A Multidimensional Network Approach to Studying Team Members' Information Seeking From Human and Digital Knowledge Sources in Consulting Firms

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The goal of this study is to understand how consultants' information seeking from human and digital knowledge sources is influenced by their relationships with both types of knowledge sources and the characteristics of the knowledge domain in which information seeking takes place. Grounded on and extending transactive memory theory, this study takes a multidimensional approach to predict consultants' information seeking based on expertise recognition, source accessibility, peer information-seeking behaviors, knowledge complexity, and codifiability. Using data collected from 110 consultants across 9 project teams from 2 multinational consulting firms, this study found that consultants' information seeking from human knowledge sources was mostly driven by the expertise and accessibility level of their team members, whereas their information seeking from digital knowledge repositories was strongly influenced by how much information the digital knowledge source had and whether colleagues with whom they had strong social communication ties were seeking information from the digital source. Finally, knowledge complexity had a negative influence on consultants' information seeking from digital knowledge repositories, but knowledge codifiability had no significant effects on information seeking from either knowledge source. This study demonstrates the importance and viability of using a multidimensional network approach to advancing transactive memory theory to study consultants' information-seeking practices.

Introduction

People seek information to reduce perceived uncertainty and equivocality in their social and work environments (Huber & Daft, 1987). Members of today's organizations can seek information directly from their coworkers (Cross, Parker, Prusak, & Borgatti, 2001; Morrison, 2002; Palazzolo, 2005; Yuan, Carboni, & Ehrlich, 2010) or impersonally from digital knowledge repositories such as intranets and electronic databases (Kankanhalli, Tan, & Kwok-Kee, 2005; Lee & Kim, 2009; Yuan, Fulk, & Monge, 2007). A thriving context in which information seeking takes place is the consulting industry, which is characterized by knowledge-intensive practices (Sturdy, Handley, Clark, & Fincham, 2009), a multitude of available information sources (Haas & Hansen, 2007), and tremendous time pressure to make decisions and deliver actionable knowledge to clients (Lee & Thomas, 2008).

A growing literature has examined the processes and outcomes of consultants' information seeking and knowledge sharing (Haas, 2010; Hansen & Hass, 2001; Pereira & Barbosa, 2008; Starbuck, 1992). However, most research to date tends to focus on either interpersonal or impersonal information seeking without studying them within an integrated conceptual and analytical framework (Haas & Hansen, 2007). Thus, the goal of the present study is to bridge this research gap by examining and comparing factors that influence consultants' information seeking from human expertise in the copresence of digital knowledge repositories. Further, this study seeks to investigate how knowledge characteristics, specifically knowledge complexity and codifiability, affect consultants' preference of knowledge sources. To this end, this study takes a multidimensional network approach (Contractor, 2009a; Contractor, Monge, & Leonardi, 2011) to extend transactive memory theory (Hollingshead, in press; Wegner, 1987; Wegner, Erber, & Raymond, 1991) to understand how members of consulting project teams seek information from their team members and digital knowledge repositories in a given knowledge domain.

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This article is organized as follows. First, we begin by reviewing what is currently known about the characteristics of consultants' information-seeking behaviors. Second, we introduce and review the multidimensional network approach and transactive memory theory, on which we base a set of hypotheses concerning consultants' information-seeking tendencies. Next, we discuss how consultant's preference of human versus digital knowledge sources could be influenced by the level of complexity and codifiability of a given knowledge domain. Then, we use exponential random graph modeling (ERGM) and multiple regression analysis to test the hypotheses with survey data from 110 individuals across nine consulting project teams. Finally, we discuss the findings as well as the limitations and future directions of this study.

Literature Review and Hypothesis Development

Consultants' Information Seeking

Consultants are professionals who provide expert advice or solutions to their clients (Sturdy et al., 2009). Previous research has suggested three crucial characteristics of information seeking and knowledge sharing within consulting firms. First, consultants work in a knowledge-intensive organizational environment (Glückler & Armbrüster, 2003; Robertson & Swan, 2003). A knowledge-intensive organization values individual expertise and emphasizes knowledge utilization and coordination among its employees. In consulting firms, the processes and outputs of task completion entail a streamlined process of information gathering, knowledge generation, expertise sharing, and advice giving (Haas & Hansen, 2007). The success and profits of a consulting firm are largely determined by the quality and efficiency of coordinating and utilizing consultants' expertise. Second, consultants work in an "insecure" industry (Sturdy, 1997), because there is a high level of fluidity and uncertainty in their internal and external work environment (Robertson & Swan, 2003), and much of their work involves dealing with complex and obscure knowledge (Sturdy et al., 2009). Consultants are often challenged by how to translate such ambiguous knowledge directly into actionable advice that would quickly solve clients' problems or improve clients' productivity (Kramer, 1988). Third, consultants are usually located outside their organizational contexts (Czarniawska & Mazza, 2003) and travel frequently, which creates hurdles to face-to-face information seeking and transferring knowledge in physical forms. Consequently, an increasing number of consulting firms has adopted and implemented digital knowledge management tools such as intranets and electronic document repositories (Glückler & Armbrüster, 2003; Hansen & Hass, 2001). As a matter of fact, compared with other industries, the consulting industry has had a relative long history and achieved a critical mass of using digital knowledge repositories to support internal knowledge management (Kankanhalli et al., 2005). Interestingly, some research reveals that although consultants most frequently seek information from digital knowledge repositories, they perceive human knowledge sources to be more relevant and reliable (Pereira & Barbosa, 2008).

The above-mentioned characteristics of the consulting industry help explain and contextualize consultants' motivations for information seeking. Haas and Witte (2001) suggest that a major motive for consultants to seek information is to reduce uncertainty and ambiguity in their work environment. Further, Pereira and Barbosa (2008) note that consultants seek information to make sense of the changes in the external environment, to develop personal expertise, and to support decision making. In their study of consultants' information-seeking practices in a global IT services company, Lee and Thomas (2008) find two emerging themes of consultants' information seeking from digital knowledge sources. First, consultants perceive a high time cost to information seeking, which includes the time spent on searching and retrieving the right information from the digital knowledge repository. Second, because the primary goal of consultants' work is to address clients' needs in a timely fashion, consultants tend to interact with the digital knowledge repository "with very instrumental ends in mind, looking for things that resembled more tidbits than knowledge" (Lee & Thomas, 2008, p. 3543). Such instrumental and strategic use of digital knowledge repositories is driven by the fact that there is an overwhelming abundance of information available on electronic knowledge management systems in today's consulting firms (Hansen & Hass, 2001). Research shows that consultants will pay more attention to and seek more information from the digital knowledge repository only if the provided information is selective and concentrated on a few knowledge domains (Hansen & Hass, 2001). Therefore, given the fast work pace and time pressure faced by consultants, they tend to seek information from a knowledge source that provides ready-to-use information with a minimum investment of time and effort from their end.

Previous research has also examined the outcomes of consultants' information-seeking practices. Contrary to popular belief that intensive information seeking and knowledge sharing would enhance organizational performance (Argote & Ingram, 2000), some research suggests that this is not guaranteed in the consulting industry. Instead, researchers have suggested a situated performance perspective in which the positive relationship between information seeking and consultants' performance is moderated by team characteristics, task features, political structures, and types of knowledge sources utilized (Haas & Hansen, 2005, 2007). For example, in a study of 182 teams of a management consulting company, Haas and Hansen (2005) found that as team task experience and task competitiveness increased, consultants' information seeking from human and digital knowledge repositories was more likely to hurt the team's chances of winning a competitive bid. Using the same sample, Haas and Hansen (2007) found that external information seeking would improve team performance only if the team had more slack time, organizational experience, and decision-making autonomy. For teams without these advantages, more information seeking would hurt their performance. Further, their research revealed that

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team members' information seeking from human knowledge sources improved work quality but was time costly. In contrast, information seeking from electronic repositories saved time during task completion, but it did not improve work quality (Haas & Hansen, 2007). A more recent study on multiple consulting teams found that members were more satisfied with their teamwork when proactively seeking information from other members than when receiving unsolicited information from others (Su, Huang, & Contractor, 2010). Taken together, these studies lend support to a situated and contextualized evaluation of the consequences of information seeking and sharing in consulting firms.

Most research to date tends to study consultants' information seeking from human and digital knowledge sources separately (Haas & Hansen, 2007). As previous research suggests, consultants are increasingly interacting with both types of knowledge sources for information. There is a need to examine such behaviors within an integrated theoretical and analytic framework. To bridge this research gap, this study takes a multidimensional network approach to examine and compare the effects of those factors that influence consultants' information seeking from team members in the copresence of digital knowledge repositories.

