The Rich Get Richer: Enabling Conditions for Knowledge Use in Organizational Work Teams

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Abstract

Individuals benefit from accessing others’ expertise, known as knowledge sourcing. Previous research has theorized supply-side explanations (e.g., availability of knowledge) and demand-side explanations (e.g., a challenging task) for why people source knowledge, but thus far the influence of information processing – how people interpret and synthesize information – on knowledge sourcing has received little attention. In this paper, we introduce an information processing perspective on knowledge sourcing by theorizing how knowledge sourcing is enabled by conditions known to influence individual and group information processing. We develop a multi-level model to examine knowledge sourcing from an electronic knowledge repository (KR) and find that when individuals have strong information processing capabilities – stemming from experiential knowledge-bases like work experience or experience with the organizational context – they engage in more frequent KR sourcing. Also, when individuals are embedded in teams with strong social information processing capabilities, such as teams with experience working together, they engage in more KR sourcing. The multi-level perspective is critical: we also find that team experience moderates the relationship between individual experience and KR sourcing. Our paper advances theory on knowledge management and offers insight for supporting team performance.

Key Words: Information Processing, Knowledge Management, Knowledge Sourcing, Multilevel Theory, Team Performance

1. Introduction

When organizational success and performance depend crucially on how knowledge is created and used (Argote & Ingram, 2000; Spender, 1996), a globally distributed workforce faces particular challenges. Such a workforce may be distributed across locations, lacking ready access to knowledgeable colleagues (Bell & Zaheer, 2007; Cramton, 2001; Cummings, Espinosa, & Pickering, 2009). Moreover, a global workforce often draws on individuals in developing markets who are relatively earlier in their careers and have less personal experience from which to draw upon in their daily work (Levenson, 2012; Ready, Hill, & Conger, 2008). An electronic knowledge repository (KR) offers a practical solution to the challenges of making knowledge available to people who might otherwise lack access to relevant expertise (Davenport & Prusak, 1998; Stein & Zwass, 1995). A well-designed KR that is constantly available across time zones and continents can help individuals gain access to knowledge they would otherwise lack. However, the presence of a knowledge repository will not solve the problem of access to knowledge unless it is used.
Retrieving knowledge from a KR is a form of knowledge sourcing – accessing the knowledge and expertise of other organizational members (Gray & Meister, 2004). Knowledge sourcing is conceptualized as a demand-side theory of knowledge management and was developed as a counterpoint to the many existing supply-side theories of knowledge management, which focus on how to increase the volume and accessibility of knowledge available within the organization (Alavi & Leidner, 2001; Davenport & Prusak, 1998; Hansen, Nohria, & Tierney, 1999). This demand-side theory of knowledge management argues that individual traits (such as learning orientation) and task demands (such as the complexity of the task) predict why certain people are more likely to source knowledge than others. Although valuable, both the supply- and demand-side theories of knowledge management offer an incomplete view of knowledge use in organizations. In particular, each perspective underplays the critical role of information processing in knowledge management. Information processing refers to the gathering, interpreting, and synthesis of information in the context of decision making in organizations (Tushman & Nadler, 1978). We argue that not only must knowledge be available (supply-side) and there be a need for knowledge (demand-side), individuals must also be able to effectively interpret and synthesize task-based and social information to source knowledge. In this paper, we focus our attention on knowledge sourcing from a KR because such repositories are widely used to support knowledge sourcing in organizations (Davenport & Prusak, 1998; Murphy & Hackbush, 2007).

An information processing perspective provides an additional lens for understanding knowledge sourcing, and in so doing leads to different predictions than prior theories. For example, a demand-side perspective would suggest that those individuals who are most in need of knowledge – such as individuals with the least work experience – are most likely to source knowledge. In contrast, an information processing perspective suggests that the process may be more complex. Studies of channel expansion theory (CET) have shown that individuals with more experience (referred to in CET as experiential knowledge-bases) are better able to interpret and synthesize information from information and technology systems (Carlson & Zmud, 1999). Experienced individuals therefore expect more value from using such information technologies, and this expectation is likely to motivate more use. Extending this theory, we
reason that individuals expected to have the least demand for others’ knowledge, like those with significant work experience, are likely those who have greater information processing capabilities, which may enable and motivate KR sourcing. Therefore, individuals with greater experiential knowledge bases may engage in more KR sourcing, not less.

An information processing perspective considers not only individuals, but also groups to be information processing units (Hinsz, Tindale, & Vollrath, 1997). We therefore also examine how conditions that influence group-level information processing may affect knowledge sourcing. A demand-side perspective would predict that individuals in groups with characteristics that complicate group information processing (like lack of interpersonal familiarity) might have a greater need for external knowledge and therefore be most likely to source knowledge from a KR. In contrast, an information processing perspective would predict that teams with greater familiarity would be better able to interpret both their work problems and the knowledge in the KR, and would therefore be more likely to use the KR system because they could derive more value from use. We therefore theorize individual, group, and also cross-level effects of information processing capabilities on knowledge use in organizational work teams.

We develop this perspective using a multi-level model that conceptualizes KR sourcing as an individual-level behavior occurring in the context of a team information processing system (Burton-Jones & Gallivan, 2007; Kane & Alavi, 2008). We obtained archival data on KR sourcing at Wipro Technologies, a global, outsourced provider of software services. Repository use was tracked for over 9,000 individuals in more than 300 software project development teams on a per-click basis. We linked these empirical data with other Wipro databases for software development projects completed during 2008 and 2009. Our results show that despite the potentially higher need and demand for knowledge among inexperienced and off-site individuals, in fact, experienced individuals and on-site individuals use the KR more, consistent with an information processing perspective. Relatedly, teams with little experience working together may also seem to have higher need, but in fact individuals working on familiar teams use the KR more. By introducing an information processing perspective we gain a fuller understanding of when individuals source knowledge within an organization.
2. Information Processing, Experiential Knowledge and Knowledge Sourcing

