

The Use of Different Information and Communication Technologies to Support Knowledge Sharing in Organizations: From E-Mail to Micro-Blogging

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Previous research has revealed the following three challenges for knowledge sharing: awareness of expertise distribution, motivation for sharing, and network ties. In this case study, we examine how different generations of information and communication technologies (ICTs), ranging from e-mail to micro-blogging, can help address these challenges. Twenty-one interviews with employees from a multinational company revealed that although people think social media can better address these challenges than older tools, the full potential of social media for supporting knowledge sharing has yet to be achieved. When examining the interconnections among different ICTs, we found that employees' choice of a combination of ICTs, as affected by their functional backgrounds, could create "technological divides" among them and separate resources. This finding indicates that having more ICTs is not necessarily better. ICT integration, as well as support for easy navigation, is crucial for effective knowledge search and sharing. Adaptation to local culture is also needed to ensure worldwide participation in knowledge sharing.

Introduction

Knowledge is a critical resource for organizations functioning in today's knowledge economy (Due, 1995). In this context, a key challenge for contemporary organizations of all types (including for-profit, nonprofit, and governmental) is connecting and sharing knowledge that is distributed throughout an organization (Nonaka, von Krogh, & Voelpel, 2006). Organizations have tried to address these tasks

through formal knowledge management (KM) systems such as expertise directories and group decision-making support systems. However, these systems have not always lived up to their expectations (Hinds & Pfeffer, 2003).

In recent years, social media have been increasingly adopted in organizations (Danis & Singer, 2008; Holtzblatt, Damianos, & Weiss 2010; Zhang, Qu, Cody, & Wu, 2010). The term *social media* refers to "a group of Internet-based applications that build on the ideological and technological foundations of web 2.0, and that allow the creation and exchange of user generated content" (Kaplan & Haenlein, p. 61). Some popular social media tools include online forums, bookmarking services (Millen, Feinberg, & Kerr, 2006), micro-blogging services (Zhao & Rosson, 2009), enterprise wikis (Holtzblatt et al., 2010), and online social networking sites (Stephens, Sornes, Rice, Browning, & Saetre, 2008). Although both scholars (Treem & Leonardi, 2012) and practitioners (Brown, Schadler, & Catino, 2008; Yehuda, McNabb, Young, Burnes, & Reiss-Davis, 2008) are excited about the potential of using social media to address the challenges in knowledge sharing, to the best of our knowledge, few empirical studies have been done to investigate this topic. The main objective of the current research is therefore to fill this void.

One key question that needs to be addressed is how social media compare with existing information and communication technologies (ICTs) in serving employees' knowledge-sharing needs. Most of the studies on the usage of social media within organizations, however, focus on one tool at a time (e.g., Holtzblatt et al., 2010), with only a few exceptions (DiMicco et al., 2008). Even fewer have paid attention to how social media tools are used in combination with earlier generations of technologies to advance the goal

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of knowledge sharing. There is no doubt that studies on one specific technology at a time are valuable. Recent research on technology use in organizations, however, calls for more studies on the complementary usage of multiple technologies in serving employees' communication and work needs (Haas & Hansen, 2007; Haythornthwaite & Wellman, 1998; Stephens, 2007; Yuan, Rickard, Xia, & Scherer, 2011), because employees in contemporary organizations seldom use only one tool at work. Thus, the second goal of the current research is to explore how different generations of ICTs have been used in combination to support knowledge sharing in organizations.

We aim to make two contributions to the research on ICT use for knowledge sharing. First, in our investigation, we paid attention not only to how each tool helps reduce challenges in knowledge sharing but also to how the different tools relate to each other in serving employees' work needs. Many field studies have examined how technology is used in organizations (Kane & Alavi, 2007; Leonardi & Barley, 2010; Yuan, Fulk, & Monge, 2007), how designs could help address challenges from existing ICTs (e.g., Ackerman & Malone, 1990; Ackerman & McDonald, 1996; Cohen & Prusak, 2001; Reichling & Wulf, 2009), and how users with different skills or cultural backgrounds might use ICTs differently (e.g., Normark & Randall, 2005; Pipek & Wulf, 2003). Very few studies, however, have examined whether and how the different tools compete with or complement each other in serving employees' knowledge-sharing needs. We believe that an explicit examination of such relationships among ICTs is needed to control redundancies in ICT offerings, to avoid wasting resources on acquiring and maintaining overlapping ICTs, and to ensure smooth transitions when an organization decides to replace an older generation of ICTs with a newer one.

Second, in comparing ICTs, we connect behavioral research on knowledge management with empirical studies on ICT design. Even in the design-driven human-computer interaction (HCI) research community, there has been a clear trend since the ethnographic study by McDonald and Ackerman (1998) on how organizational knowledge gets created and shared. Because knowledge management is deeply social in nature (Thomas, Kellogg, & Erickson, 2001), we believe that making such a connection between behavioral research and tool design can make a valuable contribution to the HCI research community, because the absence of such a connection may result in a proliferation of tools that do not necessarily address real-life work challenges.

To achieve this goal, we first offer a brief review of existing KM research on the key challenges hindering effective knowledge sharing in organizations. We then use these challenges as key dimensions to evaluate the usefulness of different ICT tools through an interview study of 21 employees in the Chinese branch of a multinational software company. Building on these findings, we propose a few directions for future theorizing about technology use in organizations, particularly regarding the issue of media multiplexity.