Social Networks and Multidimensional Network Approach

Social network research is characterized by its focus on structural properties of the interrelationships between a collective of social entities (Monge & Contractor, 2003; Wasserman & Faust, 1994). Previous research has studied how organizational members' information seeking could be influenced by different dimensions of network structures such as the strength of communication ties (Yuan, Fulk, Monge, & Contractor, 2010), nodal centralities (Tsai, 2001), reciprocity of information seeking (Palazzolo, 2005; Su et al., 2010), structural holes (Burt, 1992), and network centralization (Albrecht & Ropp, 1984; Rulke & Galaskiewicz, 2000). These studies suggest that organizational members' information seeking is driven not only by traditionally important individual-specific attributes such as job tasks and organizational ranks, but, more important, by "whom they communicate with" and "how they are connected" in the organizational networks.

As information seeking is intrinsically a communicative practice between the information seeker and the knowledge source, it is profoundly influenced by the characteristics of the relationship(s) of the two parties (Contractor, Wasserman, & Faust, 2006; Cross & Borgatti, 2004; Hollingshead, Costa, & Beck, 2007). Previous studies have found four relational factors that exert influence on organizational members' information seeking from their coworkers: expertise recognition, access to experts, engagement in information provision, and relationship safety (Cross & Borgatti; Cross, Parker, et al., 2001; Cross, Rice, & Parker, 2001). These interpersonal relationships have shaped and constrained the fundamental structures of these managers' information-seeking behaviors. Additionally, organizational members' information seeking tends to display a structured rather than a random pattern. A recent network study discovered a centralized information-seeking structure in team members' information-seeking behaviors (Su et al., 2010). In such centralized network, only one or a few members emerged as the central or "star" information source. These members served as knowledge "hubs" for all other information seekers within the team. Thus, these studies lend support to the viability and importance in using a social network approach to understand people's information-seeking behaviors.

With the increasing popularity of digital knowledge repositories for storing and sharing organizational knowledge (Ackerman, 2000; Lee & Kim, 2009), it is imperative for social network scholars to examine how these nonhuman knowledge sources are structurally utilized in the information-seeking network (Monge & Contractor, 2003). The inclusion of both human and nonhuman nodes in the network demands a new way to conceptualize social networks as multidimensional networks. A multidimensional network is defined as a collection of multiple types of nodes together with multiple types of relational ties among them (Contractor, 2009a; Contractor, Monge, & Leonardi, 2011). Compared with the traditional human-exclusive network, a multidimensional network comprises a diversified types of nodes such as people, documents, databases, servers, datasets, analytic tools, instruments, etc. (Hollingshead & Contractor, 2002). What connects these distinct types of nodes in the multidimensional network are the relational behaviors or interactions among them. For example, the links of an emerging multidimensional network in a software development team could be mapped out like the following: team members communicating and collaborating with one another, team members posting software codes on the team intranet, the intranet publishing beta versions of the software, and the software being tested by different tools and by different members (Poole & Contractor, in press).

This study seeks to apply the multidimensional network approach to examine the information-seeking networks that emerge in consulting project teams. Drawing upon previous research on consultants information-seeking practices, we have identified two types of nodes in consultants' information-seeking network: individual consultant and the digital knowledge repository. On one hand, consultants would turn to their team members (*human knowledge source*) for information in a given knowledge domain (Haas, 2006; Su et al., 2010). On the other hand, they actively seek and retrieve information from the digital knowledge repository (*digital knowledge source*; Hansen & Hass, 2001). In this study, digital knowledge repository is a broad term used to define electronic systems that archive, store, and publish information. A popular example of digital knowledge repositories in the consulting industry is the intranet, which usually comprises web pages, documents, and databases that store client information and expert knowledge in consultancy practices (Glückler & Armbrüster, 2003; Hansen & Hass, 2001).

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With the composition of the multidimensional network defined, we next turn to transactive memory theory, which provides theoretical foundations for this study to develop the relational ties between the two types of nodes in consultants' multidimensional information-seeking networks. The goal of this study is to use theory-derived mechanisms to understand how the information-seeking relationship is driven by other types of relationships between the information seeker and the knowledge source in consulting project teams.

Transactive Memory Theory

Transactive memory theory (for a review, see Hollingshead, in press; Moreland, 1999; Wegner, 1987; Wegner et al., 1991) explains how a group of individuals utilize information through an expertise recognition process. Transactive memory is developed when information is encoded and stored in knowledge repositories within a group of individuals. Traditionally, these knowledge repositories are individuals who provide specialized expertise in relevant knowledge domains (Moreland, 1999). When a work task requires knowledge beyond their areas of expertise, group members tend to seek information from perceived experts in that area without learning everything from scratch (Brandon & Hollingshead, 2004; Hollingshead, 1998b). Similarly, group members tend to allocate information to perceived experts of that domain so that information can be properly stored and retrieved for future use. Consequently, both the workload and the redundancy of knowledge learning within the group are greatly reduced, which leads to better group performance (Littlepage, Hollingshead, Drake, & Littlepage, 2008; Moreland & Myaskovsky, 2000). Empirical research has consistently supported organizational members' tendency to seek information from colleagues they perceive to be knowledgeable in relevant knowledge domains (Contractor et al., 2004; Cross, Rice, et al., 2001; Palazzolo, 2005). A recent study (Yuan, Fulk, Monge, & Contractor, 2010) confirms that individual members are more likely to engage in information exchange with other members when they have developed a sense of "who knows what" within the team.

Previous transactive memory research has studied a variety of organizational contexts, but rarely the consulting industry. Transactive memory theory was originated to study how dyads of close relationships coordinate tasks based on perceptions of each other's expertise and responsibilities (Wegner et al., 1991; Wegner, Giuliano, & Hertel, 1985). Later transactive memory research primarily focused on how group members identify, seek, and share knowledge within the group. These groups cut across different work settings and industries, such as geographically dispersed research team (Palazzolo, 2005), emergent response groups (Majchrzak, Jarvenpaa, & Hollingshead, 2007), clerical staff members (Littlepage et al., 2008), online groups (Brandon & Hollingshead, 2008), global IT product and service sales team (Yuan, Carboni, et al., 2010), and computer-supported collaborative groups (Schreiber & Engelmann, 2010). At the organizational level, studies have examined how transactive memory develops in public sectors of a state government (Kankanhalli et al., 2005) and among engineers in high-technology firms (Zhang, Hempel, Han, & Tjosvold, 2007). Unfortunately, scant research to date has looked into transactive memory development in consulting organizations. For ones that have (Su et al., 2010; Yuan, Fulk, Monge, & Contractor, 2010), they tend to focus on human-to-human information seeking and sharing without considering the digital knowledge repository as a knowledge source for consultants.

Transactive memory theory has indeed recognized the existence and potential benefits of nonhuman knowledge repositories (Moreland, 1999; Wegner, 1987). Fulk and her colleagues conceptualize two types of knowledge repositories in transactive memory development: *connective* and *communal* knowledge (Fulk, Flanagin, Kalman, Monge, & Ryan, 1996; Yuan et al., 2007). The connective knowledge repository refers to human experts who share their knowledge with information seekers through direct interpersonal communication, whereas the communal knowledge repository refers to collectively shared information sources such as digital databases and intranets. When human expertise is not identifiable or available, information seekers can turn to digital repositories for information, which serves as a generalized exchange of information to replace direct communication with human experts (Fulk et al., 1996; Hollingshead, Fulk, & Monge, 2002). However, so far the inclusion of digital knowledge repositories in transactive memory research remains theoretical and lacks empirical exploration. Given the knowledge-intensive nature and advanced penetration of intranet use in the consulting industry, consulting project teams are the ideal test bed to expand transactive memory theory to explain how team members seek information from both human and digital knowledge sources.

