ATTAINING INDIVIDUAL CREATIVITY AND PERFORMANCE IN MULTI-DISCIPLINARY AND GEOGRAPHICALLY-DISTRIBUTED IT PROJECT TEAMS: THE ROLE OF TRANSACTIVE MEMORY SYSTEMS

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Abstract

Contemporary IT project teams demand individual members to generate and implement novel ideas in response to the dynamic changes in IT and business requirements. Firms rely on multi-disciplinary, geographically-distributed IT project teams to gather necessary talents, regardless of their locations, for developing novel IT artifacts. In this team context, individuals are expected to leverage dissimilar others' expertise for creating ideas during idea generation (IG) and then implement their ideas during idea implementation (II), known as the IGII process. Although much has been done to explain individual creativity, the extant literature offers little theoretical understanding on how to address the double-edged effects of dispersions in both *functional expertise* (ExpDisp) and *geographical locations* (GeoDiss)—the two defining characteristics of multi-disciplinary, cross-locational IT project teams—on individual creativity and subsequent performance. Drawing on the IGII framework, we propose transactive memory systems (TMSs) as a plausible team-level solution to tackle the challenge. With a multi-wave multi-level dataset from 141 members and their supervisors from 35 IT project teams, we found that team-level TMS and GeoDiss interactively moderate individual-level IGII processes in multi-disciplinary geographically -distributed IT project teams during both II and IG, but in qualitatively different ways.

Keywords*: Expertise dissimilarity, IT project teams, geographic dispersion, transactive memory system, idea generation idea implementation, cross-level analysis, future work, creativity*

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1. INTRODUCTION

Contemporary firms conduct digital innovation and develop novel IT artifacts to effectively respond to emerging opportunities and challenges in this digital era (Nambisan et al. 2017). Rapid advances in IT knowledge, however, make it difficult to identify co-located experts with necessary cutting-edge skills in multiple functional areas and the creativity required to develop these novel IT artifacts (Lakhani et al. 2012). In response, more firms increasingly use the practice of *multi-disciplinary, geographically-distributed IT project teams* to recruit the best possible talent for novel IT artifact development (Haselberger 2016). This practice is likely to be a dominant form of future work (e.g., Kudyba et al. 2020)

Due to the dynamic nature of IT projects, the crucial role that individual team member creativity plays in developing IT artifacts has long been recognized by practitioners (ComputerWeekly 2019; Forbes 2019). Compared to non-IT projects (e.g., construction, vehicle, or infrastructure), IT projects are especially dynamic. This is largely because the development of IT artifacts demands that members iteratively meet emerging business requirements (Besner and Hobbs 2012) with volatile IT knowledge (Ren et al. 2006) that is rapidly evolving (Artto et al. 2017; Nambisan et al. 2017). As these business needs change faster and technical knowledge decays more quickly in this environment, communication and coordination among team members becomes more crucial than in relatively stable settings (Ren et al. 2006; Argote and Ren 2012; Lewis and Herndon 2011). Such complex processes could drag on as IT artifacts are often provisionally offered and therefore frequently updated (Esmaeilzadeh 2020).

The vibrant and evolving nature of IT development requires individual team members to be creative in problem solving, as in generating and implementing novel ideas as a part of the IT project team. Furthermore, novel IT artifacts typically combine hundreds or thousands of interdependent components, each developed by individuals with distinct functional expertise (Cramton and Webber 2005; Sia et al. 2010). This combinational and interdependent nature highlights the criticality of coordination in an *IT project team* environment, wherein individual members generate and implement creative ideas into novel pieces (IT components) of an eventual IT artifact (Windeler et al. 2017).

While prior research has offered theoretical insights on individual creativity in teams on a general basis (e.g. Richter et al. 2012) and IT project teams in particular (e.g. Huang et al. 2014), our study focuses on an important but understudied issue in the literature: managing the double-edged effects of dispersions in both *functional expertise* (Huang et al. 2014) and *location* (Gilson et al. 2015)—the two defining characteristics of multi-disciplinary, cross-locational IT project teams—on individual creativity and subsequent performance. The literature has examined dispersion in functional expertise as a key antecedent to creativity, largely through the construct of expertise dissimilarity (ExpDiss), defined as the difference in expertise between a focal team member and his or her team members (cf. Van der Vegt et al. 2003). Expertise dissimilarity could be especially crucial for creativity in IT project teams, wherein "team processes involve more complex forms of interdependence among team members relative to, say, industrial work teams" (Tiwana and McLean 2005, p.21). Other scholars have conceived of ExpDiss as a double-edged sword (e.g. Huang et al. 2014), in that it may bring communication difficulties and dissension due to the lack of shared understanding among members with dissimilar expertise, which could in turn compromise creativity (Haas and Hansen 2005; van Knippenberg et al. 2004).

Similar to these contrasting effects of ExpDiss, scholars have competing arguments about the impact of geographical dispersion (GeoDisp). GeoDisp, defined as the extent to which a team is geographically dispersed, is a core team-level contextual factor (Cummings and Haas 2012; Salazar et al. 2012; Wang et al. 2019). While some have argued that GeoDisp constrains communication, social interaction, and knowledge sharing among team members, thus inhibiting creativity and performance (e.g. Gibson and Gibbs 2006), others believe that GeoDisp enables individuals to maintain autonomy and independence, and concentrate their cognitive resources on developing and implementing creative ideas (e.g. Leenders et al. 2003; Rico et al. 2011). The varying effects of GeoDisp may further complicate individual creativity and performance in IT project teams.

While much has been done to explain individual creativity, prior studies offer limited theoretical insights on how to address these two simultaneous double-edged effects on individual creativity and performance in *multi-disciplinary, cross-locational* IT project teams. Based on our literature review, we propose the use of transactive memory systems (TMSs) as a possible team-level solution. A TMS refers to the cooperative division of labor for storing, retrieving, and communicating team knowledge (Lewis 2003), which is a suitable approach for addressing the complications that ExpDiss and GeoDisp can impose on individual creativity in team settings. A well-developed TMS helps members access, digest, and integrate each other's expertise (Lewis and Herndon 2011) and obtain necessary coordination and social support (Bachrach et al. 2014; Fan et al. 2016; Hood et al. 2014). It is especially valuable in dynamic team settings, such as our focal IT project team context, where communication and coordination among team members is particularly important.

To reveal how TMS addresses the double-edged impact of ExpDiss and GeoDisp on individual creativity and performance, we build on the rich literature of the idea generation-idea implementation (IGII) framework. This framework provides an ideal theoretical lens to study how individuals produce creative ideas at the stage of idea generation, and convert their creative ideas into actual innovations to achieve good job performance at the stage of idea implementation (Baer 2012; Perry-Smith and Mannucci 2017). More specific to our purpose, the IGII framework enables us to understand how ExpDiss—a key factor in our focal IT project team context—affects individual creativity during the idea-generation stage, and how individual creativity is converted into actual IT components as performance outcomes during the idea-implementation stage. The IGII framework also affirms GeoDisp and TMS as two important team-level factors that interact to shape the individual-level relationships between ExpDiss and creativity, as well as between creativity and performance. This cross-level modeling effort is theoretically pertinent, in that scholars of both IGII and IT project teams have urged a cross-level approach to capture the effects between the individual and team levels (Chae et al. 2015; Škerlavaj et al. 2014; Windeler et al. 2017) and to inform more effective and holistic interventions (Windeler et al. 2017). TMS scholars have also called for cross-level research on the effects of higher-level TMS on lower-level behavioral patterns, and in particular, how team-level TMS moderates individual-level relationships (Bachrach et al. 2017).

Given this backdrop, we examine how team-level GeoDisp and TMS jointly moderate the individual-level relationships between ExpDiss and creativity, and between creativity and innovative performance, in multi-disciplinary, distributed IT project teams, leading to:

RQ1: How do team-level GeoDisp and TMS jointly moderate the individual-level relationship between ExpDiss and creativity in cross-functional, cross-locational IT project teams?

RQ2: How do team-level GeoDisp and TMS jointly moderate the individual-level relationship between creativity and performance in cross-functional, cross-locational IT project teams?

2. LITERATURE REVIEW

2.1 The Dynamic Nature of IT Project Teams

IT projects are the key practice leveraged by firms to develop IT artifacts. Prior research has differentiated IT projects from non-IT projects based on the levels of dynamism associated with business requirements, IT knowledge, and IT artifacts (e.g. Artto et al. 2017; Besner and Hobbs 2012). First, the business requirements of IT projects usually start with ambiguous customer needs, and then change rapidly to accommodate dynamic market conditions (Besner and Hobbs 2012). The final delivery of an IT project, unlike those of construction projects for instance, is often quite different from the project's initial requirements (Butler et al. 2019). Next, IT knowledge generally has a short lifespan because of constantly emerging technologies and their applications (Nambisan et al. 2017). IT knowledge is also highly volatile, especially when the underlying software gets scaled and complicated. In these cases, the knowledge associated with software development becomes so detailed and complex that it can easily be forgotten or hard to retrieve (Ren et al. 2006). Nambisan et al. (2017) thus viewed the development of digital innovations as a dynamic problem-solution pairing process, as both the problems and solutions are moving targets. In any case, IT artifacts eventually embody the dynamism of both business requirements and IT knowledge.

Specifically, as the IT artifacts add to this dynamism, IT projects are often uniquely different from other projects. Unlike other artifacts such as buildings, automobiles, airplanes, and infrastructure—which are rarely modified after their design has been agreed upon or after production—IT artifacts (e.g. a software application or an enterprise system) are often designed to be malleable during development and after their implementation (Yoo et al. 2010). Users of digital technologies nowadays are used to, and even expect, constant updates (Esmaeilzadeh 2020). An IT artifact can be introduced to users in its beta version and then be updated and/or upgraded later for enhancement (Collyer et al. 2010). This iteratively morphing nature of IT artifacts not only accommodates ongoing changes in business requirements and IT knowledge, but also distinguishes IT projects from other types of projects (Artto et al. 2017; Besner and Hobbs 2012; Ko et al. 2007). Given the need to accomplish the dynamic-pairing process through highly malleable IT artifacts, the success of IT project teams (relative to non-IT project teams) not only requires individuals to be particularly creative in problem solving, but also demands that team members become more effective in coordination (Artto et al. 2017; Besner and Hobbs 2012).

Furthermore, as a novel IT artifact typically consists of hundreds or even thousands of components (Cramton and Webber 2005), each developed by individuals with different expertise, work on the IT artifact requires combining all these components (Windeler et al. 2017). This interdependent and combinational nature of IT artifacts not only accentuates the challenges in generating and implementing individual creativity in relation to IT project dynamism, but also makes effective team coordination more crucial for implementing innovations (Venkatesh et al. 2017; Windeler et al. 2017). Our research addresses specific aspects of individual member creativity and subsequent performance in the cross-functional and cross-locational IT project team context.

2.2 Expertise Dissimilarity, Individual Creativity and Performance in IT Project Teams

There is much research on individual creativity in teams, including IT project teams (e.g. Huang et al. 2014; Tiwana and McLean 2005) (see Appendix A). Different from prior research, our study examines how to best assist focal members in leveraging dissimilar other's expertise (i.e. ExpDiss). This process helps nurture creativity and ensure subsequent performance (i.e., covert his or her ideas to innovative performance outcomes) in a cross-functional, cross-locational (GeoDisp) IT project team context. To do so, we first review the idea generation-idea implementation (IGII) literature, which explores how individuals produce creative ideas at the *idea-generation* stage and then implement these ideas as actual innovations at the *idea-implementation* stage (Baer 2012). This study draws on IGII as the basis for theoretical development for two reasons. First, IGII provides a foundation to better understand the antecedents and consequences of individual creativity, as well as the difficulties that individuals face during these two stages (Baer 2012; Perry-Smith and Mannucci

2017). Second, the IGII literature inspires us to incorporate GeoDisp and TMS as two critical team-level boundary conditions that may interactively moderate the individual-level IGII process, as discussed below. Based on the IGII literature, we first focus on the relationships between ExpDiss and individual creativity and performance.

Studies on idea generation have examined the drivers and inhibitors of individual creativity. Of particular interest in this study is ExpDiss, which describes the contrast between a focal individual's functional expertise and the expertise of others in the same team (Van der Vegt et al. 2003). Functional expertise could be particularly important for creativity in IT project teams, because team processes in this context involve complex interdependencies among members with different functional expertise (Tiwana and McLean 2005). Unlike differences in demographics (e.g. age), ExpDiss cannot be assessed along a continuum of a particular property shared by a team; rather, it captures variance in category between team members' expertise (Harrison and Klein 2007). The highest ExpDiss level occurs when a member's expertise differs in kind from that of every other member, while the lowest occurs when a member possesses the same expertise as everyone else.

Research has suggested that ExpDiss may have double-edged effects on individual creativity at the idea-generation stage. Specifically, a high level of ExpDiss exposes a focal member in a team to new, non-redundant information resources and alternative perspectives that can stimulate creativity (Mueller and Kamdar 2011; Zhou et al. 2009). Access to a diverse range of knowledge in this case encourages the individual to question common assumptions and established paradigms, and to develop a more complete understanding of the available choices. This approach creates a wider range of options and nurtures creativity (Janssen and Huang 2008; Sosa 2011). But the distinct backgrounds of individuals in the same team may also hamper individual member creativity. Developing new ideas generally entails substantial cognitive effort, as one has to change cognitive structures and/or combine information from different sources in novel ways (Cropley 2006; Mumford et al. 2012). This processing and integration of diverse information from distinct experts can be cognitively demanding in different ways (Huang et al. 2014). When interacting with dissimilar others, for example, an individual may experience difficulty in communicating and digesting informational resources due to a lack of shared understanding or common functional language (Haas and Hansen 2005; Jehn et al. 1999). This may compromise opportunities to leverage other's expertise that could enhance individual creativity (Eriksson et al. 2016; Kratzer et al. 2004).