Importance of Technology in Organizations

Challenges for Sharing Organizational Knowledge

Existing KM research has revealed that knowledge sharing contains two subprocesses: *knowledge search/seeking* and *knowledge transfer/learning* (Borgatti & Cross, 2003; Hansen, 1999; Hansen, Mors, & Lovas, 2005). The knowledge search process focuses on locating needed knowledge, whereas the knowledge transfer process focuses on learning and acquiring knowledge. Between these two subprocesses, three main challenges have been identified.

The first challenge is awareness of expertise distribution, that is, the knowledge of where the needed knowledge exists (Borgatti & Cross, 2003; Hinds & Pfeffer, 2003). For knowledge search/seeking, people must first know where or in whom specific knowledge resides. Particularly in large organizations, many employees have trouble keeping up to date about other people's competencies and achievements (Alavi & Leidner, 2001). As a result, employees, unaware of other people's accomplishments, may waste a tremendous amount of time reinventing the wheel. Lew Platt, a former CEO of Hewlett-Packard (HP), is quoted as saying, "If HP knew what HP knows, we would be three times as profitable" (Davenport & Prusak, 1998, p. xii).

Although awareness of expertise distribution facilitates the search process in knowledge sharing by providing a mental map for the seekers as to where to locate the needed knowledge, providers' *motivation* for sharing is a second challenge influencing whether the located knowledge and expertise can actually be transferred to complete the whole knowledge-sharing process (Cabrera & Cabrera, 2002; Wittenbaum, Hollingshead, & Botero, 2004; Yuan, Carboni, & Ehrlich, 2010). KM research has identified multiple factors that can increase costs and therefore curb motivation for sharing. First, knowledge sharing takes time, particularly when the knowledge to be shared is tacit and thus difficult to articulate (Hansen, 1999; Polanyi, 1967). Second, because sharing can erode the competitive advantage of knowledge providers, employees' motives can have a significant impact on their willingness to share. Both laboratory and field research has found that employees are open to sharing in a cooperative environment; however, when in a competitive environment, or when driven by self-interest rather than social-collective interest, they withhold and even distort information (De Dreu, Nijstad, & van Knippenberg, 2008; Steinel, Utz, & Koning, 2010).

To deal with both the awareness and motivation challenges, empirical evidence exists that an effective strategy is to develop *social capital* (Hansen, 1999; Hansen et al., 2005; Reagans & McEvily, 2003), defined as resources embedded in a network of relations that people can mobilize for purposeful actions (Bourdieu, 1985; Burt, 1992; Lin, 2001). People can obtain social capital through both strong (Krackhardt & Kilduff, 2002) and weak network connections (Granovetter, 1982) from dense networks (Coleman, 1988) or via connections with high-status people (Bonacich, 1972). Research on organizational management shows that strong

ties are beneficial for transferring knowledge, whereas weak ties are preferred for searching for information from diverse sources (Hansen, 1999). Despite these confirmed benefits of social capital, the development of network ties between people in different parts of an organization can be difficult because people have only limited time and resources to maintain frequent communication ties with others. To deal with these challenges, we believe that the adoption and use of ICTs can be useful because they reduce the cost of maintaining network ties (Treem & Leonardi, 2012).

Use of ICTs in Organizations

Organizations' investments in ICTs provide employees with a wide range of tools to support their knowledge-sharing needs (Alavi & Leidner, 2001). An organization might have any combination of both long-standing tools, such as e-mail, telephones, teleconferencing, intranets, group decision support systems, or databases, and newer interactive social media tools, such as wikis, blogs, online communities, social networking sites, and micro-blogging. Because organizational tasks are typically very complicated and may involve multiple subprocesses (e.g., knowledge sharing contains both the search and the transfer stages [Hansen, 1999]), employees need to use different tools to satisfy their work needs during different stages of a work process. As a result, task complexity, along with the availability of different types of ICTs, calls for more research on the issue of media multiplexity (Haythornthwaite & Wellman, 1998), that is, how multiple ICTs can be used in combination to support communication and knowledge sharing needs. For instance, Haythornthwaite and Wellman found a high correlation between strength of network relationship and the number of ICTs used for communication. Stephens (2007) proposed that the sequence of using different ICTs could impact group dynamics. Su and Mark (2008) explored media choices, especially the temporal routines of media switching when individuals are multitasking at work.

Existing research on the usage of ICTs in organizations also provides ample suggestions as to how different tools can be combined to serve communication needs for knowledge sharing (Groth & Bowers, 2001; Haythornthwaite & Wellman, 1998; Stephens, 2007; Stephens et al., 2008). For instance, certain expertise is tacit, hard to articulate, and hence difficult to share (Hansen, 1999; Polanyi, 1967; Uzzi, 1996). Face-to-face communication is considered more appropriate for obtaining tacit expertise because it allows the expertise seeker to learn through observation, even when the expertise provider encounters difficulties in verbalizing his or her thoughts. In contrast, when expertise can be easily codified, sharing expertise through documents or e-mails may improve both accuracy and efficiency in expertise sharing. Other aspects of technology suggest that media multiplexity facilitates greater flexibility in fulfilling knowledge-sharing needs. For example, asynchronous ICTs allow expertise holders and retrievers to carry out their tasks at their own pace (Kalman, Monge, Fulk, & Heino, 2002).