The term “information processing” originated in communications research and was adapted by organizational theorists to describe organizational and group processes for identifying, analyzing, interpreting and synthesizing information (Driver & Streufert, 1969; Galbraith, 1974; Hinsz et al., 1997; Shannon & Weaver, 1971; Tushman & Nadler, 1978). Subsequent research in organizational theory, psychology, and human development identified variation in information processing capabilities between firms (e.g., Bensaou & Venkatraman, 1995), groups (e.g., Greening & Johnson, 1996), and individuals (e.g., Domsch, Lohaus, & Thomas, 2009; Hsu, Chen, & Cheng, 2013; Rice, 1992). Research in human development has demonstrated ways in which information processing capabilities are innate (e.g., Domsch et al., 2009; Weiler, Bernstein, Bellinger, & Waber, 2002), but research on organizations has focused more on identifying conditions under which information processing capabilities are supported or improved. For example, the broad literature on absorptive capacity recognizes differences in firms’ and individuals’ abilities to “recognize the value of new information, assimilate it, and apply it” (Cohen & Levinthal, 1990) and has shown that absorptive capacity is stronger under various conditions, such as strong socialization (Jansen, Van den Bosch, & Volberda, 2005), strong relationships and social cohesion (Reagans & McEvily, 2003), and greater prior knowledge (Kim, 1998; Zahra & George, 2002).

We build on this research to develop an information processing perspective on knowledge sourcing. People seek others’ knowledge and expertise for many reasons. They may have a learning orientation that disposes them toward seeking knowledge or they may be motivated by a need for knowledge because their task demands are greater than their personal expertise (Gray & Meister, 2004). We argue that individuals’ and groups’ information processing capabilities also strongly influence whether and how they source knowledge, and we identify conditions under which these capabilities may be strengthened or supported. We focus on conditions that build experiential knowledge and thereby enable effective information processing in individuals and groups.

We develop hypotheses for three experiential knowledge-bases (based on channel expansion
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theory, see Carlson and Zmud (1999)) that improve information processing – work experience, experience with teammates, and experience with the organizational context – and argue that people working under each of these conditions will make more use of a KR than their more “experience poor” counterparts. Specifically, we argue that the expectation of deriving value from KR sourcing will motivate frequent use among certain individuals and groups who have strong information processing capabilities (Bock, Sabherwal, & Qian, 2008; Fishbein & Ajzen, 1975; Vroom, 1964; Watson & Hewett, 2006). In contrast, those with weaker information processing abilities may be intimidated by the knowledge sourcing process. Even though a KR provides knowledge access in the sense that anyone can make use of the KR whenever they want, this shallow access does not guarantee that useful knowledge will be anticipated, identified or understood. We consider how individual KR sourcing is affected when an individual has more of each knowledge-base, when the individual’s team has more of each knowledge-base, and also when the individual has high experience relative to his or her teammates.

2.1 Work Experience – Individual, Team, and Relative

Consistent with CET, we first consider work experience as a source of experiential knowledge (Carlson & Zmud, 1999). Individuals learn as they perform their work tasks, and thereby gain work experience (Argote, 1993; Argote & Miron-Spektor, 2010). Work experience can be measured in terms of the cumulative number of task performances (Boh, Slaughter, & Espinosa, 2007; Reagans, Argote, & Brooks, 2005) or when appropriate, in terms of organizational tenure as a proxy for number of task performances (Gardner, Gino, & Staats, 2012). Performance typically improves with experience, because experience helps individuals understand their tasks better, understand relationships between variables related to the task more clearly, and better adapt existing knowledge to new and different tasks (Bohn, 2005; Dutton & Thomas, 1984; Huber, 1991). Each of these mechanisms suggest that as individuals gain experience, they become more sophisticated and skilled at interpreting and synthesizing organizational information that is both closely and distantly related to their tasks.

We argue that these capabilities will support expectations of efficacious sourcing, thereby motivating the behavior. KR sourcing is most effective when prompted by a well-developed question
about how to do something specific (Markus, 2001). Inexperienced individuals may be struggling with questions like “What does this mean?” or “How does this relate to that?” and not know how to pose a specific question in the technical language of the organization (Gray & Durcikova, 2005). In contrast, individuals with more experience may have a greater appreciation of the valuable knowledge stored in a KR and be more likely to use it; work experience increases individuals’ perceptions of the richness or usefulness of communication channels (Carlson & Zmud, 1999).

It is worth noting that a strong experiential knowledge-base from work tenure might inhibit knowledge-sourcing, if experienced individuals adopt a “not-invented-here” attitude toward others’ expertise and rely primarily on their own experience to solve work problems (Katz & Allen, 1982). However, based on the above research suggesting that work experience enables information processing capabilities and that such capabilities support expectations of effective sourcing, we hypothesize that:

HYPOTHESIS 1a: Individuals with more work experience will use the KR more than individuals with less work experience.

Teams and groups have also been conceptualized as information processing units (Hinsz et al., 1997), and in this paper we investigate how group information processing is likely to influence the sourcing behavior of individuals embedded in teams (Burton-Jones & Gallivan, 2007). This requires a multi-level model of hypothesized effects on individual behavior. Moving from the individual to group level of theory requires careful consideration about how individual level effects are to be aggregated (Kozlowski & Klein, 2000). Specifically, as individual characteristics are gathered in a social collective, effects of the characteristics might be simply additive, or may be enhanced or muted by the group context and group dynamics (Harrison & Klein, 2007; Klein, Conn, Smith, & Sorra, 2001). We argue that work experience influences group information processing in both additive and moderating ways.