The literature has acknowledged that at the idea-implementation stage, creativity is an important precondition for actual innovative job outcomes (Baer 2012), yet is still a challenging process, especially in the IT project team context. Due to the combinational and interdependent nature of IT artifacts, the IT components contributed by different members need to be merged to function as a whole. Importantly, an IT component conceived by a focal member may have cascading effects in terms of the component design and implementation as developed by other members, and vice versa (Ko et al. 2007; Windeler et al. 2017). To convert one's ideas into actual IT components, the individual must communicate with others and secure their agreement and support, such as for sharing resource codes or programming rationale (Maruping et al. 2009b). Also, because individuals are nested in different functional areas, members of cross-functional teams may have inconsistent views on how to technically address business problems. A focal member thus needs to carefully coordinate with dissimilar experts in order to effectively implement creative ideas.

2.3 GeoDisp: Another Double-Edged Sword

Along with this study's focus on ExpDiss, the other key concept that characterizes multi-functional and cross-locational IT project teams is geographic dispersion (GeoDisp). Defined as the extent to which members of a team are spread across more than one location (Gibson and Gibbs

2006), GeoDisp as a core team-level property captures the cross-locational characteristic of teams. Prior research that has portrayed GeoDisp as a double-edged sword includes the extensively documented negative effects of GeoDisp on team processes (see review by Gilson et al. 2015). Specifically, members of certain GeoDisp teams may experience low levels of interaction frequency (e.g. Espinosa et al. 2012), face-to-face interaction (e.g. Cramton and Webber 2005), shared context (e.g. Espinosa et al. 2007), informal communication (e.g. Kotlarsky and Oshri 2005), and common understanding (e.g. Griffith et al. 2003). Yet recent studies have appreciated the positive effects of GeoDisp (Gilson et al. 2015), where it is found to reduce value judgements (Stahl et al. 2010), shelter individuals from unnecessary social conflicts found in shared work spaces (Rico et al. 2011), and offer independence and autonomy (Leenders et al. 2003; Rico et al. 2011) (see Table 1).

Table 1: Effects of Geographical Dispersion (GeoDisp)

Negative Effects of GeoDisp	Studies
GeoDisp constrains interaction frequency.	Bardhan et al. 2013; Cataldo and Nambiar 2012; Cramton and Webber 2005; Espinosa et al. 2012; Espinosa et al. 2007; Hakonen and Lipponen 2008; Hoegl and Proserpio 2004; Joshi et al. 2009; Lahiri 2010; Monge and Kirste 1980; Mortensen and Hinds 2001; Robert Jr 2016; Staats 2012; Van den Bulte and Moenaert 1998
GeoDisp constrains face-to-face interaction.	Bardhan et al. 2013; Cramton and Webber 2005; Espinosa et al. 2012; Espinosa et al. 2007; Ganesan et al. 2005; Gibson and Nolan 1974; Hakonen and Lipponen 2008; Hoegl and Proserpio 2004; Hu et al. 2016; Joshi et al. 2009; Monge and Kirste 1980; Mortensen and Hinds 2001; Peñarroja et al. 2013; Robert Jr 2016; Staats 2012; Van den Bulte and Moenaert 1998
GeoDisp constrains the development of shared context and common understanding.	Cannella et al. 2008; Cataldo and Nambiar 2012; Charlier et al. 2016; Chudoba et al. 2005; Cramton and Webber 2005; Espinosa et al. 2012; Espinosa et al. 2007; Foster et al. 2015; Gibson and Gibbs 2006; Griffith et al. 2003; Hakonen and Lipponen 2008; Hinds and Mortensen 2005; Hoegl and Proserpio 2004; Joshi et al. 2009; Lahiri 2010; Mortensen and Hinds 2001; Peñarroja et al. 2013; Siebdrat et al. 2008; Siebdrat et al. 2014; Staats 2012; Tzabbar and Vestal 2015; Van den Bulte and Moenaert 1998
GeoDisp constrains social interaction and informal communication.	Kotlarsky and Oshri 2005; Nguyen-Duc et al. 2015; Van den Bulte and Moenaert 1998
GeoDisp increases cognitive effort.	Cataldo and Nambiar 2012; Gibson and Gibbs 2006; Mortensen and Hinds 2001; Tzabbar and Vestal 2015
Positive Effects of GeoDisp	**Studies**
GeoDisp reduces value-judging interaction.	Gilson et al. 2015; Peñarroja et al. 2013; Stahl et al. 2010
GeoDisp shelters individuals from distraction and social conflict.	Leenders et al. 2003; Rico et al. 2011; Robert Jr 2016; Stahl et al. 2010
GeoDisp provides independence and autonomy.	Charlier et al. 2016; Gilson et al. 2015; Leenders et al. 2003; Rico et al. 2011; Robert Jr 2016

This literature review implies that GeoDisp could both positively and negatively affect how individual members process divergent information during the idea-generation stage. On the one hand, as geographically distributed teams must use electronic communication (via email, text chat, or video conferencing), they are less capable of engaging in synchronous inter-personal exchange of richer information and cues (e.g. body language and facial expressions). This setting requires more cognitive effort for complex knowledge exchange (Froehle 2006) compared to co-located teams. On the other hand, GeoDisp allows individuals to work in an independent and autonomous environment, thereby shielding an individual from direct dissension and social conflict (Burke and Chidambaram 1999; Schmidt et al. 2001; Thatcher and Brown 2010). GeoDisp also permits individual members with more cognitive capacity integrating divergent knowledge for idea generation (Kratzer et al. 2004).

GeoDisp may also exacerbate or alleviate idea implementation. Due to the lack of social interaction and informal communication in these environments, it is more difficult for a focal individual to obtain other team members' endorsement to implement creative ideas (Kotlarsky and Oshri 2005; Nguyen-Duc et al. 2015). Social interactions in informal settings are also conducive to gaining support from others (Kijkuit and Van den Ende 2007). For instance, social exchanges among programmers "promote camaraderie" in collocated IT project teams (Ko et al. 2007, p.352). Yet social interactions can be problematic in geographically dispersed settings, because they usually take place on a personal basis in common areas like corridors and coffee rooms during lunch time or snack breaks (Kotlarsky et al. 2007) or at recreational events (e.g. golf or bowling) during non-work hours (Berger 2005). Because GeoDisp offers more autonomy and independence (Gilson et al. 2015) for individual members to concentrate on converting creative ideas into actual innovations, they may be more protected from conflict or disagreement that often besets their co-located peers (Leenders et al. 2003; Rico et al. 2011).

Our literature review so far suggests that while ExpDiss and GeoDisp could each has double-edged effects on individual IGII process, these effects could exist simultaneously in multi-functional and cross-locational IT project teams, making idea generation and implementation a more challenging process. However, the extant literature offers limited knowledge for how to address this challenge, particularly in IT project teams featuring high dynamism, where individual creativity is much needed yet demands more careful team coordination to materialize. To that end, we propose transactive memory systems (TMSs) as a team-level solution to address this challenge, by tapping into the benefits and overcoming the constraints that ExpDiss and GeoDisp bring to individual idea generation and then implementation in IT project teams.

2.4 Transactive Memory Systems (TMS)

The TMS literature builds on the understanding of collective memory as a social phenomenon through which individuals supplement their own memory with that of others (Mohammed and Dumville 2001). Defined as a team's cooperative division of cognitive effort for storing, retrieving, and communicating team knowledge (Lewis 2003, 2004), TMS represents a team-level cognitive state, in that it is "not traceable to any of the individuals alone, nor can it be found somewhere 'between' individuals" (Wegner 1987, p.191). It thus captures the collective ability of team members to coordinate their cognitive effort.

The literature has focused on three manifestations of TMS (Lewis 2003): (1) *specialization*, which describes a team's differentiated knowledge structure; (2) *credibility*, which refers to team members' trust in each other's expertise; and (3) *coordination*, which represents a team's effective and orchestrated knowledge processing. Systematic reviews of TMS research suggest that these three manifestations collectively constitute TMS as a holistic concept (Heavey and Simsek 2015; Lewis and Herndon 2011; Ren and Argote 2011). Lewis and Herdon (2011) further proposed that one cannot interpret these variables as components of a TMS: "…the three manifest variables cannot be meaningfully analyzed or interpreted in isolation" because "considered separately, the specialization, credibility, and coordination variables do not imply that a TMS exists" (p.1257). Following this holistic approach, we conceptualize (and operationalize) TMS as a higher-order construct consisting of these three sub-dimensions, which is consistent with most prior research (e.g. Bachrach et al. 2017; Chiang et al. 2014; Dai et al. 2017; Fan et al. 2016) (see Appendix B). While some other studies have modeled these three dimensions of TMS as distinct constructs (e.g. Kanawattanachai and Yoo 2007), they generally emphasized relationships between each of the three dimensions and other factors. By contrast, we are interested in the integrative effect of these three dimensions as a whole to address the aforementioned challenges in multi-functional and cross-locational IT project teams.[1]

The extant literature suggests that a well-developed TMS brings numerous advantages for individual team members. Those individual members in teams with a well-established TMS will likely have a highly developed knowledge map about other members' specializations (Jarvenpaa and Majchrzak 2008), trust in other members' expertise (Lewis 2004), and sound coordination mechanisms to communicate and collaborate with others (Choi et al. 2010; Hood et al. 2014; Lewis 2004). A strong TMS also enables individuals to take team members' backgrounds into consideration when exchanging and interpreting information (Akgun et al. 2006; Choi et al. 2010). Such advantages enable individuals to better digest and integrate knowledge from dissimilar others

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[1] The specialization manifestation of team-level TMS and individual-level ExpDiss are two different notions. Specialization is one manifestation of team-level TMS and is usually subjectively evaluated by individual members and then aggregated to the team level. ExpDiss, however, is an individual-level construct that concerns the contrast between a focal individual's expertise and that of other members in the same team. ExpDiss is usually operationalized objectively based on each expert's functional background versus that of other members (e.g. the functional department in which the expert works [Huang et al. 2014]). Consider a team with one database expert and four network specialists: every member shares the same degree of specialization, which is a team-level variable. However, the values for individual-level ExpDiss will be markedly different between the database expert and the network specialists: the database expert has a much higher value of ExpDiss as he or she is the only person who is a database expert on this team; the network specialists have much lower values of ExpDiss as four of the five members on this team have similar expertise (i.e. network).

(Lewis 2004; Lewis and Herndon 2011; Zhang and Guo 2019), thereby fostering individual creativity at the idea-generation stage.

Recent TMS studies have further discovered various social benefits that TMS can yield. The shared “who knows what” knowledge map in TMS enables members to become aware of each other’s viewpoints and personalize their communication approach (e.g. content and language) based on the other’s backgrounds (e.g. Choi et al. 2010), which is instrumental for obtaining support from others (Peltokorpi and Hasu 2016). Further, the knowledge-coordination effort underlying TMS facilitates shared understanding among team members, increasing their chances of gathering group support (Hood et al. 2014) and diminishing conflicts (Bachrach et al. 2014). A TMS also provides members with trust in each other’s expertise, and such trust can increase collective confidence in the team’s ability to attain its goals (Bachrach et al. 2019; Lewis 2004), thus enhancing team members’ willingness to provide support like collaborative relationships and task-related assistance (Fan et al. 2016; Hood et al. 2014). These TMS-related advantages could all facilitate individual members to convert their creative ideas into IT components during idea implementation.[2]

2.5 Toward a Cross-Level Model on Individual Creativity in Multi-Disciplinary and Cross-Locational IT Project Teams

Our literature review on the IGII framework regarding ExpDiss, individual creativity and performance, GD, and TMS, points to the need for building a cross-level model to address our research questions. This is because the relationships between ExpDiss and creativity and

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[2] The TMS literature has also examined TMS antecedents, including group member familiarity (Akgun et al. 2005), team size (Hood et al. 2016), communication frequency (Lewis 2004), task difficulty (Lewis 2004), and information technologies supporting knowledge management practice (Choi et al. 2010). One may question if TMS exists in teams with high GeoDisp (given such teams’ communication disadvantages) and if team-level TMS and GeoDisp are conceptually different. Our review of the TMS literature suggests that these two concepts are different, and that teams can attain high TMS regardless of GeoDisp. Specifically, research has shown that virtual teams do develop TMS, through interactions via electronic media (e.g. O’Leary and Mortensen 2010). Importantly, Kanawattanachai and Yoo (2007) showed that a team’s TMS stabilizes five weeks after team formation, and that the effect of communication on TMS, if any, subsides after that period. In this study, we focus on the downstream impacts, rather than the preconditions and formation, of team-level TMS on the individual-level IGII process in multi-disciplinary, cross-locational IT project teams.

performance are established at the individual level, whereas GeoDisp and TMS are established as team-level properties in their respective literatures. Specifically, our review of the IGII literature suggests that GeoDisp and TMS, as the two critical team-level boundary conditions, may interactively moderate the individual-level IGII process in multi-disciplinary, cross-locational IT project teams. First, many IGII studies have consistently highlighted GeoDisp as a core team-level property that affects how team members, especially in distributed teams, engage in creativity and innovative behaviors (e.g. Cummings and Haas 2012; Wang et al. 2019). For instance, Wang et al. (2019) positioned GeoDisp as a team-level contingency and examined how it *moderates* team-level relationships. Nonetheless, the extant literature offers limited explanation whether GeoDisp exerts a cross-level moderating effect on individual-level relationships—specifically in our case, that of the individual-level idea-generation and idea-implementation processes.

Second, TMS is included in this study as a team-level contingency for its potential to address challenges inherent in both idea-generation and idea-implementation stages. As discussed earlier, TMS has been proposed as a tool to facilitate information processing in diversified or distributed teams (Ali et al. 2019; Bachrach et al. 2019; Belbaly 2018; Gino et al. 2010; Huang and Hsieh 2017). Yet scholars have further discovered that TMS helps during the idea-implementation stage by allowing individual members to better understand other members (Choi et al. 2010), and persuade them to agree with and support their ideas (Peltokorpi and Hasu 2016). In securing needed support, such as collaborative relationships and task-related assistance (e.g., necessary resources) (Fan et al. 2016), TMS could exert a cross-level effect on the individual-level idea-generation and idea-implementation processes.