As long as expertise holders have communicated or shared their expertise at any time prior to the request for that expertise, for example, through e-mails or a common electronic expertise repository, it will be available on demand to expertise seekers. More recent social media tools that allow the creation of artifacts, such as wikis, blogs, and podcasts, also allow expertise holders to satisfy multiple expertise-seeking requests with a single post, which can greatly improve knowledge-sharing efficiency. When multiple ICTs are available for use and are needed for different stages of a task, it would be interesting to explore not only how an ecology of tools is used together in serving people's needs (e.g., Turner, Qvarfordt, Biehl, Golovchinsky, & Back, 2010), but also how the tools compete with or complement each other in serving people's needs. Taken together, we are interested in exploring the following research questions:

RQ1: How are different information and communication technologies used in organizations to help employees handle challenges (e.g., awareness, motivation, and the development of social capital) in knowledge sharing?

RQ2: How do the tools compete with or complement each other in helping employees handle these challenges in knowledge sharing?

Methods

To address these research questions, we conducted a case study of the Chinese branch of a multinational company. The branch provides a perfect site for our study, because the company specializes in producing and selling commercial business software to improve work efficiency and has multiple tools in use to support knowledge sharing among employees. Moreover, interviewing employees at the Chinese branch allows us to examine knowledge-sharing practices from the perspective of those whose first language is not English. Their opinions can provide valuable insights into how to design tools to better support knowledge sharing in a global arena, where intercultural collaboration has become more common (Danis & Singer, 2008; Davenport & Prusak, 1998).

We interviewed 21 employees (E1–E21) from this branch. When recruiting participants, we contacted people from different business units, including administration, human resource, sales, research and development (R&D), and postsale support teams. We also intentionally recruited people with various tenures with the organization, because younger people may feel more comfortable using social media tools in their daily work. We stopped recruiting new participants when additional interviews stopped yielding new insights. Table 1 and Table 2 provide a summary of the interviewees' background information, as well as their media usage patterns.

We started our interview with a few general questions about how people share information and knowledge in organizations. We then asked open-ended questions about what technologies they have been using in their daily work, how they take advantage of different ICT offerings for sharing

TABLE 1. Summary of the interviewees' background information.

No.	Years in current position	Gender	Job title	Tools frequently used at work for sharing knowledge
1	4	M	Research scientist	Communication* and long-standing KM tools [†]
2	5	F	Financial analyst	All three
3	5	F	Senior administrator	Communication and long-standing KM tools
4	2	M	Sales specialist	Communication and long-standing KM tools
5	3	M	Software sales specialist	All three
6	6	M	Research scientist	All three
7	4	M	Research scientist	Communication and social media [‡]
8	7	F	Software engineer	All three
9	2	M	Software engineer–manager	Communication and social media
10	1.5	M	Software engineer	All three
11	0.5	M	Sales specialist	Communication and social media
12	2	F	Sales operations specialist	Communication and long-standing KM tools
13	1	M	Senior software engineer	Communication and social media
14	4	M	Software engineer	Communication and social media
15	1	F	Financial analyst	Communication and long-standing KM tools
16	4	M	Technical sales support	All three
17	2	M	Software engineer	All three
18	0.5	F	Sales operations specialist	Communication and long-standing KM tools
19	4	F	Software engineer	All three
20	1	M	Technical sales support	Communication and social media
21	5	M	Software engineer	Communication and social media

Note. F indicates female; M, male; KM, knowledge management.

*Communication tools: e-mail, telephone, instant messaging, videoconferencing, and so on.

[†]Long-standing KM tools: databases, team digital archives, et cetera.

[‡]Social media: wikis, forums, profiles, blogs, social networking sites, micro-blogging, and so on.

TABLE 2. Summary of the interviewees' frequently used KM tools.

No.	Years in current position	Gender	Job title	Frequently used tools at work for sharing knowledge
1	4	M	Research scientist	E-mail, telephone, instant messaging, videoconferencing, databases
2	5	F	Financial analyst	E-mail, telephone, instant messaging, videoconferencing, databases
3	5	F	Senior administrator	E-mail, telephone, instant messaging, databases
4	2	M	Sales specialist	E-mail, telephone, instant messaging, databases
5	3	M	Software sales specialist	E-mail, telephone, instant messaging, databases, internal SNS, external SNS
6	6	M	Research scientist	E-mail, telephone, instant messaging, video conferencing, databases, internal SNS, external SNS, wiki, forum
7	4	M	Research scientist	E-mail, telephone, instant messaging, wiki, forum, internal SNS, external SNS
8	7	F	Software engineer	E-mail, telephone, instant messaging, wiki, internal SNS, external SNS
9	2	M	Software engineer–manager	E-mail, wiki, forum, internal SNS, external SNS
10	1.5	M	Software engineer	E-mail, telephone, instant messaging, databases, internal SNS, wiki, external SNS
11	0.5	M	Sales specialist	E-mail, telephone, instant messaging, internal SNS, wiki, external SNS
12	2	F	Sales operations specialist	E-mail, instant messaging, databases
13	1	M	Senior software engineer	E-mail, telephone, instant messaging, videoconferencing, internal SNS, wiki, profile
14	4	M	Software engineer	E-mail, telephone, instant messaging, internal SNS, wiki, forum, external SNS
15	1	F	Financial analyst	E-mail, telephone, instant messaging, database
16	4	M	Technical sales support	E-mail, telephone, instant messaging, database, internal SNS, wiki, forum
17	2	M	Software engineer	E-mail, telephone, instant messaging, database, internal SNS, blog, profile, forum, wiki
18	0.5	F	Sales operations specialist	E-mail, telephone, instant messaging, database
19	4	F	Software engineer	E-mail, instant messaging, database, internal SNS, wiki, blog, profile, external SNS
20	1	M	Technical sales support	E-mail, telephone, instant messaging, video conferencing, internal SNS, wiki, blog, profile, external SNS
21	5	M	Software engineer	E-mail, telephone, internal SNS, wiki, blog, profile, external SNS