First, team work experience can be seen as an additive rendering of individual work experience. Every individual has their own accumulated work experience and related information processing capabilities, and these capabilities can in some respects be summed across the team. A team of highly experienced individuals simply has a larger store of experience and knowledge to draw on as they work
together (Gardner et al., 2012; Wageman, 2005), with the result that in the absence of process loss and conflict, more experienced teams will have greater information processing abilities (Hinsz et al., 1997; Steiner, 1972). Therefore, individuals on experienced teams may have direct intellectual support for KR sourcing; they may participate in or be exposed to expert discussions that help define and articulate specific problems; and they may also be better supported in applying information obtained from the KR, thus having a greater motivation for use because of this expected and achieved value (Bock, Kankanhalli, & Sharma, 2006; Watson & Hewett, 2006). We argue that the superior information processing capabilities of experienced work teams will support average team members in sourcing from the KR, and thus hypothesize that:

**HYPOTHESIS 1b:** Individuals on teams with more work experience will use the KR more than individuals on teams with less work experience.

Team experience may also moderate the relationship between individual work experience and KR sourcing. Experienced individuals working on experienced teams enjoy the benefit of their own strong information processing capabilities and are also part of a work unit that similarly has strong information processing capabilities. Taken together, individual and team work experience may support greater information processing capabilities than either alone, because those with more knowledge are better able to benefit from others’ knowledge (Cohen & Levinthal, 1990). With more work experience, an individual is able to identify valuable information stored within more experienced teams, and may also be able to synthesize and utilize the information more effectively than inexperienced individuals (Clark, Huckman, & Staats, 2013; Zahra & George, 2002). More experienced individuals may be better able to learn when working on more experienced teams because learning and innovation result from new combinations of existing knowledge, which more experienced teams have in greater supply (Fleming & Sorenson, 2004). This complementarity between individual work experience and overall team work experience strengthens information processing capabilities, which may motivate and support KR sourcing. Experienced individuals on experienced teams can ask more specific and technical questions, can more easily identify valuable knowledge in the KR, and can more confidently retrieve and apply knowledge sourced from the
KR when they are working with experienced team mates. As such we hypothesize:

HYPOTHESIS 1c: *Team work experience moderates individual use, such that individuals with more work experience use the KR even more on teams with more work experience.*

The moderating effect of team experience on individual information processing may arise not only from average experience within the team, but also from the configuration of the experience within the team. Distribution of work experience is a configural team property, which must be considered when moving from an individual to group level of theorizing (Harrison & Klein, 2007; Salancik & Pfeffer, 1978). When team experience is distributed unevenly across the team then two different social dynamics are likely to occur, both of which predict that experienced people will use a KR even more, and that inexperienced people will use it even less. The first is that the experienced individuals may take on the role of a gatekeeper for the team (Tushman & Katz, 1980a), assuming the majority of the KR sourcing on behalf of inexperienced coworkers. This kind of specialization may be an efficient team strategy because those who are most skilled at KR sourcing can specialize in KR sourcing and do it on behalf of the team (Lewis & Herndon, 2011).

A second and related social dynamic relates to the status implications of the disparity. Disparities of experience within a team can complicate team knowledge sharing processes (Bunderson & Reagans, 2011). Lower ranking team members may avoid behaviors that might seem too proactive (Keltner, Gruenfeld, & Anderson, 2003) because they may not feel that they have permission to seek resources for themselves or for the team. Lower status team members may be distracted by the dynamics of the hierarchy, whereas experienced and higher status team members can focus on organizational goals and can engage in more goal-directed work (Guinote, 2007; Overbeck & Park, 2006; Smith, Jostmann, Galinsky, & van Dijk, 2008). A high-status person might recognize a knowledge gap and feel empowered to immediately search for the answer, whereas an inexperienced person might be concerned about overstepping. The resulting pattern would be high levels of KR sourcing for experienced
individuals, and low levels of use for inexperienced team members, when disparity of team experience is high. To capture these moderation dynamics, we hypothesize that:

**HYPOTHESIS 1d**: Disparity of team experience moderates individual use, such that individuals with more work experience use the KR even more when disparity of experience is high, and individuals with less work experience use even less.

### 2.2 Interpersonal Experience – Individual, Team, and Relative

A second source of experiential knowledge recognized in CET is experience with communication partners, which is theorized to increase expectations of efficacious use of an information channel (Carlson & Zmud, 1999). We extend this theory to argue that team experience working together (sometimes called team familiarity (Huckman, Staats, & Upton, 2009; Reagans et al., 2005)) will support more KR sourcing by any focal team member. Experience working together establishes trust, shared mental models and shared language (Alge, Wiethoff, & Klein, 2003; Hofmann, Lei, & Grant, 2009; Huber & Lewis, 2011; Salas, Cooke, & Rosen, 2008). Experience working together also supports information sharing, and effective coordination (Lewis, Lange, & Gillis, 2005). Teams with experience working together are more likely to have a shared understanding of task requirements (Balkundi & Harrison, 2006; Staats, 2012). Familiar teams are also more likely to know who knows what within the team and use this knowledge to coordinate their activities (Gino, Argote, Miron-Spektor, & Todorova, 2010; Lewis et al., 2005; Wegner, 1987). All of these characteristics of teams that are experienced working together can support effective group information processing, which will enable the critical processes of articulating specific work problems and anticipating and identifying useful information from KR sourcing. Teams with interpersonal experience together can help their team members to derive value from the KR.

We do not hypothesize an individual effect of interpersonal experience (i.e., a focal individual’s interpersonal experience with teammates, holding the overall team familiarity constant) because of previous research that has shown social cohesion not individual dyadic ties increases “the willingness and motivation of individuals to invest time, energy, and effort in sharing knowledge with others” (Reagans &
McEvily, 2003, pg. 240). We suggest, therefore, that team-level interpersonal experience may create a supportive social system unmatched by individual ties, and that this social system will support group information processing that supports individual team members in sourcing from the KR. In the absence of the group-level cohesion, individual ties may not provide the kind of social support that supports information processing. Relatedly, because we do not hypothesize an individual benefit to interpersonal experience with teammates, we do not hypothesize a cross-level effect.\(^1\)

**HYPOTHESIS 2:** *Individuals on teams that have more interpersonal experience working together use the KR more than individuals on teams that have less interpersonal experience together.*

### 2.3 Organizational Contextual Experience – Individual, Team, and Relative

A third source of experiential knowledge recognized in CET is experience with organizational context (Carlson & Zmud, 1999). Experience with the organizational context supports expectations of effective information flow by enabling people to encode and interpret rich information, using, for example, shared symbols or cultural references. This particular experiential knowledge-base is especially relevant for work teams that have globally distributed membership, such that some team members are located at client sites or peripheral offices, and others are located in the central organizational offices (O'Leary & Cummings, 2007).