We find this cross-level model building effort is not only structurally superior for addressing our research objective, but also adds additional theoretical value to the related literature. Structurally, a cross-level approach can reasonably accommodate our key constructs established at their respective levels in the literature. This approach serves to minimize contextual and ecological fallacies when scholars "obtain spurious relationships at a lower level…because they fail to account for higher level factors that impact the relationship" or "incorrectly assume that a relationship found at a higher level…exists in the same way at a lower level" (Burton-Jones and Gallivan 2007, p.660).

Theoretically, the cross-level model approach allows the conception of individuals as meaningful social actors, rather than isolated entities in IT project team contexts (Windeler et al. 2017). This conception is important because in IT project teams, each member's behavior is a function of both individual-level processes and team-level factors that can either constrain or enable these processes (Windeler et al. 2017). As individual members are responsible for developing IT components that will later be assembled at the team level, researchers have cautioned that concentrating exclusively on the single level provides an incomplete understanding of the individual-level processes in IT project teams (Windeler et al. 2017). Indeed, along with the more general IGII literature (e.g. Škerlavaj et al. 2014), some recent IT project team research has started exploring how some other team-level factors affect individual creativity (Chae et al. 2015; Huang et al. 2014; Wang et al. 2015). A similar trend toward the cross-level approach to examining the effect of TMS on individual-level outcomes is also observed in the TMS literature (e.g. Bachrach et al. 2017; Fan et al. 2016; Jarvenpaa and Marchrzak 2008), which was originally dominated by single-level research at the team level (see Appendix B). Our model-building effort therefore adds to the literature of these areas by responding to the call for more cross-level research.

3. RESEARCH MODEL AND HYPOTHESES

Following the earlier discussion, we develop a cross-level model on individual creativity and performance in cross-functional, cross-locational IT project teams by synthesizing the aforementioned literatures (Figure 1). Table 2 lists the construct definitions. The individual-level relationships between ExpDiss and creativity, and between creativity and performance, represent the key processes in idea-generation and idea-implementation stages. Team-level GeoDisp captures the characteristic of geographically dispersed teams, whereas team-level TMS represents an intervention that facilitates both idea-generation and idea-implementation of IT projects.

Figure 1. Research Model and Hypotheses

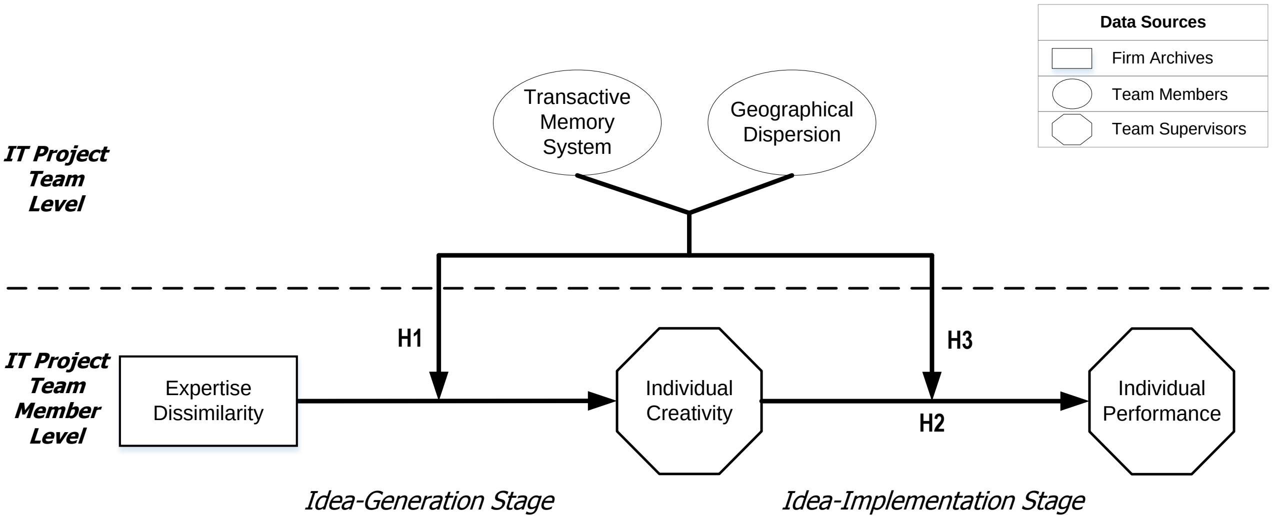

Table 2: Construct Definitions

Construct Name	Level	Definition	Supporting References
Expertise Dissimilarity (ExpDiss)	Individual	The difference in expertise between a focal team member and his or her fellow team members.	Harrison and Klein 2007; Huang et al. 2014; Van der Vegt et al. 2003
Individual Creativity	Individual	The generation of new and useful ideas by an individual team member.	Zhou and George 2001
Individual Performance	Individual	The actions specified and required by an individual team member's job description.	Borman and Motowidlo 1997; Janssen and Van Yperen 2004
Transactive Memory System (TMS)	Team	A team's cooperative division of cognitive effort for storing, retrieving, and communicating team knowledge.	Lewis 2003, 2004
Geographical Dispersion (GeoDisp)	Team	The extent to which a team is geographically dispersed.	Ganesh and Gupta 2010; Gilson et al. 2015

Note that the links between ExpDiss and creativity, and between creativity and performance, represent two distinctive stages: idea generation and idea implementation. The specific challenges that individual members need to deal with during these two stages are qualitatively different. We neither expect that ExpDiss will directly affect performance nor theorize that creativity mediates the effect of ExpDiss on performance. H1, H2, and H3 do not represent moderated mediation.

3.1 Joint Effects of Team-Level GeoDisp and TMS on the ExpDiss-Creativity Link

Per §2.2, individual exposure to ExpDiss represents a double-edged sword that may either enhance or decrease creativity during idea generation. Prior research has consistently shown that it is the in-depth processing of, rather than the access to, dissimilar knowledge that converts other's expertise into one's own creativity gains (Mueller and Kamdar 2011; Perry-Smith and Mannucci 2017). The importance of integrating dissimilar expertise in IS development has also been well recognized in the IT project team literature (Faraj and Sproull 2000; Tiwana and McLean 2005). Below we elaborate the role of team-level TMS in addressing an IT project team member's need to capitalize on the benefits of ExpDiss for individual creativity in high- versus low-GeoDisp conditions. Four possible scenarios in Table 3 are used to facilitate our discussion.

Table 3: Four Scenarios of TMS and GeoDisp in IT Project Teams

	Low GeoDisp	**High GeoDisp**
Low TMS	*Scenario I* Low-TMS/Low-GeoDisp Teams	*Scenario II* Low-TMS/High-GeoDisp Teams
High TMS	*Scenario III* High-TMS/Low-GeoDisp Teams	*Scenario IV* High-TMS/High-GeoDisp Teams

3.1.1 Low-TMS Scenarios (I and II)

Low TMS means that team members do not understand other members' specializations, have little trust in other members' expertise, and do not coordinate effectively with other members (Lewis 2004). This situation constrains individuals from locating, processing, and utilizing other members' expertise for idea stimulation. The dynamic nature of IT project teams could make this situation even worse, because the constant changes in business requirements and IT knowledge give rise to more uncertainty (Collyer et al. 2010; Xia and Lee 2005). The development of IT artifacts (software applications or enterprise systems) requires a great deal of coordination—much of which is unexpected (Besner and Hobbs 2012; Nambisan et al. 2017)—and requires particularly high efforts from everyone involved (Butler et al. 2019; Ko et al. 2007). In this vein, we argue that among low-TMS IT project teams, the challenges an IT expert faces in identifying, accessing, processing, and utilizing dissimilar other's expertise are likely more severe in low-GeoDisp teams than in high-GeoDisp teams for the following reasons.

Scenario I (Low TMS and Low GeoDisp). Among low-TMS/low-GeoDisp IT project teams, without a mature TMS that facilitates shared understanding among dissimilar experts, frequent interaction that occurs because of geographical proximity could activate function-based bias, rendering members less willing to value different perspectives from dissimilar members (Bunderson and Sutcliffe 2002). Ironically, such shared understanding is pivotal to IT project development due to the dynamic nature of IT artifacts stemming from the constantly shifting business requirements and IT knowledge (Butler et al. 2019; Nambisan et al. 2017). Even worse, the co-location of dissimilar experts without a well-developed TMS represents a markedly challenging environment in which the drawbacks of co-location, where task and relational conflict among dissimilar members (Leeders et al. 2003; Maruping et al. 2009b), can easily emerge and stifle creativity. The creativity of members in low-TMS/low-GeoDisp IT project teams may thus not benefit from exposure to dissimilar others (ExpDiss).

Scenario II (Low TMS and High GeoDisp). Relative to Scenario I, a low-TMS/high-GeoDisp IT project team is basically a team in name only. In this setting, a low level of TMS may not help convert individual members' exposure to dissimilar expertise into personal creativity. Nevertheless, a high level of GeoDisp provides autonomy and independence (Gilson et al. 2015) that can buffer members against possible dissension and conflict with dissimilar others (Rico et al. 2011), thereby freeing up individual cognitive energy for idea generation (Kiesler and Cummings 2002).

In short, low TMS provides no support for individuals in cross-functional IT project teams in identifying, processing, and integrating dissimilar other's expertise for creative idea generation. While ExpDiss may negatively affect individual creativity, the effect is likely worse in low-GeoDisp teams than in high-GeoDisp teams.

3.1.2 High-TMS Scenarios (III and IV)

TMS is found to be instrumental in retrieving, elaborating, and integrating knowledge from dissimilar others (Lewis 2004), facilitating knowledge sharing and integration among members (Dai et al. 2017). As discussed in §2.4, a TMS ensures that a focal member is aware of "who knows what" (specialization) and who to turn to (credibility) for support (Jarvenpaa and Majchrzak 2008), allowing this member to effectively communicate and coordinate with other members (coordination) (Lewis 2004). Because the development of novel IT artifacts involves continuously matching new digital technologies with constantly shifting business requirements (Nambisan et al. 2017), members in IT project teams need to acquire new knowledge and update their own expertise in their functional domains on an ongoing basis (Resick et al. 2014). A TMS is particularly valuable in helping individual members in a cross-functional IT project team efficiently understand and effectively leverage other's expertise for their own creativity (Nambisan et al. 2017; Ren et al. 2006). With this notion in mind, we next examine the different situations of low- vs. high-GeoDisp.

Scenario III (High TMS and Low GeoDisp). In low-GeoDisp cross-functional IT project teams, dissension and conflict are likely to occur because team members usually work closely with dissimilar others (Huang et al. 2014; Leenders et al. 2003; Rico et al. 2011). Fortunately, in this scenario, a well-developed TMS provides members with a timely knowledge map, trust in each other's expertise, and effective coordination (Austin 2003), which collectively help a focal member quickly access and understand other's expertise in the context of rapidly changing customer needs and IT knowledge, thus fostering new ideas for IT components (Nambisan et al. 2017). High-TMS levels can also mitigate functional bias (Bunderson and Sutcliffe 2002), dissension, and conflict (Bachrach et al. 2014), making members more open-minded in leveraging dissimilar other's expertise for creative idea generation.

Scenario IV (High TMS and High GeoDisp). For high-GeoDisp/high-TMS IT project teams, geographical separation may not compromise an individual member's ability to leverage dissimilar other's expertise for idea generation, because the spontaneous communication and orchestrated knowledge coordination endowed by a high level of TMS enable the member to tap into distinctive expertise possessed by dissimilar members, in turn stimulating his or her own creativity (e.g., Choi et al. 2010; Kanawattanachai and Yoo 2007).

Scenarios III and IV suggest that a well-developed TMS facilitates individual knowledge integration such that members of both low- and high-GeoDisp IT project teams can enjoy the creativity benefits from ExpDiss. Combining §3.1.1 and §3.1.2, we argue that ExpDiss may have either an enabling or constraining effect on an IT project member's creativity. The effect would depend on *how* team-level TMS and GeoDisp jointly shape a condition that either facilitates or inhibits individual members from transforming dissimilar other's expertise for their personal creativity. We therefore hypothesize:

H1: Team-level TMS and team-level GeoDisp jointly moderate the individual-level relationship between ExpDiss and creativity such that (a) in the low-TMS context, the negative effect of ExpDiss on individual creativity is stronger in low-GeoDisp IT project teams than in high-GeoDisp IT project teams, but (b) in the high-TMS context, the effect of ExpDiss on individual creativity is positive in both low-GeoDisp and high-GeoDisp IT project teams.

3.2 Creativity and Performance

Prior IGII research has shown that individual creativity is a prerequisite for individual performance that involves implementing novel ideas for solving complex problems (Pirola-Merlo and Mann 2004). Indeed, creativity provides individuals with alternatives that improve or replace existing components, allowing for better work performance and response to changes (Gong et al. 2009). Some studies have revealed the positive impact of employee creativity on performance in various settings (e.g., Gong et al. 2009; Zhang and Bartol 2010). In the IT project team context, notably cross-functional, cross-location IT project teams, the evolving business requirements, IT knowledge, and IT artifacts require individuals to continuously shift their cognitive frames and nurture creative ideas in order to develop novel IT artifacts that can meet emerging customer and market needs (Jasperson et al. 2005; Nambisan et al. 2017). We thus propose:

H2: Individual creativity positively influences individual performance in cross-functional, cross-location IT project teams.

3.3 Joint Effects of Creativity, GeoDisp, and TMS on Performance

Dissimilar members of an IT project team are likely to have diverse goals and perceive the team's tasks differently, leading to distinctive interpretations of what is needed for the project (Cronin and Weingart 2007). However, the combinational and interdependent nature of IT artifacts demands that a member obtains consensus with and support from others on the team to convert his or her creative idea into actual IT components (Zhang and Guo 2019). Theoretically, the IGII framework suggests that individuals need to forge supportive social relationships that provide access to resources, garner support, and establish a shared vision with colleagues to convert creative ideas into actual outcomes during the idea-implementation stage (Baer 2012; Škerlavaj et al. 2014). Effective development of IT artifacts requires such a social construction process (Maruping et al. 2009a; Nambisan et al. 2017). For IT project teams, the idea-implementation process includes frequently revisiting and gaining consensus on key issues, such as data structure, programming logic, development tools, and how different IT components can in combination fulfill the requirements of IT artifacts (Ko et al. 2007; Nambisan et al. 2017). To accommodate such circumstances, IT project teams place far more emphasis on communication and coordination than general project teams in more stable environments (Chen et al. 2018; Resick et al. 2014). Considering the above, we next discuss how TMS and GeoDisp jointly affect this process in the different scenarios.

