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# IT-mediated social interactions and knowledge sharing: Role of competence-based trust and background heterogeneity

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## Abstract

In the knowledge-based economy, organizational success is dependent on how effectively organizational employees share information. Many studies have investigated how different types of communication activities and communications media influence knowledge sharing. We contribute to this literature by examining increasingly prevalent yet understudied IT-mediated social interactions and their effects on knowledge sharing among employees in comparison to face-to-face social connections. By integrating the literature on knowledge sharing, social networks, and information systems, we theorize the ability of IT-mediated social interaction to (1) afford interactions between individuals with heterogeneous backgrounds and (2) facilitate frequent IT-mediated social interactions that are high in competence-based trust—both supporting effective sharing of knowledge. Through a social network analysis of the employees in a high-tech organization, this study finds that IT-mediated frequent social interactions are the most effective in promoting knowledge sharing.

## KEYWORDS

background heterogeneity, competence-based trust, knowledge sharing, social networks, social ties, technology-mediated social interactions

## 1 | INTRODUCTION

Continuous knowledge creation and sharing are imperative in order for contemporary organizations to stay competitive in a market environment characterized by frequent competitive moves and fast-changing customer needs

[Correction added on 19 January 2018, after first online publication: Xiaojie Zhang's second affiliation has been added and the corresponding author's email address has been corrected]

(Kogut & Zander, 1996). Because of its importance to organizational success, both practitioners and scholars have long sought to understand how knowledge is created and shared among employees (Grant, 1996; Nonaka, 1994). One focus of research is how individuals communicate with each other, for example, through information seeking (Borgatti & Cross, 2003), knowledge seeking (Cross & Sproull, 2004) or coordination, knowledge sharing, information gathering (Davison, Ou, & Martinsons, 2013), relationship development or conflict resolution (Watson-Manheim & Belanger, 2007), or for task- or work-specific activities. An often mentioned, although rarely empirically studied element of this phenomenon, is the specific role of social interactions in knowledge sharing. Social interactions (also called socializing) are forms of nonwork-related communication, including sharing jokes, hobbies, and family stories (Bhardwaj, Qureshi, Konrad, & Lee, 2016; Cross & Sproull, 2004), and are substantially different from formal communication in workplaces (Kurland & Pelled, 2000), such as reporting about work activities in a meeting. Conceptually, we understand that employees build relationships with each other over time through “serendipitous interactions” (Borgatti & Cross, 2003, p. 436), which are conceived of as proximate, face-to-face (F2F) interactions that support future knowledge-sharing episodes. Employees build and maintain social ties through social interactions, whether F2F or IT-mediated, by learning about nonwork interests, hobbies, and families (Cross & Sproull, 2004) in future episodes of knowledge sharing, and they then rely on these relationships. However, in our review of the literature, we found very little empirical work that has specifically investigated these social interactions, despite assertions as to their conceptual importance. This problem comprises the subject of our research, and we suggest that social interactions can be understood as social networking interactions between employees that impact knowledge sharing.

We believe this is particularly important at the current time because information technology is profoundly changing the way all interactions are accomplished (Ou, Pavlou, & Davison, 2014), especially in the workplace (Ou & Davison, 2011). With the advancement of IT in contemporary organizations, the spectrum of interactions that employees engage in is less restricted by space and time. Employees routinely interact using a variety of IT tools (eg, email, cell phones, instant messengers, and social networking tools) (Koch, Leidner, & Gonzalez, 2013; Watson-Manheim & Belanger, 2007), regardless of geographical or temporal boundaries (Kirkman & Mathieu, 2005). The arrival of “digital natives” (Prensky, 2001) into the workforce (those born between 1980 and 2000) is predicted to increase the use of IT for social interactions because such employees arrive with much experience using IT for social interactions outside of the workplace (Deal, Altman, & Rogelberg, 2010). In this context, we see an important avenue of investigation: What is the role of socializing in promoting work-related knowledge sharing, and how does IT-mediated socializing compare to F2F socializing in terms of the impact on knowledge sharing.

Remarkably, we know little about how effective IT-mediated social interaction is in supporting interpersonal knowledge sharing between 2 people (ie, knowledge sharing at the dyadic level), in comparison to more conventional F2F interactions. Although there is a conceptual acknowledgement of the need for social interactions as a foundational support for future knowledge-sharing activities (Cross & Sproull, 2004), surprisingly, neither the knowledge-sharing literature nor the IS literature has examined the relative effect of different transmission media (IT-mediation vs F2F) for social interactions in facilitating interpersonal knowledge sharing, although transmission medium is acknowledged as one of the key constituting elements in the process of knowledge sharing (Gupta & Govindarajan, 2000). More specifically, the knowledge-sharing literature has explained interpersonal knowledge sharing from the perspectives of knowledge characteristics (eg, Griffith, Sawyer, & Neale, 2003; Huang, Hsieh, & He, 2014; Leonard & Sensiper, 1998; Uzzi & Lancaster, 2003), knowledge source and seeker characteristics (eg, Kim & Yun, 2015; Morrison, 1993; Shah, 1998), social tie structural characteristics (eg, Cross & Cummings, 2004; Granovetter, 1973; Hansen, 1999; Reagans, Singh, & Krishnan, 2015), and relational characteristics (eg, Borgatti & Cross, 2003; Tzabbar & Vestal, 2015; Xu, Tan, & Yang, 2006), either separately or in combination (eg, Cannella Jr & McFadyen, 2016; Cross & Sproull, 2004; Levin & Cross, 2004; Tsai & Ghoshal, 1998).

Our research builds on the findings that knowledge sharing among actors having social ties with different strengths has distinct characteristics that are unable to exist simultaneously. Particularly, the effective sharing of knowledge by weak ties is characterized by information diversity due to actors' background heterogeneity (Granovetter, 1973; Granovetter, 1983), while knowledge sharing by strong ties is characterized by a high level of

trust that actors hold for each other (eg, Lincoln & Miller, 1979; McPherson, Smith-Lovin, & Cook, 2001). However, this literature has largely assumed F2F as the default transmission medium and largely has not accounted for the possible distinctive effect of IT as a transmission medium on the characteristics of interpersonal knowledge sharing (see Constant, Sproull, & Kiesler, 1996, for an exception). We argue that the use of IT as a transmission medium could support (1) differences in the background characteristics of the ties, as social cues are less salient (Constant, Kiesler, & Sproull, 1994; Walther, 1995), and (2) competence-based trust between dyadic actors of the network. These 2 aspects of IT-mediated ties would support knowledge sharing.

The IS literature, in contrast, does put an emphasis on the role of IT as a transmission medium in knowledge sharing. However, this literature has not focused on explaining knowledge sharing in a dyadic context; instead, it has studied knowledge sharing at a more general level or at an individual level. This literature often addresses IT-mediated platforms that support many-to-many knowledge sharing among employees (Alavi & Leidner, 2001), such as electronic knowledge repositories (Arazy, Gellatly, Brainin, & Nov, 2016; Bock, Kankanhalli, & Sharma, 2006; He, Fang, & Wei, 2009; Kankanhalli, Tan, & Wei, 2005a; Kankanhalli, Tan, & Wei, 2005b; Leonardi & Treem, 2012; Taylor, 2004), electronic networks of practices (Wasko & Faraj, 2005), virtual teams (Robert, Dennis, & Ahuja, 2008; Sarker, Ahuja, Sarker, & Kirkeby, 2011), and virtual communities (Ma & Agarwal, 2007), among many others. While these studies are useful, they do not address the role of IT in sharing knowledge at the *dyadic* level and, consequently, are unable to examine the role of IT in affecting the mechanisms through which knowledge is shared between actors of a dyadic relationship, which is at the core of the research on interpersonal knowledge sharing.

Given the gap in the literature, our study aims to advance the theoretical understanding of the association of IT-mediated social interactions with interpersonal knowledge sharing at the dyadic level. Specifically, our study aims to address the research question: *To what extent and through what mechanisms* do IT-mediated social interactions between 2 employees affect knowledge sharing between them, in comparison to F2F social connections?

To address this research question, we relate the transmission medium (IT-mediated vs F2F) to 2 key characteristics found instrumental for knowledge sharing in the literature on social ties—ie, *background heterogeneity* and *trust* between actors in interpersonal (dyadic) social interactions—by extending social networks research to the context of IT-mediated interactions. We hypothesize and empirically find that in comparison to the F2F social interactions—which prior literature has largely assumed is the setting for the activity of socializing—a dyad engaging in IT-mediated social interactions is more effective in sharing knowledge because the individuals involved are more heterogeneous in their backgrounds and possess a higher level of trust in each other.

## 2 | THEORETICAL BACKGROUND

### 2.1 | Interpersonal knowledge-sharing overview

Interpersonal knowledge sharing is of great importance to contemporary organizations because it has direct positive impacts on individual job outcomes (eg, Constant et al., 1996; Gray & Meister, 2004; Gray & Meister, 2006) and has substantial implications for higher-level performance in teams (eg, Choi, Lee, & Yoo, 2010; Robert et al., 2008), other collaborative groups (eg, Leonardi & Bailey, 2008; Malhotra, Majchrzak, Carman, & Lott, 2001), and societal contexts (Qureshi, Sutter, & Bhatt, 2017).

