borgatti, S. P., & Cross, R. (2003). A relational view of information seeking and learning in social networks. *Management Science, 49*(4), 432-445.

Bresman, H. (2010). External learning activities and team performance: A multimethod field study. *Organization Science, 21*(1), 81-96.

Brown, S. A. (2005). Absorptive capacity in information systems. In C. L. Cooper, C. Argyris, & W. H. Starbuck (Series Eds.), *The Encyclopedia of Management: Vol. VII. The Blackwell Encyclopedic Dictionary of Management Information Systems* (pp. 1). Oxford: Blackwell.

Brown, J. S., & Duguid, P. (1998). Organizing knowledge. *California Management Review, 40*(3), 90-111.

Burton-Jones, A., & Gallivan, M. (2007). Toward a deeper understanding of system usage in organizations: Multilevel perspective? *MIS Quarterly, 31*(4), 657-679.

Cadiz, D., Griffith, T. L., & Sawyer, J. E. (2009). Developing and validating field measurement scales for absorptive capacity and experienced community of practice. *Educational and Psychological Measurement, 69*(6), 1035-1058.

Chao, C. C., Jen, W. Y., Chi, Y. P., & Lin, B. (2007). Improving patient safety with RFID and mobile technology. *International Journal of Electronic Health Care, 3*(2), 175-192.

Cohen, S. G., & Bailey D. E. (1997). What makes teams work? Group effectiveness research from the shop floor to the executive suite. *Journal of Management, 23*(3), 239-290.

Cohen, W., & Levinthal, D. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly, 35*(1), 128-152.

Cold, S. (2006). Using really simple syndication (RSS) to enhance student research. *ACM SIGITE Newsletter* (http://portal.acm.org/citation.cfm?id=1113378.1113379&coll=Portal&dl=GUIDE&CFID=11880760&CFTOKEN=98943480)

Cramton, C. D. (2001). The mutual knowledge problem and its consequences for dispersed collaboration. *Organization Science, 12*(3), 346-371.

Cross, N. (2001). Design/science/research: Developing a discipline. Keynote speech of the *5th Asian Design Conference: International Symposium on Design Science*, Seoul, Korea.

Cross, R., & Cummings, J. N. (2004). Tie and network correlates of individual performance in knowledge-intensive work. *Academy of Management Journal, 47*(6), 928-937.

Dennis, A. R., Fuller, R. M., & Valacich, J. S. (2008). Media, tasks, and communication processes: A theory of media synchronicity. *MIS Quarterly, 32*(3), 575-600.