We draw from CET and research on distributed work teams to argue that the contextual experience that comes from being located in the core organizational offices will support KR sourcing. Those located in the client sites or peripheral offices may be expected to have greater need for knowledge about best practices and useful ways to solve problems because they lack personal access to a large pool of knowledge exchange partners (O'Leary & Mortensen, 2010). In contrast, individuals located in the main offices may have a richer understanding of the expertise and the nature of the work in the firm, such as clients, industries, and technologies served, which may help them understand what is done and what is

\(^{1}\) Although we do not theorize an effect, for robustness we test our models both with and without the additional team familiarity terms (individual team familiarity and the interaction of individual and team) and we generate the same pattern of results.
known in the organization (Orlikowski, 2002). They tacitly experience the scope of their organization (see for example Mortensen & Neeley, 2012). They also have more non-project interactions in hallways and social spaces (Festinger, Schachter, & Back, 1963; Kiesler & Cummings, 2002) and such face-to-face interactions with a variety of colleagues enables discussions about new ways to solve or think about problems (Cramton, 2001). We argue that individuals with direct experience with the organizational context are more likely to be fluent in both the technical and the social language of the organization (Carlson & Zmud, 1999; Gray & Durcikova, 2005), which will aid them in articulating specific questions, structuring queries, and applying retrieved knowledge. There may therefore be less a sense of needing to create knowledge or solutions from scratch. This tacit understanding of the scope of knowledge in the organization and fluency in the language of the organization will support information processing and expectations of useful KR sourcing. We thus hypothesize:

HYPOTHESIS 3a: Individuals with experience with the organizational context (because of their location) will use the KR more than individuals who are at client locations.

Team location also may influence individual KR sourcing. Centrally located teams – where the majority of team members are at the core office – may have a critical mass of people with fluency in the technical and social languages of the organization (Gray & Durcikova, 2005) and this may increase awareness of the potential value of the KR. This proposed relationship is an additive rendering of the information processing capabilities of team members at the core offices (Klein et al., 2000), but also reflects that there may be more group cohesion around KR norms among the more centrally located teams (Bock et al., 2006; Kahn & McDonough, 1997). Together, centrally located team members have a better understanding of the scope and expertise in the organization, and how their specific information needs relate to existing organizational knowledge, like in the KR. Through either direct influence (e.g., telling a teammate to look at a certain knowledge artifact in the system) or through indirect influence (e.g., telling a teammate about value found in the system) centrally located team members may spread the norm of KR sourcing (Bock et al., 2006), even to distant team members. Altogether this means that teams with a
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collection of team members in the center of the organization (i.e., with greater contextual experience) will have information process capability which will lead to more individual KR sourcing. Thus, we hypothesize that

HYPOTHESIS 3b:  Individuals on teams where more members are at the core office will use the KR more than individuals on teams where more members are at client sites or peripheral offices.

Finally, as in the case with work experience, individual and team contextual experience may have a complementary effect on individual knowledge sourcing. The motivation for Hypotheses 3a and 3b suggests that individual and team contextual experience may aid in the development of individual and team information processing related to KR sourcing. Although each effect may occur on its own, the combination of the two may be important as well. When an individual is centrally located and therefore has greater contextual experience, she may be more likely to recognize and utilize related contextual knowledge within her team (Cohen & Levinthal, 1990). For example, an individual’s team may know more about the scope of the firms’ expertise if they are centrally located, and if the individual is also centrally located, she may be better able to draw on her team’s experience. Thus, with greater information processing capability developed through contextual experience, an individual may be better able to benefit from the team’s information processing capability. Therefore, we hypothesize:

HYPOTHESIS 3c:  Team location moderates individual use, so that individuals who are located in the core office use the KR even more on teams located primarily at client sites, and individuals who are at client sites use less.

3. Setting and Data

3.1 Setting

We test our hypotheses in the setting of Wipro Technologies, a company operating in the software services industry. Wipro delivers software system development projects to a global customer base. Software development projects involve implementing new software programs within existing firms
by establishing customer requirements, creating adapted solutions for these specific requirements, writing
the software code to create the solution and then testing the final product (Boehm, 1981). Team members
rely on access to knowledge to successfully complete their projects (Faraj & Sproull, 2000; Huckman et
al., 2009), making this an ideal setting for investigating our hypotheses.

We received data from Wipro on all software development projects that occurred in 2008 and
2009. This time period was marked by significant competition from other software services firms (e.g.,
Accenture, IBM, TCS and Infosys) and Wipro senior management felt that their continued success
depended on delivering projects both efficiently and effectively. To accomplish these goals, management
focused on capturing and providing access to previously generated organizational knowledge. The
company had established a knowledge management initiative many years before, but in 2007 Wipro
launched a new effort to enhance this initiative and invested substantial time and financial resources.
Wipro enhanced the interface used for knowledge management (called KNet) and implemented analytic
technology to enable the tracking of person-level use of the KR.