Interpersonal knowledge sharing in our study refers to an individual's perceived sharing (both receiving and giving) of knowledge and/or information that is new and useful to one's work and is acquired through interaction with another individual in the organization. With this definition, we focus on knowledge sharing as both a receiving and giving behaviour that provides benefits to employees' daily work. We restrict our focus to knowledge that has not been explicated but is explicable—ie, can be communicated orally or in written form—because knowledge must be made explicit before it can be shared using IT (Alavi & Leidner, 2001). Furthermore, we focus on dyadic interaction

(communication between 2 people) as the means of sharing such knowledge, consistent with the purpose of our study to examine the role of IT-mediated interactions.

Prior research has explained interpersonal knowledge sharing from multiple aspects. Some studies have examined knowledge characteristics in terms of tacit versus explicit (Polanyi, 1967), suggesting that tacit knowledge is more difficult to share than explicit knowledge (eg, Griffith et al., 2003; Leonard & Sensiper, 1998; Uzzi & Lancaster, 2003). Others have investigated individual attributes like knowledge source (eg, source's expertise and job roles) (Morrison, 1993; O'Reilly, 1982) and seeker characteristics (eg, gender, job roles, and task expertise) (Ibarra, 1992; Shah, 1998). Yet another set of studies has introduced contextual factors that induce knowledge sharing, such as job importance and demands (Gray & Meister, 2004; Xu et al., 2006), as well as psychological safety environment (Edmondson, 1999).

More importantly for this study, a stream of prior research has stressed the importance of dyad-specific characteristics to explain knowledge sharing by focusing on background heterogeneity and trust between actors of the dyad relationship. *Background heterogeneity* refers to the difference in the backgrounds of individuals connected through a social tie (Ibarra, 1995), which can include tenure and functional area (Perry-Smith, 2006; Williams & O'Reilly, 1998), race and ethnicity (Ibarra, 1995; Konrad, Seidel, Lo, Bhardwaj, & Qureshi, 2017), age and education (Klein, Lim, Saltz, & Mayer, 2004), gender and national culture (Salk & Brannen, 2000), among other qualities. Background heterogeneity between members of a knowledge-sharing dyad has been found to be beneficial in terms of obtaining new ideas, information, and resources (Reagans & Zuckerman, 2001), because it allows people to draw upon more diverse experiences from their connections with others (Ancona & Caldwell, 1992; Haas, 2006).

Trust is defined as "the willingness of a party to be vulnerable" (Mayer, Davis, & Schoorman, 1995) and is the most studied relational feature of interpersonal relationships (Coleman, 1988; Portes, 1998). Two dimensions of trust that are of particular relevance to knowledge sharing are competence-based and benevolence-based trust (Levin & Cross, 2004). Benevolence indicates a trustor's belief that the trustee wants to do good to the trustor, whereas competence is the trustor's perception of the expertise that forms a critical characteristic of the trustee (eg, Kramer, 1999; Mayer et al., 1995). While benevolence-based trust affects knowledge sharing by making knowledge seekers more open to learning in general (a position of vulnerability), competence-based trust promotes knowledge sharing by making knowledge seekers appreciate the source's ability and expertise in the relevant knowledge domain (eg, Butler, 1991; Mishra, 1996). Considerable evidence has found that trusting relationships lead to greater knowledge sharing. When trust exists, people are more willing to seek and absorb one another's knowledge (eg, Levin & Cross, 2004; Mayer et al., 1995; Szulanski, 1996) and are themselves more willing to provide insights and useful knowledge (Tsai & Ghoshal, 1998). Trust can also make knowledge sharing less costly by reducing the need to verify information (Currall & Judge, 1995; Hansen, 1999).

Competence-based trust is important in the organizational working context, where interactions are more instrumental for the completion of tasks (Abrams, Cross, Lesser, & Levin, 2003). When seeking task-related knowledge, individuals turn to those who possess the information needed (Lin, Geng, & Whinston, 2008). As competence-based trust derives from the belief of the trustor about the trustee's skills, knowledge, and expertise (Mayer et al., 1995), competent trustees are more likely to be identified as qualified knowledge providers by trustors seeking task-related information. As a result, knowledge would be sought from those competent trustees, signifying the importance of competence-based trust. Furthermore, the instrumental intentions are facilitated through IT-mediated interactions (Kanawattanachai & Yoo, 2007), compared with F2F interactions, because IT provides opportunities for individuals to access the information about the competent trustees even with spatial and organizational distance. In contrast, since IT-mediated communication enables the transmission of few social or emotional cues (Sproull & Kiesler, 1986), it is less likely that benevolence-based trust—which can also be considered affect-based trust (Levin & Cross, 2004)—will manifest as prominently in the context of IT-mediated communication as it does in F2F interactions. Thus, for this study, we focus on competence-based trust.

Background heterogeneity and trust are essential in explaining how interaction between 2 individuals affects knowledge sharing between them. However, the social network literature reveals that these 2 characteristics are respectively embedded in different types of social ties, and therefore, it is difficult to attain both at the same time.

In the next section, we review how these 2 characteristics function to affect knowledge sharing between socially connected individuals by drawing on the literature of social ties.

## 2.2 | Social ties and knowledge sharing

Tie strength is the network concept that has probably attracted the most research attention in the social network literature (Granovetter, 1973). Tie strength can be understood in multiple ways (Granovetter, 1973). *Frequency* measures how often an individual interacts with another, whereas *intensity* measures how close an individual feels in association with another (eg, emotional ties). *Multiplexity* indicates the number of different contexts in which 2 individuals interact (eg, 2 individuals exercise at the same club and work at the same company) (Marsden & Campbell, 1984). Of these, frequency of interaction is the most commonly adopted metric for tie strength (Friedkin, 1982; Granovetter, 1983), and it is the focus of our study.

In comparison to work ties, social ties, formed largely through social interactions within or outside of an employee's formal job scope, are generally found to facilitate knowledge sharing by helping broaden the contact boundary of the employee (eg, getting to know more people from different backgrounds, not just those within his/her immediate work boundary) and his/her understanding of other employees in the company (eg, what they are good at, or their competence). Building on this premise, the social network literature demonstrates that both strong and weak ties, manifested as high and low frequency of interactions, respectively, can be valuable for knowledge sharing but that they operate through different mechanisms. Weak ties, characterized by low frequency of interaction, are valuable for sharing novel information due, in part, to their bridging effect—ie, weak ties are better than strong ties at bridging individuals with higher background heterogeneity (Granovetter, 1973; Granovetter, 1983). Background heterogeneity is more likely to be observed in weak ties than in strong ties because homogenous individuals, those with similarities rooted in shared backgrounds such as kinship, experience, and appearance (Mehra, Kilduff, & Brass, 1998; Qureshi, Kistruck, & Bhatt, 2016), are likely to bundle together and form strong ties than heterogeneous individuals—an effect called homophily (eg, McPherson et al., 2001). Homogeneity breeds strong ties because it has the capacity to make communication easier, improve predictability of behaviour, and foster a relationship of cohesion and trust (eg, Lincoln & Miller, 1979; McPherson et al., 2001). By contrast, weak ties are less contingent on the effect of homogeneity (Granovetter, 1983). Furthermore, loosely connected individuals can often constitute a “local bridge” to groups of individuals that would otherwise be disconnected (Granovetter, 1973). This bridging effect makes weak ties more likely than strong ties to yield diverse information sources by involving relationships with people of diverse backgrounds, perspectives, experiences, and expertise (eg, Podolny & Baron, 1997). Because of the known effect of background heterogeneity on interpersonal knowledge sharing, weak ties have been found to be beneficial in terms of providing greater cognitive resources for solving problems (eg, Bantel & Jackson, 1989), increasing the probability of finding useful technical advice (Constant et al., 1996), providing unique, less redundant information (Friedkin, 1982), promoting new ideas (Perry-Smith, 2006; Wang, Fang, Qureshi, & Janssen, 2015), and supporting social entrepreneurial initiatives (Bhatt, Qureshi, & Riaz, 2017; Qureshi et al., 2016).

On the other hand, strong ties, characterized by frequent interactions, are valuable for knowledge sharing partly because of trust—ie, in comparison to weak ties, strong ties bond individuals by building stronger mutual trust. Social network researchers argue that trust is built and enhanced either through homophily or through frequent interactions (Tsai & Ghoshal, 1998). As 2 persons engage in frequent interactions (ie, build a strong tie), each will calibrate the other's skills and expertise and seek information squarely in domains of competence, leading to strong competence-based trust (Levin & Cross, 2004; Rulke & Rau, 2000). Such trusting relationships, in turn, reinforce frequent interactions and retain the trust effect. In contrast, this line of argument implies that infrequent interactions are more likely to be characterized by a lack of trust and a lack of willingness to exchange useful knowledge (Krackhardt, 1992; Nelson, 1989). Because of the effect of trust, strong ties have also been found to be instrumental in knowledge sharing, with very few exceptions (Morrison, 2002). For instance, Krackhardt (1992) and Nelson (1989) reemphasized the importance of strong ties in an organizational context. More recently, strong social ties were found to be more

beneficial for receiving useful (Hansen, 1999; Levin & Cross, 2004; Szulanski, 1996; Uzzi, 1997) and actionable knowledge (Cross & Sproull, 2004).