Dennis, A. R., & Valacich, J. S. (1999). Rethinking media richness: Towards a theory of media synchronicity. *Proceedings of the 32nd Hawaii International Conference on System Sciences*.
Dennis, A. R., & Valacich, J. S. (1994). Group, sub-group and nominal group idea generation: New rules for a new media? *Journal of Management, 20*(4), 723-736.
Dennis, A. R., & Wixom, B. (2002). Investigating the moderators of the group support systems use with meta-analysis. *Journal of Management Information Systems, 18*(3), 235-257.
Dennis, A. R., Wixom, B. H., & Vandenberg, R. J. (2001). Understanding fit and appropriation effects in group support systems via meta-analysis. *MIS Quarterly, 25*(2), 167-193.
Dosi, G., Nelson, R. R., & Winter, S. G. (2000). *The nature and dynamics of organizational capabilities*. Oxford, UK: Oxford University Press.
Easley, R. F., Devaraj, S., & Crant, J. M. (2003). Relating collaborative technology use to teamwork quality and performance: An empirical analysis. *Journal of Management Information Systems, 19*(3), 247-268.
Espinosa, J. A., Slaughter, S. A., Kraut, R. E., & Herbsleb, J. D. (2007). Team knowledge and coordination in geographically distributed software development. *Journal of Management Information Systems, 24*(1), 135-169.
Faraj, S., & Sproull, L. (2000). Coordinating expertise in software development teams. *Management Science, 46*(12), 1554-1568.
Fairchild A. J., & MacKinnon, D. P. (2009). A general model for testing mediation and moderation effects. *Prevention Science, 10*(2), 87-99.
Fuller, R. M., & Dennis, A. R. (2009). Does fit matter? The impact of task-technology fit and appropriation on team performance in repeated tasks. *Information Systems Research, 20*(1), 2-17.
Gallivan, M. J., Eynon, J., & Rai, A. (2003). The challenge of knowledge management systems: Analyzing the dynamic processes underlying performance improvement initiatives. *Information Technology & People, 16*(3), 326-352.
Goodhue, D. L., & Thompson, R. L. (1995). Task-technology fit and individual performance. *MIS Quarterly, 19*(2), 213-236.
Grant, R. M. (1996). Prospering in dynamically-competitive environments: Organizational capability as knowledge integration. *Organization Science, 7*(4), 375-387.
Gregor, S. (2006). The nature of theory in information systems. *MIS Quarterly, 3*(30), 611-642.
Gregor, S., & Jones, D. (2007). The anatomy of a design theory. *Journal of the Association for Information Systems, 8*(5), 312-335.
Griffith, T. L., Sawyer, J. E., & Neale, M. A. (2003). Virtualness and knowledge in teams: managing the love triangle of organizations, individuals, and information Technology. *MIS Quarterly, 27*(2), 265-287.
Guzzo, R. A., & Dickson, M. W. (1996). Teams in organizations: Recent research on performance and effectiveness. *Annual Review of Psychology, 47*(1), 307-338.
Haas M. R. (2006). Knowledge gathering, team capabilities, and project performance in challenging work environments. *Management Science, 52*(8), 1170-1184.
Henderson, J. C., & Lee, S. (1992). Managing I/S design teams: A control theories perspective. *Management Science, 38*(6), 757-777.
Hevner, A., March, S., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quarterly, 28*(1), 75-105.
Hinds, P. J., & Bailey, D. E. (2003). Out of sight, out of sync: Understanding conflict in distributed teams. *Organization Science, 14*(6), 615-632.
Hjelt, M., & Björk, B. (2006). Experiences of EDM usage in construction projects. *ITcon Journal, 11*(Special issue), 113-125.
Hollingshead, A. B. (1996). Information suppression and status persistence in group decision making: The effects of communication media. *Human Communication Research, 2*3(2), 193-219.
Hong, W., Thong, J .Y. L., & Tam, K. Y. (2004a). Design of product listing pages on e-commerce websites: An examination of presentation mode and information format. *International Journal of Human-Computer Studies, 61*(4), 481-503.
Hong, W., Thong, J. Y. L., & Tam, K. Y. (2004b). Does animation attract online users' attention? The effects of flash on information search performance and perceptions. *Information Systems Research, 15*(1), 60-86.