All employees could download content from the KR, and were also encouraged to submit content.
Submitted content was solicited and evaluated by a knowledge management team in order to maintain the
intended quality standards of the system (the team functioned like the knowledge intermediaries described
by Markus (2001)). Wipro did not dictate a specific policy on KR sourcing during the study period and all
employees (both on and off-site) received similar messaging about the system by email. The KNet portal
resided on the Wipro intranet and was accessible by all employees. After reaching the KNet page
employees saw links to knowledge on different topics (e.g., Java, .Net, or SAP), as well as a box to enter
search terms. By entering keywords or phrases an employee could source knowledge related to their
particular query. The content of the KR included a limited amount of reusable software, but mainly
consisted of documents detailing how the author of the document accomplished a specific task. For
example, one knowledge artifact explained how an individual implemented mechanisms to lock a
database in Sybase (Sybase provides database software and locking the database prevents different
individuals from simultaneously entering data which creates a conflict). Another artifact provided an
overview of how to use $AVRS (a tool that allows a system administrator to quickly examine system information online). The knowledge artifacts within Wipro’s system are specific to Wipro’s context and work processes, the general process of knowledge sourcing that takes place through KNet is generalizable to many other organizations and Wipro’s approach to knowledge management resembles that of many other organizations (Davenport & Prusak, 1998; Hansen et al., 1999).

3.2 Data

Archival data captured individual KR sourcing and information about individual and team characteristics. The KR data captured how many unique downloads each individual completed on a given day between January 1, 2008 and December 31, 2009. Wipro did not record an identifier for the knowledge artifact viewed so the specific content viewed is not known. We matched the above data with demographic data on the 13,470 individuals that worked on software development team projects (discussed more below). Our final dataset included information on the 481 software development projects that were started and completed during the study period, meaning we had comprehensive KR sourcing data for the entirety of each project’s lifetime. Table 1 provides summary statistics for study variables.

3.2.1 Dependent Variable.

**Individual KR Sourcing.** The first outcome variable, *individual KR sourcing*, was calculated as 
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\log(\sum_{n}^{\text{unique}_n}),
\]
where unique equaled the total number of unique knowledge artifacts accessed during a day and n denoted each day during the duration of the project.

3.2.2 Independent Variables.

**Individual Experience and Team Experience.** Consistent with prior literature examining human capital (Hitt, Bierman, Uhlenbruck, & Shimizu, 2006; Huckman & Pisano, 2006) we measured experience using an individual’s firm-specific experience. We constructed a variable, *individual experience*, which captured the number of years an individual worked at Wipro prior to the start of the project. We assessed *team experience* by averaging the individual experience variable across all members on the team. We include both variables in the model, as well as the interaction of the two in order to test our hypotheses.

**Distribution of Team Experience.** To examine the configuration of experience on a team we created a
variable, *distribution of experience*, which uses the Herfindahl index to measure the concentration of firm experience within the team (Harrison & Klein, 2007). We calculated this measure by dividing each team member’s individual firm experience by the total firm experience for the entire team, squaring the individual value, and then summing these values across the entire team. Thus, a larger number is related to more concentrated experience and a smaller number is related to more distributed experience. We then added the interaction of individual experience and distribution of team experience to test our hypothesis.

**Team Familiarity.** Project team members typically worked on one project at any given time and each team member was reassigned to new projects when the original project was completed. Team members also had different amounts of firm tenure. These dynamics created variability in the prior interactions between team members. Our team familiarity measure is consistent with prior work (Espinosa, Slaughter, Kraut, & Herbsleb, 2007; Huckman et al., 2009; Reagans et al., 2005). We summed the count of the number of projects that each unique dyad on the team completed together during the previous three years. Using a window of three years accounted for the potential decay of knowledge over time (e.g., Argote, Beckman, & Epple, 1990). The average project lasted for about seven months, so a three-year window also matches the empirical context, and allowed us to include multiple cycles of projects. We then divided the sum by the total unique dyads within the team to generate our variable, *team familiarity* (Reagans et al. 2005). We also measure an individual’s *team familiarity* by counting the number of projects that an individual completed with every other team member, during the previous three years, and then divided by the number of team members minus one to scale the variable. We include team familiarity in the model to test our hypothesis. We also include the individual variable, as well as the interaction term, in order to check for the robustness of our results.

**Individual Contextual Experience.** Wipro is an Indian organization, with its headquarters in India and the majority of its workers in India. Within the organization, and the Indian software services industry in general, workers are described as being offshore (in India) or onsite (at customer locations). Although offices are located in different cities within India, each typically has hundreds, if not thousands of workers located within a campus. Therefore we create a variable, *individual contextual experience*, which is equal
to one if an individual is located in an Indian facility, and is zero otherwise.

**Team Contextual Experience.** We measured the contextual experience of the team by calculating the percentage of hours that were completed by the team at the Indian facilities and dividing this value by the total number of hours worked by the team. Repeating the analyses with a variable calculated using the number of team members in each location, instead of the hours, generates the same pattern of results as those we report. In addition to the main effects for location, we also include the interaction term of these two variables in order to test for moderation.

### 3.2.3 Control Variables.

We controlled for individual and team variables that may have affected individual knowledge sourcing.

**Gender and Hierarchical Role.** Prior work showed that individuals’ gender and/or hierarchical role within a team affected knowledge search and transfer choices (Katz & Kahn, 1966; Singh, Hansen, & Podolny, 2010; Staats, 2012). Therefore, we constructed indicators for each. First, we constructed an indicator, *female*, which equaled one if the individual was female and zero otherwise. Second, the hierarchical roles within a team were project manager (the leader of the project), middle manager (an individual who managed a sub-team within the project and also wrote code) and project engineer. We created indicators for *project manager* and *middle manager*, which equaled one if an individual held the respective title and zero otherwise.

**Project Complexity.** We controlled for the complexity of the project because more complex projects may have had greater knowledge needs and resulted in more use of a knowledge repository (Gray & Meister, 2004). We captured project complexity by creating a composite measure consisting of: (1) the log of the kilolines of new source code (KLOC) written (MacCormack, Verganti, & Iansiti, 2001); (2) the log of the estimated total person-hours; (3) the log of the estimated total days (we used the estimate in each of these latter two cases because a project that exceeded its effort budget or delivery target would have larger actual values than a project that successfully delivered by its estimates). To construct the composite measure, we conducted a principal components analysis and all three variables load with positive values on the first component (0.41, 0.65, 0.64, respectively). The eigenvalue of the first component is 1.82 and
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it explains 61% of the variance. Inserting each variable individually generates the same pattern of results for the hypotheses as we report.