Gatekeeper Research

The development of transactive memory theory is accompanied by a relevant line of research in information science and management studies that examine the important role of *gatekeepers* in information seeking and dissemination (for a review, see Barzilai-Nahon, 2008; Barzilai-Nahon, 2009). Gatekeepers refer to a small number of key individuals who possess the knowledge about where to find relevant expertise or information, thereby having a powerful influence on information access and control (Lu, 2007; Shoemaker, 1991). Gatekeepers play an important role in transferring and disseminating information within groups (Bantz, 1990), organizations (Allen, 1977; Tushman & Katz, 1980), as well as communities (Agada, 1999; Metoyer-Duran, 1993). Although gatekeeper research cuts across a wide range of disciplines (Barzilai-Nahon, 2009), they all find support for the central role of gatekeepers in information seeking and transmission. Further, Lancaster (1999) recognizes and foresees the increasing important role of digital databases as information gatekeepers for information seekers. The gatekeeper research supports and strengthens the premise of transitive memory theory that people tend to seek information from the

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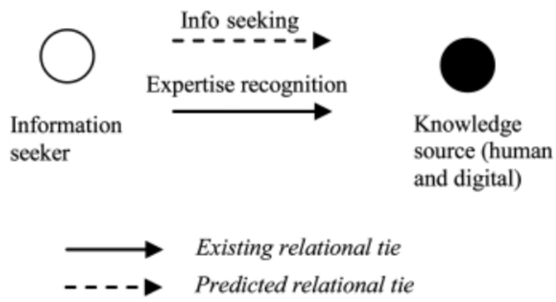

FIG. 1. Hypothesis 1.

gatekeepers, usually the recognized experts in a knowledge domain who maintain intensive interactions with information seekers to transfer the information in need.

Information Seeking Based on Expertise Recognition

Based on transactive memory and gatekeeper research discussed above, we develop a basic structure of consultants' multidimensional information-seeking network, in which an individual's information seeking is associated with one's perception of the expertise level of the knowledge repository, whether it be human or digital. This structure is described in the following hypothesis (see Figure 1 for a graphical representation), and is the basis for our further development of consultants' information-seeking networks.

H1: Members of a consulting team tend to seek information in a particular knowledge domain from a knowledge source (human and digital) that they perceive to be knowledgeable in that domain.

Information Seeking Based on Source Accessibility

According to transactive memory theory, expertise recognition is a necessary but not sufficient condition for information seekers to actually seek and retrieve information from the knowledge source (Casciaro & Lobo, 2008; Moreland, 1999). Although knowing "who knows what" is a fundamental mechanism in predicting the selection of knowledge source in transactive memory development (Hollingshead, 1998a), this study concurs with previous research that underscores the importance of knowledge accessibility (Cross & Borgatti, 2004; Yuan & Carboni, et al., 2010). Researchers have found that the accessibility of knowledge sources strongly influences physicians' seeking of drug innovation information (Coleman, Katz, & Menzel, 1966), electronics engineers' seeking of technical information (Gerstberger & Allen, 1968), and managers seeking information about corporate management (Cross & Parker, et al., 2001). Further, it is found that while the rated importance of the knowledge source is related to perceived quality of the information provided by the source, the actual frequency of using the knowledge source is primarily influenced by its accessibility (O'Reilly, 1982). Based on a 5-year long research on 493 organizational project teams, research shows that when a high percentage of experts are geographically dispersed and difficult to access, the coordination costs within the project team would increase and their net earnings would decrease (Boh, Ren, Kiesler, & Bussjaeger, 2007). Therefore, when experts have been identified, information seekers are more likely to seek information from those experts who are easily accessible than those who are not (Cross, & Parker, et al., 2001; Yuan, & Carboni, et al., 2010).

The accessibility of human expertise is positively associated with a strong communication and collaboration relationship between the information seeker and the expert. Hertzum and Pejtersen (2000) state that a significant barrier for information seeking is the intellectual and social efforts invested in triggering the information provider's attention. Thus, a frequent social communication and prior collaboration relationship would help reduce the high social costs related to information seeking, and consequently ease information seekers' access to the experts (Contractor et al., 2004; Cross & Borgatti, 2004). Indeed, interpersonal communication is the central facilitator of transactive memory development (Hollingshead & Brandon, 2003) and mediates the relationship between expertise recognition and information exchange (Yuan, Fulk, Monge, & Contractor, et al., 2010). Previous research suggests that researchers are more likely to create new knowledge when they maintain close relationships with their collaborators and when they have many such collaborators (McFadyen, Semadeni, & Cannella, 2009). In addition, a number of studies have indicated that prior collaboration relationship helps shorten the learning curves of organizational members (Argote & Ophir, 2002), facilitates the assimilation, interpretation, and application of new knowledge (Cohen & Levinthal, 1990; Szulanski, 1996), and generates tacit knowledge that cannot be readily articulated (Haas & Hansen, 2007). Therefore, the accessibility of human knowledge sources can be determined by the strength of communication and collaboration relationships between the information seeker and the human knowledge source.

Regarding information seeking from digital knowledge repositories, the accessibility of such knowledge source is negatively related to the time and efforts taken to find the relevant information in the digital system, the difficulties in using the technology, and the potential risks of obtaining outdated or inaccurate information (Hollingshead et al., 2002). Previous research finds that organizational members' information provision to, as well as information seeking from, organizational intranets is positively related to their technology-specific competency and the ease of use of the intranets (Yuan et al., 2005). Additional research shows that employees' usage of the intranet is influenced by their web experiences and perceived ease of use of the intranet (Lee & Kim, 2009), as well as the availability and accessibility of digital knowledge repositories (Kankanhalli et al., 2005). In this sense, the costs associated with information seeking from digital knowledge sources include individuals' efforts in overcoming their difficulties in using the technology. The lower the costs, the easier access information seekers would have to the digital knowledge repository, and the more likely they would seek information from such systems.

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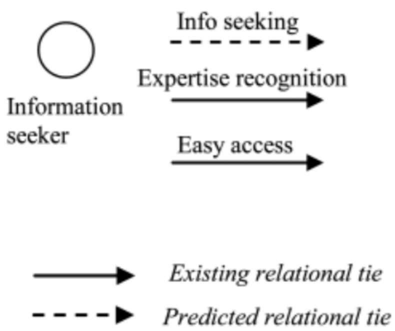

FIG. 2. Hypothesis 2.

As the accessibility factor was overlooked in previous transactive memory research, this study proposes that consultants' information seeking is likely to be influenced by not only expertise recognition but also their easy access to the knowledge source, whether it be human or digital. This network model extends the fundamental transactive memory model that is solely based on expertise recognition to include the effects of perceived accessibility of the knowledge source. Thus, we propose the following hypothesis (see Figure 2 for a graphical representation):

H2: Members of a consulting team tend to seek information in a particular knowledge domain from a knowledge source (human and digital) that they perceive to be knowledgeable in that domain and to which they have easy access.

Social Influence on Information Seeking

The above-mentioned network models predict a consultant's information seeking based on one's direct relationships with the knowledge source: expertise recognition and ease of access. However, as Monge and Contractor state (2003), a defining characteristic of social networks is that the relationship between a pair of individuals is likely to be influenced by the relationship they have with others in the same network. In the information-seeking network, an individual's seeking behavior is subject to the influence of other members' information-seeking behaviors. Particularly in the consulting industry where there is a high level of uncertainty and competition in the internal knowledge environment (Sturdy et al., 2009), employees are more likely to be influenced by the attitudes and behaviors of their peers. Thus, it is important to extend the basic transactive memory model to examine social influences on information seeking in the consulting project teams.

The well-established social influence literature argues that an individual's attitudes, beliefs, and behaviors are influenced by others with whom they have frequent social interactions (Burt, 1987; Fulk, 1993; Fulk, Schmitz, & Steinfield, 1990; Salancik & Pfeffer, 1978). A number of empirical studies have found that employees with frequent social communication tend to develop similar levels of job satisfaction (Pollock, Whitbred, & Contractor, 2000), patterns of turnover

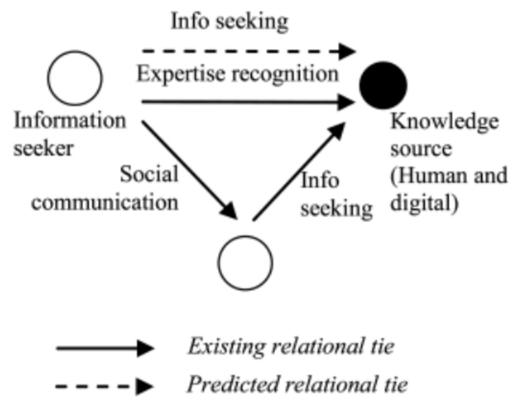

FIG. 3. Hypothesis 3.