Many types of interactions have been studied in the literature: knowledge seeking, advice seeking, and resource seeking (eg, Baker, 2000; Cross & Borgatti, 2004; Cross & Parker, 2004). The commonality in these studies is that they focus on work-related interactions (ie, what we defined as formal interactions, as compared with our study of informal, social interactions). Most of these studies assume (but do not empirically study) the central role of social interactions, which build relationships between people. Some research discusses water cooler effects, for example, to support the value of socializing (Pratt, 1984). However, socializing as an interaction and its effect on knowledge sharing has not been explicitly studied.

The social ties literature has provided a solid theoretical foundation for understanding the mechanisms through which interaction affects knowledge sharing (through the formation of social ties), but most of the studies are silent on the medium of interaction and thus do not account for the types of transmission medium used for interaction. We believe it is important to investigate distinctions between different transmission mediums, particularly between the F2F and the IT medium. Theoretically, the choice of transmission medium can be a key factor affecting interpersonal knowledge sharing (Gupta & Govindarajan, 2000). Moreover, IT as a medium for social interactions is rapidly growing in contemporary organizations, making use of IT a major alternative to the F2F medium. The advancements in IT may facilitate such interactions, and the resulting IT-mediated socializing may further help promote knowledge sharing by making people from different backgrounds more accessible compared with F2F interactions (ie, higher background heterogeneity). However, concurrently, organizations have been concerned about lost productivity because of socializing at work, particularly IT-mediated socializing, and have acted to curtail it, despite the possibility that it has the capacity to yield heretofore untested knowledge-sharing value. To address the distinctive role of IT in supporting interpersonal knowledge sharing, we now turn to the IS literature, the related knowledge management systems (KMS) research in particular, with a focus on understanding how IT enables knowledge sharing within a dyadic relationship.

### 2.3 | Defining and characterizing IT-mediated social ties

Numerous IT tools have been proposed to support knowledge sharing in the KMS literature and have been used, to varying degrees, in practice (Alavi & Leidner, 2001; Davison et al., 2013; Ou et al., 2014; Ou & Davison, 2011). IT tools for knowledge sharing can be categorized in multiple ways. The nature of the task for which knowledge is shared is a key distinction, separating tools for supporting specific business functions (Stein & Zwass, 1995) from more complex strategic organizational initiatives (Markus, Majchrzak, & Gasser, 2002). IT tools can also be categorized in terms of whether they connect “people to document” versus “people to people” (Hansen, Nohria, & Tierney, 1999), on the basis of the locus of the knowledge to be shared (Hahn & Subramani, 2000). The design and use of IT tools to support connecting people to knowledge artefacts (eg, documents) has been examined in various technological contexts, such as electronic knowledge repositories (Durcikova, Fadel, Butler, & Galletta, 2011; He et al., 2009; Kankanhalli et al., 2005b; Ko & Dennis, 2011), retrieval systems (Stenmark, 2000), and competitive intelligence systems (Schultze & Boland Jr., 2000).

IT tools designed to support “connecting people to people,” which is most relevant to our focus, are also studied in the literature. Tools investigated include organization-wide applications such as yellow pages of experts (Hahn & Subramani, 2000), virtual communities (Ma & Agarwal, 2007), electronic bulletin boards (Constant et al., 1996), and the emerging online social networking sites (SNS) (Boyd & Ellison, 2007). They also include IT applications supporting group or peer-to-peer interactions, such as email and groupware (Robertson, Sørensen, & Swan, 2001), videoconferencing facility (Paul, 2006), online messengers (Robert et al., 2008), intranet (Scott, 1998), and the more common phone/mobile devices (Tiwana, 2003).

In general, this literature suggests that the IT tools used to support social interactions between people function individually or collectively to help individuals identify, access, and communicate with other colleagues. First, some tools help employees identify sources of competence, such as yellow pages of experts (Hahn & Subramani, 2000)



and deep profiles in virtual communities (Ma & Agarwal, 2007). Even the phonebook in a mobile device, the contact list in a corporate email system, or a chatting tool can help an employee identify and better organize contacts of colleagues with areas of specialization. Thus, with the wide availability of these “competence identification” tools, employees can become increasingly aware of who holds what competence in the organization.

Second, these IT tools can help employees access and communicate with knowledge sources despite various barriers between the source and recipient. Using IT, employees can access colleagues at different times and in different locations in ways that are impossible or too costly in a F2F format (Constant et al., 1996). For instance, use of email, videoconferencing facilities (Paul, 2006), and online messengers (Robert et al., 2008) can facilitate access to people in different locations. Moreover, the availability of IT tools has contributed to the flattening of organizational hierarchy or social status differences through reducing social cues, so that employees are more likely to approach colleagues of different ranks or social status, (eg, upper management) by using IT tools such as an intranet (Scott, 1998) or email (Sproull & Kiesler, 1986).

We extend this literature to the context of interpersonal knowledge sharing in 2 ways. First, most prior research focuses on a specific type of tool, each with a different usage context, to support interactions between people. This is beneficial as it allows researchers to investigate the interaction between the specific technology characteristics and the ways in which the technologies are used. However, from an interpersonal exchange perspective, the members of a dyad could use any single tool or combination of tools to perform their interactions. For instance, they may identify an expert through an online directory, initiate contact by text message, continue via Skype or other conferencing services, and conclude by email. Recent IS literature acknowledges this as well. For instance, while the media richness literature evaluated the ability of specific IT tools to convey rich messages (eg, Carlson & Zmud, 1999; Daft, Lengel, & Trevino, 1987; Lee, 1994; Markus, 1994), recent studies in this literature emphasize that, in practice, employees interact with each other for different purposes using a repertoire of technologies (Watson-Manheim & Belanger, 2007) and that such repertoires should be the focus of study, rather than single technology types. Media synchronicity theory takes it further by arguing that individuals should (and do) use a variety of media to accomplish their interaction purposes (Dennis, Fuller, & Valacich, 2008). Moreover, the multiplicity of tools that are simultaneously used for interactions are emergent from and idiosyncratic to their specific dyadic context and therefore cannot be prespecified. For instance, an individual may interact with a colleague in an online discussion forum, but with another via a text messaging tool, or even with the same individual using a different tool at different times. Thus, to investigate interpersonal knowledge sharing through IT-mediated interactions, we need to define IT at a level that is independent from the type and number of technologies in use.

Second, most prior KMS research examines IT-mediated interactions in a group or organization-wide context (eg, Alavi & Tiwana, 2002; Choi et al., 2010; Dennis, George, Jessup, Nunamaker Jr, & Vogel, 1988; Jarvenpaa & Leidner, 1999). Studies do not take the dyad as the unit of analysis and hence are unable to provide a theoretical account of how IT-mediated social interactions can make a difference in a dyadic relationship that social network research has seen as consequential to knowledge sharing. In our study, we define interactions at the dyadic level rather than a collective level, consistent with the study objective. In doing so, we are able to highlight the theoretical distinctions of IT tools to enable interpersonal knowledge sharing, in comparison to F2F interactions.

On the basis of the above discussion, we define *IT-mediated social ties* as social ties mediated by any IT tools that the individuals use in practice to fulfil their need to identify, access, and communicate with each other. Accordingly, IT-mediated social interactions can be defined as nonwork-related socializing through IT tools—such as forwarding jokes by email, online chatting, and playing online games together—while F2F social interactions take place in person, eg, sharing jokes, eating lunch, playing sports, discussing hobbies, and sharing family stories. With this definition, we can focus on IT-mediated versus F2F interactions in general. Thus, our emphasis is on the general medium of transmission rather than on specific technological features. Defining IT-mediated interactions at the general level is not only consistent with how IT-mediated interactions are performed in practice, but also allows us to identify key common characteristics underlying all types of IT-mediated interactions and compare them with F2F interactions in terms of their respective abilities to improve knowledge sharing.

### 3 | DEVELOPMENT OF HYPOTHESES

In this section, we integrate the literatures reviewed above to develop hypotheses. Specifically, we argue that social interactions occur in both F2F and IT-mediated settings. Socializing involves nonwork-related communication, including sharing jokes, personal stories, hobbies, and/or family information. The value of this social interaction lies in its capacity to influence the building and maintenance of social ties, which is an important channel for knowledge sharing. As such, the effectiveness of knowledge sharing can be influenced by characteristics of the actors connected by the social tie. Regarding the impact of the interaction medium, we assert that compared with F2F socializing, IT-mediated social interactions can better integrate the merits of strong ties and weak ties and also support differences in (1) background heterogeneity between actors of a dyad, by allowing employees to access and communicate with more diverse knowledge sources, and (2) competence-based trust, by creating conditions for strong competence-based trust embedded in the dyad.