Notes. F indicates female; M, male; SNS, social network site.

knowledge, and the perceived usefulness and limitations of these tools in supporting knowledge sharing. The specific ordering of these questions varied across participants, depending on the flow of each interview.

In analyzing the data, we took a grounded approach. Specifically, after transcribing all the interviews, the authors worked independently first and then jointly in coding the data into different themes. Common themes identified across authors were compared and included in this paper upon reaching consensus. Discussion of these common themes is organized first around the type of ICTs used (RQ1), then the interconnections among the ICTs (RQ2).

Results

RQ1 on the Usage of Different ICTs for Knowledge Sharing

Participants reported using a wide range of ICTs. The ICT¹ offerings can be classified into the following categories:

- Communication tools, for example, e-mail, instant messaging, telephone, and video conferencing
- Long-standing KM tools, for example, databases and team digital archives
- Social media, for example, wikis, forums, profiles, blogs, social networking sites, online communities, and micro-blogging tools, hosted by the company behind its firewall

Interviews showed that all tools have an active user base in the organization and helped to reduce at least one of the three challenges for knowledge sharing that are reviewed above, albeit to varying degrees. We discuss each in turn.

Communication Tools

Of all the tools we studied, communication tools are the only ones used by all 21 participants. We found that the four most popular communication tools (e-mail, instant messaging, telephone, and video conferencing) are complementary to each other in supporting both synchronous (e.g., instant messaging) and asynchronous (e.g., e-mail), as well as intrusive (e.g., telephone calls) and less intrusive (e.g., using instant messaging to respond to an urgent request for Project A during a meeting about Project B) communication among employees. Although most communications via instant messaging and telephone are used for informal discussions (e.g., E2) and cannot be used as formal supporting evidence (e.g., E3) when disputes happen, half of our participants consider communication tools as very informative and more importantly, most efficient in providing up-to-date information (e.g., E3, E20). Because communication tools directly connect knowledge seekers and providers, they help

¹Although *ICT* and *tools* are used interchangeably in this article, the term *tool* focuses more on the technical affordances and functionalities of the ICT offerings.

build stronger connections between them and thereby make providers more motivated to share knowledge. Furthermore, the company has recently upgraded its e-mail system to allow integration with its instant messaging tool and to display people's availability status at the beginning of e-mails (e.g., E3). This feature, which is more "social" in nature, makes it even easier for people to initiate synchronous conversations. However, it is not clear how communication tools contribute to the development of awareness of expertise distribution and networking beyond those who are directly involved in knowledge sharing.

Long-Standing KM Tools

Although a number of participants, especially those from R&D divisions, consider long-standing databases to be outdated technology (e.g., E7), we found that databases and digital archives are used widely in this software company, which leads in developing innovative business solutions. Fourteen of the 21 participants in our study list these as frequently used KM tools. These databases and digital archives typically do not have built-in tools that allow searching or communicating with document contributors, hence their value for developing awareness of expertise distribution and social capital is limited. However, the plethora of documents archived in such long-standing KM tools make them invaluable resources for storing codified knowledge. Particularly for those who work in long-standing divisions that provide administration or sales support, almost all participants reported regular usage of these tools (e.g., E2, E3, E4, E15). In a sense, the documents stored in these databases and archives have helped prolong the use of such tools. That said, more than half of interviewees who use long-standing tools reported that their contributions to these databases were mandated by managers (e.g., E5, E14) and hence may not contain as many details as when the contributions were more voluntary. The lack of contextual information of knowledge stored in such databases calls for the integration of other ICT offerings to satisfy employees' knowledge-sharing needs. This topic is revisited in a later section.

Social Media

In addition to these databases, the company has also deployed two generations of social media internally to support knowledge sharing. The first generation provided wikis, blogs, social networking and bookmarking tools, communities, and forums, but as separate packages. In the second release, these tools were made available on one common platform. Fifteen of the 21 participants in our study listed internal social media as one of the regular tools that they use for knowledge sharing. More than half of those 15 participants said that the second release, the integrated platform, has the advantage of better supporting social interactions and networking among users over disparate tools such as wikis and forums (e.g., E6, E16, E17). Overall, almost all