Hong, W., Thong, J. Y. L., & Tam, K. Y. (2007). How do web users respond to non-banner-ads animation? The effects of task type and user experience. *Journal of the American Society for Information Science and Technology, 58*(10), 1467-1482.
Hsieh, J. P., Rai, A., & Keil, M. (Forthcoming). Addressing digital inequality for the socio-economically disadvantaged through government initiatives: Forms of capital that affect ICT utilization. *Information Systems Research*.
Hu, P. J., Ma, P. C., & Chau, P. Y. (1999). Evaluation of user interface designs for information retrieval systems: A computer-based experiment. *Decision Support Systems, 27*(1-2), 125-143.
Huber, G. P. (1999). Facilitating project team learning and contributions to organizational knowledge. *Creativity and Innovation Management, 8*(2), 70-76.
Hwang, M., & Li, L. (2000). A new remote user authentication scheme using smart cards. *IEEE Transactions on Consumer Electronics, 46*(1), 28-30.
James, L. R., Demaree, R. G., & Wolf, G. (1984). Estimating within group interrater reliability with and without response bias. *Journal of Applied Psychology, 69*(1), 85-98.
Jan, N., Lin, S., Tseng, S., & Lin, N. (2009). A decision support system for constructing an alert classification model. *Expert Systems with Applications, 36*(8), 11145-11155.
Juang, W. S. (2004). Efficient multi-server password authentication key agreement using smart cards. *IEEE Transactions on Consumer Electronics, 50*(1), 251-255.
Kanawattanachai, P., & Yoo, Y. (2007). The impact of knowledge coordination on virtual team performance over time. *MIS Quarterly, 31*(4), 783-808.
Kankanhalli, A., Tan, B. C. Y., & Wei, K. (2005). Contributing knowledge to electronic knowledge repositories: An empirical investigation. *MIS Quarterly, 29*(1), 113-143.
Kogut, B., & Zander, U. (1992). Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science, 3*(3), 383-397.
Landry, R., Amara, N., & Rherrad, I. (2007). Determinants of knowledge transfer: Evidence from Canadian University researchers in natural sciences and engineering. *Journal of Technology Transfer, 32*(6), 561-592.
Lane, P. J., Salk, J. E., & Lyles, M. A. (2001). Absorptive capacity, learning, and performance in international joint ventures. *Strategic Management Journal, 22*(11), 1139-1161.
Leonardi, P. M., & Bailey, D. E. (2008). Transformational technologies and the creation of new work practices: Making implicit knowledge explicit in task-based offshoring. *MIS Quarterly, 32*(2), 411-436.
Lewis, M. W. (2000). Exploring paradox: Towards a more comprehensive guide. *Academy of Management Review, 25*(4), 760-766.
Li, S., & Chang, W. (2009). Exploiting and transferring presentational knowledge assets in R&D organizations. *Expert Systems with Applications, 36*(1), 766-777.
Locke, E. A. (2007). The case for inductive theory building. *Journal of Management, 33*(6), 867-890.
Ma, M., & Agarwal, R. (2007). Through a glass darkly: Information technology design, identity verification, and knowledge contribution in online communities. *Information Systems Research, 18*(1), 42-67.
Majchrzak, A., Malhotra, A., & John, R. (2005). Perceived individual collaboration know-how development through information technology-enabled contextualization: Evidence from distributed teams. *Information Systems Research, 16*(1), 9-27.
Majchrzak, A., Rice, R. E., Malhotra, A., King, N., & Ba, S. (2000). Technology adaptation: The case of a computer-supported inter-organizational virtual team. *MIS Quarterly, 24*(4), 569-600.
Malhotra, A., & Majchrzak, A. (2009). Communication context-dependent technology use in virtual teams. *Proceedings of the International Conference on Information Systems (ICIS'09)*, Phoenix, AZ, USA December, 15-19.
Malhotra, A., Majchrzak, A., Carman, R., & Lott, V. (2001). Radical innovation without collocation: A case study at Boeing-Rocketdyne. *MIS Quarterly, 25*(2), 229-250.
Martins, L. L., Gilson, L. L., & Maynard, M. T. (2004). Virtual teams: What do we know and where do we go from here. *Journal of Management, 30*(6), 805-835.
Mathieu, J. E., DeShon, R. P., & Bergh, D. D. (2008). Mediational inferences in organizational research: Then, now and beyond. *Organizational Research Methods, 11*(2), 203-223.
Maznevski, M. L., & Chudoba, K. M. (2000). Bridging space over time: Global virtual team dynamics and effectiveness. *Organization Science, 11*(5), 473-492.