#### 3.1 | Background heterogeneity

We argue that IT-mediated social interactions are more likely to occur between individuals of heterogeneous backgrounds, because IT-mediated interactions are subject less to the homophily effect that we discussed earlier. Homophily exerts strong effect in F2F interactions as individuals are more likely to be attracted by visible similarities in the F2F context (McPherson et al., 2001); in contrast, homophily does not play a comparably prominent role for IT-mediated social interactions since IT-mediated communication filters such visual cues (Sproull & Kiesler, 1986).<sup>\*</sup> Specifically, we reason that IT-mediated social interactions are related to background heterogeneity in 3 ways: They facilitate interactions among individuals who are not visibly similar to each other (who lack homophily), connect individuals with different organizational backgrounds, and support ties with individuals across spatial and temporal divides (who lack physical and temporal proximity).

First, people who perceive each other as similar in terms of such personal characteristics as gender, age, race, and ethnicity are more likely to perform social interactions frequently than those who do not (eg, McPherson et al., 2001). This homophily effect is most salient in F2F interactions because people can directly observe these personal characteristics that come with visual cues in appearance, gestures, attire, and facial expressions (Walther, 1992). By contrast, since people most often do not see each other through IT-mediated interactions, these cues become less visible during the interaction process (Sproull & Kiesler, 1986), making people less likely to be subject to the homophily effect when socializing online (Tidwell & Walther, 2002).

Second, organizational backgrounds, such as hierarchy and department, also contribute to background heterogeneity. Organizational backgrounds can be more easily identified in a F2F context, where it is possible to evaluate the immediate social context surrounding the other individual, such as private office space, business attire, and office location (Sproull & Kiesler, 1986). According to homophily effect, individuals with similar organizational backgrounds are more likely to socialize in the F2F context. Thus, when engaged in socializing, IT-mediated interactions are more likely to maintain communication with diverse individuals across different hierarchical levels and departments in the organization (Constant et al., 1996; Sproull & Kiesler, 1986).

Finally, IT is more likely to be used to access a spatially distant individual, thus overcoming the proximity effect. Proximity is an important antecedent of F2F social interaction since employees are more likely to have F2F contact with those who are spatially closer to them than with those who are distant (Zipf, 1949). Historically, spatial distance has largely limited the ability of employees to connect with remote others. In fact, spatial distance can still impede F2F interactions, even in situations where employees are colocated or close to one another (eg, different corners, offices,

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<sup>\*</sup>It is important to note we do not rule out the possibility that strong ties created in F2F context (where homophily is important) can be maintained through IT medium; however, our argument is that even when this mechanism is at play, individuals involved in IT-mediated social interactions have potential to be more heterogeneous, compared with individuals in F2F social interactions because homophily plays much stronger role in the face-to-face ties than IT mediated ties.



or floors) (Allen, 1977; Zahn, 1991). The advent of IT has helped employees reach remote others with much less effort (eg, Borgatti & Cross, 2003). To the extent that remote others are usually more heterogeneous in terms of social circles (eg, McPherson et al., 2001), we argue that socializing through IT can increase the likelihood of connecting with remote others, who are more likely to have heterogeneous backgrounds. Thus, we propose

**H1** *The backgrounds of the ties are more heterogeneous when their social interactions are IT mediated rather than face-to-face.<sup>†</sup>*

### 3.2 | Competence-based trust

In terms of differences in the level of competence-based trust between actors of a dyad, IT use has made information available to better support the search for employees in the organization (eg, yellow pages). This helps employees learn and appreciate what others know, which may lead them to seek useful knowledge—a process traditionally initiated by socializing with other individuals (Borgatti & Cross, 2003). This creates an initial condition for competence-based trust underlying potential interactions that are instrumental to dyadic knowledge sharing (Levin & Cross, 2004).<sup>‡</sup> While F2F social interactions might be catalysed by location convenience, homophily (eg, McPherson et al., 2001), and trust (Levin & Cross, 2004), this is not the case for IT-mediated interactions. IT-mediated communication, which takes place more often with remote others, is most strongly motivated by the need for competence that is not locally available and not catalysed by physical proximity or homophily. Indeed, in the context of IT-mediated interactions, individuals are more likely to be motivated to initiate social interaction with others because these others can meet their information or knowledge needs, which is the base for developing competence-based trust. Therefore, we argue that IT-mediated social interactions are initiated because of competence-based trust more than other possible factors. For instance, virtual workforces, where members frequently interact via IT communication tools, are often formed to leverage and integrate dispersed competence that is not available locally (Griffith et al., 2003). IT-mediated interactions, and specifically social interactions as an extension of other interactions, take place when remote expertise is sought, suggesting strong competence-based trust. Thus consonant with this prior research we hypothesize that IT-mediated social interactions would embed stronger competence-based trust than F2F social interactions. Stated formally,

**H2** *Competence-based trust is stronger in the ties that are formed through IT-mediated social interactions than face-to-face social interactions.*

### 3.3 | Mode of interactions and knowledge sharing

On the basis of the theoretical reasoning underlying hypotheses 1 and 2, we expect IT-mediated social interactions to be more strongly related to knowledge sharing than F2F social interactions because IT-mediated social interactions connect individuals with more heterogeneous backgrounds, hence improving the possibility of acquiring unique information from sources whose competence is strongly trusted, thus increasing motivation to seek out and trust the information being shared. Thus, we propose

<sup>†</sup>It is important to note that we are not suggesting a causal direction for this hypothesis (or for our other hypotheses). We are not suggesting that people who are more heterogeneous necessarily choose to adopt IT-mediated interaction nor that IT-mediated interaction causes heterogeneity. Rather we are recognizing the emergence (Markus & Robey, 1988) of a pattern on the basis of mutual influence (DeSanctis & Poole, 1994; Yates & Orlikowski, 1992)

<sup>‡</sup>It is important to note that competence-based trust is different from general trust. The organizational environment provides some degree of general trust for employees to begin with (Turner, 2001), and repeated interactions in an organizational environment strengthen generalized trust (Mayer et al., 1995) among individuals. This is no different for IT-mediated social interactions. Indeed, Walther (1995) found that there was no difference in generalized trust between members of a F2F group and those of an IT-mediated group.

**H3** *Knowledge sharing is more strongly associated with IT-mediated social interactions than face-to-face social interactions.*

Finally, we argue that frequent IT-mediated social interactions are more effective for sharing knowledge than F2F social interactions or infrequent IT-mediated social interactions. As hypothesized earlier, controlling for interaction frequency, IT-mediated social interactions are more strongly related to knowledge sharing than F2F social interactions. Furthermore, we argue that IT-mediated frequent social interactions are more strongly associated with knowledge sharing than IT-mediated infrequent social interactions. On the one hand, as with F2F social interactions, frequent IT-mediated social interactions help maintain trust (Levin & Cross, 2004), particularly competence-based trust. On the other hand, although the social network literature suggests that strong ties lack background heterogeneity—or alternatively, that individuals with strong background heterogeneity would not interact as frequently in the F2F situation as those with low background heterogeneity (McPherson et al., 2001)—we argue that this would not be the case in IT-mediated social interactions. This is because homophily has the strongest effect when social or personal cues indicating different backgrounds are most visible. In the case of IT-mediated social interactions, employees typically do not see each other at the time of interaction, thus largely eliminating the homophily effect. Thus, frequent IT-mediated social interactions achieve the benefit of high trust without the limitation of loss of background heterogeneity. Infrequent IT-mediated social interactions are expected to have lower trust but lack the compensation of higher heterogeneity. Taken together, we propose

**H4** *Knowledge sharing is more strongly associated with IT-mediated frequent social interactions than IT-mediated infrequent social interactions, face-to-face frequent social interactions, and face-to-face infrequent social interactions.*

## 4 | RESEARCH METHODOLOGY

The 4 hypotheses were tested by studying socializing and knowledge-sharing interactions among the employees of a single organization. Social network data were collected to examine the linkages between social interactions (F2F and IT-mediated), competence-based trust, and knowledge sharing for each dyad within the firm. The dyadic background heterogeneity was calculated from attribute data as explained in the subsection on measures.

### 4.1 | Research site

Innosoft (a pseudonym) is a small- to medium-sized entrepreneurial firm founded in 2002 in Southeast China. At the time of data collection, there were 135 employees in the firm. Innosoft was an appropriate empirical context for our study for several reasons. First, consistent with the focus of our study, knowledge sharing among employees was important and prevalent in Innosoft. Innosoft specializes in the design, development, and commercialization of embedded middleware and operating systems and operates in a fiercely competitive market in China and overseas. The high-tech and competitive nature of the industry makes knowledge sharing and creation crucial for the performance and perhaps even the survival of the firm.

Second, the firm had a flat organizational structure and was reasonably small and agile, which makes knowledge sharing among employees and across hierarchies natural to employees' daily work. Indeed, preliminary interviews revealed that all the employees were professionals engaged in knowledge-intensive work (eg, product development, technical design and support, marketing, and sales) and relying heavily on colleagues for information to solve problems and coordinate their work.