3.3.1 Low-TMS Scenarios (I and II)

Low TMS-levels reflect deficiencies in a team's shared knowledge map, credibility, and coordination (Lewis 2004), and hence a lack of shared understanding (Hood et al. 2014), personalized communication (Choi et al. 2010), and collective belief in team success (Bachrach et al. 2019). In IT project teams, this can undermine individual members' ability to gather other's support, such as through collaborative relationships and task-related assistance (Fan et al. 2016), making it difficult to implement their creative ideas as actual IT components that are combinational, interdependent (Windeler et al. 2017), and dynamic (Nambisan et al. 2017). We posit that this issue is likely to be more serious in low-GeoDisp teams than in high-GeoDisp teams.

Scenario I (Low TMS and Low GeoDisp). Because a creative idea is often unique and potentially discomfiting (Perry-Smith and Mannucci 2017), frequent interaction in co-located environments is likely to increase cognitive conflicts among members in low-GeoDisp IT project teams in making sense of or appreciating other's creative ideas (Nambisan et al. 2017). Moreover, members of low-GeoDisp IT project teams could easily face task-related problems, such as when an emerging idea is quickly denied by other members because of the cascading effects on their programming codes (Jehn et al. 1999; Maruping et al. 2009b; Srikanth and Puranam 2014). Unfortunately, low TMS does not help ease these conflicts in this scenario.

Scenario II (Low TMS and High GeoDisp). Like their counterparts in low-GeoDisp/low-TMS IT project teams, individuals in high-GeoDisp/low-TMS IT project teams also have no TMS-related benefits in garnering dissimilar other's support to implement their creative ideas. Yet the physical distance in high-GeoDisp work settings minimizes frequent social interaction as well as unnecessary conflict and distraction (Leenders et al. 2003; Rico et al. 2011). Physical distance also provides individuals with autonomy and independence (Gilson et al. 2015) to concentrate on the actual development process (e.g. coding process) (Kiesler and Cummings 2002). The above discussion collectively suggests that, compared to members of low-TMS/low-GeoDisp IT project teams, members of low-TMS/high-GeoDisp IT project teams could be better sheltered from conflict and hence focus on implementing their creative ideas as actual IT components.

3.3.2 High-TMS Scenarios (III and IV)

Per §2.4, members of high-TMS teams have well-developed knowledge about "who knows what" that enables them to personalize their communication based on others' backgrounds for effective communication (Faraj and Sproull 2000); trust in each other's expertise that promotes collective confidence in the team's ability to successfully execute the project (Bachrach et al. 2019; Lewis 2004); and coordination that nurtures shared understanding, which is in turn the foundation for reducing intra-team conflicts (Bachrach et al. 2014) and gathering support from others (Fan et al. 2016; Hood et al., 2014). TMS can thus serve as a catalyst that enables an individual member to successfully implement his or her creative ideas.

Scenario III (High TMS and Low GeoDisp). The dynamic nature of IT artifact development imposes extra burdens on individual IT project team members to communicate with and gain support from dissimilar others when converting their novel ideas into IT components (Besner and Hobbs 2012; Nambisan et al. 2017). To that end, a TMS is particularly useful in communication (Peltokorpi and Hasu 2016) to secure agreement (e.g. data definition) and support (e.g. sharing source codes, programming logic, and design rationale) (Ko et al. 2007) from others for idea implementation (Hood et al. 2014). Meanwhile, physical proximity, which allows for frequent social interaction and informal communication, could synergistically amplify the instrumental effect of TMS for idea implementation, facilitating a member to transform his or her creativity into useful IT components.

Scenario IV (High TMS and High GeoDisp). Similar to those in low-GeoDisp/high-TMS IT project teams, individuals in high-GeoDisp/high-TMS IT project teams also enjoy the advantages of TMS for transforming their creativity into IT components. Yet physical separation could reduce the social interaction and informal communication that are crucial for obtaining other's support (sharing source codes, programming rationale, etc.) (Kijkuit and Van den Ende 2007) and even trigger or exacerbate perceived differences (e.g. different programming preferences) among dispersed members (Polzer et al. 2006). As such, the catalyst effect of TMS for translating individual creativity into actual IT components is likely weaker for individuals in high-TMS/high-GeoDisp IT project teams than in high-TMS/low-GeoDisp IT project teams.

Summarizing Scenarios III and IV, relative to counterparts in high-TMS/high-GeoDisp IT project teams, individuals on high-TMS/low-GeoDisp IT project teams have a better chance to garner other's endorsement to implement their own ideas toward actual IT component. Together, §3.2 and §3.3 propose that while individual creativity promotes individual performance (H2), the strength of this link is contingent on the interactive effect of team-level TMS and GeoDisp. Hence, we propose:

H3: Team-level TMS and team-level GeoDisp jointly moderate the relationship between individual creativity and performance such that (a) in the low-TMS context, the positive effect of individual creativity on individual performance is stronger in high-GeoDisp IT project teams than in low-GeoDisp IT project teams, but (b) in the high-TMS context, the positive effect of individual creativity on individual performance is stronger in low-GeoDisp IT project teams than in high-GeoDisp IT project teams.

4. METHODS

4.1 Sample

The study sample is obtained from data collected using a two-wave multi-sourced survey from three leading IT consulting firms in China. We chose these firms because they are leading IT solution providers that offer a broad set of consulting, design, and engineering services in the areas of telecom networks, enterprise systems, and cloud computing. As digital innovation is a core value of these firms, they place great emphasis on creativity and innovation in the workplace so as to accommodate the dynamic nature of IT project teams. To assemble individual professionals with the distinct functional expertise required for a given project, these firms establish IT project teams. The length of projects varies from several months to two to three years based on project complexity and customer needs. Team members are usually required to work at multiple sites and frequently travel from headquarters to frontline offices in different cities.[3] During the pilot study, one author randomly selected and interviewed eight teams from these firms to ensure that the sampled teams were knowledge intensive; characterized by varying levels of GeoDisp; and undertook project tasks that demanded diversified expertise, as represented by the fact that project team members commonly came from multiple functional departments.

Prior research has shown that a team's TMS stabilizes after a few months (e.g. two months [Kanawattanachai and Yoo 2007]) and becomes less susceptible to the influence of factors like communication frequency and member familiarity that tend to affect the formation of TMS in brand new teams (e.g. Akgun et al. 2005; Kanawattanachai and Yoo 2007). Given our emphasis on the downstream impacts of TMS, rather than the antecedents and formation of TMS, we included teams

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[3] There are various aspects of GeoDisp, including spatial, temporal, and configurational (O'Leary and Cummings 2007). In our context, the sampled teams were *spatially* dispersed across different cities but within the same time zone. Temporal dispersion was therefore naturally controlled. Our focus on spatial GeoDisp allows us to examine its pure effect on teams with different levels of TMS.

with ongoing projects that had been working for more than three months, which is also a common sampling criterion in prior TMS studies (e.g. Lewis 2003; Zhang et al. 2007).

As an employee might participate in multiple projects, and project team members might need to move from one team to another when necessary, we took precautions to ensure the validity of our study. To minimize common method bias (Sharma et al. 2009), we designed two versions of our questionnaire for IT project teams: a member version and a supervisor version. The firms identified a list of eligible projects (with the aforementioned characteristics) and the key members of these teams to fill out the member survey. If a particular employee was involved in more than one project, we chose only one project in which he or she was a primary member. Also, if the same group of employees worked together on several projects, we chose only one project to minimize redundant responses. This initial screening resulted in a list of employee respondents who appeared on only one IT project team and would answer the questionnaire once only.

Second, following Arnold et al.'s (2000) procedure, we invited the key members of each project team to an independent survey environment (a meeting room) at a pre-scheduled time so that each participant would sit with his or her project team members when taking the survey. Next, before the participants filled out the questionnaire, we explained that this would be a study about their interaction in the XXX project (the specific name of their project) (Zellmer-Bruhn and Gibson 2006). Participants were then instructed to look around their group, where facilitators emphasized that for all the questions regarding "our team" or "team members," they should recall scenarios of interacting *with exactly the people* sitting in the room and *for the particular project* only. We invited the corresponding supervisor of each project team to rate each member's creativity and performance in the particular project, with a specific project name stated on the top of the supervisor questionnaire.

Finally, as a manipulation check of the respondents' eligibility, we asked each supervisor whether he or she assigned project tasks to the focal employees who filled out the member questionnaire, and whether he or she was the direct assessor of those particular members' performance in the respective project. Administrating the survey following this procedure helped ensure the subjects' suitability and minimized concerns due to employees' mobility across teams.

4.2 Data and Data-Collection Procedure

We conducted two waves of onsite surveys with individual project team members and their project supervisors using different questionnaires. At Time 1, the researchers visited each of the sample teams to explain the purpose and procedure of the survey, and to assure the responses' confidentiality. Members received their assigned version that assesses their project team's TMS and GeoDisp, together with a return envelope. The project supervisors were taken to a different room to rate the creativity of each team member under their supervision using their own version of the questionnaire. Two months later (Time 2), we sent another questionnaire to the project supervisors asking them to rate the performance of the same team members. To ensure confidentiality and avoid invoking socially desired answers, survey facilitators were asked to leave the room during the process. All respondents were instructed to seal their completed questionnaires in the envelopes provided and return them directly to the researchers onsite (Huang et al. 2014). This time-lagged design helps reveal the impact of creativity on performance rather than the other way around.

Following prior TMS research, we excluded teams with fewer than three member responses (Lewis 2003). Further, teams in which fewer than half the key members participated in the survey were removed to ensure the sample provided a truly representative evaluation of entire teams. Ultimately, 141 team-member responses from 35 teams were obtained for analysis. The size of the sampled teams varied from three to seven members. This sample size is comparable to those reported in other cross-level studies on creativity and/or innovation, including the works by Gajendran and Joshi (2012) with 147 members from 24 teams, Richter et al. (2012) with 176 members from 34 teams, Mueller (2012) with 212 members from 26 teams, Sacramento et al. (2013) with 123 members from 41 teams, and Dokko (2014) with 87 members from 26 teams, among others. Our sample size is also comparable to those in prior TMS research, such as the studies by Kanawattanachai and Yoo (2007) with 146 members from 38 teams, Robert Jr. et al. (2008) with 172 members from 46 teams, and Tiwana and McLean (2005) with 142 members from 42 teams. The mean age of respondents was 30.6 years (s.d. = 4.8), and the average tenure at their job was 6.2 years (s.d. = 5.8). Additionally, 78% of the respondents were male.

4.3 Measures

We used respondents' functional department as a proxy for expertise and then calculated ExpDiss for every individual. This operationalization is consistent with prior studies measuring functional diversity based on functional units in organizational charts (Cummings 2004; Huang et al. 2014; Keller 2001). While people working in the same department could vary in terms of their *level* of expertise, they essentially shared the same *type* of expertise. Following Huang et al. (2014), we invited these firms' human resources managers to help identify the various functional departments based on their organizational charts, and asked them to confirm that each department focused on a specialized functional area, such as wireless communication, data transmission, network switching, etc.

We calculated ExpDiss using the procedure developed by Tsui et al. (1992) and applied by others (Huang et al. 2014; Van der Vegt et al. 2003). First, we coded ExpDiss between a particular member *i* and every other member in each team; we assigned "1" if team member *j* worked in a different department from member *i* or "0" if team member *j* worked in the same department as member *i*. We then calculated the square root of the sum of the squared dissimilarities between focal member *i* and every other key member in this team divided by the team size (*n*), as shown in the formula:

$$\text{Expertise Dissimilarity} = \sqrt{\frac{1}{n}\sum_{j=1}^{n}(Dept_i - Dept_j)^2}$$

The resulting score for ExpDiss ranged from 0 to 1, representing "extreme similarity" and "extreme dissimilarity" between the expertise of a focal member and that of other members in the same team.

The dynamic working environment of IT project teams led us to adopt a subjective measure of GeoDisp. While some have used objective data to measure GeoDisp (Bardhan et al. 2013; Espinosa et al. 2012), this was not feasible in our study, as contemporary IT project teams (especially service teams) are highly mobile. Following Chudoba et al. (2005), Hoegl et al. (2007), and Siebdrat et al. (2014), we adopted a perceptual measure of team co-location using the four five-point Likert items by Kerr and Jermier (1978). Respondents were asked to rate the extent to which team members were co-located, had direct interaction with them, and were distributed among various locations. We were thus able to take several aspects of GeoDisp into account (O'Leary and Cummings 2007).

TMS was measured using the scale developed by Lewis (2003), which has 15 items in total, five for each of the three dimensions. Following Lewis and Herndon's (2011) advice and based on our interest in understanding the integrative effects of TMS (see Section 2.4), we measured TMS as a second-order latent factor with three dimensions in the ensuing measurement analysis. Also following Lewis (2004), after validating the measurement model, we computed a team-level TMS score for the ensuing cross-level analysis.

Following the recent IGII study by Škerlavaj et al. (2014), we measured idea generation using the widely adopted creativity scale by Zhou and George (2001) but excluded two items related to implementation.[4] The supervisors of each project team were invited to assess each team member's creativity on a five-point Likert scale ranging from 1 = "strongly disagree" to 5 = "strongly agree." Performance was measured using three seven-point scales from Van Scotter and Motowidlo (1996). Having supervisors evaluate team members' performance is consistent with the approach used in top IS (e.g. Sykes and Venkatesh 2017), marketing (e.g. Chan et al. 2010), and management research (e.g. Nyberg et al. 2016). In fact, Sykes and Venkatesh (2017) explicitly indicated that the best measures are typically "those provided by supervisors as they are free of some of the biases inherent in self-ratings" (p.927). (See Appendix C.)