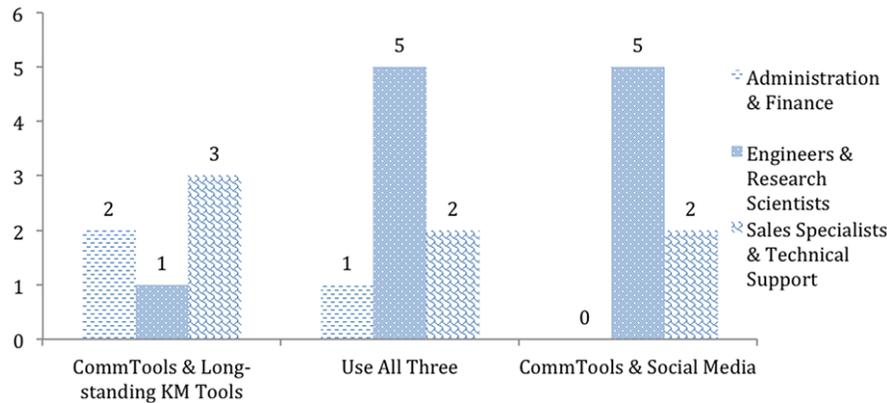


FIG. 1. Numbers of participants using different combinations of knowledge management (KM) tools. Comm, communications. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

social media users think social media tools are better at supporting social interactions than long-standing KM databases.

When compared with both communication tools and long-standing KM tools, interviews showed that social media can better address challenges to knowledge sharing. First, it was commonly mentioned that using social media helped people develop better awareness of both their colleagues' expertise (e.g., from employees' profiles) and their personal lives (e.g., from status updates; E16, E21). Such knowledge can help knowledge seekers network more effectively with providers because the providers' self-reported interests or posts help the seekers better understand the interests and expertise of the providers (e.g., E9, E17, E21). Second, consistent with findings from earlier research (Thomas et al., 2001), more than half of internal social media users interviewed think the increased social capital associated with social media use increases their motivation for sharing expertise with one another (e.g., E9, E17, E21).

RQ2 on the Interconnections Among Different ICTs for Supporting Knowledge Sharing

Consistent with findings and predictions from recent research on media multiplexity (Haythornthwaite & Wellman, 1998; Stephens, 2007; Yuan et al., 2010), we found that employees indeed used multiple tools in combination to serve their knowledge-sharing needs. Among these tools, long-standing KM and communication tools are complementary to each other in function. In contrast, long-standing KM and social media seem to have more overlapping technical affordances and thus compete with each other for resources and users. Figure 1 provides a visual summary of the number of participants in different job positions who use different combinations of tools.

Long-Standing KM and Communication Tools

Consistent with findings from KM research, a commonly mentioned drawback of long-standing KM tools is the lack

of contextual information around archived documents (Alavi & Leidner, 2001). In the company's fast-changing operating environment, these documents become outdated quickly (e.g., E4, E5). As a result, direct follow-ups with people involved are frequently required. However, these databases typically do not support interaction. As E1 said,

"[name of the database] is not good at supporting communication around some topics of discussion . . . but it is very important. If we want to provide some descriptions or explanations for the task items we usually need to make a call." (E1)

Use of communication tools to complement the lack of interactivity of long-standing KM databases to locate contextual information is very common (e.g., E4, E11). In certain cases, employees even bypassed databases completely to find what they need quickly. E3, a senior administrator, said,

"Operation has a website of documents explaining administrative procedures, but people rarely read them. I would have received much fewer instant messages seeking help if people had started from there when running into questions. Most people just prefer to seek help from a person directly [instead of documents], because it is just faster." (E3)

Also consistent with earlier research (Hansen, 1999), most participants from our study said that communication tools are irreplaceable for sharing knowledge that is difficult or too time-consuming to put in databases. As E11 said,

"I still believe that valuable, tacit knowledge needs to be dug out via interpersonal communication." (E11)

Taken together, it seems that although switching between tools can be frustrating at times, long-standing KM tools and communication tools complement each other well in serving employees' knowledge-sharing needs. Long-standing KM databases provide a rich archive of formal, documented knowledge, whereas communication tools are valuable for sharing tacit, informal, contextual knowledge.

Long-Standing KM and Social Media

Although communication tools and long-standing KM tools complement each other well to support both archiving knowledge (mostly formal) and ad hoc knowledge sharing (mostly informal), the two parts of knowledge sharing are separated on different platforms. In contrast, the second-generation social media platform brings social interactions and knowledge storage together. Such integration between the two functions gives social media an edge over long-standing KM tools in addressing employees' knowledge-sharing needs (e.g., E6, E9, E16). As E9 pointed out, using social media,

"Our community has mail groups, wiki, activities and other tools integrated together . . . I am very optimistic because it (the integrated platform) significantly increases attachment to the community. Now we can arrange work activities around the community and don't have to send information to separate tools."

"You can easily follow updates from a senior technical person and see what he has been up to and thinking about. You can also search . . . to get the most updated PowerPoint from the sales team. You probably cannot get these, or get them a month later following the traditional top-down approach, unless you have some personal connections with people in charge." (E9)

In addition to ease of seeking knowledge, most employees who use social media also experienced higher levels of motivation when they shared expertise on social media than on long-standing KM tools (e.g., E8, E13, E17), as reported by E5 and E17.

"If there is no requirement to update files in [the name of a database] there will be no updates. I am open to sharing my experience with other people, but if other colleagues provide no feedback or do not contribute, that will be a setback for my motivation to share." (E5)

"One important reason why I am motivated to share on social media is that I could increase my visibility in the organization by interacting with others on the platform. For example, some worldwide colleagues who I don't work with can recognize me by following my blog." (E17)

During the interviews, most employees who use social media regularly (8 of 15) find the tools more effective in supporting knowledge sharing when compared with long-standing tools.