Third, both F2F and IT-mediated social interactions were common among employees in Innosoft. On the one hand, most of the Innosoft employees were colocated. They were separated into 2 adjacent and connected buildings, occupying a single floor in each building. This setting provided enough opportunities to interact and socialize F2F. On

the other hand, most of the employees were quite young (over 80% were less than 28 years old) and technologically savvy, making IT-mediated socialization prominent as well. Indeed, our observation and interviews with a group of employees across different functions revealed that Innosoft employees used a variety of IT tools for social interactions. The most commonly used tool, as in most organizations, was email. Text messengers and audio tools were also made available to employees at work.<sup>5</sup> Thus, Innosoft employees could interact and share knowledge through F2F interactions, IT-mediated interactions via a wide repertoire of IT tools, or both.

Finally, Innosoft represents a good setting for social network analysis. Social network analysis requires a high response rate (ie, 70% or above), which is difficult to achieve in large organizations because employees need to report their social relationships with all other employees (Kilduff & Tsai, 2003; Scott, 2000), and this creates severe respondent fatigue. Small firms are more suitable for social network analysis and are commonly studied in social network research (Brass, 1984; Brass, 1985; Ho, Rousseau, & Levesque, 2006; Ibarra, 1992; Labianca, Brass, & Gray, 1998). Small entrepreneurial firms in high-tech industries, as used in this study, are a common research setting for social network research (Kilduff & Krackhardt, 1994; Mehra, Kilduff, & Brass, 2001).

## 4.2 | Data collection

A voluntary online survey soliciting dyadic and demographic information was administered. All employees were invited to participate in the survey. We provided incentives (token gifts with a monetary value of less than \$10) to encourage participation. All 135 employees responded to at least some portion of an online survey within 3 working days; however, only 120 (44 women, 76 men) employees responded to all the variables used in the current study, resulting in a response rate of 89%. The average age of the employees was 25 years and 7 months, with over 80% being in the "millennial generation" age group (<28 y). An average employee had spent around 2 years with the company, and most of the employees held at least a bachelor's degree.

Network data were collected using the roster method (Scott, 2000; Wasserman & Faust, 1994). In this method, respondents were provided with an alphabetical listing of the names of all of their colleagues (134 names, with their own name excluded). The roster method is considered to be a more reliable method of network data collection than simple name generation techniques as it overcomes potential recall biases (Scott, 2000; Wasserman & Faust, 1994). To minimize participant fatigue and facilitate the location of colleagues, the names of the employees on the list were grouped together by department (there were 10 departments in total). We then asked the participants to indicate their degree of relationship with each name on the list.

## 4.3 | Measures

Most of the data collected in this study are dyadic in nature. Dyadic data reflect a relationship between 2 individuals as perceived by the individual who reports it. This type of data does not describe a property of an individual; instead, it describes a relationship between a pair of individuals. The dyadic level of analysis is appropriate for our study since we focus on interpersonal knowledge sharing between 2 employees of a dyad.

We use single-item questions to measure the network constructs in our study, including F2F/IT-mediated social interactions, knowledge sharing, and competence-based trust. "Network research typically relies on single-item sociometric questions" (Seideman, 1996, p. 226), to reduce respondents' fatigue. In dyadic measures where respondents are requested to state their relationship with each participant, each question must be asked "N" times, where N is the number of the target sample (ie, employees) in the research site. In other words, the number of total questions in a network survey increases dramatically for every additional item included, which quickly becomes unwieldy and undermines the quality of the provided data.

<sup>5</sup>In the survey, we asked employees to distribute 100 points across 7 ways through which they might share knowledge. On average, 32 points were assigned to email, 24 to bilateral face-to-face interactions, 15 to face-to-face group discussions/meetings, 12 to online text chat, 10 to online audio chat/phone, 4 to social networking software/sites, and 3 to video chat.

With single-item survey questions, the focus of data quality shifts from internal consistency reliability to obtaining a high response rate, since higher response rates increase the chance of obtaining a complete picture of relationships in the network and hence offer better assessments of reciprocity, which serve as a reliability check (Marsden, 1990; Rogers & Kincaid, 1981; Seibert, Kraimer, & Liden, 2001). Indeed, a recent study has found that single-item social network questions are cost effective, have low respondent fatigue, and can be a reasonably reliable means of collecting social network data compared with the more resource-intensive, time-consuming methods, such as contact diaries and participant observations (Fu, 2005). As such, multiple-item survey methods are uncommon for social network data collection. Hence, we adopt a single item for each dyadic measure.

### 4.3.1 | Social interactions

#### F2F social interactions

Participants were asked to indicate the average frequency of their in-person (F2F) interaction with each of their colleagues for nonwork-related socializing activities, such as sharing jokes, eating lunch, playing sports, discussing hobbies, sharing family stories, and other similar activities.<sup>†</sup> Building on well-established research (Pearce & Axinn, 1998; Rice & Aydin, 1991; Shelley, Bernard, Killworth, Johnsen, & McCarty, 1995), we asked respondents to choose one of 7 options: (1) never, (2) several times a year, (3) once a month, (4) once a week, (5) several times a week, (6) once a day, and (7) several times a day. To test the reliability/agreement in the responses, we calculated correlation between the socializing ties matrix and its transpose (Calloway, Morissey, & Paulson, 1993), which was greater than 0.9. Thus, there was a high degree of agreement in the strengths of outgoing ties and corresponding incoming ties. Consequently, we kept the socializing matrix as is rather than symmetrizing it.<sup>#</sup>

Where possible, such as in correlations analysis and multiple regression quadratic assignment procedure (MRQAP), we used valued ties, which account for both the existence and strength of a tie. For *t* tests, we recoded the responses as follows. Option 1 was coded as no F2F social interactions. All other options were combined to indicate presence of social interaction. For analysis of variance (ANOVA), we grouped options 2 to 4 together as infrequent F2F social interactions (weak F2F social ties) and options 5 to 7 together as frequent F2F social interactions (strong F2F social ties). Thus, in these cases, we dichotomized social interactions, as traditionally done in the literature.

#### IT-mediated social interactions

Concerning IT-mediated interactions, respondents were asked to indicate the frequency of their social interactions with each of their colleagues through any IT tools, such as email, online chat, bulletin board systems, and SNS, for nonwork-related activities, such as forwarding jokes, sending e-cards, and playing online games together.<sup>\*\*</sup> Here again, we calculated the correlation between the online socializing ties matrix with its transpose to test reliability. The

<sup>†</sup>We conducted a pilot study to understand the most common nonwork-related socializing activities in the face-to-face environment and online environment and designed and worded our survey tool accordingly.

<sup>#</sup>Symmetrization is a process through which a relationship reported by A about B and by B about A is forced to be equal (if they are not originally so). There are various ways of achieving this: assign (1) larger, (2) smaller, or (3) average values of the two to both versions of the relationships (reported by the ego as well as by the alter). Therefore, we conducted 3 additional analyses as robustness test for our results. We symmetrized the F2F social interaction (and ICT mediated social interactions) ties matrix with the rule that pair receive the score that is (1) lower, (2) higher, and (3) average of the 2 scores. The results were unchanged in direction and their significance level. Similarly, for the sake of completeness, we performed one additional analysis. It has been argued in the literature that asymmetric ties tend to dissolve over time rather than become symmetric (Hallinan, 1979). Thus, we replaced all the ties that were asymmetric with no ties and reanalysed our data. As there were very few asymmetric ties, as expected, the results were same in the direction and in significance level.

<sup>\*\*</sup>We include all forms of IT-mediated communication in the same category for 2 reasons. The first reason is respondent fatigue. Asking each respondent to recall how often they shared knowledge with each of their ties using each type of IT would have placed an unrealistically large response burden on the participants. Second, we believed that it would be very unlikely that respondents could accurately recall and report on their knowledge-sharing activities with a person according to each IT tool they use given the range of IT tools at their disposal. Since our goal was to focus on the social interactions, and the link between structural and relationship characteristics in F2F vs IT mediated communications, we believe that this choice is justified.

correlation was greater than 0.9; thus, as in the case of F2F socializing ties, we did not symmetrize the IT-mediated socializing matrix.

#### 4.3.2 | Knowledge sharing

We defined *knowledge sharing* as an individual's perceived sharing (both receiving and giving) of knowledge and/or information that is new and useful to one's work and is acquired through interaction with another individual in the organization. On the basis of this definition, we developed 4 measures of knowledge sharing by combining media and direction of sharing: F2F versus IT-mediated contexts with knowledge sharing as receiving and giving explicit knowledge/information.

##### F2F knowledge sharing

This was measured in 2 different ways: (1) providing unique information and (2) receiving unique information. First, respondents were asked to indicate how frequently they *provided* information in-person (F2F) to each of their colleagues. They were specifically asked about "information that is related to [their colleague's] work and that he/she did not know before and would not have easily found in company manuals and other offline or online documents." The frequency scale was the same as mentioned above: specifically, 1 (never) and 7 (several times a day). Respondents were then asked how frequently they *received* unique information in-person (F2F) from each of their colleagues ("information ... offline or online documents"). The response "1" was recoded as no ties in both the matrices to indicate that there was no knowledge sharing. Other responses were left as is. The knowledge-sharing matrix is directional—ie, "A" might go to "B" for information where as "B" may or may not seek information from "A." Thus, we do not expect it to be symmetrical.

##### IT-mediated knowledge sharing

We asked the same questions here as for F2F knowledge sharing, except that these questions were about information provided/received through IT, such as email, online chat, electronic discussion board, and SNS.