We also collected several variables to rule out alternative explanations. Individual-level control variables include demographics like gender, age, education, and job tenure. We also controlled for individual learning orientation, which may facilitate knowledge acquisition and creativity (Gong et al. 2009). Individual learning orientation, defined as a concern for and dedication to developing one's competence, was measured using three items adapted from Gong et al. (2009). A sample item includes "I often look for opportunities to develop new skills and knowledge." To control for the potential impact of project characteristics, we included project task difficulty and project duration as measured in months (Windeler et al. 2017). At the team level, we controlled for team size (Hülsheger et al. 2009), project task difficulty (Chae et al. 2015), and project duration (Leenders et al. 2003) that may impact idea generation and/or idea implementation. In addition, team reflexivity (also known as task reflexivity)—defined as the extent to which team members collectively reflect on and adapt their team's objectives, strategies, and processes (Tjosvold et al. 2004)—is a team process that may translate the effects of diverse knowledge into idea generation and implementation

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[4] The two excluded items are item 7 (i.e. this employee promotes and champions ideas to others) and items 9 (i.e. this employee develops adequate plans and schedules for the implementation of new ideas) by Zhou and George (2001). We thank the expert reviewer for this insightful suggestion.

(West 2002). We measured team reflexivity using four items from De Dreu (2007). A sample item is “We regularly discuss whether the team is working effectively together.”

Since our measures were adapted from prior studies published in English and the survey was administrated in Chinese, we had two certified professional translators independently translate and back-translate the questionnaires between English and Chinese (Brislin et al. 1973; Keil et al. 2000). We made minor changes in wording to ensure accuracy in meaning and alignment between the English and Chinese versions of the questionnaires.

5. RESULTS

We conducted our analysis in the following steps. First, we examined the measurement model. Second, we assessed the appropriateness of aggregating individual-level responses into a team-level score. Third, we tested the hypotheses by conducting cross-level analyses.

5.1 Measurement Model

To assess the measurement model, we first performed principal factor analysis (PCA) with oblique rotation and minimum eigenvalue = 1 for factor retention. Four items for TMS and one item for creativity were dropped because of low loadings or high cross-loadings. As can be seen in the PCA results that retain 27 items for key variables (Appendix D), each item loads much higher on its principal construct than on other constructs. The resulting responses-to-item ratio (141/27 = 5.22) complies with the typically expected 5:1 (Hair et al. 2010). When including two multi-item latent control variables, our ratio (141/34 = 4.15) is at lower end of the acceptable range of the minimum ratio, from 3:1 to 10:1 (Cattell 1978; Everitt 1975). MacCallum et al. (1999) and Mundfrom et al. (2005) proposed that when communalities of the measures are high (0.6 to 0.8), sample size tends to have little influence on the quality of factor solutions; in this vein, we found supporting evidence that the communalities of the retained measures are all higher than 0.6. We further assessed the

Kaiser-Meyer-Olkin measure of sampling adequacy (KMO = 0.878) and the Bartlett's test of sphericity (2304, p = 0.000) and found support for the validity of using this data for factor analysis (Chang et al. 2017; Chen et al. 2014).

As all the measures were adapted from prior literature, we further conducted confirmatory factor analysis (CFA) using AMOS 22.0 to perform a more conservative evaluation of the measurement model. Following Lewis (2003), we modeled TMS as a second-order latent construct with three first-order dimensions; other multi-item constructs were all modeled as first-order latent constructs. We revised the measurement model iteratively by dropping, one at a time, items that had low loadings or shared a high level of residual variance with other items (Gefen et al. 2003). Similar to PCA, the CFA model shows acceptable fit after dropping four items for TMS and one item for creativity (see Appendix C). The CFA fit indicators consistently used in prior studies demonstrate acceptable fit. The ratio of Chi-square over degree of freedom ($\chi 2/DF = 1.265$) is much lower than the threshold of 5 (Gefen et al. 2003); the comparative fit index (CFI = 0.975) and Tucker Lewis index (TLI = 0.970) are both higher than the required 0.95 (Hu et al. 1999); the standardized root-mean square residual (SRMR = 0.050) is lower than the threshold of 0.08 (Hu et al. 1999); and the root-mean square error of approximation (RMSEA = 0.043) is lower than the required 0.06 (Hu et al. 1999). Importantly, given the available sample size and model complexity, we further performed a bootstrapping simulation and found a Bollen-Stine p-value of 0.17, which is higher than the suggested 0.05 (Bollen and Stine 1992; Hsieh et al. 2011), providing further support for the measurement model given our sample size.

Table 4 lists the descriptive statistics and correlations, together with the Cronbach's alphas, composite reliabilities (CRs), and average variance extracted (AVE) based on the CFA results. As can be seen, the Cronbach's alphas and CRs are all higher than the required 0.707 (Nunnally 1978),

Table 4: Descriptive Statistics, Reliabilities, and Correlations (N = 141)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Gender	n.a.																
2. Age	-0.17*	n.a.															
3. Education	0.13	-0.27**	n.a.														
4. Tenure	-0.13	0.87**	-0.45**	n.a.													
5. Learning Orientation	-0.04	-0.07	0.26**	-0.13	0.85												
6. Team Size	0.03	-0.12	0.01	-0.10	-0.15	n.a.											
7. Task Difficulty	-0.05	-0.09	0.19*	-0.05	0.10	-0.06	n.a.										
8. Team Reflexivity	0.04	-0.09	0.06	-0.10	0.17*	0.10	0.02	0.79									
9. Project Duration	0.00	0.10	-0.12	0.12	-0.15	0.05	-0.17	0.03	n.a.								
10. ExpDiss	0.13	0.03	0.01	0.11	-0.13	0.22**	-0.04	0.01	0.24**	n.a.							
11. TMS	-0.01	0.08	0.09	-0.02	0.26**	0.06	0.09	0.37**	-0.03	-0.02	0.77						
12. TMS Specialization	-0.02	0.13	0.15	0.06	0.17*	0.03	0.17*	0.07	-0.13	-0.10	0.75**	0.79					
13. TMS Credibility	-0.20*	0.08	-0.07	0.00	0.13	0.11	-0.03	0.31**	0.04	-0.10	0.74**	0.55**	0.78				
14. TMS Coordination	0.13	-0.06	0.04	-0.12	0.24**	-0.01	-0.02	0.47**	0.07	0.10	0.68**	0.35*	0.52**	0.79			
15. GeoDisp	-0.17*	0.21*	-0.14	0.25**	-0.03	-0.20*	-0.08	-0.06	-0.11	-0.36**	-0.09	-0.03	0.02	-0.17*	0.77		
16. Creativity	-0.16	0.07	-0.09	0.11	0.11	-0.07	0.11	0.01	-0.32**	0.02	0.13	0.13	0.08	0.07	0.02	0.79	
17. Performance	-0.11	0.13	-0.03	0.15	0.16	-0.10	0.17*	-0.06	-0.29**	-0.01	0.24**	0.22*	0.18*	0.11	0.06	0.64**	0.90
Mean	0.21	30.59	4.72	49.64	5.95	5.85	3.90	3.71	10.16	0.52	5.45	5.04	5.78	5.62	2.94	3.82	5.43
S.D.	0.41	4.76	0.48	59.57	0.75	0.70	1.07	0.80	9.75	0.40	0.74	1.24	0.81	0.99	1.69	0.62	1.09
α $^{(a)}$	n.a.	n.a.	n.a.	n.a.	0.82	n.a.	n.a.	0.79	n.a.	n.a.	0.71	0.82	0.78	0.84	0.74	0.94	0.93
CR$^{(b)}$	n.a.	n.a.	n.a.	n.a.	0.89	n.a.	n.a.	0.87	n.a.	n.a.	0.82	0.87	0.82	0.87	0.81	0.95	0.93
AVE$^{(c)}$	n.a.	n.a.	n.a.	n.a.	0.73	n.a.	n.a.	0.62	n.a.	n.a.	0.60	0.63	0.60	0.62	0.59	0.62	0.81

Notes: ExpDiss: = expertise dissimilarity, TMS = transactive memory system, GeoDisp = geographical dispersion.
(a) Cronbach's alpha, (b) composite reliability, (c) average variance extracted.
Diagonals represent the square roots of the AVE values. The off-diagonal elements are inter-construct correlations.
$^{*}p < 0.05$, $^{**}p < 0.01$

confirming reliability and convergent validity. All the AVE values are above the threshold of 0.5 (Fornell and Larcker 1981), and the square roots of all the AVE values are all higher than the correlations among the latent constructs (Hair et al. 2010), indicating adequate convergent validity and discriminant validity (Barclay et al. 1995).

We further examined whether the scores reported by individual team members for GeoDisp and TMS could be aggregated to the team level. We calculated the interclass correlation coefficients, ICC(1) and ICC(2), for each of the two constructs (James 1982). ICC(1) reflects within-team agreement—that is, the extent to which the total variance of a variable can be commonly accepted in organizational studies (Bliese and Hanges 2004). The ICC(2) values, though slightly low, are comparable to the median or recommended ICC(2) values for team-level constructs reported in prior studies (e.g. Huang et al. 2014; Liao and Rupp 2005; Richter et al. 2006). Moreover, aggregation should not be avoided if it is justified by theory and supported by a high Rwg, which is a widely used within-team agreement index (James et al. 1984). We computed the Rwg of each construct for each team and found a mean value of 0.74 for TMS and a mean value of 0.77 for GeoDisp, both higher than the generally accepted 0.707 (Klein and Kozlowski 2000), thus supporting data aggregation.

5.2 Hypothesis Testing

To test the hypotheses, we applied the linear mixed-effects models (MIXED) procedure in IBM-SPSS to perform cross-level analyses with the hierarchically nested data. MIXED is a common cross-level software program that has been widely used for this purpose in published studies (Judd et al. 2012; Peugh and Enders 2005; Verbeke and Molenberghs 2000).

We list the equations for the proposed relationships in Table 5. Taking H1 as an example to test our hypotheses, we used data from J teams, with a different number of respondents n_j in each team, to explain the outcome (i.e. $Creativity_{ij}$) of ExpDiss for respondent i in group j (i.e. $ExpDiss_{ij}$). The individual-level model (Level 1) thus includes a random intercept term (β_{0j}), five fixed-slope terms ($\beta_{1j} \sim \beta_{5j}$) to model the effects of the individual-level control variables, and a random-slope term (β_{6j}) to model the main effect of ExpDiss.

Table 5: Cross-Level Model Specifications for H1

Level 1: Individual-Level Model

$$\text{Creativity}_{ij} = \beta_{0j} + \beta_{1j}(\text{Gender}_{ij}) + \beta_{2j}(\text{Age}_{ij}) + \beta_{3j}(\text{Education}_{ij}) + \beta_{4j}(\text{Tenure}_{ij}) + \beta_{5j}(\text{LearningOrientation}_{ij}) + \beta_{6j}(\text{ExpDiss}_{ij}) + e_{ij}$$

Level 2: Team-Level Model

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{TeamSize}_j) + \gamma_{02}(\text{TaskDifficulty}_j) + \gamma_{03}(\text{TeamReflexivity}_j) + \gamma_{04}(\text{ProjectDuration}_j) + \gamma_{05}(\text{Firm Dummy-1}_j) + \gamma_{06}(\text{FirmDummy-2}_j) + \gamma_{07}(\text{TMS}_j) + \gamma_{08}(\text{GeoDisp}_j) + \gamma_{09}(\text{TMS*GeoDisp}_j) + \mu_{0j}$$

$$\beta_{1j} = \gamma_{10}$$

$$\beta_{2j} = \gamma_{20}$$

$$\beta_{3j} = \gamma_{30}$$

$$\beta_{4j} = \gamma_{40}$$

$$\beta_{5j} = \gamma_{50}$$

$$\beta_{6j} = \gamma_{60} + \gamma_{61}(\text{TeamSize}_j) + \gamma_{62}(\text{TaskDifficulty}_j) + \gamma_{63}(\text{TeamReflexivity}_j) + \gamma_{64}(\text{ProjectDuration}_j) + \gamma_{65}(\text{Dummy-1}_j) + \gamma_{66}(\text{Dummy-2}_j) + \gamma_{67}(\text{TMS}_j) + \gamma_{68}(\text{GeoDisp}_j) + \gamma_{69}(\text{TMS*GeoDisp}_j) + \mu_{6j}$$

Cross-Level Interaction Model (Combined)

$$\text{Creativity}_{ij} = \gamma_{00} + \gamma_{10}(\text{Gender}_{ij}) + \gamma_{20}(\text{Age}_{ij}) + \gamma_{30}(\text{Education}_{ij}) + \gamma_{40}(\text{Tenure}_{ij}) + \gamma_{50}(\text{LearningOrientation}_{ij}) + \gamma_{60}(\text{ExpDiss}_{ij}) + \gamma_{01}(\text{TeamSize}_j) + \gamma_{02}(\text{TaskDifficulty}_j) + \gamma_{03}(\text{TeamReflexivity}_j) + \gamma_{04}(\text{ProjectDuration}_j) + \gamma_{05}(\text{FirmDummy-1}_j) + \gamma_{06}(\text{FirmDummy-2}_j) + \gamma_{07}(\text{TMS}_j) + \gamma_{08}(\text{GeoDisp}_j) + \gamma_{09}(\text{TMS*GeoDisp}_j) + \gamma_{61}(\text{ExpDiss}_{ij})(\text{TeamSize}_j) + \gamma_{62}(\text{ExpDiss}_{ij})(\text{TaskDifficulty}_j) + \gamma_{63}(\text{ExpDiss}_{ij})(\text{TeamReflexivity}_j) + \gamma_{64}(\text{ExpDiss}_{ij})(\text{ProjectDuration}_j) + \gamma_{65}(\text{ExpDiss}_{ij})(\text{FirmDummy-1}_j) + \gamma_{66}(\text{ExpDiss}_{ij})(\text{FirmDummy-2}_j) + \gamma_{67}(\text{ExpDiss}_{ij})(\text{TMS}_j) + \gamma_{68}(\text{ExpDiss}_{ij})(\text{GeoDisp}_j) + \gamma_{69}(\text{ExpDiss}_{ij})(\text{TMS*GeoDisp}_j) + \mu_{0j} + \mu_{6j}(\text{ExpDiss}_{ij}) + e_{ij}$$

The team-level model (Level 2, Table 5) specifies the random-intercept and random-slope terms as a function of TMS, GeoDisp, and the interaction between the two team factors after controlling for the effects of the team-level control variables ($\gamma_{01} \sim \gamma_{06}$). As such, the cross-level main effects of TMS and GeoDisp are captured by γ_{07} and γ_{08}, respectively, while their interaction effect is captured by the coefficient γ_{09}. In addition, the interaction effect of ExpDiss and TMS and the interaction effect of ExpDiss and GeoDisp are captured by γ_{67} and γ_{68}, respectively. Finally, the three-way interaction effect is captured by the coefficient γ_{69}. The individual-level error term (τ_{ij}) and random effects (μ_{0j}, μ_{6j}) are also specified.