Mitchell, V. (2006). Knowledge integration and information technology project performance. *MIS Quarterly, 30*(4), 919-939.
Nelson, K. M., & Cooprider, J. G. (1996). The contribution of shared knowledge to IS group performance. *MIS Quarterly, 20*(4), 409-432.
Nidumolu, S. R., & Subramani, M. (2003). The matrix of control: Combining process and structure approaches to managing software development. *Journal of Management Information Systems, 20*(3), 159-196.
Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science, 5*(1), 14-37.
Norman, D. (1976). *Memory and attention*. New York: Wiley.
Orlikowski, W. J., & Iacono, C. S. (2001). Desperately seeking the 'IT' in IT research: A call to theorize the IT artifact. *Information Systems Research, 12*(2), 121-134.
Park, J. H., Suh, H. J., & Yang, H. D. (2007). Perceived absorptive capacity of individual users in performance of enterprise resource planning (ERP) usage: The case for Korean firms. *Information & Management, 44*(3), 300-312.
Patnayakuni, R., Ruppel, C. P., & Rai, A. (2006). Managing the complementarity of knowledge integration and process formalization for systems development performance. *Journal of the Association for Information Systems, 7*(8), 545-567.
Poole, M. S., & Van de Ven, A. H. (1989). Using paradox to build management and organization theories. *Academy of Management Review, 14*(4), 562-578.
Poston, R. S., & Speier, C. (2005). Effective use of knowledge management systems: A process model of content ratings and credibility indicators. *MIS Quarterly, 29*(2), 221-244.
Powell, A., Piccoli, G., & Ives, B. (2004). Virtual teams: A review of current literature and directions for future research. *Database for Advances in Information Systems, 35*(1), 6-36.
Rai, A., Brown, P., & Tang, X. (2009a). Organizational assimilation of electronic procurement innovations. *Journal of Management Information Systems, 26*(1), 257-296.
Rai, A., Lang, S. S., & Welker, R. B. (2002). Assessing the validity of IS success models: An empirical test and theoretical analysis. *Information Systems Research, 13*(1), 50-69.
Rai, A., Maruping, L. M., & Venkatesh, V. (2009b). Offshore information system project success: The role of social embeddedness and cultural characteristics. *MIS Quarterly, 33*(3), 617-641.
Reagans, R., & McEvily, B. (2003). Network structure and knowledge transfer: The effects of cohesion and range. *Administrative Science Quarterly, 48*(2), 240-267.
Revere, D., Turner, A. M., Madhavan, A., Rambo, N., Bugni, P. F., Kimball, A., & Fuller, S. S. (2007). Understanding the information needs of public health practitioners: A literature review to inform design of an interactive digital knowledge management system. *Journal of Biomedical Informatics, 40*(4), 410-421.
Ringle, C. M., Wende, S., & Will, A. (2005). *Smart PLS 2.0*. University of Hamburg, Hamburg, Germany (http://www.smartpls.de).
Robert, L. P., Dennis, A. R., & Ahuja, M. K. (2008). Social capital and knowledge integration in digitally enabled teams. *Information Systems Research, 19*(3), 314-334.
Rothaermel, F. T., & Alexandre, M. T. (2009). Ambidexterity in technology sourcing: The moderating role of absorptive capacity. *Organizational Sciences, 20*(4), 759-780.
Sauer, C., Gemino, A., & Reich, B. H. (2007). The impact of size and volatility on IT project performance: Studying the factors influencing project risk. *Communications of the ACM, 50*(11), 79-84.
Simon, H. (1996). *The sciences of the artificial*. Cambridge: MIT Press.
Simonin, B. L. (1997). The importance of collaborative know-how: An empirical test of the learning organization. *Academy of Management Journal, 40*(5), 1150-1174.
Sundstrom, E. (1999). The challenges of supporting work team effectiveness. In E. Sundstrom (Ed.), *Supporting Work Team Effectiveness: Best Management Practices for Fostering High Performance* (pp. 3-23). San Francisco, CA: Jossey-Bass.
Te'eni, D. (2001). Review: A cognitive-affective model of organizational communication for designing IT. *MIS Quarterly, 25*(2), 251-312.
Thong, J. Y. L., Hong, W., & Tam, T. Y. (2002). Understanding user acceptance of digital libraries: What are the roles of interface characteristics, organizational context, and individual differences? *International Journal of Human-Computer Studies, 57*(3), 215-242.