To get overall knowledge sharing in the organization, we summed these measures to arrive at an aggregate matrix of knowledge sharing; this matrix was used for all the analysis presented in this paper.<sup>††</sup>

#### 4.3.3 | Competence-based trust

On a scale of 1 (strongly disagree) to 7 (strongly agree), respondents were specifically asked to indicate "whether you will trust his/her competence on work related issues." Similar to other dyadic measures, respondents were asked to indicate their level of competence-based trust in each of their colleagues.

#### 4.3.4 | Background heterogeneity

Background heterogeneity was measured using multiple criteria. The basic notion is that background heterogeneity is the opposite of homophily; that is, the more similar a contact of a focal individual is according to one or more dimensions, the less background heterogeneity there would be between the 2 individuals. We measured background heterogeneity by comparing the 2 members of a dyad across 6 attributes: gender, province of origin (to capture potential cultural differences), department, hierarchy (eg, supervisor vs regular employees), tenure, and education. The first 4 attributes are categorical. We created a difference matrix for each of these attributes. For the first 4 attributes, if a dyad shared the attribute, they were assigned "0," otherwise they were assigned "1." Thus, if their attributes were different across all the 4 aspects, we rated the background heterogeneity of this dyad as 4. In contrast, if their attributes were the same across all 4 aspects, we rated the background heterogeneity of this dyad as 0. Education was measured on an ordinal scale. To convert education to a dyadic matrix, we used the absolute difference between

<sup>††</sup>Our statistical results remain the same when the 4 knowledge-sharing measures (F2F/IT-mediated knowledge giving/receiving) were included as DV individually and separately. Detailed results are available upon request.

dyads. To keep equal weights for all the components of background heterogeneity, we rescaled absolute difference in education by dividing each cell by the maximum cell value, thus resulting in minimum value of 0 and maximum value of 1. Similarly, for tenure (measured in number of months), we used the absolute difference between dyads and rescaled absolute difference in education from 0 to 1 by dividing each cell by the maximum cell value. After rescaling, we added both these matrices to the background heterogeneity matrix. Thus, the composite variable background heterogeneity varies from 0 to 6.

#### 4.3.5 | Control variables

We included several control variables for the MRQAP analysis. Familiarity reduces uncertainty and risk in a relationship (Hinds, Carley, Krackhardt, & Wholey, 2000), and individuals prefer to share with those who are familiar. Hinds et al. used the length of time that individuals have known each other as an indicator of familiarity, which we used as a control in our study. In addition, we believe that the number of projects 2 individuals have worked on together in the past and the number of projects they are currently working on together may also be important in creating familiarity, and thus, we included them as controls. We also controlled for organizational tenure, measured in months. To operationalize tenure at the dyadic level, a matrix for tenure was created in such a way that the tenure of each individual (a row in the matrix) was repeated in the respective column of the matrix (representing their ties). For example, if A, B, and C have tenures of 40, 20, and 30 months, respectively, then the first column of the tenure matrix has 40 in all the rows, the second column has 20 in all the rows, and the third column has 30 in all the rows. This type of operationalization captures the assumption that an employee's tenure may be associated with the amount of information that others seek from him/her and has been commonly used in the literature (Reagans & Zuckerman, 2001; Sparrowe, Liden, Wayne, & Kraimer, 2001).

#### 4.4 | Analysis technique

In social network data, observations cannot be assumed to be independent. For this reason, standard statistical tests such as parametric *t* test, ANOVA, and correlations cannot be used. To address this nonindependence issue, robust standard errors are obtained using permutation methods (Snijders & Borgatti, 1999). For the same reasons, ordinary least squares regression cannot be used, and MRQAP with "Double Dekker Semi-Partialling MRQAP" (Krackhardt, 1988; Krackhardt, 1993) extension must be used instead to overcome the issues associated with nonindependence in the observations. We used UCINET software (Borgatti, Everett, & Freeman, 2002) to provide the needed random permutation methods for *t* tests, ANOVA, and correlation and analysis, as well as MRQAP for our hypothesis tests.

Testing H1 and H2 required comparing the mean value of background heterogeneity and competence-based tests between F2F social interactions and IT-mediated social interactions. Similarly, H4 required comparing knowledge sharing between frequent and infrequent IT-mediated social interactions. We used *t* tests for these comparisons. Hypothesis H3 considers the association between social interactions and knowledge sharing. We used correlation analysis for testing this hypothesis. However, social network analysis software does not provide an option for partial correlation, and this did not allow us to include our control variables. We therefore conducted a regression analysis using MRQAP to test whether the relationships between knowledge sharing and social interactions change when the control variables are accounted for. We performed ANOVA as a post hoc test to compare knowledge sharing across the 4 scenarios: IT-mediated (frequent and infrequent) and F2F (frequent and infrequent) as an extension of H4.

### 5 | RESULTS

Results for hypotheses H1 and H2 are presented in Table 1. Both hypotheses were supported. *t* tests indicate that background heterogeneity was higher ( $P < .001$ ) in IT-mediated interactions (3.47) compared with F2F interactions



**TABLE 1** Permutation-based dyadic *t* test<sup>9</sup>

	Min	Max	IT-mediated Social Interactions	F2F Social Interactions	P Value
Background heterogeneity	0	6	3.47	2.41	<.001
Competence-based trust	1	7	3.30	1.95	<.001
Knowledge sharing	0	28	9.18	5.57	<.001

Abbreviation: F2F, face-to-face.

<sup>9</sup>For this test, we created an attribute matrix where each row represents a dyad and the columns represent the reported (or calculated) dyadic scores for background heterogeneity, competence-based trust, and knowledge sharing. Then we performed permutation-based *t* test available in UCINET.

(2.41), and competence-based trust was higher ( $P < .001$ ) in IT-mediated interactions (3.30) compared with F2F interactions (1.95). In addition, Table 1 shows that knowledge sharing was higher ( $P < .001$ ) in IT-mediate interactions (9.18) compared with F2F interactions (5.57).

We examined correlations among the variable of interest to test the associational relationship hypothesized in H3. Table 2 presents these results. The frequency of IT-mediated social interaction between members of a dyad was positively and significantly correlated with the degree of knowledge sharing between those individuals. Moreover, this correlation was stronger than that between the frequency of F2F interaction and degree of knowledge sharing (0.69 vs 0.08).

Table 2 also provides confirmation of the key theoretical arguments relating background heterogeneity, trust, and knowledge sharing. Like Levin and Cross (2004), we find that without considering the transmission medium, general knowledge sharing is positively related to competence-based trust and negatively related to background heterogeneity. Thus, our respondents, like those in prior studies, were more likely to share information with those that they trust and less likely to share with those who are different from themselves on characteristics such as gender, province of origin, department, and hierarchy. However, our results here go beyond prior studies, since they differentiate the IT-mediated and F2F interactions between dyad members. Here, we find a key difference from prior research. While the correlations between F2F interaction, background heterogeneity, and competence-based trust are as expected (greater heterogeneity is associated with lower F2F socializing while greater competence-based trust is associated with an increase in F2F socializing), the results for IT-mediated socializing are different. Both background heterogeneity and competence-based trust are positively related to IT-mediated social interactions. This suggests that IT-mediated social ties can be simultaneously high in competence-based trust (which promotes sharing) and background heterogeneity (which provides more novel information when it is shared). We further elaborate these insights in the discussion.

The correlation analysis in Table 2 showed a positive association between IT-mediated social interaction and knowledge sharing. However, this analysis did not include the control variables, as partial correlation analysis is not available in the UCINET software. To account for the effects of other variables (and rule out alternative explanation),

**TABLE 2** Permutation-based correlation results

	Mean	SD	1	2	3	4
1. Background heterogeneity	3.35	1.05				
2. Competence-based trust	1.15	2.33	-.18**			
3. Knowledge sharing	3.57	6.71	-.10**	.71**		
4. IT-mediated social interaction	1.86	1.96	.16**	.79**	.69**	
5. F2F social interaction	.92	1.19	-.49**	.10**	.08**	.03*

Abbreviation: F2F, face-to-face.

\* $P < .05$ .

\*\* $P < .01$ .

we conducted MRQAP to test the relationship between knowledge sharing and social interactions, controlling for relevant variables.

There are 4 models in Table 3. Model A presents only the results for control variables. This model explains 40.8% variance in knowledge sharing. As expected, comembership in current projects was a significant predictor ( $\beta = 0.25$ ,  $P < .001$ ) of knowledge sharing—ie, if members of a dyad share more current projects, they will share more information. Similarly, the number of months that members of a dyad have known each other significantly predicts ( $\beta = 0.52$ ,  $P < .001$ ) their knowledge sharing. However, neither tenure ( $\beta = -0.01$ , n.s.) nor comembership in past projects ( $\beta = 0.01$ , n.s.) was a significant predictor.