(Feeley & Barnett, 1996), tendency to conduct unethical deeds (Zey-Ferrell & Ferrell, 1982), perceptions of risks (Scherer & Cho, 2003), and attitudes toward and use of information technologies and new media (Fulk, Schmitz, & Ryu, 1995; Rice & Aydin, 1991; Schmitz & Fulk, 1991; Vishwanath, 2006). In addition, scholars have suggested that information is increasingly being sought and transferred in social contexts rather than through the formal organizational chart (Cross & Rice, et al., 2001). The implication is that organizational members with frequent social communication relationships are likely to develop similar information-seeking structures. Therefore, an individual member's information seeking is influenced by not only one's perception of the expertise level of the knowledge source (as suggested by the basic transactive memory model), but also one's social communication with other members and those members' information seeking from the knowledge source. Thus, this study proposes the following network structure (H3, see Figure 3 for a graphical representation) to explain the social influence on consultants' information seeking from human and digital knowledge sources in the multidimensional network.

H3: Members of a consulting team tend to seek information in a particular knowledge domain from a knowledge source (human and digital) if they perceive it to be knowledgeable in that domain, and those with whom they have frequent social communication also seek information from that source in that domain.

Effects of Knowledge Characteristics on Information Seeking

So far the previous network models have not distinguished the differences between human and digital knowledge sources in consultants' multidimensional information-seeking network. In each of the above-mentioned three models, the same theoretical mechanism has been applied to predict information seeking from a generic knowledge source, whether it be human or digital. A critical question that remains unanswered in these models is: Are there any differences between consultants' information seeking from

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human versus digital knowledge repositories? If yes, then are these differences attributed to the characteristics of the knowledge domain in which information seeking takes place? Indeed, Haas and Hansen (2007) suggest that human and digital knowledge sources are not substitutes for each other. Thus, the following section seeks to explore the effects of knowledge characteristics, specifically knowledge complexity and codifiability, on consultants' preference of human versus digital knowledge sources.

Over the decades, a significant body of scholarships has studied two dimensions of knowledge characteristics that strongly influence organizational members' information sharing and learning: knowledge complexity and codifiability (Kogut & Zander, 1996; Nonaka, 1994; Nonaka & von Krogh, 2009; Polanyi, 1958; Szulanski, 1996; Wood, 2009). Knowledge complexity is defined as the number and variation of different competencies required to execute a practice in a knowledge domain, and codifiability refers to the degree to which organizational knowledge could be encoded by means of written codes (Zander & Kogut, 1995). While knowledge complexity focuses on the depth and breadth of competencies required to understand and process certain information, knowledge codifiability measures the level of transferability of certain information in the form of texts and codes such as books, drawings, manuals, blueprints, and documentations (Flanagin, 2002; Wood, 2009; Zander & Kogut, 1995). Thus, these two dimensions are conceptually independent from each other, as they are characterizing different aspects of human knowledge. In this sense, a complex knowledge domain can be codifiable if it can be easily transferred in coded forms. Likewise, a codifiable knowledge domain can be very complex if it involves a great level of sophistication and variation of competencies. For example, the knowledge about communication skills can be translated into written formats such as articles and books that instruct people how to become a better communicator. Meanwhile, the knowledge about communication skills involves a wide range of competencies such as oral communication, nonverbal communication, emotional intelligence, and rhetorical sophistication. Therefore, Dixon (2000) argues that when characterizing organizational knowledge, knowledge complexity and codifiablity are not mutually exclusive and should be examined as different dimensions of knowledge characteristics.

Knowledge complexity on information seeking. According to Zander and Kogut (1995, p. 79): "Knowledge, no matter the level of the education of the worker, is simply more complex when it draws upon distinct and multiple kinds of competencies." Wood (2009) notes that knowledge of high complexity would require a greater number of different skills or competencies to be effectively understood and transferred. Further, Ruta (2003) argues that in a highly complex knowledge domain, knowledge is deeply embedded in the work processes and outputs that are difficult to be observed and replicated by others. In addition, within the practice of such knowledge domain, it is hard to predict outcomes from a given action, and the quality of the outcomes is usually determined by personal judgment rather than defined rules (Ruta, 2003). Thus, given the degree of sophistication and variety of competencies required to understand and interpret complex knowledge, it is easier and more effective for information seekers to interact with human experts to seek complex knowledge, because interpersonal interactions can facilitate real-time observations, in-depth learning, fast feedback and assessment (Davenport & Prusak, 1998).

In their research on information seeking in a public administrative department, Byström and Järvelin (1995) found that the more complex information people needed, the more likely they would seek information from general-purpose knowledge sources, such as human experts and personal collections, and the less likely they would turn to fact-oriented or problem-oriented information sources, such as computerize files and databases. In addition, a later study (Byström, 2002) on two government agencies revealed that as information acquisition became more complex (i.e. more efforts and more information types were required), information seekers tended to go to human knowledge sources rather than all types of documentary sources. An explanation for all these findings is that interpersonal interactions lead to a higher level of trust, which consequently lubricate the transfer of complex organizational knowledge (Janowicz-Panjaitan & Noorderhaven, 2009; Kachra & White, 2008).

Current literature does shed light on how knowledge complexity influences consultants' information seeking in particular. Consultants' work involves seeking and utilizing highly complex knowledge (Sturdy et al., 2009). For example, Bloomfield and Danieli (1995) have identified two crucial skill sets for management consultants in IT development: sociopolitical skills and technical skills, both of which are essential for successful accomplishments of their work and service to their clients. Hansen and Hass (2001) found that consultants were less attracted to seeking information from electronic documents systems when the information provided there covered too many knowledge topics. The finding implies that when the knowledge domain is complex and covers a wider array of topics, consultants would be reluctant to seek information from digital knowledge sources. Further, their later research (2007) found that consultants' information seeking from human knowledge sources improved work quality, whereas their information seeking from electronic knowledge repositories did not enhance work quality or signal competence to their clients.

In sum, as consultants perceive human knowledge sources to be more reliable and relevant (Pereira & Barbosa, 2008), interpersonal information seeking would facilitate the transfer of complex knowledge because information seekers can closely observe and make sense of the complex knowledge in transfer. Also, it would be easier for expertise providers to clarify confusing and ambiguous problems in a one-on-one setting, and offer information across multiple topic areas beyond what is originally asked by the information seeker. Thus, this study posits that knowledge complexity

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is positively related to consultants' tendency to seek information from their team members, but negatively related to their tendency to seek information from digital knowledge repositories.

> H4: The more complex a knowledge domain, the greater tendency for members of a consulting team to seek information from human knowledge sources, and the lower tendency to seek information from the digital knowledge repository in that domain.

Knowledge codifiability on information seeking. The effects of knowledge codifiability on information transfer have been abundantly examined and published in organizational research (Janowicz-Panjaitan & Noorderhaven, 2009; Levin & Cross, 2004; Nonaka & von Krogh, 2009). Scholars have defined codifiable knowledge as the type of knowledge that can be explicitly expressed or transmitted in the form of texts and codes, such as books, manuals, written documents, blueprints, and computer programs (Schulz, 2001; Zander & Kogut, 1995). This type of knowledge can usually be easily transferred and migrated between individuals and organizations. Based on a varying degree of codifiability, organizational knowledge falls into a continuum from *tacit* (least codifiable) to *explicit* (most codifiable) knowledge (Grant, 1996; Nonaka & Takeuchi, 1995; Wood, 2009). Tacit knowledge usually refers to the cognitive and technical knowledge such as beliefs, skills, craftsmanship, unique talents, etc. This type of knowledge is deeply embedded in the context and personal experiences through which it is gained, and it is difficult to be codified into written forms (Nonaka & von Krogh, 2009). On the other hand, explicit knowledge is more migratory in the form of systematic and symbolic codes, which makes it easier to be encoded and transferred (Flanagin, 2002; Zander & Kogut, 1995).

Previous studies have suggested that as knowledge becomes more codifiable, people depend less on interpersonal communication to seek and transfer such knowledge (Hansen, 1999; Levin & Cross, 2004). It is argued that tacit knowledge is most effectively transferred through interpersonal communication rather than electronic forms (Hansen, 1999). Later, Hansen (2002) found that although direct human-to-human relationships could promote the transfer of tacit knowledge, it impeded the transfer of explicit knowledge because such relationships involved high social costs and were not cost efficient in transferring highly codifiable knowledge. Instead, people are more likely to seek information from digital knowledge repositories in domains that are highly codifiable, because the digital systems provide a systematic and efficient platform in transferring and retrieving coded information (Hertzum & Pejtersen, 2000). In addition, it is found that people are more likely to use digital knowledge repositories for information seeking when the knowledge to be sought is less tacit and more explicit (Kankanhalli et al., 2005). In another study on information seeking in physician practices, researchers found that physicians relied on their self-memory or their colleagues for the tacit knowledge they needed, but they relied on digital knowledge repositories for the explicit knowledge that was essential for their decision-making processes (Pluye & Grad, 2004). Therefore, Yuan, Carboni, et al (2010a) state that although face-to-face communication facilitates information seeking on tacit knowledge domains, digital knowledge repositories would provide a more accurate and efficient venue for seeking and sharing knowledge that is highly codifiable. The fact that digital knowledge sources have become the most frequently accessed information source for Brazilian consultants imply that its convenience and efficiency in seeking explicit knowledge makes it a desirable source when information is urgently needed for decision making (Pereira & Barbosa, 2008). Thus, this study proposes the following hypothesis:

> H5: The more codifiable a knowledge domain, the greater tendency for members of a consulting team to seek information from the digital knowledge repository, and the lower tendency to seek information from human knowledge sources in that domain.