"The thing about long-standing KM tools is that once you put something in it, it becomes dead knowledge. There is no easy way you could share that knowledge with more people. But . . . the internal social media platform makes it so easy to share." (E17)

Despite increased awareness of expertise distribution, higher motivation for sharing, and increased social capital, the new tools are not as widely used as we had anticipated. As shown in the last column of Table 1, of the 10 interviewees who work in conventional business divisions, such

as administrative support, human resources, and sales, 5 prefer long-standing databases to find and store knowledge. In contrast, those who work in or for R&D have started migrating to social media to serve their knowledge-sharing needs. Only 1 of the 11 software developers and researchers interviewed still uses long-standing KM tools, whereas 10 use the integrated social media platform. Such a divide in technology use between people from different functional backgrounds can create barriers for knowledge sharing because people are unlikely to venture into strange territory to find out what resources are available, particularly when different tools have different interfaces. Although not every business unit is expected to communicate or collaborate with everyone else, working on a common platform is nevertheless desirable because doing so eases sharing when such needs arise. An interesting question then becomes the following: What makes people want to stay with long-standing KM tools when the new generation of ICT offerings promises more advanced technological affordances? Half of the participants, split between users and nonusers of long-standing tools, said that the value of long-standing databases lies in the documents stored in them (e.g., E2, E3, E4, E15). E19, a software engineer, commented,

"Our team uses both [name of a long-standing database] and [name of the integrated social media]. [name of the database] is still useful, because it archives many historical documents. [name of social media] has only been released for a year, and people have different preferences. So [name of the database] won't be replaced very soon." (E19)

Additional Challenges

In addition to motivation, awareness, and social capital, participants also discussed a number of challenges they face when using the existing tools to share knowledge. The first challenge mentioned by almost half of the participants (e.g., E11, E12) is that having too many choices makes it hard to decide where to start. As E3 pointed out,

"We have too many databases scattered all over the place to archive different things. As a result, targeted information or knowledge search has been difficult." (E3)

In addition to the large number of knowledge repositories supported by different generations of technologies, the sheer number of documents in existence (e.g., E4, E11) and the lack of an overarching directory of all the existing repositories (e.g., E6, E13, E17) are contributing factors commonly mentioned as difficulties in locating needed knowledge or expertise.

"I really cannot say how I discovered these tools or links . . . sometimes you might discover a link to a very helpful wiki maintained by a Western European team that has been in existence for a long time, but you were simply not aware of it. It will

become a reference place that you visit often, but there is nothing to help me discover useful platforms or tools like this.” (E16)

The second challenge is the difficulty in documenting expertise in real time. For documents stored in both long-standing databases (e.g., E4, E16) and social media tools such as wikis and blogs (e.g., E11, E14), people expressed concerns about contributing or retrieving up-to-date documents. Two thirds of participants reported having limited time to document their expertise despite their awareness that documenting and sharing their expertise is beneficial to the company, particularly in helping newcomers (e.g., E11). The need to deal with more urgent requests from supervisors and customers (e.g., E4), time and skill needed to produce quality documentation (e.g., E4), and lack of extra incentives (e.g., E17) can all reduce motivation for sharing. As E4, a sales person, described,

“Our sales policies change all the time. Writing out a detailed instruction can take a week or two. After all, we are not professional writers. If we want to document things, we have to do so in our spare time, because we have other work to do. However, by the time you get the document done, the policies are changed again; and your document becomes useless right away.” (E4)

The third challenge relates to the issue of globalization in cross-cultural knowledge sharing. As is typical for multinational corporations, best practices and knowledge created in one culture do not translate automatically to another culture. Although participants found it eye-opening to read documents that describe how colleagues in the United States and other countries handle issues in different ways (e.g., E19), participants, especially those from R&D divisions, find it hard to share knowledge of best practices with teams in the other parts of the world (e.g., E5, E13, E14) because of the language barrier and low relevance of the content shared. Due to language difficulties, a few Chinese employees also found it challenging to contribute to the forum in English directly (e.g., E11, E14) and find the English interface alienating (e.g., E1). Thus, they are likely to be consumers but not contributors to the organization’s global knowledge repository. Many employees who work in the conventional divisions of the organization, and who are not required to collaborate with their global counterparts, are not even aware of the existence of such a global platform for knowledge sharing.

Discussion

In the current study, we examined how different generations of ICTs are used in the Chinese branch of a multinational software company to support knowledge sharing among employees. With multiple generations of ICTs in use, the company represents an ICT landscape that is common to many organizations and industries. Our research contributes

to behavioral research on knowledge management and the usage of ICTs within organizations, as well as research on designing tools for knowledge sharing. We discuss these contributions below.

Conceptual Contribution to Research on KM and ICT Usage in Organizations

Consistent with recent research on media multiplexity, we found that no one single ICT can satisfy all of an employee’s communication and knowledge-sharing needs. As a result, people need to use different combinations of tools. We found that although communication tools are a staple across all participants, the choice of knowledge repositories to store formal documents varies across divisions, functions, and teams. As shown in Figure 1, people whose work is R&D related are more likely to use social media to store knowledge, whereas those who work in less technical divisions (e.g., administration, finance) are more likely to stay with long-standing databases. Sales-related people are the only group of employees that shows all three usage profiles because they need to serve more diverse clienteles. This finding showed the value of studying multiple tools in the same study because otherwise we would not be able to uncover such different usage profiles, nor examine relationships among how the tools are used. We believe that understanding the complexities exhibited in employees’ tool selection and their practices around combining tools can inform the design and development of future technologies to better support knowledge-sharing activities within enterprises.