In Model B, we added F2F social interactions to Model A. This model explains 40.9% of the total variance in knowledge sharing, a modest increase by 0.1% over Model A. F2F social interaction was a significant predictor ( $\beta = 0.03$ ,  $P < .05$ ). Model C added IT-mediated social interactions to Model A, explaining a 59.1% variation in knowledge sharing, an improvement of 18.3% over Model A. IT-mediated social interaction was a significant predictor ( $\beta = 0.50$ ,  $P < .001$ ). Finally, we included both F2F social interactions and IT-mediated social interactions in Model D, which explained a 59.2% variance in knowledge sharing, and improvement of only 0.1% over Model C. Collectively, this analysis shows that even controlling for relevant variables, the association between IT-mediated social interactions and knowledge sharing is stronger than that between F2F social interactions and knowledge sharing. This provides strong support for H3.

Hypothesis 4 proposed that IT-mediated frequent interactions would have the highest impact on knowledge sharing. We tested this hypothesis using ANOVA in UCINET. Results in Table 4 support H4. Knowledge sharing was higher ( $P < .001$ ) for IT-mediated frequent interactions (13.04) compared with IT-mediated infrequent interactions (6.88) and F2F frequent/infrequent interactions (4.69 and 5.92).

Table 4 also shows the results of ANOVA for background heterogeneity and competence-based trust. These results provide further insights that are complementary to the correlation analysis conducted for H3.

**TABLE 3** MRQAP analysis (DV = knowledge sharing)

	Model A	Model B	Model C	Model D
Tenure	-.01	-.01	.00	.00
Comembership (past projects)	.01	.01	.00	.00
Comembership (current projects)	.25***	.25***	.18***	.18***
Month known	.52***	.52***	.29***	.29***
IT-mediated interactions			.50***	.50***
F2F interactions		.03*		.03*
$R^2$	40.8%	40.9%	59.1%	59.2%

Abbreviations: F2F, face-to-face; MRQAP, multiple regression quadratic assignment procedure.

N = 14 280.

\*\* $P < .05$ .

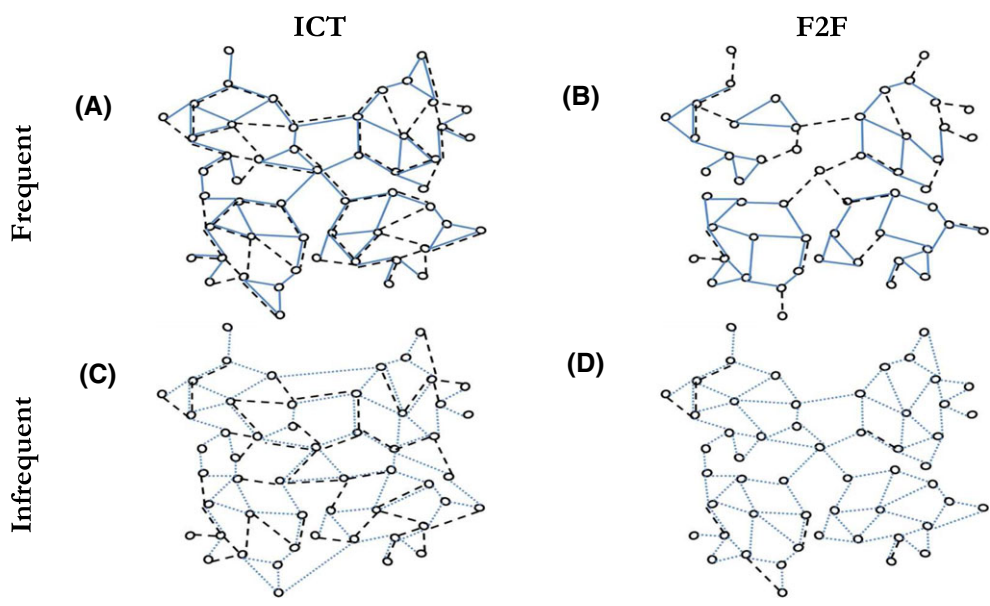
\*\*\* $P < .001$ .

**TABLE 4** Permutation-based ANOVA results

	IT-mediated Interactions		F2F Interactions	
	Frequent	Infrequent	Frequent	Infrequent
Knowledge sharing	13.04 <sup>a</sup>	6.88 <sup>b</sup>	4.69 <sup>c</sup>	5.92 <sup>d</sup>
Background heterogeneity	3.47 <sup>a</sup>	3.46 <sup>a</sup>	1.81 <sup>b</sup>	2.65 <sup>c</sup>
Competence-based trust	5.47 <sup>a</sup>	2.01 <sup>b</sup>	1.66 <sup>c</sup>	2.06 <sup>b</sup>

Abbreviations: ANOVA, analysis of variance; F2F, face-to-face.

Different superscripts within rows indicate means that are statistically different from each other at  $P < .05$ .



**FIGURE 1** Association of knowledge sharing with, A, IT-mediated frequent interactions, B, F2F frequent interactions, C, IT-mediated infrequent interactions, and, D, F2F infrequent interactions. F2F, face-to-face [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

**TABLE 5** Knowledge sharing at different levels of IT-mediated and F2F interactions

Frequency of Interaction → ↓ Medium	Several Times a Year	Once a Month	Once a Week	Several Times a Week	Once a Day	Several Times a Day
IT	4.23	5.47	9.00	9.66	11.37	17.81
F2F	5.25	5.74	3.77	4.7	5.16	3.33

Abbreviation: F2F, face-to-face.

**TABLE 6** Competence-based trust at different levels of IT-mediated and F2F interactions

Frequency of Interaction → ↓ Medium	Several Times a Year	Once a Month	Once a Week	Several Times a Week	Once a Day	Several Times a Day
IT	1.29	1.37	3.07	4.79	5.17	6.38
F2F	2.53	1.81	1.79	1.80	1.66	0.83

Abbreviation: F2F, face-to-face.

Competence-based trust is highest in IT-mediated frequent interactions (and is significantly higher than in IT-mediated infrequent interactions), while background heterogeneity is no lower in IT-mediated frequent interactions than in IT-mediated infrequent interactions. These results further support our theoretical arguments leading to H4.

Figure 1 presents how H3 and H4, if true, would look schematically in a social network: Solid lines indicate social ties and dashed lines represent knowledge-sharing ties—ie, whether or not individual “A” shares knowledge with individual “B.” The presence of both solid and dashed lines between 2 individuals indicates co-occurrence of socializing and knowledge-sharing ties. This co-occurrence is much more common in Figure 1A, compared with Figure 1B, 1C, and 1D, indicating the stronger association of IT-mediated frequent social interactions with knowledge sharing.

**TABLE 7** Background heterogeneity at different levels of IT-mediated and F2F interactions

Frequency of Interaction → ↓ Medium	Several Times a Year	Once a Month	Once a Week	Several Times a Week	Once a Day	Several Times a Day
IT	3.50	3.47	3.42	3.47	3.46	3.50
F2F	3.01	2.62	2.33	2.14	1.39	1.10

Abbreviation: F2F, face-to-face.

## 6 | DISCUSSION AND CONCLUSION

This study addresses the questions to *what extent* and *how* IT-mediated social interactions between 2 employees in an organization affect knowledge sharing between them, in comparison to F2F social interactions. On the basis of a social network analysis, our hypotheses are all supported. Specifically, our results show that IT-mediated social interactions between 2 employees are indeed related to the sharing of unique and useful knowledge that would otherwise be difficult to find in documented form. More importantly, this relationship is stronger than the relationship between F2F social interactions and knowledge sharing (H3), justifying the value of IT-mediated social interactions in comparison to the de facto F2F alternative. Our results also reveal 2 plausible mechanisms behind this interesting finding: The members of a dyad engaging in social interaction through IT (1) are more heterogeneous in their background (H1) and (2) are more strongly trusted by each other in terms of their competence (H2) than those through F2F. Use of IT thus allows employees to socialize with colleagues of more diverse backgrounds and stronger competence, 2 important dyad-specific characteristics instrumental to knowledge sharing. Finally, we also find that highly frequent IT-mediated social interactions are more strongly associated with knowledge sharing than any other type of interaction (H4), since competence-based trust is stronger but background heterogeneity is not lower in frequent IT-mediated interactions.

Examination of the descriptive statistics for knowledge sharing at different levels of IT-mediated and F2F social interactions provides further insights (Tables 5--7). In Table 5, we observe that while knowledge sharing does not change much as the frequency of F2F social interactions increases, it grows rapidly as the frequency of IT-mediated social interaction increases.

To explore the mechanisms behind this pattern difference, we reviewed how background heterogeneity and competence-based trust change as the frequency of IT-mediated and F2F social interactions change. As shown in Table 6, competence-based trust seems to grow rapidly as the frequency of IT-mediated social interactions increases while no such pattern is evident for F2F social interactions. In fact, competence-based trust appears to decrease as F2F interaction frequency increases. This analysis suggests that competence-based trust is a much stronger mechanism for colleagues to sustain IT-mediated social interactions than F2F social interactions. In contrast, F2F social interactions may be additionally afforded by other factors, such as physical proximity or homophily. This is consistent with our theoretical argument made to support H2.