In sum, this study first proposes a basic multidimensional network model of consultants' information seeking grounded on the fundamental mechanism of transactive memory development: expertise recognition. Then we extend the transactive memory model to include other important relationships in the information-seeking network: the ease of access to the knowledge source and the social influence from other members in the consulting team. The final two models are developed to explain variations in information seekers' tendency to seek information from human versus digital knowledge sources, which has been rarely addressed in previous transactive memory literature. Together, these theoretical models have advanced transactive memory theory by using a multidimensional network approach to studying the similarities as well as differences in consultant's information seeking from two primary knowledge sources: their team members and digital knowledge repositories.

Method and Analysis

Sample and Procedure

To test the hypotheses proposed in this study, we collected data from 110 individuals across nine work teams from two multinational consulting firms in global IT services. Each of these nine teams worked in a local project site of their parent companies. The teams had been working with their clients for at least 6 months at the time of this study. Teams ranged in size from 8 to 20 members. Participants had an average tenure of 2.76 years (standard deviation [SD] = 2.11) and an average age of 32 years (SD = 3.96). The leaders in each team identified several distinct knowledge domains that were essential for their task completion. There were a total of 56 knowledge domains across these nine teams, ranging from four to eight in each team (see Appendix A). Each of these knowledge domains represented the actual context in which participants' information seeking took place. For example, for Team A

DOI: 10.1002/asi

to effectively accomplish their project tasks, members of this team were required to possess knowledge about "configuration management systems." Members lacking such knowledge would seek information from those knowledge sources that provide information in this knowledge domain. In addition to human knowledge sources, each team had access to a corporate intranet that provided task-related information in each of these knowledge domains. Thus, the information-seeking behaviors studied in our research refer to consultants' seeking of work-related information from human and digital knowledge sources in a very specific knowledge domain that is essential to the project accomplishment of the team.

Although these nine teams differed in their specific task goals and knowledge domains required to accomplish their tasks, they were by and large homogeneous in the types of job activities that they performed. Most team members were involved in tasks that were related to business processes (e.g., purchases, sales, and logistics), market units (e.g., insurance, banking, products, etc), implementations and services of information technologies, and project and change management within the consulting team. As a matter of fact, the task area "project management" was identified as a primary task area in all of these teams, and "change management" in four out of the nine teams. Consequently, one knowledge domain that these teams required in common was "project management methods and tools." In general, these work teams had a good representation of the typical job tasks performed in the IT consulting business. Further, each team had access to the organizational intranet provided by the consulting firm. These intranets provided multiple gateways to organizational resources, such as client information, problem solutions, technology documentations, deliverables, and directory information. These resources were organized by knowledge domains and geographical locations.

Data were collected through a web-based survey titled the Knowledge Asset Mapping Exercise (KAME). Each KAME was customized for each team before participants were granted private access to complete it online. The customization was based on an interview protocol conducted with team leaders to identify the primary knowledge domains and intranet use within the team. The KAME improved over traditional paper-based and online surveys in its creative and user-friendly design. Its interactive network visualization allowed for the reduction of burdens on participants in social network studies.

Measures

The key variable in this study was information seeking from team members and the digital knowledge repository. In the KAME, participants were asked to report how often they sought information from every other member and the intranet in each knowledge domain using a 5-point scale ranging from 1 (*never*) to 5 (*very often*). The KAME also asked participants to report their perceptions of the knowledge level of every other member and the intranet in each knowledge domain. The response set for human expertise included *none, beginner, intermediary,* and *expert*. The response set for intranet's knowledge level ranged from 1 (*none*) to 5 (*a lot*) on a 5-point scale. To maintain the consistency of the scales used to measure the knowledge level of human and digital knowledge sources, we recoded the perception of human knowledge level from a 4-point scale to a 5-point scale.

As discussed in the hypothesis development, easy access to team members was measured by the combination of responses to two questions: team members' frequency of social communication and their prior collaboration relationships. In the KAME, participants were asked to report their frequency of social communication with each other (7-point scale ranging from *never* to *once per day*) as well as their previous collaboration relationships (*yes* or *no*). Easy access to the digital knowledge repository was measured by reversing participants' rating of the difficulty in seeking information from the intranet in each knowledge domain, on a 5-point scale ranging from 1 (*not difficult*) to 5 (*extremely difficult*).

Finally, knowledge complexity and codifiability were measured using a 5-item and 4-item scale in the KAME. These scales were adapted from the constructs used in Zander and Kogut (1995) to compute a comprehensive measurement of the complexity and codifiability level of the knowledge domains identified in each team we studied. The responses to each item were on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The inter-item reliability measure (Cronbach's alpha coefficient) was 0.74 for knowledge complexity and 0.81 for knowledge codifiability. Appendix B provides a detailed description of the scales and questions used for this study.

Analysis

This study used the ERGM analysis, also known as $p*$ analysis (Frank & Strauss, 1986; Robins & Pattison, 2005; Wasserman & Pattison, 1996), to test the network hypotheses (H1–H3). ERGM analysis tests whether the observed network data exhibit the theoretically hypothesized structural tendencies. Because social network data violate the sample independence assumption of traditional statistical analysis, ERGM analysis has been developed to properly test the interdependencies between relational ties within social networks (Robins, Pattison, Kalish, & Lusher, 2007a). ERGM analysis helps uncover structural signatures in the observed network, thus reflecting the underlying social processes that generate such network structures (Robins & Pattison, 2005; Robins et al., 2007a). In particular, EGRM analysis is considered the "statistical network MRI" to appropriately reveal the theoretically grounded structures of different types of nodes in the multidimensional network (Contractor, 2009a).

To test the network hypotheses (H1–H3), the multiplexity parameters were estimated using the Monte Carlo Markov chain (MCMC) maximum likelihood estimation in the ERGM analysis (Robins, Snijders, Wang, Handcock, & Pattison, 2007b). The multiplexity parameter tests the tendency for multiple relational ties to co-occur between the

DOI: 10.1002/asi

same pair of nodes in a network. The computer program used to perform the ERGM analysis was XPNet, which was designed specifically for multidimensional network analysis (Wang, Robins, & Pattison, 2006). A positive and significant estimate for the multiplexity parameter indicates that the hypothesized network structure is statistically more likely to be observed than by random chance. A larger estimate value indicates a greater likelihood for such structure to occur in the observed network.

This study tested the network models at three different levels: the knowledge domain level, the team level, and the overall network level. The knowledge domain level refers to how members of a specific consulting team seek information in a specific knowledge domain. For example, one of the consulting teams identified the following areas to be the primary knowledge domains required to accomplish their tasks (see Appendix A): *organizational and contract rules, hardware and basic software, installation of particular applications, use of the software, data management,* and *project management tools and methods*. This study would examine how members in this team seek information in each of these six domains respectively. The next level is the team level, which aggregates all team members' information seeking across all knowledge domains identified by this team. Finally, the overall network level aggregates team members' information seeking across all knowledge domains ($N = 56$) and all teams ($N = 9$).

The last two hypotheses (H4 and H5) were tested by multiple regression analyses. Because these two models were knowledge domain specific, they were tested at the knowledge domain level only. To test H4 and H5, the independent variables (knowledge complexity and codifiability) were regressed on two dependent variables, respectively: team members' tendency to seek information from other members (human knowledge source) and from the digital knowledge repository. The data of team members' tendency to seek information from human and digital knowledge sources was not directly collected in KAME. Instead, it was computed in the ERGM analysis, in which the choice parameter was estimated for team members' information seeking from both human and digital knowledge sources. The magnitude of the parameter estimate represented the likelihood for team members to seek information from one type of knowledge source, given their tendency to seek information from the other type. These parameter estimates were used in the multiple regression analysis as dependent variables. Significant and positive regression coefficients would provide support to the hypothesized effects of knowledge complexity and codifiability on team members' preference of human or digital knowledge sources.