Conceptually, our findings can contribute to theories of media multiplexity in two ways. First, they highlight the importance of exploring competing versus complementary relationships among ICTs, a topic that has not been explored in this area. Our study found that the four most popular communication tools (e-mail, instant messaging, telephone, and video conferencing) complement each other by providing different forms of communication: formal versus informal, synchronous versus asynchronous, and so on. In addition, long-standing KM tools and communication tools also complement each other in supporting the sharing of formal versus informal and codified versus tacit knowledge. In contrast, substantial redundancies were found across different generations of knowledge storage tools, particularly between long-standing databases and such Web 2.0 tools as wikis and communities. These redundancies create competition among the tools, which can result in segregation of both resources and user groups by division, business unit, or project team. The resulting knowledge silos can not only create real barriers for knowledge sharing but also reduce social capital across the whole organization. As discussed earlier, development of social capital is valuable for multiple purposes. It can increase both awareness of expertise distribution and motivation for sharing that helps turn the knowledge of expertise distribution into actual access to expertise. In principle, the goal of ICT offerings, particularly in large

organizations, should be to support the development of social capital via the development of network ties among people from across the globe. However, when multiple ICT offerings compete for resources and more importantly user groups, the resulting separation creates divides in the development of network ties, which in turn would also influence the amount of social capital that employees can mobilize to achieve their goals. How to reduce redundancies across competitive tool offerings is an issue that has not been explored in existing media multiplexity research on ICT usage, but is certainly worthy of further exploration.

The second finding that can have significant implications for media multiplexity is the issue of numbers. Consistent with existing research on knowledge management (Borgatti & Cross, 2003; Yuan et al., 2010), we found that awareness is a major challenge for knowledge sharing. Unexpectedly, however, this challenge was caused not only by the size or the complexity of the company, but simply by the existence of a large number of knowledge repositories of different generations. Hence, it is important for media multiplexity research to explore the optimal number of tool offerings that can best support productivity, particularly when the tools have overlapping functionality.

Third, our findings show that studies on the usage of ICTs for knowledge sharing should consider both the technical affordances and the content of tools. Our research shows that in comparison to databases, social media are more effective in addressing the three knowledge-sharing challenges revealed in behavioral research: (a) they help increase employees' awareness of each other's expertise and personal interests; (b) they can motivate contribution through frequent, timely feedback and through soliciting reciprocal exchange; and (c) they can better support the development and maintenance of social capital. However, the diffusion of the new tools was more limited than we had expected. Despite their technological advantages over earlier ICTs that offered similar but more limited functionality, new ICT offerings were used along with, rather than in place of, older ones. Our interviews revealed that the rich resources stored in those long-standing databases have played a major role in prolonging the competitiveness of the older tools, particularly in divisions where the consistency and legacy of previous practices and policies are valuable.

Finally, our findings highlight the importance of the social aspects of technology use in organizations. First, consistent with findings from the social influence model of technology use (Fulk, 1993), our study showed that social norms played an important role, influencing both the adoption and the usage of technology. Although newer ICTs offered more advanced features to support knowledge sharing, adoption was not universal because norms about technology use within specific groups and business units favored more long-standing tools. Our research also highlighted the important role that management plays in technology migrations. New ICTs do not diffuse by themselves, and hence making a new offering technically available does not mean that related technology migration will

happen automatically. If the management plans to push for the adoption of a new tool to support knowledge sharing, concerted efforts should be made. They should be particularly mindful that the value of an older tool lies beyond the tool per se. Clear guidelines should be provided to help employees handle the "sticky" aspects of earlier tools. In the absence of such guidelines, employees may go in different directions, which may create more difficulties for knowledge sharing.

These findings, taken together, reveal an understudied area of research on technology use in organizations, that is, how to handle transitions in technology use. Extensive conceptual and empirical works explain how features of technology and human agency interact to influence how technologies are used in organizations (see Leonardi & Barley [2008] for a comprehensive review). However, most of these theories focus on tool adoption and usage, whereas much less attention has been paid to tool migration. Our research shows that this topic is worthy of serious consideration because chaotic information/knowledge landscapes may be created unintentionally when different generations of tool offerings coexist to compete for resources.

Design Recommendations for KS Systems

Based on participants' suggestions for improving ICT tools and our own analysis of the causes of the challenges they face, below we provide a number of design suggestions for ICTs to support knowledge sharing. First, to increase awareness of expertise distribution, creating an integrated platform of tools is critical. The goal is to remove artificial technological divides among people and among tools. Existing studies on the workplace ecology have indicated the importance of preserving interoperability between new communication channels and older ones (Turner et al., 2010) as well as the effectiveness of providing linkages among different tools for supporting interrelated activities that help reduce fragmentation in collaborative work (Balakrishnan, Matthews, & Moran, 2010). Our research also calls for further integration that goes beyond the coexistence of different technologies, so as to effectively support seeking knowledge that resides across tools. We believe that such integration will minimize the costs of technology switching and hence increase employees' motivation for sharing. Although the second release of the company's social media tools allows a common access point to multiple tools, such as wikis, blogs, forums, communities, and profiles, deeper integration of content and communication beyond a simple shared platform is needed. How to better integrate information shared across these tools to allow automatic updates across the tools is an area worthy of further exploration.