Moreover, as shown in Table 7, while background heterogeneity decreases as the frequency of F2F social interactions increases (consistent with the homophily effect), this tendency is not observed in IT-mediated social interactions. Background heterogeneity remains almost constant across all levels of frequency. This interesting observation lends support to our argument that the homophily effect is reduced or eliminated in IT-mediated social interactions, a key theoretical distinction from F2F social interactions that led to our prediction of H1.

### 6.1 | Theoretical and managerial implications

This study extends prior work by adding to our theoretical understanding of the effect of social interactions on knowledge sharing broadly and of IT-mediated social interactions on interpersonal knowledge sharing more specifically. In doing so, it contributes to the literature in 3 ways. First, it extends the existing literature on interpersonal knowledge sharing by formally incorporating the role of IT as the transmission medium. Transmission medium is a key element

constituting the knowledge-sharing process (Gupta & Govindarajan, 2000), and IT has been increasingly used in practice as an alternative to F2F interactions (Watson-Manheim & Belanger, 2007). However, while prior research on interpersonal knowledge sharing has addressed the effects of many other factors, it has not yet formally investigated IT as a medium to support sharing. By integrating the KMS literature into the research on interpersonal knowledge sharing, we provide theoretical insights and empirical evidence into how use of IT for social interactions allows differences in the structural (background heterogeneity) and relational (competence-based trust) characteristics of the interpersonal relationship.

Second, our study contributes to the KMS literature by investigating the role of IT in the context of dyadic interpersonal social interactions, which, practically speaking, is an important level at which knowledge sharing actually occurs. KMS research has been fruitful for understanding the design and use of a broad variety of IT tools to support social interactions among individuals. However, most prior studies take a tool-oriented perspective, addressing the design and use of a specific category of IT tool, be it virtual communities (Ma & Agarwal, 2007), electronic bulletin boards (Constant et al., 1996), or online SNS (Boyd & Ellison, 2007). Our study builds on this research by examining knowledge sharing from the perspective of the social interaction process. We argue that users appropriate whatever tools are available to support their identification of, access to, and communication with targeted individuals, to fulfil their need for social interaction. This reorientation is meaningful not only for addressing our research question concerning IT-mediated social interactions—with IT generalized as any supporting technologies—but also for understanding the emergent nature of IT use particularly in the context of social interactions among employees.

Moreover, the KMS literature primarily addresses knowledge sharing in a collective context, be it group or community, rather than in the dyadic context—ie, how 2 participants in the context actually communicate with each other. While many findings from the collective context are useful to research at the dyadic level, prior KMS research is silent on how IT use might interact with certain dyad-specific characteristics, such as background heterogeneity and mutual competence-based trust. In this sense, our research extends KMS research to the dyadic level by providing nuanced theoretical insights as to how use of IT in support of social interactions improves knowledge sharing by affording differences in the structural and relational characteristics of a tie.

Third, our study contributes to the social network literature by differentiating the medium through which social ties operate and thus offering insights into how background heterogeneity and trust between dyadic actors—which are traditionally studied in the F2F context—can vary because of use of IT. Prior social network research developed the understanding of how tie strength relates to background heterogeneity and trust with an implicit assumption that F2F is the de facto medium for developing social ties (eg, Cross & Sproull, 2004; Krackhardt, 1992; Levin & Cross, 2004). By integrating theories of strong/weak social ties with the IS literature, our study extends the prior social tie research by addressing the ability of IT as a medium to afford more diverse and trusted social ties than the F2F medium. We find that IT-mediated ties are simultaneously more heterogeneous and more trustworthy<sup>††</sup> than F2F ties. In doing so, we also respond to the call for disaggregation of tie strength (in terms of F2F and IT), to calls for more fine-grained analysis (Fulk & Boyd, 1991), and calls for using multitheoretical perspectives (the theories of social ties and the KMS literature) in social network research (eg, Contractor, Wasserman, & Faust, 2006; Fulk & Boyd, 1991).

Our study also contributes to the social network literature by addressing a conundrum implied in the literature. On the one hand, employees share knowledge with those whom they trust, an act witnessed among people with strong social ties, but the strong social ties of a focal individual are less heterogeneous, and therefore, it is difficult to obtain unique information. On the other hand, employees receive unique information from heterogeneous sources that are generally present in weak social ties, but weak ties may lack the necessary trust to motivate knowledge sharing. This *knowledge sharing conundrum* highlights 2 seemingly mutually exclusive prerequisites of knowledge sharing through social ties: trust, which is present in strong ties rather than weak ties (Levin & Cross, 2004), and heterogeneity, which is present in weak ties rather than strong ties (Perry-Smith, 2006). Prior research partly addressed this conundrum by proposing the notion of “trusted weak ties,” which suggests that certain weak ties could

<sup>††</sup>We focus here on competence-based trust, consistent with our analysis.

exhibit an above-average level of trust, thus yielding the most useful knowledge compared with other weak ties (Levin & Cross, 2004). Our study offers an alternative perspective. On the basis of our finding that IT-mediated strong ties formed through online socializing are the most beneficial among the 4 types of social ties, we are able to introduce the theory of “heterogeneous frequent IT-mediated ties” in the context of IT social interactions. In our study, 30% of IT-mediated socializing ties were classified as strong ties,<sup>55</sup> having frequency of at least several times per week. Heterogeneous frequent IT-mediated ties are most beneficial for the sharing of unique and useful knowledge, due to the additive effects of competence-based trust and background heterogeneity embedded within them. With this finding, we also respond to the call for continuous integration of the relational (ie, trust) and structural (ie, background heterogeneity) aspects of social networks (Levin & Cross, 2004).

Finally, we feel that our work holds significance for practitioners. Our findings suggest that firms should be attentive to IT-mediated social interactions, a practice often banned in organizations that lock down access to social media sites and create email use policies to prevent what they anticipate as productivity losses because of nonwork-related communication. In actuality, organizations that attach great importance to knowledge sharing among employees could benefit from making a variety of IT tools available for social interactions and resisting instituting policies to completely block IT-enabled socializing, since social connections initiated and maintained through IT are particularly useful for sharing knowledge that may not be easily found in documented sources. Tools that can be used to support social interactions could include not only most commonly used technologies in organizational context, such as email, but also other tools such as instant messengers and short message services. Furthermore, emerging Web 2.0 technologies, such as SNS, Twitter, and wikis, could also be deployed as they could support social interaction among employees, regardless of geographical, temporal, and departmental boundaries. Employees, too, should recognize the opportunity to leverage available IT tools to develop and maintain social ties in the organization, because of the superior effect of IT-mediated social interactions on sharing knowledge. Our study further suggests that practitioners should focus on developing IT-mediated strong ties, because these ties are most helpful for sharing unique and useful knowledge.

## 6.2 | Limitations and future research

Our study has several limitations, which we discuss in the context of the opportunities they represent for future research. First, by confining an employee's social network within the organizational boundary, we may have missed social ties outside the organization that are also important for knowledge sharing (Perry-Smith & Shalley, 2003). However, our choice of the organizational boundary is consistent with the focus of our study on knowledge sharing among employees within the organization. We leave the role of IT-mediated ties outside the organizational boundary for future research.

Second, given the relative youth of the workforce in our empirical context, we realize there may be some limitations to the generalizability of our findings for organizations with older employees. In contrast to older generations, digital natives, represented by most employees in Innosoft, have grown up in the midst of rapid advancement and penetration of IT applications. This new generation of workers' familiarity and rich experience with IT applications make them inherently suited to working and socializing using IT-based media (Wang & Haggerty, 2009). However, this specific empirical context also opens up interesting considerations with respect to social ties, IT use, and knowledge sharing among the “millennial” workers, who will be a significant portion of the workforce in most enterprises in the future, just as they are in Innosoft today. As the demography of organizations shifts to include increasingly higher proportions of millennial employees, IT-mediated ties, involving a repertoire of information and communication technologies, may increase in significance, playing a more important role in facilitating a wider array of dyadic behaviours. Future research could focus on understanding the role of IT-mediated ties in other important outcomes, such as in the creation of social capital (Tsai & Ghoshal, 1998). It would also be interesting to better understand and then design emerging technologies helpful for creating IT-mediated social ties, such as the organizational adoption of

<sup>55</sup>There were 1277 ICT-mediated strong ties, compared with 3010 weak ICT ties, 856 strong and, 991 weak F2F ties.



SNS. The theoretical arguments and results presented in this research represent a modest but important step in that direction.

### 6.3 | Concluding thoughts

Our study represents an integrative attempt to understand how the intersection of medium type (F2F vs IT-mediated) and interaction-type socializing between members of a dyad affects their mutual knowledge sharing by incorporating knowledge sharing, social network, and IS literatures. The results show that IT-mediated social interactions are more beneficial for interpersonal knowledge sharing since they simultaneously afford stronger competence-based trust and higher background heterogeneity between the members of a dyad, something that is more difficult to achieve with F2F interactions. Furthermore, our study establishes that frequent IT-mediated social interactions are most beneficial for interpersonal knowledge sharing. In theorizing and empirically testing our research hypotheses, this study extends the knowledge sharing, KMS, and social network literatures in meaningful ways. On the basis of our findings, we suggest opportunities for practice that will help improve knowledge sharing among both collocated and distributed employees in contemporary organizations where both F2F and IT-mediated interactions prevail.

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