Results

The EGRM analysis results for network models (H1–H3) are displayed in Table 1. The parameter estimates and corresponding probability measures indicate the likelihood for the hypothesized network structures to be observed in the consulting teams we studied. Because the parameter estimates are positive for all hypotheses at the overall network level, the structural propensities proposed in H1–H3 are overall supported. In other words, among all participating teams across all knowledge domains, there is a general tendency for consultants' information seeking to be based on the following: (a) expertise recognition (the basic transactive memory model), (b) expertise recognition and easy access to the knowledge source, and (c) expertise recognition and social influence (whether colleagues of strong social ties are also seeking information from the same knowledge source).

Although the analysis results provide general support for all network hypotheses, the magnitudes of corresponding parameter estimates and probabilities vary from one theoretical model to another, which has an important implication that different structural propensities would have different degrees of likelihood to be observed. As Table 1 demonstrates, when it comes to information seeking from human knowledge sources, the H2 model has the highest parameter estimate (1.52) and probability level (0.82). These results suggest that the consultants in our study have the greatest tendency to seek information from colleagues they perceive to be not only knowledgeable but also accessible in relevant knowledge domains. In other words, when those consultants are seeking information from human knowledge sources, the two most important factors they consider are the expertise and accessibility level of their colleagues.

However, for information seeking from the digital knowledge repository, the H3 model has the highest parameter estimate (2.14) and probability level (0.89). Thus, the consultants in our study have the greatest tendency to seek information from the organizational intranet if they perceive it to contain the information they need in relevant knowledge domains and their close colleagues (with strong social communication ties) are also seeking information from the intranet. This finding suggests when predicting consultants' information seeking from digital knowledge sources, expertise recognition and social influence together play a more important role than expertise recognition alone, and the combination of expertise recognition and easy access to digital knowledge sources.

Table 1 also reports the ERGM analysis results at the team and knowledge domain level. At the team level, the networks are aggregated across all knowledge domains for each team. The results report the proportion of teams in which the hypothesized network structure is supported. The knowledge domain level is the smallest unit of network analysis in this study. The results report the proportion of knowledge domains in which the proposed network structure is supported. The results demonstrate that although all structural models are supported at the overall network level, such structures differ in their tendencies to be observed in different teams and knowledge domains. These findings justified our investigations into how the characteristics of each knowledge domain would affect consultants' preference of human versus digital knowledge sources in the related domain (examined by H4 and H5).

DOI: 10.1002/asi

TABLE 1. ERGM analysis results for multidimensional network models (H1–H3).

Hypotheses	Knowledge source type	Overall network level		Team level (9 teams in total)[c]	Knowledge domain level (56 domains in total)
		Parameter estimate[a]	Probability[b]		
H1: Information seeking based on expertise recognition	Human[d]	1.32	0.79	9/9	54/56
	Digital	1.39*(0.10)	0.80	7/9	26/56
H2: Information seeking based on expertise recognition and easy access	Human	1.52	0.82	9/9	55/56
	Digital	1.44*(0.11)	0.81	7/9	23/56
H3: Information seeking based on expertise recognition and social influence	Human	0.92	0.72	7/9	55/56
	Digital	2.14*(0.36)	0.89	9/9	53/56

Note. ERGM = exponential random graph modeling.

[a]At the overall network level, the parameter estimate value is provided, with the standard error included within brackets. The significance of a parameter estimate is flagged by ∗, which indicates that the estimate value is at least twice the standard error.

[b]Probability = $\exp^{\text{parameter estimate}}/[1+\exp^{\text{parameter estimate}}]$ (Wasserman & Pattison, 1996). The range of the probability measure is from 0 to 1.

[c]Given the space limit, the detailed estimation results at the team and knowledge domain level are not reported in this table. Only the number of supported teams and knowledge domains are reported.

[d]When testing all human-to-human information seeking hypotheses, the current version of the XPnet program was not able to generate the standard errors and significance measures when the human-to-digital relationships were analyzed in the same model. This is a known limitation of the software.

TABLE 2. Descriptive results and correlation matrix for models H4–H5.

Variables	1	2	3	4
1. Knowledge complexity	–	−0.34*	−0.18	−0.39**
2. Knowledge codifiability	–	–	0.21	0.28*
3. Information seeking from human knowledge sources	–	–	–	0.45**
4. Information seeking from digital knowledge sources				–
Mean	1.84	2.17	−0.95	−0.29
Standard deviation	0.18	0.28	0.82	1.49
Scale range	1–5	1–5	–	–
Cronbach's alpha	0.74	0.81	–	–

$^*p < 0.05$. $^{**}p < 0.01$.

To test H4 and H5, we analyzed two multiple regression models, in which the independent variables were the same in both models (knowledge complexity and codifiability) and the dependent variable was team members' tendency to seek information from human and digital knowledge sources, respectively (see Table 2 for descriptive statistics and correlational relationships among these variables). The multiple regression analysis results showed that when predicting consultants' information seeking from human knowledge sources, the overall model was not significant ($F = 1.61$, $p > 0.05$, see Table 3). According to Cohen, Cohen, West, and Aiken (2003), the insignificant F-statistic suggests that neither knowledge complexity nor codifiability had a significant influence on team members' information seeking from their colleagues. However, when predicting team members' information seeking from digital knowledge repositories, the overall model was significant ($F = 5.63$, $p < 0.01$, see Table 3). This result suggests that either knowledge complexity or codifiability significantly predicted team members' information seeking from digital knowledge repositories. The β statistic of each variable would help us test the influence of knowledge complexity (H4) and knowledge codifiability (H5), respectively.

The fourth hypothesis (H4) posits that consultants are more likely to seek information from human than digital knowledge sources in complex knowledge domains. This hypothesis is partly supported as knowledge complexity is found to have a negative influence ($\beta = -0.33$, $p < 0.05$, see Table 3) on members' information seeking from digital knowledge repositories. However, knowledge complexity has no significant influence ($\beta = -0.12$, $p > 0.05$, see Table 3) on members' tendency to seek information from their colleagues. In other words, although knowledge complexity does not motivate consultants to seek information from human knowledge sources, it does impede them from seeking information from digital knowledge repositories.

The last hypothesis (H5) predicts that knowledge codifiability would increase consultants' tendency to seek information from digital knowledge repositories and decrease their tendency to seek information from human knowledge sources. This hypothesis is not supported because there is no significant influence of knowledge codifiability on team members' tendency to seek information from human knowledge sources ($\beta = 0.17$, $p > 0.05$, see Table 3) or digital knowledge repositories ($\beta = 0.18$, $p > 0.05$, see Table 3). Thus, contrary to what this study has hypothesized, the codifiability level of a knowledge domain has no significant impact on consultants' preference of digital over human knowledge repositories when seeking information in that knowledge domain.

DOI: 10.1002/asi

TABLE 3. Summary of multiple regression analysis for variables predicting information seeking from human and digital knowledge sources.

Independent variables	Standardized coefficient (β)	Adjusted R-squared	F-statistics
Predicting information seeking from human knowledge sources			
1. Knowledge complexity	−0.12	0.02	1.61
2. Knowledge codifiability	0.17		
Predicting information seeking from digital knowledge sources			
1. Knowledge complexity	−0.33*	0.14	5.63**
2. Knowledge codifiability	0.18		

*$p < 0.05$. **$p < 0.01$.

Discussion

The goal of this study is to examine and compare factors that influence consultants' information seeking from two major types of knowledge sources, team members' expertise, and digital knowledge repositories. Grounded on transactive memory theory and existing research on consultants' information-seeking practices, this study employs a multidimensional network approach to unravel three structural signatures of consultants' information-seeking networks: information seeking based on expertise recognition, easy access to knowledge sources, and social influence. Our analysis results show that consultants' information seeking from human knowledge sources is mostly driven by how knowledgeable and accessible their team members are, whereas their information seeking from digital knowledge repositories is strongly influenced by how much information the digital source has and whether their colleagues of strong social communication ties are seeking from the digital knowledge source. Additionally, the complexity level of a given knowledge domain had a negative influence on consultants' information seeking from digital knowledge repositories in that domain, but the codifiability level of a given knowledge domain had no significant effects on their information seeking from either human or digital knowledge sources in that domain.