Second, we recommend that designers be mindful about designing tools to be complementary rather than competitive. We recommend that in the integrated platform, multiple generations of tools that serve similar goals should

be avoided, because a large number of tool offerings that have overlapping functionalities can be counterproductive for knowledge sharing, particularly when the tools are not connected.

A third strategy to increase awareness of different resources is to create a master directory and dashboard of different knowledge repositories. The directory should support complex, combinational search (E19) and be placed on the portal page of the company's website. Interviewees reported easily getting lost in the "oceans of documents" (E5) stored in a plethora of repositories (E11). A master directory, along with a brief description of the objectives and possibly a demonstration of the tool (E13), can inform employees about available resources and help them better navigate the landscape. Interviewees also stressed the importance of creating a dashboard on the front portal page for getting a quick overview of the content shared in different applications, not behind layers of pages (E16) that they have to dig through. This will be especially valuable for the integrated platform when content from multiple sources is pooled.

We also have several recommendations to boost motivation for sharing. First, there is a strong need for tools that support easy documentation of real-time social interactions. As discussed earlier, many people think it time-consuming to produce high-quality documents that capture expertise and best practices in real time. Voice or video recordings may be a valuable future direction because not only are they fast to make, but they can also capture contextual and procedural knowledge that would be hard or time-consuming to document in text. Moreover, conversations via instant messaging are also valuable resources that both contain knowledge and indicate expertise, but tools do not support sorting, organizing, or searching such real-time knowledge sharing. Tools that can leverage such conversations with limited additional cost can make it easier for employees to share and open up questions around identifying the usefulness of the large volume of unstructured information shared in real-time communication.

A second design consideration to boost motivation for sharing is to make consumption data more visible. This is consistent with earlier studies that emphasized the impact of social media consumers such as blog readers (Baumer, Sueyoshi, & Tomlinson, 2008; Yardi, Golder, & Brzozowski, 2009) on content production. Many participants reported that the value of a knowledge repository depends on the usage by other people. Although most interviewees do not contribute to organizational knowledge repositories frequently, they do search and browse these repositories regularly. Although such consumption data are crucial indicators of the value of a knowledge repository, they are not visible to either contributors or consumers. Making browsing and downloading activity visible can inform both contributors and consumers about the overall activity level of a tool, and thereby serve as a collective incentive to motivate more quality contributions.

Finally, to boost contribution to the company's knowledge repositories from employees around the world, we

recommend adapting the tools to local culture and language to make them friendlier to those employees whose first language is not English. We found that Chinese employees seldom contribute to the repository in either English or Chinese, indicating that language difficulty was not the only factor that hinders contribution. Participant E2 suggested that the user interface for the company's Chinese website should use colors or graphics that are closer to the Chinese culture. Doing so can shorten employees' psychological distance from the company's website, which is already dominated by English content, a finding that was also revealed in earlier studies on Chinese employees' use of social media in global companies (e.g., Liao, Pan, Lai, & Yang, 2011). Moreover, translations or descriptions of certain functions of the website should use terminology that is more easily understandable for local employees. Although language difficulties are more difficult to overcome, using the tool to share content in Chinese can still be valuable for Chinese employees.

As to how to further support social networking among Chinese employees, again we think it is an important design consideration to make lurking or consumption activity data more visible. Interviews revealed that Chinese employees feel more comfortable following the opinions and blogs of high-rank and/or high-status people (e.g., E6), instead of contributing to or participating in discussions directly. Making the lurking behavior more visible may help break the ice between lurkers and contributors, and thereby eventually contribute to the development of social capital.

Limitation and Directions for Future Research

There are a few limitations to the existing case study. First, our study was based on interviews with 21 participants from a single organization, which means some results might not be directly applicable to other organizations. For example, we found that media multiplexity is an important challenge facing this company, which specializes in developing commercial business software. For other organizations, the number of tools or platforms for knowledge sharing might not be comparable to the company we studied. However, we believe that studying an organization that leads in developing KM software and also uses multiple tools itself enables us to better understand the usage of different generations of ICTs and the trend of future KM practice. Second, our current sample only includes the Chinese branch of the global corporation, which might prevent the results of this study from being generalizable to other cultural contexts. Although our interviewees often commented on cultural differences in using knowledge-sharing tools in day-to-day work, future study might explicitly explore this topic by including samples from different cultures. Third, our study focuses on comparisons among different generations of ICTs, which are divided into the following three categories: communication tools, long-standing KM tools, and social media. Future research should explore differences within each category.

Conclusion

In an ever-globalizing knowledge economy, effective knowledge sharing can give an organization a competitive edge. ICTs have the potential to broaden an employee's horizon of knowledge, but to fully unleash this potential requires both careful management and strategic tool design. In this study, we examined how different generations of ICTs are used in combination to serve employees' knowledge-sharing needs in the Chinese branch of a multinational corporation. Studying multiple tools simultaneously allowed us to explore both complementary and competing relationships among the tools. The ultimate goals are to improve design and deployment of ICTs to support and simplify knowledge-sharing processes and to reduce unwanted complexities. Further research that integrates both management considerations and tool design is also needed to ensure that ICTs can indeed enable more effective knowledge sharing and better organizational performance.

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