Tremblay, M. C., Fuller, R., Berndt, D., & Studnicki, J. (2007). Doing more with more information: Changing healthcare planning with OLAP tools. *Decision Support Systems, 43*(4), 1305-1320.

Treiber, M., & Dustdar, S. (2007). Active web service registries. *IEEE Internet Computing, 11*(5), 66-71.

Thomas, D., & Bostrom, R. (2010). Vital signs for virtual teams: An empirically developed trigger model for technology adaptation interventions. *MIS Quarterly, 34*(1), 115-142.

Tsai, W. (2001). Knowledge transfer in intraorganizational networks: Effects of network position and absorptive capacity on business unit innovation and performance. *Academy of Management Journal, 44*(5), 996-1004.

Valacich, J. S., Dennis, A. R., & Connolly, T. (1994). Idea generation in computer-based groups: A new ending to an old story. *Organizational Behavior and Human Decision Processes, 57*(3), 448-467.

Valacich, J. S., & Schwenk, C. (1995). Devil's advocacy and dialectical inquiry effects on group decision making using computer-mediated versus verbal communication. *Organizational Behavior and Human Decision Processes, 63*(2), 158-173.

van Aken, J. E. (2004). Management research based on the paradigm of the design sciences: The quest for field-tested and grounded technologies rules. *Journal of Management Studies, 41*(2), 219-246.

van Aken, J. E. (2005). Management research as a design science: Articulating the research products of mode 2 knowledge production in management. *British Journal of Management, 16*(1), 19-36.

Van den Bosch, F. A. J., Volberda, H. W., & De Boer, M. (1999). Co-evolution of firm absorptive capacity and knowledge environment: Organization forms and combinative capabilities. *Organization Science, 10*(5), 551-568.

Venkatesh, V., & Agarwal, R. (2006). From visitors to Customers: A usability-centric perspective on purchase behavior in electronic channels. *Management Science, 52*(3), 367-382.

Volberda, H., Foss, N. J., & Lyles, M. (2009). Absorbing the concept of absorptive capacity: How to realize its potential in the organization field. *Organization Science, 21*(4), 931-951.

Wagner, C. (2004). Wiki: A technology for conversational knowledge management and group collaboration. *Communications of the Association for Information Systems, 13*(1), 265-289.

Walsham, G., Robey, D., & Sahay, S. (2007). Foreword: Special issue on information systems in developing countries. *MIS Quarterly, 31*(2), pp. 317-326.

Wei, C., Hu, P. J., & Chen, H. (2002). A knowledge management system for IC packaging and testing: Design, evaluation and implications for software engineering. *IEEE Software, 19*(3), 56-59.

Whetten, D. A. (1989). What constitutes a theoretical contribution. *Academy of Management Review, 14*(4), 490-495.

Xue, P., & Ramesh, B. (2008). Impact of knowledge support on the performance software process tailoring. *Journal of Management Information Systems, 25*(3), 277-314.

Zhang, P. (2008a). Motivational affordances: Fundamental reasons for ICT design and use. *Communications of the ACM, 51*(11), 145-147.

Zhang, P. (2008b). Toward a positive design theory: Principles for designing motivating information and communication Technology. In W. Jansen (Series Ed.), *Advances in Appreciative Inquiry Series: Designing Information and Organizations with a Positive Lens* (pp. 45-73). Amsterdam: Elsevier.

Zhang, P., & Li, N. (2005). The intellectual development of human-computer interaction research: A critical assessment of the MIS literature (1990-2002). *Journal of the Association for Information Systems, 6*(11), 227-292.

Zigurs, I., & Buckland, B. K. (1998). A theory of task/technology fit and group support systems effectiveness. *MIS Quarterly, 22*(3), 313-334.

Appendices

Appendix A. Measures

Ownership

1. Team members can easily know who contributed knowledge to the system.
2. Team members can easily find specific entries in the system that have been contributed by specific individuals.