Importance of Accessibility of Experts

This study lends support to prior research that finds coworkers' expertise and accessibility to be the two most important factors influencing organizational members' information seeking (Borgatti & Cross, 2003; Cross & Parker et al., 2001). Our findings suggest that when consultants are seeking information from human knowledge sources within the team, they would make rational decisions by considering not only "who knows what" but also "who is accessible." Because the consulting teams we studied were in the global IT services industry, team members were facing a tremendous amount of pressure to make quick decisions and deliver solutions to their clients worldwide based on the best expertise available. Pfeffer and Salancik (1977) argue that decision makers are often confronted with an ambiguous choice of information sources, yet at the same time, great pressure to make rapid decisions. To produce satisfying results in an efficient manner, the consultants in our study tend to find a balance between the quality of information they can obtain and the ease of access to human expertise. As reported in a previous study, a consultant once disclosed: "I just have to find information, and the information may not be perfect, and I may have to find [what I need] inside the information I have …[to not find it] would be failure" (Lee & Thomas, 2008, p. 3546). This statement reflects that the accessibility of knowledge source is just as important, if not more, as the quality of information in knowledge-intensive organizations such as the consulting firms.

As the accessibility factor is largely overlooked in previous transactive memory research, this study underscores the importance in including the accessibility of knowledge sources in future theoretical development. For example, a previous study has revealed a very intriguing phenomenon that organizational employees would rather go to incompetent but likeable coworkers (dubbed as *lovable fools*) for information rather than those experts who are not lovable (dubbed as *competent jerks*; Casciaro & Lobo, 2005). Although this study did not directly test the effects of personal liking on information seeking, we did conceptualize and measure accessibility by virtue of social communication and prior collaboration relationships. It is based on the same premise that an increasing number of expertise locator knowledge management tools start to place equal emphasis on people's expertise level as well as their accessibility in social communication networks and professional collaboration networks (Alavi, Kayworth, & Leidner, 2006; Blair, 2002; Contractor, 2009b).

Social Influence on Using Digital Knowledge Repositories

Regarding consultants' information seeking from digital knowledge repositories, the combination of expertise recognition and social influence matters most. Our study found that team members' information seeking from organizational intranets was mostly influenced by the information-seeking behaviors of those with whom they had frequent social communication. Such a finding is attributed to the nature of the IT consulting teams under study as well. In these global IT service teams, consultants have experienced a high level of institutional uncertainty, which derives from the lack of formal work procedures and routinized information-seeking guidelines (Glückler & Armbrüster, 2003). Rice (1993) argues that people are more likely to submit to peer

DOI: 10.1002/asi

pressures in uncertain and ambiguous work settings. Thus, when consultants feel uncertain as to where to seek for information while pressed to deliver quick services to their clients, they are more likely to imitate the information-seeking practices of their colleagues, especially those with whom they frequently interact.

The strong social influence in using digital knowledge sources can also be explained by the overwhelming volume of information available on the intranets of the consulting firms we studied, which creates a cognitive overload for the consultants to search and find the relevant information they need. The intranets under study provide a number of categories of information to the consultants such as articles and research findings, deliverables, events and communication, learning resources, references and engagement profiles, sales and marketing, people, and policies, etc. Under each category, there are subcategories that store and publish a large volume of documents and data. According to Hansen and Hass (2001), consultants have only limited attention that they can allocate to identifying, evaluating, and seeking information from electronic knowledge sources. In addition, they argue that digital knowledge repositories are experience goods whose quality and relevance cannot be fully determined before used (Hansen & Hass, 2001). Therefore, consultants tend to use their peers' information-seeking behaviors as a compass to guide them to allocate their limited time and resources to the right knowledge source for information.

Beyond the consulting context, our study provides support to the social influence model in general. Based on Fulk's (1993) social influence model on technology-related attitude and use, Vishwanath (2006) found that in highly cohesive groups faced with high level of situational uncertainty, members' attitudes towards new media were strongly predicted by how their peers perceived the new media in terms of its richness and usefulness. Their findings have important implications for consulting project teams as well. On the one hand, a consulting team is a highly cohesive group in which individual member's work depends on one another. On the other hand, compared with traditional ways of seeking information directly from human experts, information seeking from digital knowledge repositories is an unconventional and risky method in acquiring knowledge. Very often information seekers are concerned about the recency, quality, and accuracy of information provided by the intranet or digital database (Hollingshead et al., 2002). However, their concerns would be alleviated if many others (especially those with whom they have frequent social communication) were also seeking information from the digital knowledge repository. The social influence reinforces the expertise recognition mechanism to inform organizational members about the location of desired information published on the digital knowledge repository. As the adoption and use of digital knowledge repositories become widely diffused in today's organizations, this study suggests that transactive memory research can be and should be enriched by incorporating social influence models into the examination of organizational members' information-seeking behaviors.

Different Effects of Knowledge Complexity and Codifiability

The present study provides additional support to the widely studied effects of knowledge characteristics on knowledge learning and sharing (Haas & Hansen, 2007; Hansen, 1999; Szulanski, 1996; Zander & Kogut, 1995). This study found that although knowledge complexity did not increase consultants' tendency to go to their colleagues for information, it did impede them from seeking information from digital knowledge repositories. In short, while consultants' information seeking from digital repositories is greatly influenced by the characteristics of a knowledge domain, their seeking from coworkers seem to be unaffected by the complexity or codifiability level of that knowledge domain. Such results reiterate the advantages of examining both human and digital knowledge repositories in the same theoretical and analytic framework as demonstrated in the present study.

In knowledge-intensive organizations such as IT consulting firms under our study, consultants' practice involves both tacit and explicit knowledge, which are the two ends of the codifiability dimension of organizational knowledge (Grant, 1996; Wood, 2009). Given that consultants are obligated to deal with information of both low and high levels of codifiability, which is saturated in almost every aspect of their work processes, it is not surprising to find the absence of a significant influence of knowledge codifiability on consultants' information seeking from either knowledge source in our study. In effect, the organizational intranets in the consulting teams we studied contain both tacit (e.g., skill learning, sales and marketing) as well as explicit (e.g., articles, deliverables, and policies) information. Thus, consultants are motivated to turn to digital knowledge sources regardless of whether or not the information is codifiable. In addition, the lack of significant effects of knowledge codifiablity may reflect a unique paradox faced by the consultants. Previous research suggests that in contrast to professionals in medical practice or accounting, consultants may actually benefit from the absence of a clearly defined and codified body of knowledge, because it would be more difficult for their clients to evaluate the quality of their services (Glückler & Armbrüster, 2003). Again, the uncertainty and intensiveness that characterize the internal knowledge environment in the consulting industry may have undermined the effects of the intrinsic knowledge characteristics on consultants' information seeking.

Theoretical and Practical Implications

This study has important implications for information-seeking research across multiple disciplines such as information science, organizational communication, and management studies. First, this study utilizes a new theoretical lens to examining information seeking in the consulting industry. Grounded in transactive memory theory, this study tests a set of structural signatures of consultants' information-seeking networks, which include both human and digital knowledge sources. It contributes to current transactive

DOI: 10.1002/asi

memory research by incorporating source accessibility and social influence into the development of transactive memory within consulting project teams. This theory-driven approach addresses a critical concern about the lack of substantive theoretical foundations commonly found in previous social network approaches (Contractor et al., 2006; Salancik, 1995).

Second, this study provides a contextualized analysis of information-seeking practices, which contributes to our current understanding of how and why individual members choose to seek information from human and digital knowledge sources in this particular industry and the knowledge-intensive organizations at large. In addition to the organizational context, this study pays special attention to the contextual influence of the knowledge domain as well. This study lends additional empirical validation to the effects of knowledge characteristics (knowledge complexity and codifiability) on organizational members' information seeking and knowledge transfer. The scrutiny on both organizational and knowledge-domain contexts in which information seeking takes place provides a richer and more comprehensive view of consultants' information-seeking practices.

Finally, this study takes a multidimensional approach to unravel the interconnections between information seekers and two different types of knowledge sources (human and digital). Despite an increasing belief in the importance of using a multidimensional network approach to studying organizational knowledge management and information seeking (Contractor, 2009a), so far this approach remains largely conceptual and demands extensive empirical application. As one of the first empirical research taking a multidimensional approach, this study showcases the advantages of analyzing both human and digital knowledge sources within the same theoretical and analytic framework, which makes it possible to compare the explanatory power of different theoretical models on human-to-human and human-to-digital information seeking simultaneously rather than separately. Further, this study performed the ERGM analysis to analyze networks that included multiple attributes (human and digital) with multiple relationships (information seeking, expertise recognition, easy access, and social communication) at multiple levels (the knowledge domain, team, and overall network). This multilevel approach applies and exemplifies a new methodological advancement in social network analysis, which provides a complex and integrated analytic framework to enrich our understanding of consultants' information-seeking behaviors.