Table 6 presents the results of the cross-level analyses for creativity (H1), with an improvement in the model-fit statistic in each step. We now delineate the procedure for testing H1. In Step 1, we entered all individual-level control variables for creativity. In Step 2, we added the ExpDiss scores.

Table 6: Results of the Cross-Level Analyses on Individual Creativity

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Step 1: Individual-Level Control Variables						
Intercept (γ_{00})	3.86***	3.86***	3.83***	3.86***	4.00***	3.99***
Gender (γ_{10})	-0.10	-0.10	-0.12	-0.10	-0.10	-0.08
Age (γ_{20})	-0.47**	-0.48**	-0.48**	-0.30	-0.42*	-0.36*
Education Level (γ_{30})	-0.10	-0.10	-0.14	0.19	0.32	0.40
Tenure (γ_{40})	0.48**	0.50**	0.40*	0.20	0.02	-0.02
Learning Orientation (γ_{50})	0.27**	0.27**	0.20*	0.16	0.20*	0.23*
Step 2: Individual-Level Variable						
ExpDiss (γ_{60})		-0.03				
Step 3: Testing the Slope						
ExpDiss			0.02	0.16	0.23	0.17
Step 4: Team-Level Variables						
Team Size (γ_{01})				-0.02	-0.18	-0.23
Task Difficulty (γ_{02})				0.09	-0.09	-0.07
Team Reflexivity (γ_{03})				-0.09	-0.08	-0.06
Project Duration (γ_{04})				-0.22**	-0.24**	-0.23**
Firm Dummy 1 (γ_{05})				-0.42	-0.65	-0.76
Firm Dummy 2 (γ_{06})				-0.06	-0.21	-0.29
TMS (γ_{07})				0.13	0.09	-0.00
GeoDisp (γ_{08})				0.15	0.17*	0.08
TMS x GeoDisp (γ_{09})				0.09	0.26*	0.26*
Step 5: Cross-Level Two-Way						
ExpDiss x Team Size (γ_{61})					-0.07	0.02
ExpDiss x Task Difficulty (γ_{62})					0.05	0.14
ExpDiss x Team Reflexivity (γ_{63})					0.23	0.17
ExpDiss x Project Duration (γ_{64})					-0.15	-0.14
ExpDiss x FirmDummy 1 (γ_{65})					-0.01	-0.02
ExpDiss x FirmDummy 2 (γ_{66})					-0.13	-0.12
ExpDiss x TMS (γ_{67})					0.26*	0.32*
ExpDiss x GeoDisp (γ_{68})					0.13	0.09
Step 6: Cross-Level Three-Way						
ExpDiss x GeoDisp x TMS (γ_{69})						-0.15**
Increase in Model Fit	$\chi^2(5) = 12.49^{*}$	$\chi^2(1) = 0.15$	$\chi^2(1) = 3.69^{*}$	$\chi^2(9) = 18.71^{**}$	$\chi^2(8) = 9.47$	$\chi^2(1) = 4.52^{*}$
R^2	11.9%	12.0%	15.5%	33.3%	42.3%	46.6%
Delta R^2		0.1%	3.5%	17.8%	9.0%	4.3%

Note: All coefficients reported here are unstandardized beta coefficients. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

ExpDiss was not found to be significantly related to creativity ($\gamma_{60} = -0.03$, $p > 0.1$). In Step 3, we performed the random-slope test to determine if the individual-level link between ExpDiss and creativity varies significantly across teams. The results reveal a significant increase in model fit ($\chi^2 = 3.69$, $df = 1$, $p < .05$), suggesting noteworthy variation in slopes across teams. In Step 4, we included two team-level factors, TMS and GeoDisp, together with other team-level control variables. In Step 5, we included the cross-level two-way interaction effects among ExpDiss, GeoDisp, and TMS. In Step 6, we added the cross-level three-way interaction effect (ExpDiss x GeoDisp x TMS) and found a significant effect on individual creativity ($\gamma_{68} = -0.15$, $p < 0.05$).

Figure 2
ExpDiss & Creativity in Low-TMS Teams

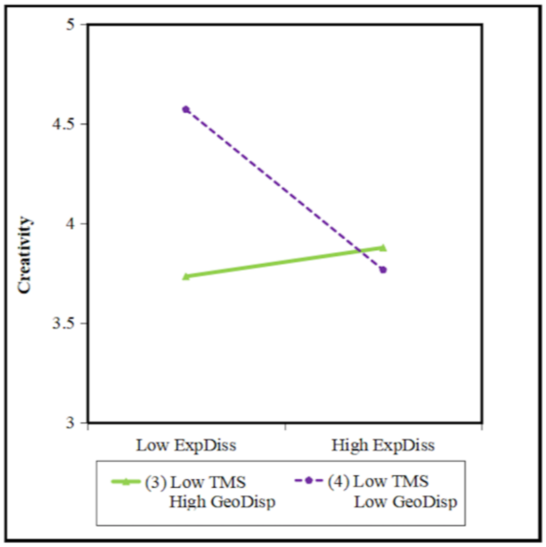
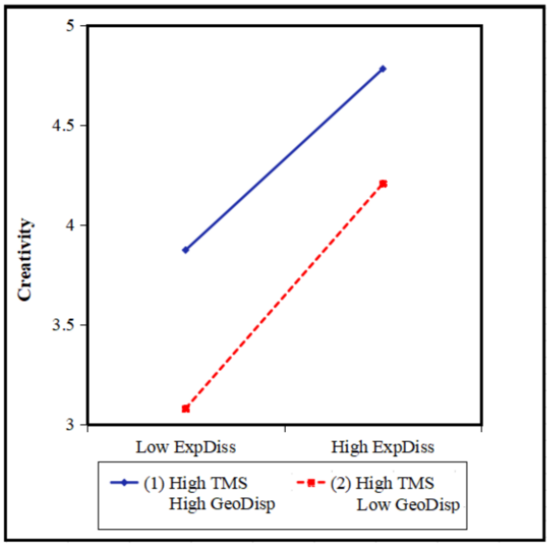


Figure 3
ExpDiss & Creativity in High-TMS Teams



To interpret the three-way interaction, we plotted the relationship between individual ExpDiss and creativity at high and low levels of team-level TMS and GeoDisp, which were one standard deviation above and below the mean, respectively (Dawson and Richter 2006). The plots of the interactive effects are shown in Figures 2 and 3. To gain a more nuanced understanding of these effects, we conducted simple slope tests to further probe this relationship. As shown in Figure 2, among low-TMS teams, the relationship between ExpDiss and creativity is not significant for the high-GeoDisp teams ($B = 0.04$, $p > 0.05$) and is negative for the low-GeoDisp teams ($B = -0.58$, $p <$

0.05). Following Dawson and Richter (2006), we compared these two groups and found this link to be statistically different. H1a is supported. Next, as shown in Figure 3, among high-TMS teams, this link is slightly higher for low-GeoDisp teams (B = 0.45, $p < 0.05$) than for high-GeoDisp teams ($B = 0.40$, $p < 0.05$). When comparing the coefficients of these two groups, however, we did not find the relationship to be statistically different across teams ($p > 0.05$). H1b is also supported.

Table 7: Cross-Level Model Specifications for H3

Level 1: Individual-Level Model

$$\text{Performance}_{ij} = \beta_{0j} + \beta_{1j}(\text{Gender}_{ij}) + \beta_{2j}(\text{Age}_{ij}) + \beta_{3j}(\text{Education}_{ij}) + \beta_{4j}(\text{Tenure}_{ij}) + \beta_{5j}(\text{LearningOrientation}_{ij}) + \beta_{6j}(\text{Creativity}_{ij}) + e_{ij}$$

Level 2: Team-Level Model

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{TeamSize}_j) + \gamma_{02}(\text{TaskDifficulty}_j) + \gamma_{03}(\text{TeamReflexivity}_j) + \gamma_{04}(\text{ProjectDuration}_j) + \gamma_{05}(\text{FirmDummy-1}_j) + \gamma_{06}(\text{FirmDummy-2}_j) + \gamma_{07}(\text{TMS}_j) + \gamma_{08}(\text{GeoDisp}_j) + \gamma_{09}(\text{TMS*GeoDisp}_j) + \mu_{0j}$$

$$\beta_{1j} = \gamma_{10}$$

$$\beta_{2j} = \gamma_{20}$$

$$\beta_{3j} = \gamma_{30}$$

$$\beta_{4j} = \gamma_{40}$$

$$\beta_{5j} = \gamma_{50}$$

$$\beta_{6j} = \gamma_{60} + \gamma_{61}(\text{TeamSize}_j) + \gamma_{62}(\text{TaskDifficulty}_j) + \gamma_{63}(\text{TeamReflexivity}_j) + \gamma_{64}(\text{ProjectDuration}_j) + \gamma_{65}(\text{Dummy-1}_j) + \gamma_{66}(\text{Dummy-2}_j) + \gamma_{67}(\text{TMS}_j) + \gamma_{68}(\text{GeoDisp}_j) + \gamma_{69}(\text{TMS*GeoDisp}_j) + \mu_{6j}$$

Cross-Level Interaction Model (Combined)

$$\text{Performance}_{ij} = \gamma_{00} + \gamma_{10}(\text{Gender}_{ij}) + \gamma_{20}(\text{Age}_{ij}) + \gamma_{30}(\text{Education}_{ij}) + \gamma_{40}(\text{Tenure}_{ij}) + \gamma_{50}(\text{LearningOrientation}_{ij}) + \gamma_{60}(\text{Creativity}_{ij}) + \gamma_{01}(\text{TeamSize}_j) + \gamma_{02}(\text{TaskDifficulty}_j) + \gamma_{03}(\text{TeamReflexivity}_j) + \gamma_{04}(\text{ProjectDuration}_j) + \gamma_{05}(\text{FirmDummy-1}_j) + \gamma_{06}(\text{FirmDummy-2}_j) + \gamma_{07}(\text{TMS}_j) + \gamma_{08}(\text{GeoDisp}_j) + \gamma_{09}(\text{TMS*GeoDisp}_j) + \gamma_{61}(\text{Creativity}_{ij})(\text{TeamSize}_j) + \gamma_{62}(\text{Creativity}_{ij})(\text{TaskDifficulty}_j) + \gamma_{63}(\text{Creativity}_{ij})(\text{TeamReflexivity}_j) + \gamma_{64}(\text{Creativity}_{ij})(\text{ProjectDuration}_j) + \gamma_{65}(\text{Creativity}_{ij})(\text{FirmDummy-1}_j) + \gamma_{66}(\text{Creativity}_{ij})(\text{FirmDummy-2}_j) + \gamma_{67}(\text{Creativity}_{ij})(\text{TMS}_j) + \gamma_{68}(\text{Creativity}_{ij})(\text{GeoDisp}_j) + \gamma_{69}(\text{Creativity}_{ij})(\text{TMS*GeoDisp}_j) + \mu_{0j} + \mu_{6j}(\text{Creativity}_{ij}) + e_{ij}$$

Table 7 shows the equations for the proposed relationships between individual creativity and performance. Table 8 presents the results of the cross-level analysis on individual performance (H2 and H3). We entered all of the individual-level control variables for individual performance in Step 1. We then added the creativity score to the model in Step 2. As can be seen in Table 8, creativity is significantly associated with performance ($\gamma_{60} = 0.78$, $p < 0.001$), supporting H2. In Step 3, we performed the random-slope test to determine whether the link between creativity and performance varies across teams. The results show a significant increase in model fit ($\chi 2 = 12.08$, $df = 1$, $p < 0.001$), suggesting notable variation in slopes across teams. In Step 4, we added team-level TMS and GeoDisp as well as other team-level control variables. In Step 5, we included the cross-level

Table 8: Results of the Cross-Level Analysis on Individual Performance

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Step 1: Control Variables						
Intercept (γ_{00})	5.54***	5.52***	5. 56***	5.53***	5.52***	5.97***
Gender (γ_{10})	-0.13	-0.01	0.07	0.03	0.11	0.09
Age (γ_{20})	-0.70*	-0.14	0.02	-0.01	0.12	0.11
Education Level (γ_{30})	-0.13	-0.01	-0.04	-0.01	0.03	-0.16
Tenure (γ_{40})	0.62*	0.05	0.01	0.03	-0.00	0.09
Learning Orientation (γ_{50})	0.49**	0.16	0.13	0.15	0.14	0.13
Step 2: Individual-Level Variable						
Creativity (γ_{60})		0.78***				
Step 3: Testing the Slope						
Creativity			0.97***	0.90***	1.00***	1.35***
Step 4: Team-Level Variables						
Team Size (γ_{01})				0.13	0.03	0.34*
Task Difficulty (γ_{02})				0.11	0.07	-0.18
Team Reflexivity (γ_{03})				-0.17	-0.23	-0.05
Project Duration (γ_{04})				-0.05	0.03	0.04
FirmDummy 1 (γ_{05})				0.03	0.01	0.17
FirmDummy 2 (γ_{06})				0.03	0.01	-0.02
TMS (γ_{07})				0.10	0.18	0.13
GeoDisp (γ_{08})				-0.04	0.02	0.13
TMS x GeoDisp (γ_{09})				0.06	0.12	0.21*
Step 5: Cross-Level Two-Way						
Creativity x Team Size (γ_{60})					-0.09	-0.16
Creativity x Task Difficulty (γ_{62})					-0.02	-0.16
Creativity x Team Reflexivity (γ_{63})					-0.04	0.01
Creativity x Project Duration (γ_{64})					0.03	-0.17
Creativity x FirmDummy 1 (γ_{65})					-0.02	-0.10
Creativity x FirmDummy 2 (γ_{66})					0.27	-0.13
Creativity x TMS (γ_{67})					-0.23	-0.19
Creativity x GeoDisp (γ_{68})					-0.00	-0.18
Step 6: Cross-Level Three-Way						
Creativity x TMS x GeoDisp (γ_{69})						-0.51***
Increase in Model Fit	$\chi^2(5) = 11.17^{*}$	$\chi^2(1) = 30.22^{***}$	$\chi^2(1) = 12.08^{***}$	$\chi^2(9) = 3.56$	$\chi^2(8) = 8.25$	$\chi^2(1) = 21.13^{***}$
R^2	6.7%	24.9%	32.2%	34.3%	39.3%	52.0%
Delta R^2		18.2%	7.3%	2.1%	5.0%	12.7%

Note: All coefficients reported here are unstandardized beta coefficients. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

two-way interaction effects on performance. Finally, in Step 6, we entered the cross-level three-way interaction effect among individual creativity, team-level TMS, and team-level GeoDisp and found a significant effect on individual performance (B = -0.51, $p < 0.001$).