**Colocated Team Members.** We measured the colocation of the team by counting the number of team members at the same location as the focal individual (*colocated team members*). Our contacts at the organization noted that software engineers in the same location were usually located on the same floor in the same building.

**Contract Type.** Wipro used either a fixed-price contract structure or a time-and-materials contract structure for its development projects. In the former, the payment was agreed prior to the start of the project, while in the latter Wipro received a pre-specified rate for the hours that they worked on the project. Given the role of incentives in individual and team performance we controlled for contract type. We included an indicator variable in our models that was set to one if the project was fixed price and was zero for time-and-materials.

**Software languages: number and type.** Different software languages may have different knowledge demands leading to different patterns of KR sourcing. Similarly, projects with multiple software languages (53% of projects) may have greater knowledge demands and lead to greater KR sourcing. We controlled for the former by including indicator variables for the different languages used (C, C++, Java, query, markup, BASIC). We controlled for the latter with an indicator equal to one if a project had more than one software language and zero otherwise.

**Technologies.** Projects that used multiple classes of technologies (e.g., client server, e-commerce) could lead to more KR sourcing. Thus, we created an indicator that equals one if a project had more than one technology (10% of projects) and was zero otherwise (90% of projects).

**4. Analyses and Results**

Our study contains data at three levels, the individual, the team project, and the customer account. That is, individuals were nested in projects (teams), and projects were nested in customer accounts. We include the nesting of projects within customer accounts because most Indian software service providers,
including Wipro, organize their customer facing operations into offshore development centers. These centers provide focused resources that serve a given customer. Although individuals may move between customers, over time, they typically execute multiple projects for a given customer, prior to moving on. We note that if we drop the nesting of projects within customers then we see the same pattern of results for our hypotheses.

We tested our hypotheses by constructing a multi-level model where we first estimated separate random intercepts at: (1) the customer account-level and (2) the project-level. We then estimated a multi-level model with random coefficients estimated for the independent variables: (1) the customer account-level – Team Experience, Distribution of Team Experience, Team Familiarity, Team Contextual Experience; and (2) the project-level – Individual Experience, Individual Team Familiarity, Individual Contextual Experience. Finally, we added the interaction terms to this model. All independent variables were centered and all regressions are estimated with a multi-level, mixed effects linear regression model, using maximum likelihood estimation (Stata command: xtmixed).

Table 2 reports the results from our regression analysis. Column 1 shows the model without the independent variables. Consistent with prior findings in the knowledge sourcing literature (Gray & Meister, 2004) we find that individuals executing more demanding work (as captured by the complexity of the project) are more likely to source knowledge ($\beta_{\text{Project Complexity}} = 0.0743, p<0.01$). In Column 2, we add the independent variables to the model and estimate the model with random-intercepts at the customer- and project-levels. In Column 3, we repeat the analysis by estimating random-coefficients for the independent variables, as noted above. A Likelihood-ratio test indicates that the deviance is significantly reduced ($p<0.001$) and so we use the random-coefficients model.

Hypothesis 1a predicted that individual experience would be positively associated with KR sourcing, and we find support for this hypothesis: the coefficient on individual experience is positive and significant (Column 3, $\beta_{\text{Individual Experience}} = 0.0351, p<0.001$). A one standard deviation increase in individual experience is related to 8.3% more use than the average amount of KR sourcing. Contrary to what we predicted in Hypothesis 1b, team experience is not positively associated with KR sourcing ($\beta_{\text{Team Experience}}$...
Experience = -0.0032, p=0.83). Next, we find that the coefficient for team familiarity is both positive and statistically significant ($\beta_{Team\ Familiarity} = 0.2462$, $p<0.001$), providing support for Hypothesis 2. A one standard deviation increase in team familiarity is related to a 17.3% increase in individual KR sourcing.

Hypotheses 3a and 3b predicted that individual and team contextual experience would support more KR sourcing. Hypothesis 3a was supported: individuals located in the central offices used the KR more ($\beta_{Individual\ Contextual\ Experience} = 0.2492$, $p<0.001$). An individual in the central location used 24.9% more than an individual not in the central location. We did not find evidence that team contextual experience influenced a focal team members KR sourcing ($\beta_{Team\ Contextual\ Experience} = 0.0284$, $p=0.82$), thus failing to support Hypothesis 3b.

In Column 4, we add the interactions terms to the model. We find support for both Hypotheses 1c and 1d as the coefficients on the interaction between individual experience and team experience ($\beta_{Ind\ Exp \times Team\ Exp} = 0.0109$, $p<0.01$) and the interaction between individual experience and distribution of team experience ($\beta_{Ind\ Exp \times Dist\ of\ Team\ Exp} = 0.1060$, $p<0.05$) are both positive and statistically significant. These results indicate that additive and configural team experience (Harrison & Klein, 2007) moderates an individual’s sourcing behavior based on the individual’s experience. Finally, to test Hypothesis 3c we add the interaction between individual and team contextual experience. Although the coefficient is positive, it is outside of the range of statistical significance ($\beta_{Indvl\ Contextual\ Experience \times Team\ Contextual\ Experience} = 0.2677$, $p=0.10$).

As additional robustness checks, we estimate two other models. First, we drop individual team familiarity and the individual team familiarity x team familiarity interaction term from the model (Column 5). Results are consistent with the previously reported pattern. Second, we estimate a model with all customers who executed more than one project with Wipro during the sample time (330 projects, 9,554 individuals). With multiple projects per customer the random effects can be estimated more precisely. In this model (Column 6), we see the same pattern of results as before, with the one addition that the interaction between individual and team contextual experience is now statistically significant ($\beta_{Indvl\ Contextual\ Experience \times Team\ Contextual\ Experience} = 0.4449$, $p<0.05$).
5. Discussion and Conclusion

Organizations store and encode knowledge so that the same problems do not have to repeatedly be solved from scratch (Grant, 1996; Nickerson & Zenger, 2004). However, this potential value depends critically on organizational members actually drawing on and making use of the knowledge that exists in the organization. In this paper, we examine the conditions under which individuals make use of the knowledge available in a knowledge repository, which is one tool that organizations commonly implement to encourage sourcing of firm knowledge (Davenport & Prusak, 1998).