Easy Travel

1. Team members can easily link the team's repository with other knowledge sources and applications.
2. Team members can easily identify historical connections between entries.
3. The system allows team members to find summaries and details.

Multiple perspectives

1. Using the system, team members can easily label an entry with multiple key words it pertains to.
2. Using the system, team members can easily view annotations and comments on knowledge made by others.

Emergence

1. The system informs team members when knowledge in the system changes.
2. The systems can easily change identifiers on knowledge as team members' ideas evolve over time.

Collaboration know-how

1. Our team knows how to streamline the team's internal processes.
2. Our team knows how to reduce redundancy of information and knowledge in the team.
3. Our team knows how to coordinate the efforts of everyone on the team.
4. Our team knows how to rapidly implement new team ideas.

Absorptive capacity

1. Our team has the necessary skills to acquire knowledge.
2. Our team has the technical competence to absorb knowledge.
3. Our team knows the necessary steps to learn knowledge.
4. Our team has the educational background to acquire the knowledge.

Appendix B.

Exhibit B. Manipulation Check on Each Design Features

	Treatment group	Control group
Ownership-user login: Team members login in when using the system.	6.03 (0.20)	1.10 (0.21)
Ownership-identity persistence: Team members use consistent identities when using the system.	5.20 (0.87)	1.20 (0.21)
Easy travel-data searchability: Knowledge in the system has been well categorized.	5.51 (1.22)	3.04 (0.50)
Easy travel-search and retrieval: Powerful search engine is offered to support fast and accurate retrieval of knowledge.	5.38 (0.55)	3.22 (0.78)
Multiple perspectives-syndication: Knowledge related to similar topics has been summarized or aggregated in a succinct format and grouped together.	4.76 (0.80)	3.17 (0.60)
Emergence-expert flag: Domain experts will update critical knowledge in the system.	4.90 (0.84)	3.22 (0.83)
Emergence-notification: Team members will be notified of the knowledge change in the system.	5.88 (0.60)	1.47 (0.44)

Appendix C.

Exhibit C. Reliabilities, Descriptive Statistics, and Correlations

	Mean	SD	ICR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Project duration in days (control)	94	28.5	NA	NA															
2. Team size (control)	6.80	3.30	NA	.22[c]	NA														
3. Ownership-user login	3.57	.21	NA	.10	.01	NA													
4. Ownership-identity persistence	3.20	.54	NA	.06	.05	.82[c]	NA												
5. Easy travel-data searchability	4.28	.86	NA	.08	.03	.80[c]	.77[c]	NA											
6. Easy travel-search and retrieve capability	4.30	.67	NA	.05	.04	.83[c]	.78[c]	.87[c]	NA										
7. Multiple perspectives-syndication	3.97	.70	NA	.07	.08	.79[c]	.75[c]	.86[c]	.80[c]	NA									
8. Emergence-expert flag	4.06	.84	NA	.08	.07	.75[c]	.80[c]	.82[c]	.82[c]	.82[c]	NA								
9. Emergence-notification	3.68	.52	NA	.07	.10	.78[c]	.91[c]	.83[c]	.84[c]	.83[c]	.80[c]	NA							
10. Ownership	5.10	1.22	.75	.13[a]	.15[a]	.40[c]	.39[c]	.31[c]	.35[c]	.24[c]	.29[c]	.34[c]	.70						
11. Easy travel	4.45	1.30	.77	.10	.08	.41[c]	.29[c]	.42[c]	.30[c]	.22[c]	.29[c]	.50[c]	.31[c]	.71					
12. Multiple perspectives	3.98	1.40	.73	.08	.07	.14[a]	.07	.14[a]	.23[c]	.31[c]	.08	.13[a]	.24[c]	.20[b]	.70				
13. Emergence	4.52	1.28	.80	.07	.04	.44[c]	.35[c]	.46[c]	.33[c]	.25[c]	.33[c]	.43[c]	.32[c]	.38[c]	.23[c]	.74			
14. Collaboration know-how	4.88	1.30	.70	.14[a]	-.14[a]	.28[c]	.30[c]	.24[c]	.37[c]	.26[c]	.26[c]	.25[c]	.26[c]	.28[c]	.30[c]	.31[c]	.75		
15. Absorptive capacity	4.36	1.44	.73	.16[a]	-.15[a]	.26[c]	.29[c]	.26[c]	.32[c]	.26[c]	.31[c]	.29[c]	.34[c]	.22[c]	.33[c]	.28[c]	.32[c]	.80	
16. Team performance	29.01	8.40	NA	-.19[b]	-.13[a]	-.20[b]	-.23[c]	.28[c]	.30[c]	.30[c]	.32[c]	.33[c]	.28[c]	.24[c]	.28[c]	.33[c]	.41[c]	.44[c]	NA