Figure 4
Creativity & Performance in Low-TMS Teams

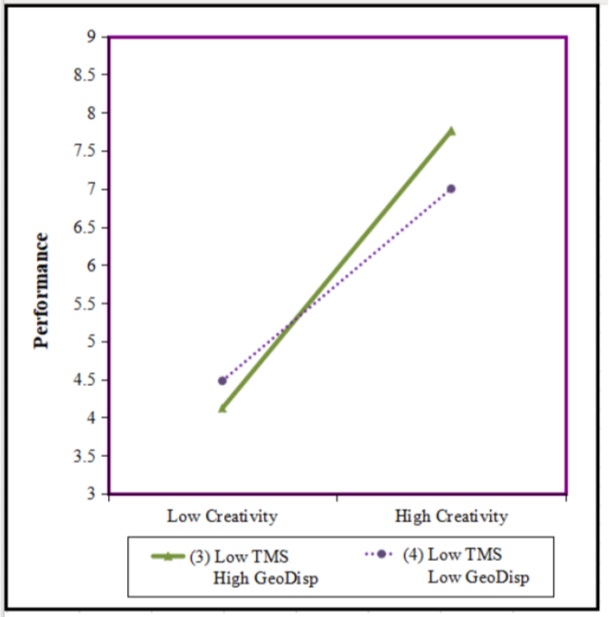
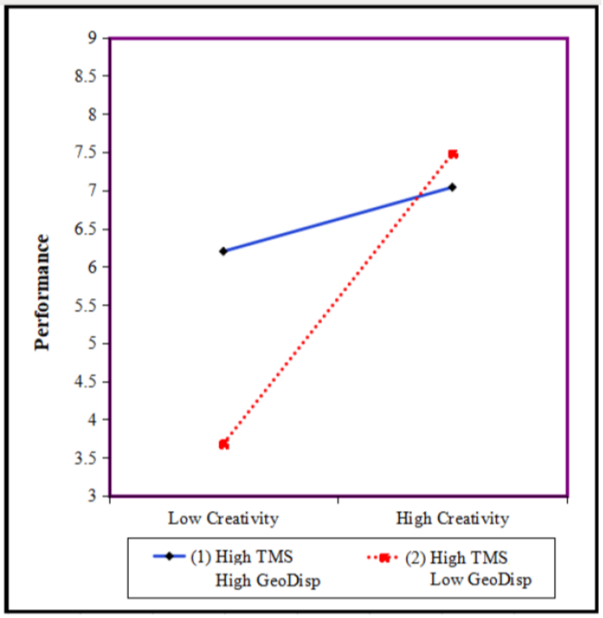


Figure 5
Creativity & Performance in High-TMS Teams



We further tested the simple slopes for the link between creativity and performance. As shown in Figure 4, among low-TMS teams, the relationship between creativity and performance is higher for high-GeoDisp teams (B = 1.42, $p < 0.001$) than for low-GeoDisp teams (B = 0.85, $p < 0.01$). Following the procedure by Dawson and Richter (2006), we found that the link varies significantly across these two groups ($p < 0.01$). Contrary to the low-TMS scenarios, among high-TMS teams, the link between creativity and performance is higher for low-GeoDisp teams (B = 1.48, $p < 0.001$) than for high-GeoDisp teams (B = 0.91, $p < 0.01$) (see Figure 5). We also found that this link varies significantly across these two groups ($p < 0.01$). H3a and H3b are therefore supported.

5.3 Additional Analyses

One may argue that ExpDiss can affect individual performance, and that this relationship is contingent on team-level factors like GeoDisp and TMS. We conducted two analyses to assess this possibility. First, we evaluated whether ExpDiss directly affects individual performance and if team-level GeoDisp and TMS moderate this relationship. Following the cross-level analysis using individual performance as the dependent variable (as reported in Table 8), we first entered all of the individual- and team-level control variables in Step 1. In Step 2, we added the dissimilarity scores to the model and found that they did not affect individual performance ($B = 0.22$, $p > 0.05$). In Step 3, we performed the random-slope test to determine whether the link between ExpDiss and performance varies significantly across the 35 teams. Importantly, the results do not show any significant change in model fit ($\chi^2 = 0.209$, $df = 1$, $p > .05$), suggesting no salient variation in the slope across teams. The results of these three steps suggest that (1) ExpDiss does not directly affect individual performance and (2) this relationship does not change significantly across teams. Second, we replicated every step reported in Table 8 while adding ExpDiss as an additional control variable. The results show (1) a non-significant effect of ExpDiss on performance and (2) a significant three-way interaction for creativity, GeoDisp, and TMS on performance ($B = -0.41$, $p < 0.001$), qualitatively the same as that reported in Table 8. The results of these two tests together suggest that ExpDiss does not directly affect performance. Namely, it is *creativity,* but ExpDiss, that affects individual performance.

Finally, in their cross-level research on teams and individual members, Liao and Chuang (2004) aggregated individual performance to the team level and confirmed that, similar to team-level performance, this aggregated measure significantly relates to customer outcomes like satisfaction and loyalty (Liao and Chuang 2004). Our research does not study team performance given our focus on individual-level process and outcome. To lend credibility to our results, we aggregated individual performance to the team level (*Rwg* = 0.72) and found that this aggregated measure correlates significantly with the team performance measure reported by team leaders (correlation=0.31, *p*<0.05). This result reinforces the importance of investigating individual performance in IT project teams.

6. DISCUSSION

6.1 Summary of Results

Firms recruit experts worldwide to form cross-locational teams to create novel IT artifacts. Yet multi-disciplinary, cross-locational IT project teams have their own challenges when it comes to individual members' creativity and performance. In this study, we develop a model to better understand the cross-level joint interaction effects of team-level GeoDisp and TMS on individual-level relationships between ExpDiss and creativity, and between creativity and performance, in the IT project team context. We summarize our findings in Table 9 and discuss their implications.

Table 9: Summary of Results

Results of Hypothesis Testing	Findings
TMS x **GeoDisp** ↓ **ExpDiss** → **Creativity** H1a: $(\beta_{\text{low-GeoDisp, low-TMS}} = -0.52^{*}) < (\beta_{\text{high-GeoDisp, low-TMS}} = 0.06, \text{ns})$ H1b: $(\beta_{\text{high-GeoDisp, high-TMS)}} = 0.26^{*})$ & $(\beta_{\text{low-GeoDisp, high-TMS}} = 0.31^{*}) > 0$	Team-level GeoDisp and TMS jointly moderate the individual-level relationship between ExpDiss and creativity such that (1) in the case of low TMS, the link is negative in low-GeoDisp teams but not significant in high-GeoDisp teams, but (2) in the case of high TMS, this link is positive for both high-GeoDisp and low-GeoDisp teams.
Creativity → **Performance** H2: $\beta = 0.79^{***}$	The creativity of an individual member is positively associated with his or her performance.
TMS x **GeoDisp** ↓ **Creativity** → **Performance** H3a: $(\beta_{\text{low-GeoDisp, low-TMS}} = 0.85^{**}) < (\beta_{\text{high-GeoDisp, low-TMS}} = 1.42^{***})$ H3b: $(\beta_{\text{low-GeoDisp, high-TMS}} = 1.48^{***}) > (\beta_{\text{high-GeoDisp, high-TMS}} = 0.91^{**})$	Team-level GeoDisp and TMS jointly moderate the individual-level relationship between creativity and performance such that (1) in the case of low TMS, the link is stronger in high-GeoDisp teams than in low-GeoDisp teams, but (2) in the case of high TMS, the link is stronger in low-GeoDisp teams than in high-GeoDisp teams.

Note: $^{*}p < 0.05$, $^{**}p < 0.01$, ** $p < 0.001$.

First, we confirm that team-level GeoDisp and TMS co-determine if an individual can or cannot leverage his or her exposure to dissimilar other's expertise for idea generation in cross-functional, cross-locational IT project teams. As hypothesized, low TMS represents an unproductive contingency. While ExpDiss has no influence on the creativity of members of high-GeoDisp teams, it compromises individual creativity in low-GeoDisp teams. Fortunately, when the team TMS level is high, members of both high- and low-GeoDisp teams can benefit from ExpDiss in terms of stronger creativity. Our results show that the positive link between ExpDiss and creativity is not significantly different between high- and low-GeoDisp teams if there is a well-developed team TMS. This finding suggests that TMS provides creativity benefits to individual members regardless of a team's GeoDisp.

Our results further reveal that there is a direct significant positive relationship between an individual member's creativity and his or her job performance in the IT project team context. This individual-level relationship is also moderated by the joint effect of team-level GeoDisp and TMS. Specifically, our findings suggest that for members of co-located IT project teams, low TMS creates a less favorable environment for implementing their creative ideas to attain performance outcomes than it does for members of geographically distributed IT project teams. In contrast, high TMS levels create more opportunities for co-located IT project team members to translate creative ideas into better performance than it does for members of distanced IT project teams.

6.2 Theoretical Contributions

This study offers important contributions to several research areas, including IT project teams, IGII, GeoDisp, and TMS. First, the rapid changes in both business environments and IT knowledge are driving more firms to adopt the practice of cross-functional, cross-locational IT project teams to assemble dissimilar experts with cutting-edge skills to develop novel IT artifacts (Lakhani et al. 2012). The hyper-dynamic nature of IT projects (per §2.1), however, along with its functional dissimilarity and GeoDisp embedded in this practice, make it particularly difficult to ensure that a focal team member can (1) benefit from, rather than be harmed by, dissimilar other's expertise for his or her own idea generation, and then (2) implement his or her creative ideas as actual IT components. Addressing these challenges demands a sound and holistic theoretical understanding of this sophisticated phenomenon. To this end, this study contributes to the literature on individual creativity and performance in the IT project teams by developing a research model that draws on TMS to address the complete IGII process in cross-functional, cross-locational IT project teams.

Meanwhile, scholars of IT project teams (e.g. Windeler et al. 2017), as well as those of IGII (e.g. Škerlavaj et al. 2014) and TMS (e.g. Ren and Argote 2011), have all discussed the limitations of single-level research and thus called for cross-level efforts. While more studies are embracing a cross-level approach (e.g. Bachrach et al. 2017), our work is among the first to consider both GeoDisp and TMS as critical team-level boundary conditions for the individual-level IGII process. Admittedly, applying a cross-level perspective empowered us to simultaneously identify GeoDisp (which complicates the IGII process) and TMS (which serves as a good solution). Our discovery that team-level GeoDisp and TMS jointly moderate the individual-level relationships between ExpDiss and creativity, and between creativity and performance, illustrates the theoretical utility of taking a cross-level approach to comprehensively study a complex phenomenon such as multi-disciplinary, distributed IT project teams this study addresses.

More importantly, a cross-level perspective enabled us to discover nuances and insights that would have been unattainable otherwise. Our findings show that during the idea-generation stage, it is unclear if ExpDiss has a positive or negative impact on individual creativity in multi-disciplinary IT project teams. Rather, it is the team-level *contingencies* (i.e. TMS and GeoDisp) that jointly determine whether an individual member in cross-functional, cross-locational IT project teams can extract the benefits and minimize the drawbacks of ExpDiss for his or her creativity (per H1). For the idea-implementation stage, we illustrate the positive effect of individual creativity on individual performance documented in prior IGII studies (Baer 2012) (per H2) and extend this finding to the

IT project team context. We further confirm that the effect of individual creativity on individual performance is also contingent on the interaction effect of team-level GeoDisp and TMS (per H3). These findings render a holistic understanding for how to manage multi-functional, distributed IT project teams, representing a critical contribution to the IT project team research.

The results of our study also expand our knowledge of the role GeoDisp plays in the IT project team literature. As mentioned in §2.3, prior GeoDisp studies have tended to emphasize its direct impacts. Although Wang et al. (2019) revealed the contingent role of team-level GeoDisp in adjusting team-level relationships, our study is among the first to uncover how team-level GeoDisp also exerts a cross-level moderating effect on individual-level relationships. Meanwhile, as globally dispersed IT project teams become more common (Haselberger 2016), researchers need to pay more attention to the impact of GeoDisp on individual team members' behavioral patterns. While most extant research has focused on the limitations of GeoDisp, only a few studies have simultaneously considered the positive and negative aspects of GeoDisp. To develop a more holistic understanding of the role of GeoDisp in IT project teams with different degrees of dispersion, this study illustrates the importance of considering *both* the pros and cons of GeoDisp. Our work offers more in-depth knowledge of the complexity that individuals encounter in cross-locational IT project teams, a very important research implication.