Prior theories of knowledge use in organizations have focused on two areas. The first approach has focused on supply-side explanations for knowledge sourcing. Research in this area shows that increasing volume and accessibility of knowledge can positively influence knowledge sourcing (Alavi & Leidner, 2001; Davenport & Prusak, 1998; Hansen et al., 1999). A second approach has theorized demand-side explanations for knowledge sourcing. Research in this area has shown that individual characteristics (e.g., learning orientation) and task characteristics (e.g., task demands) positively influence knowledge sourcing (Gray & Meister, 2004). Both approaches offer important insights for knowledge sourcing, but taken alone, they are incomplete because they do not account for the critical role of information processing in knowledge sourcing.

We develop a multi-level model introducing an information-processing perspective on knowledge sourcing, and our empirical results support this perspective. First, we found that experienced individuals are more likely to use the KR than inexperienced individuals. This result is contrary to expectations of a not-invented-here attitude among experienced individuals (Katz & Allen, 1982) and a strictly need-driven theory of KR sourcing. We did not find more KR sourcing among individuals on more experienced teams. Team experience may substitute for KR sourcing in this situation: access to experienced teammates may reduce the need for KR use; or it could be that experienced teams rely on an expert KR user to search the system on behalf of the team, acting as a KR gatekeeper (for an example of teams using gatekeepers, see Tushman & Katz, 1980b).
We also showed two ways that the multi-level relationship between team experience and individual experience play out. First, we find that individual and team work experience have a complementary relationship on knowledge sourcing. Individuals with more work experience on more experienced teams are even more likely to source knowledge. Second, we see that a disparity of experience in the team inhibited KR sourcing of inexperienced teammates. This may reflect a deliberate and functional choice (i.e., KR gatekeepers) or an unspoken status dynamic wherein the low-status person feels inhibited in taking proactive actions. In either situation, the inexperienced people on these teams may not learn to use the system. KRs have been conceptualized as learning tools (Gibson & Vermeulen, 2003) but our results suggest that this opportunity may be under realized in certain types of teams. There may also be performance consequences to the way KR use is configured within teams in the form of a learning and efficiency tradeoff. Gatekeepers may be more efficient, but may also hinder learning. Broad use by system novices may encourage learning, but may be inefficient. Further research is needed to explore how teams adopt these different configurations of KR sourcing and related performance consequences.

Our results show that other experiential knowledge-bases also support more KR sourcing. Individual contextual experience is associated with individual KR sourcing, as is team interpersonal experience. These results suggest that the experiential knowledge-base developed by working at the central location needs to be personally gained, and does not result in contagious use by remote team members. In contrast, interpersonal familiarity is not – of itself – valuable for the focal individual, rather only when the entire team has a higher level of familiarity is individual behavior influenced. This result likely reflects a similar dynamic to the finding that social cohesion – which is about overall network density rather than individual dyadic ties – increases “the willingness and motivation of individuals to invest time, energy, and effort in sharing knowledge with others” (Reagans & McEvily, 2003, pg. 240). Team-level social capital may create a powerfully supportive social system that is unmatched by individual ties. These findings also highlight that KR sourcing is enabled by more than individuals’ technical information processing – experiential knowledge-bases related to effective social information
processing also supported KR sourcing. Taken together, our results provide further evidence of the value of the multilevel model in understanding this phenomenon (Burton-Jones & Gallivan, 2007): both individual and team level factors influence individual behavior.

5.1 Team Effectiveness: Theoretical and Managerial Implications

Our study also provides a critical perspective on team effectiveness for today’s global firms, which increasingly deploy teams with fluid and distributed membership (Hackman & Katz, 2010; Mortensen, 2010). For these teams to be effective, their leaders and managers must learn how to support coordination of work between unfamiliar and virtual teammates. A KR offers a potential plug-and-play technology solution by making knowledge available even to people with limited access to knowledge exchange partners because of their remote location (O’Leary & Mortensen, 2010) or inexperience (Singh et al., 2010). Unfortunately, the KR does not overcome the taxing conditions faced by today’s work teams to reach those with less access to other sources of knowledge. Inexperienced and remote individuals and unfamiliar teams make less use of the organizational resources provided in the KR. Taken alone, this technology solution fails to resolve the challenges facing globally distributed teams.

Our findings present important implications for managers. For one, our pattern of results can be considered in the designing of KM systems or other approaches meant to encourage knowledge sourcing. The standard searchable knowledge intranet may provide less value to inexperienced people, whereas other software designs may make KMs and knowledge sourcing tools easier to use. Further research could explore which design features enable more equitable use. Second, our results can be considered in designing incentive systems or other behavioral approaches to encourage knowledge sourcing. Perhaps managers could provide new employees with specific and helpful knowledge sourcing training, or could implement knowledge sourcing outreach specifically for people working in remote office locations. At the least, focus groups may valuably tell managers ways in which their specific knowledge sourcing systems are failing to provide certain groups of people the kind of value the managers anticipated.

Our setting and analysis also provide a novel perspective on virtual teams. Much of the research on virtual teams has focused on supporting virtual team effectiveness (e.g., by establishing norms, or
developing trust) (Gibson & Cohen, 2003; Jarvenpaa & Leidner, 1999; Martins, Gilson, & Maynard, 2004), but has not explored the relationship between virtual teams and their deploying organization. Even research on technology use in virtual teams has tended to focus on how information technology connects team members to each other (Hollingshead, 1996; Majchrzak, Malhotra, & John, 2005), but less on how technology connects virtual team members to their organization as a whole (for an exception see the discussion of mass collaboration by Zammuto, Griffith, Majchrzak, Doughtery, and Faraj (2007)). Workers spread across the globe are often working on similar projects for similar clients, and could thus benefit greatly from each other’s expertise. Therefore, keeping virtual workers connected to what their organization “knows” may provide strategic value. However, we show that dispersed individuals are less likely than their centrally located counterparts to make use of the organization’s knowledge resources. Not only do they confront challenges accessing their teammates’ knowledge, they also face challenges accessing the organization’s electronic stores of knowledge. Future research could investigate what knowledge resources virtual teams draw on in their work, and under what conditions.