One of the key practical implications of this study is that the management should place equal emphasis on the quality and accessibility of knowledge sources from which employees could potentially benefit. Faraj and Sproull (2000) suggest that all three phases of a team expertise coordination process (i.e., recognizing where expertise is needed, knowing where expertise is located, and bringing expertise to bear) positively influence team performance above and beyond the mere presence of expertise. Our study concurs with them by showing that information seekers do prefer a knowledge repository that is as accessible as it is knowledgeable. Thus, we suggest that organizations, especially knowledge-intensive organizations such as consulting firms, should promote interpersonal communication and collaboration between individual members to increase their success in locating and accessing internal experts. Organizations should also establish and maintain an accurate and accessible organizational directory of employees' areas of expertise. However, note that this is only a necessary, but not a sufficient, condition for motivating organizational member's information seeking (Alavi et al., 2006; Blair, 2002).

Second, organizations should not assume that every employee is equally competent at using digital knowledge repositories. A prior study (Yuan et al., 2005) and the present research suggest that the difficulty in using digital knowledge repositories could prevent people from seeking information from the digital knowledge source. Therefore, organizations should simplify the technical procedures required to access digital knowledge and provide adequate training programs on how to use organizational intranets and databases. Last, as Dixon (2000) argues, organizational knowledge could be transferred most effectively only when the transfer process fits the characteristics of the knowledge being transferred. Thus, organizations should design appropriate knowledge transfer systems and channels to facilitate information seeking in different types of knowledge domains. For example, when the job task requires highly complex knowledge, managers should encourage interpersonal interactions such as face-to-face meetings and brainstorming sessions. When the task involves mostly codifiable and explicit knowledge transfer, organizations should design and maintain an accessible digital repository to facilitate the storage, publication, and transfer of such information.

Limitations and Future Directions

The present study considers only a handful of factors that influence consultants' information-seeking behaviors. Although these factors are theoretically driven and empirically important based on previous research, they are not sufficient to capture all variables that enable and constrain consultants' information-seeking practices. Indeed, the lack of support to some of our hypotheses implies that there exist other important explanatory variables that influence people's information seeking in the organizational settings. These factors could be individual characteristics such as gender homophily (Ibarra, 1992), tenure of the organizational employment (Morrison, 1993), intrinsic motivations for sharing knowledge with others (Wilkesmann, Wilkesmann, & Virgillito, 2009), and contributing information to organizational intranets (Bock, Rajiv, & Qian, 2008). There could also be interpersonal factors such as mutual trust and engagement in problem solving (Cross & Sproull, 2004) and interpersonal conflicts (Rau, 2005). At the organizational level, future research should consider factors such as task interdependence (Hollingshead, 2001; Yuan, Fulk, Monge, & Contractor, 2010), organizational leadership (Nonaka & von Krogh, 2009), and organizational culture (Alavi et al., 2006;

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Wilkesmann et al., 2009). Future research should examine these factors together with a deeper look at the consulting industry to enrich the theoretical model in predicting and explaining information-seeking behaviors in consulting firms.

Second, the outcomes of consultants' information seeking have not been addressed in the present study. Future research should examine the extent to which information seeking could influence individual and team performance such as work productivity and effectiveness (Schreiber & Engelmann, 2010). After all, simply seeking information and sharing knowledge do not guarantee improved performance (Haas & Hansen, 2007). As a matter of fact, too much knowledge sharing and receiving unsolicited information could reduce team members' competitive performance (Haas & Hansen, 2005) and job satisfaction (Su et al., 2010). Finally, given the focus of this research, the participants in this study were restricted to professionals working in global IT consulting firms based in Western cultures. Therefore, to enhance the external generalizability of this study, future research should expand the scope and nature of target organizational work teams to include members from a wider variety of industries and cultures.

Conclusion

In today's increasingly connected world (Easley & Kleinberg, 2010), people work in a complex fabric of communication and knowledge networks that include not only human expertise but also digital knowledge repositories (Contractor et al., 2011). As social interaction has become a critical vehicle for knowledge seeking and transfer (Cross & Rice, et al., 2001), a multidimensional approach has become a more appropriate and powerful tool in understanding and uncovering the emerging patterns of information seeking, and, more important, the underlying social processes that generate the organizational communication and knowledge networks.

Moreover, communication and information technologies have drastically reconfigured organizational structures and communication processes (Horvath & Fulk, 1994; Poole & DeSanctis, 1990). Although the popularity of digital knowledge repositories is growing, we caution against overstating the benefits of such systems because their effectiveness and utility are still not certain nor straightforward (Flanagin, 2002; Hollingshead et al., 2002) and their values are yet to be fully realized (Blackman, 2007; Haas, 2010). As demonstrated in the present study, consultants' information-seeking behaviors are complex, and even more so when they face a choice of different types of knowledge sources. Therefore, scholars and practitioners should continue to deepen our understanding of the structure, context and content of people's information-seeking behaviors. After all, how to maximize the potential benefits of organizational knowledge is critical to the success of an organization in the emerging knowledge economy.

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Appendix A

Knowledge Domains of Information Seeking Identified by Participating Teams

Team ID	Knowledge domain ID	Name of knowledge domain
Team A	1	Configuration management system
	2	Real-time systems
	3	ADA and C programming
	4	Radar management systems
	5	System management
	6	Project management tools and methods
Team B	1	Market unit and processes
	2	SAP package
	3	Programming languages
	4	Building business cases
	5	Rules of data extraction
	6	Change management tools and methods
	7	Project management tools and methods
Team C	1	Organizational and contract rules
	2	Hardware and basic software
	3	Installation of particular applications
	4	Use of the software
	5	Data management to solve users problems
	6	Project management tools and methods
Team D	1	Microsoft platform
	2	Data design and database management system
	3	Programming languages
	4	Design and architecture of web application
	5	Market unit and processes
	6	Project management tools and methods
Team E	1	Programming languages
	2	Software design
	3	Market unit finance and insurance
	4	Technological platform
	5	Change management tools and methods
	6	Decalog package
	7	Project management tools and methods
Team F	1	Market unit and processes
	2	SAP package
	3	Design and programming tools and methods
	4	Change management tools and methods
	5	Project management tools and methods
Team G	1	Market unit insurance
	2	"Denni" processes
	3	"Vita" processes
	4	Accounting processes
	5	Marketing processes
	6	Building business cases
	7	Insurance claims
	8	Project management tools and methods
Team H	1	Finance processes
	2	Purchases and warehouse processes
	3	Project management processes
	4	Sales processes
	5	Programming language
	6	JDE package
	7	Project management tools and methods
Team I	1	Market processes
	2	SAP package
	3	Change management tools and methods
	4	Project management tools and methods

Appendix B

Measurement Items

1. *Frequency of information seeking from team members*
   How frequent have you sought information from other members in each knowledge domain?
2. *Frequency of information seeking from the digital knowledge repository*
   How frequent have you sought information from the intranet in each knowledge domain?
3. *Perception of team members' knowledge level*
   What level of knowledge do you think each group member has in each knowledge domain?
4. *Perception of the digital knowledge repository's knowledge level*
   How much information do you think the intranet contains in each knowledge domain?
5. *Perception of the frequency of social communication between team members*
   How often do you think your group members (including yourself) socially communicate (either via telephone, e-mail, or face-to-face) with one another?
6. *Prior collaboration relationship*
   Please indicate any member(s) with whom you have collaborated prior to joining this project.
7. *Perceived difficulty in seeking information from the digital knowledge repository*
   How difficult is it to seek information from the intranet in each knowledge domain?
8. *Knowledge complexity*
   To what extent do you agree or disagree with the following statement for each knowledge domain?
   1) A competitor can easily learn how we produce outputs related to this knowledge domain by looking at the whole "Project Output." *(Reversely coded)*
   2) A competitor can easily learn how we produce outputs related to this knowledge domain by analyzing carefully all the related resources used and produced for these outputs.
   3) In this knowledge domain, the quality of the output depends more on the judgment of the experts than on well defined rules.
   4) Within the practice of this knowledge domain, a given action has a known outcome. *(Reversely coded)*
   5) The problems related to this knowledge domain are always different. It is not convenient to collect and store them.
9. *Knowledge codifiability*
   To what extent do you agree or disagree with the following statement for each knowledge domain?
   1) Existing work manuals and operating procedures describe precisely what people working in this knowledge domain actually do.
   2) Most of the solutions to the problems related to this knowledge domain are described in written manuals.
   3) The outputs related to this knowledge domain are well documented.
   4) It takes too much time transforming the outputs related to this knowledge domain into reusable documents. *(Reversely coded)*

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