Notes:
1. $n = 190$.
2. ICR: Internal consistency reliability.
3. Diagonal elements are the square root of the shared variance between the constructs and their measures; off-diagonal elements are correlations between constructs.
4. [a] $p < .05$; [b] $p < .01$; [c] $p < .001$.

Appendix D.

Exhibit D. Results of Predicting Knowledge Contextualization

	Knowledge contextualization			
	Ownership	Easy travel	Multiple perspectives	Emergence
R^2	.15	.20	.10	.19
Control variables				
Project duration in days				
Team size				
Design features				
Ownership-user login	.24***			
Ownership-identity persistence	.25***			
Easy travel-data searchability		.32***		
Easy travel-search and retrieval		.31***		
Multiple perspectives-syndication			.32***	
Emergence-expert flag				.29***
Emergence-notification				.31***

Notes:
1. If the area is in grey, variables are not included in the model test.
2. *p < .05; ** p < .01; *** p < .001.

About the Authors

Xiaojun ZHANG is an assistant professor of the Department of Information Systems at the Hong Kong University of Science and Technology and earlier received his PhD from the University of Arkansas. Xiaojun Zhang's primary research stream focuses on understanding the impacts of technology on performance outcomes. His secondary stream of research explores the roles of social networks, culture and knowledge management in the context of IT implementation. His research has been published or is forthcoming in information systems journals including *Information Systems Research, MIS Quarterly, European Journal of Information Systems, Information Systems Frontiers* and *Journal of Global Information Technology Management*.

Viswanath VENKATESH is a Distinguished Professor and holder of the Billingsley Chair in Information Systems at the University of Arkansas, where he has been since June 2004. Prior to joining Arkansas, he was on the faculty at the University of Maryland and received his PhD at the University of Minnesota. His research focuses on understanding the diffusion of technologies in organizations and society. His work has appeared or is forthcoming in leading journals in information systems, organizational behavior, psychology, marketing and operations management journals. His articles have been cited over 15,000 times and 5,300 times per Google Scholar and Web of Science respectively. Some of his papers are among the most cited papers published in the various journals, including *Information Systems Research*, *MIS Quarterly* and *Management Science*. He developed and maintains a web site that tracks researcher and university research productivity (http://www.vvenkatesh.com/ISRanking). He has served on or currently serving on several editorial boards. He recently published a book titled "*Road to Success: A Guide for Doctoral Students and Junior Faculty Members in the Behavioral and Social Sciences*" (http://vvenkatesh.com/book).

Susan A. BROWN is a McCoy Rogers Fellow and associate professor of Management Information Systems in the University of Arizona's Eller College of Management. She received her Ph.D. from the University of Minnesota and an MBA from Syracuse University. Her research interests include technology implementation, individual adoption, computer-mediated communication, technology-mediated learning, and related topics. Her research has been published in *MIS Quarterly, Organizational Behavior and Human Decision Processes, Information Systems Research, Journal of MIS, IEEE Transactions on Engineering Management*, *Communications of the ACM, Journal of the AIS,* and others. She has served or is currently serving as an associate editor for *MIS Quarterly, Information Systems Research, Journal of the AIS,* and *Decision Sciences.*