5.2 Limitations

We note two important limitations to our study. Although our data are archival and detailed, they did not allow us to see exactly which components were downloaded by which individuals. This information could greatly enrich our understanding of the kinds of KR artifacts that are used, under what conditions, and how this influences performance. We argue that this limitation is not likely to bias our results in a systematic way (i.e., our hypotheses focus on amount of use rather than content of use), but it does prevent broader claims and understanding. Also, our analysis is of one KR in one organization. This setting allowed us to establish a baseline for the social conditions associated with KR sourcing, but we note that as the conditions change (because of incentive programs, for example), the pattern of results may change as well.

5.3 Conclusion

With this work we bring a new, complementary lens to the study of knowledge sourcing – an information processing perspective. By taking an information processing based view of knowledge
sourcing we find that KR sourcing in a large, global firm was dominated by people with strong experiential knowledge-bases built from their work experience, familiarity with teammates, or location. This presents a conundrum. More experienced employees are advantaged to begin with, because of their enabling work conditions, (Cramton, 2001; Gardner et al., 2012; Huckman et al., 2009), which also support them in securing additional resources. Thus, instead of the KR equalizing knowledge access across organizational members, we showed that the knowledge-rich became richer through KR sourcing.
6. References


7. Tables

Table 1. Summary statistics and correlation table of variables in the individual KR sourcing models \((n=13,470)\).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>(\sigma)</th>
<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Individual KR Use(^a)</td>
<td>0.47</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>2. Individual Experience(^a)</td>
<td>1.82</td>
<td>2.36</td>
<td>0.12</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>3. Team Experience(^a)</td>
<td>2.36</td>
<td>1.12</td>
<td>0.00</td>
<td>0.14</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>4. Distribution of Team Experience(^a)</td>
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<td>0.09</td>
<td>0.03</td>
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<td>0.10</td>
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<tr>
<td>5. Individual Contextual Experience(^a)</td>
<td>0.88</td>
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<td>6. Team Contextual Experience(^a)</td>
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<td>-0.05</td>
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<tr>
<td>7. Individual Team Familiarity(^a)</td>
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<td>0.78</td>
<td>0.05</td>
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<tr>
<td>8. Team Familiarity(^a)</td>
<td>0.29</td>
<td>0.70</td>
<td>0.05</td>
<td>0.11</td>
<td>0.13</td>
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<td>-0.03</td>
<td>-0.05</td>
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<td>9. Female</td>
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<td>10. Project Manager</td>
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<td>0.04</td>
<td>0.08</td>
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<td>11. Middle Manager</td>
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<td>-0.08</td>
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<td>12. Project Scale</td>
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<td>-0.20</td>
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<td>13. Colocated Team Members</td>
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<td>-0.09</td>
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<td>14. Contract Type</td>
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<td>0.13</td>
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<td>-0.07</td>
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<td>0.02</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.23</td>
</tr>
</tbody>
</table>

Note. Bold denotes significance of less than 5%.
\(^a\) In models this variable is centered by subtracting the mean. Values here are before centering.
Table 2. Summary results of the regression of individual KR sourcing \((n = 13,470, \text{Col 6} = 9,554)\).

<table>
<thead>
<tr>
<th>Model:</th>
<th>(1) Controls</th>
<th>Random-Intercepts</th>
<th>Random-Slopes</th>
<th>Interactions</th>
<th>Dropping Indiv Fam</th>
<th>Multi Proj per Cust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Experience</td>
<td>0.0314***</td>
<td>0.0351***</td>
<td>0.0290***</td>
<td>0.0291***</td>
<td>0.0276***</td>
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<td>Team Experience</td>
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<td>Distribution of Team Experience</td>
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<td>0.5560**</td>
<td>0.5129*</td>
<td>0.5136*</td>
<td>0.4815+</td>
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<tr>
<td>Individual Experience (\times) Team Experience</td>
<td>0.0109**</td>
<td>0.0109**</td>
<td>0.0107*</td>
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<tr>
<td>Individual Experience (\times) Distribution of Team Experience</td>
<td>0.1060*</td>
<td>0.1061*</td>
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<td>Individual Team Familiarity</td>
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<td>0.0051</td>
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<td>0.2475***</td>
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<tr>
<td>Individual Familiarity (\times) Team Familiarity</td>
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<td>Individual Contextual Experience</td>
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<td>0.3137***</td>
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<td>Team Contextual Experience</td>
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<tr>
<td>Individual Contextual Experience (\times) Team Contextual Experience</td>
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<td>0.2675</td>
<td>0.4449*</td>
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<td>-0.0033</td>
<td>-0.0026</td>
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<td>Project Manager</td>
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<td>0.3348***</td>
<td>0.3347***</td>
<td>0.3050***</td>
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<td>Middle Manager</td>
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<td>0.0739**</td>
<td>0.0656**</td>
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<td>0.0692**</td>
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<td>Project Complexity</td>
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<td>Colocated Team Members</td>
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<td>0.5311***</td>
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<td>-16,471.9</td>
<td>-16,393.0</td>
<td>-16,382.5</td>
<td>-16,382.5</td>
<td>-11,778.2</td>
</tr>
<tr>
<td>Wald chi-squared</td>
<td>280.4***</td>
<td>460.8***</td>
<td>379.1***</td>
<td>401.7***</td>
<td>401.6***</td>
<td>292.1***</td>
</tr>
</tbody>
</table>

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. All models include, but results are not shown for the following variables: number of languages, software language, and number of technologies.