The findings of this work also advance the TMS literature on two fronts. First, while Bachrach et al. (2017) identified the contingency role of team-level TMS on individual-level relationships, their theoretical development and empirical tests focused exclusively on the sales team context, which is qualitatively different from our investigative context. Our findings on the cross-level moderation effects of team-level TMS on individual-level relationships in the IT project team context represent a unique contribution to the emerging literature on the cross-level impacts of TMS in rendering various types of individual-level benefits. We thus encourage more scholarly attention on the contingency role of higher-level TMS in lower-level behavioral patterns in other contexts.

Second, scholars have called for investigations of TMS benefits for both co-located and distributed IT project teams (Alavi and Tiwana 2002), and how TMS can help address the challenges of co-located versus distributed collaboration (Lewis and Herndon 2011; Ren and Argote 2011). Responding to this call, our study adds to the TMS literature by (1) explicitly incorporating GeoDisp as a team-level contingency when theorizing the influence of individual ExpDiss on creativity and the impact of creativity on performance, and (2) by identifying TMS as a critical team-level intervention. In this vein, we show that a high-TMS team environment confers advantages on individual members of both co-located and distributed teams during idea generation and implementation. In contrast, in a low-TMS team environment, low GeoDisp represents a substantial barrier to individual creativity and performance, whereas high GeoDisp offsets the potential drawbacks of low TMS. Members of low-TMS/high-GeoDisp teams actually benefit more (or suffer less) than their counterparts in low-TMS/low-GeoDisp teams. To recapitulate, our work provides a finer-grained understanding of the benefits that team-level TMS provides to individual members of both co-located and distributed IT project teams.

Finally, emerging trends like *work from home* and *digital nomads* are further pushing organizations to incorporate this multi-disciplinary and geographically dispersed approach for the design of future work (Kudyba et al. 2020). Toward this end, our findings represent a promising direction that warrants more scholarly effort in the area of future work.

6.3 Implications for Practice

The widespread digitalization of business processes and their rapid deployment on a global scale have made creative IT artifacts more important than ever (Fichman et al. 2014). Firms assemble multi-disciplinary, cross-locational IT project teams and charge them with delivering novel IT artifacts. To foster individual creativity in this setting, however, managers should not naïvely assume that individual exposure to distinct others will always lead to novel ideas, nor should they assume that team-level GeoDisp represents a negative force. Rather, managers need to realize the double-edged nature of ExpDiss and GeoDisp and realize that TMS can be a compelling solution in the IT project team context. As such, one of the highest priorities for managers who intend to form cross-functional, cross-locational IT teams is to ensure strong TMS.

While TMS may help stimulate individual creativity and performance in multi-disciplinary, cross-locational IT project teams, managers should understand the boundary regarding the effects of TMS. In particular, high team-level TMS always helps individuals leverage dissimilar other's expertise for personal creativity regardless of whether they work in a co-located or dispersed team. Yet individual creativity is likely to be hampered by co-location when team-level TMS is low. Finally, managers should use an appropriate mix of team-level contingencies (e.g. high TMS and low GeoDisp) to maximize individual performance in IT project teams.

6.4 Limitations and Future Research

This study has several limitations that also present opportunities for future research. First, while both our theoretical development and empirical setting are geared toward the IT project team context, we suspect our model could be generalized to non-IT project team settings featuring some degree of dynamism. Interested scholars should assess the extent to which our findings are applicable to other project team contexts.

Next, our measure of ExpDiss centering on individual team members' functional expertise is faithful to prior works (e.g. Huang et al. 2014; Tsui et al. 1992; Van der Vegt et al. 2003). Yet we encourage future research to further examine if other types of dissimilarity (e.g. dissimilarity in gender, age, social network, or mental mode) also affect IGII in IT project teams. Meanwhile, our measure of GeoDisp does not capture the formation of geographical sub-groups among team members. Future research could thus extend the GeoDisp measure (O'Leary and Mortensen 2010).

In addition, our cross-level model explains how team-level factors jointly affect the ExpDiss-creativity link without considering individual creative ability (Woodman et al. 1993). As an individual's own creative capacity may affect his or her ability to generate ideas (e.g. Choi et al. 2009), we recommend that interested scholars capture individual creative ability in future research to provide a more refined understanding in this regard.

Meanwhile, our decision to control higher-level factors that could affect idea generation or implementation and TMS, such as team size, task difficulty, and project duration (see §4.3), safeguards the validity of our results to a certain extent. Nonetheless, there could be other high-level factors that affect both TMS and IGII, offering alternative explanations. We encourage future research to control for additional high-level factors when studying TMS and IGII.

It is also possible that project characteristics (e.g. single-site versus multi-site) or project phase may affect the extent to which ExpDiss and GeoDisp matter for idea generation and implementation. We hence recommend controlling for the effects of task nature and project phase in future research.

Finally, our sample size of 141 members from 35 teams, although not particularly large, is comparable to some cross-level studies in the creativity (Dokko et al. 2014; Gajendran and Joshi 2012; Mueller 2012; Richter et al. 2012; Sacramento et al. 2013) and TMS (Kanawattanachai and Yoo 2007; Robert Jr et al. 2008; Tiwana and McLean 2005) literature. While the results support our three hypotheses, we propose that scholars who are interested in applying a cross-level approach maximize the sample size when resources permit.

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Appendix A. Creativity in IT Project Teams

Author(s) and Year	Individual or Team Creativity	Co-located or Distributed Team	Level of Analysis	Relevant Findings
Chen et al. 2008	Team creativity	Undefined	Team	Team-level social interaction enhances team creativity.
Cheng 2012	Team creativity	Co-located	Team	Team-level expertise integration positively impacts team creativity.
Cheng and Yang 2011	Team creativity	Co-located	Team	Team-level domain knowledge and team-level motivation both positively impact team-level creativity.
Farh et al. 2010	Team creativity	Unspecified	Team	Team-level task conflict has an inverted U-shaped effect of team creativity.
Khedhaouria et al. 2013	Team creativity	Co-located	Team	Team-level knowledge sourcing and learning orientation both enhance team creativity.
Tiwana and McLean 2005	Team creativity	Co-located	Team	Team-level expertise integration positively impacts team-level creativity.
Fagan 2004	Individual creativity	Co-located	Individual	Individual perceptions of positive contextual stimulants (freedom, challenging work, supervisory encouragement, work-group support, organizational encouragement) positively affect individual creativity. Individual perceptions of negative contextual stimulants (organizational impediments, workload pressure) negatively affect individual creativity.
Hahn et al. 2015	Individual creativity	Co-located	Individual	Individual exploitation and exploration activities positively affect individual creativity.
Chae et al. 2015	Individual creativity	Unspecified	Cross-level	Team-level knowledge sharing, and team-member exchange positively impact individual creativity.
Huang et al. 2014	Individual creativity	Unspecified	Cross-level	The effect of individual-level expertise dissimilarity on individual creativity is contingent on team-level knowledge sharing.
Wang et al. 2015	Individual creativity	Co-located	Cross-level	The effect of leader-member exchange on individual creativity is contingent on team-member exchange.

Appendix B. Studies Investigating the Impact of TMS

Authors (Year)	Level of Analysis	Direct Effect/ Moderating	TMS Conceptualization (Source)	Team Context	Outcome Variables	Findings Related to TMS
Akgun et al. (2005)	Single-level (team level)	Direct impact	Single construct (adapted from Lewis 2003)	NPD teams	Team performance (team learning, speed-to-market, new product success	TMS facilitates information processing and coordination. TMS has a positive association with team learning, speed-to-market, and new product success.
Akgun et al. (2006)	Single-level (team level)	Direct impact	Single construct (adapted from Yoo and Kanawattanachai 2001)	NPD teams	Process effectiveness (team learning, speed to market)	TMS facilitates an integrative process of information/knowledge processing and coordination among team members; team members' mutual understanding, problem solving, and decision making are faster with TMS.
Austin (2000)	Single-level (team level)	Direct impact	Three distinctive dimensions	Business teams	Team performance	TMS facilitates communication, knowledge integration
Austin (2003)	Single-level (team level)	Direct impact	Four dimensions (self-developed)	Product teams	Team performance	Task and external relationship TMS are positively related to three measures of team performance as TMS can reduce knowledge search and coordination miscues and enable knowledge use.
Bachrach et al. (2014)	Single-level (team level)	Direct impact	Single construct (Lewis 2003)	Project management teams	Team performance	TMS enhances team performance by diminishing resources losses from intra-team task, relationship, and process conflict involvement.
Bachrach et al. (2019)	Single-level (team level)	Direct impact	Consider both as a single construct and as three independent dimensions	N.A. (Meta-analysis)	Team performance (task performance, affective performance, and creative performance)	TMS facilitates faster information search, helps ensure that task-critical information is not forgotten or overlooked, and ensures knowledge is available to the team, thus contributing to team performance.
Bachrach and Mullins (2019)	Single-level (team level)	Direct impact	Single construct (Lewis 2003)	Sales teams	Team performance	TMS is positively associated with team performance and the relationship is stronger when market dynamics is higher.
Chen et al. (2013)	Single-level (team level)	Direct impact	Four distinct dimensions	Open source software teams	Knowledge sharing and Communication quality	Some dimensions of TMS facilitate communication quality, while some dimensions improve knowledge sharing.
Chiang et al. (2014)	Single-level (team level)	Direct impact	Single construct (Lewis 2003)	NPD teams	Team performance	TMS facilitates cross-functional knowledge exchange, integration, and exploitation, improving new product performance.
Choi et al. (2010)	Single-level (team level)	Direct impact	Single construct (Lewis 2003)	Business teams	Team knowledge sharing, knowledge application	TMS facilitates knowledge sharing and knowledge application, the latter significantly enhancing team performance.
Dai et al. (2016)	Single-level (team level)	Direct impact	Single construct (adapted from Lewis 2003)	Venture teams	Firm entrepreneurial orientation	TMS facilitates knowledge integration, trust in others' expertise; provides understanding of other's viewpoints; reduces conflict.
Heavey and Simsek (2015)	Single-level (team level)	Direct impact	Single construct (Lewis 2003)	Top management teams	Firm performance	TMS facilitates interpreting information from others, understanding others' viewpoints and reducing risk of being overwhelmed.
Heavey and Simsek (2017)	Single-level (team level)	Direct impact	Single construct (Lewis 2003)	Top management teams	Firm ambidexterity orientation	TMS deepens the basis of exploitative and exploratory knowledge and accelerates the ability to develop an ambidextrous orientation.
Hood et al. (2014)	Single-level (team level)	Direct impact	Single construct (conceptual paper)	N.A.	Task conflict, relationship conflict	TMS enhances team performance by generating resource surpluses and indirectly by diminishing the resources expended on task and relationship conflicts among members.
Hsu et al. (2012)	Single-level (team level)	Direct impact	Single construct (Borgatti and Cross 2003)	Individual IS professionals	Communication, coordination, team performance	TMS facilitates communication, knowledge integration; allows members to anticipate others' knowledge needs

Huang and Hsieh (2017)	Single-level (team level)	Direct impact	Single construct (Lewis 2003)	R&D teams	Team creativity	TMS facilitates trust in others' expertise, integration and coordination of others' diverse expertise.
Huang et al. (2013)	Single-level (team level)	Direct impact	Three distinctive dimensions	Business teams	Team knowledge quality, knowledge satisfaction	TMS facilitates communication and knowledge integration.
Jackson and Moreland (2009)	Single-level (team level)	Direct impact	Single construct (Lewis 2003)	Student teams	Team performance	TMS facilitates information processing, thus improves team performance.
Kanawattanachai and Yoo (2007)	Single-level (team level)	Direct impact	Three distinctive dimensions	Student teams	Team performance	TMS facilitates communication and knowledge integration, and TMS-induced trust reduces interaction complexity, leading to better performance
Lee et al. (2014)	Single-level (team level)	Direct impact	Single construct (Lewis 2003)	Student teams	Team performance	TMS enhances information processing efficiency and coordination of task and expertise-related information, improves team performance.
Lewis (2004)	Single-level (team level)	Direct impact	Single construct (Lewis 2003)	Consulting teams (MBA students)	Team performance, viability	TMS helps members share and integrate their expertise quickly and efficiently, resulting in high team performance.
Pearsall and Ellis (2006)	Single-level (team level)	Direct impact	Single construct (Lewis 2003)	Student teams	Team performance, team satisfaction	Critical team member dispositional assertiveness positively affects team performance and team satisfaction through TMS.
Peltokorpi and Hasu (2016)	Single-level (team level)	Direct impact	Single construct (Lewis 2003)	Technology research teams	Team innovation	TMS facilitates awareness of others' viewpoints, expertise integration
Ren and Argote (2011)	Single-level (team level)	Direct impact	N.A. (review and conceptual paper)	N.A. (review and conceptual paper)	Team performance behaviors and outcomes; member affective outcome	TMS facilitates the division of cognitive labor among members, the search and location of required knowledge, match of problems with the requisite expertise, the coordination of group activities, and better decisions, which improves team performance
Zhang and Guo (2019)	Single-level (team level)	Direct impact	Single construct (Lewis 2003)	Various work teams (e.g., engineering, R&D, etc.)	Team performance (effectiveness and efficiency, team satisfaction)	A project team's TMS mediates the positive effect of team member knowledge diversity on team performance when the project manager emphasizes knowledge leadership.
Zhang et al. (2007)	Single-level (team level)	Direct impact	Single construct (Lewis 2003)	Technology teams	Team performance	TMS facilitates members from various functional backgrounds to take advantage of each other's knowledge and expertise, thus is positively related to team performance.
Dai et al. (2017)	Single-level (team level)	Direct and moderating effects	Single construct (adapted from Lewis 2003)	Venture teams	New venture ambidexterity	TMS facilitates the communication and knowledge integration of entrepreneurial teams. TMS also positively moderates the relationship between the venture's new product development alliances and the venture's ambidexterity.
Marques-Quinteiro et al. (2013)	Single-level (team level)	Moderating effect	Single construct (adapted from Lewis 2003)	Police teams	Team adaptive behavior	TMS frees cognitive resources for monitoring and effective communication, thus strengthens the positive relationship between team implicit coordination and team adaptive behaviors.
Fan et al. (2016)	Cross-level	Direct impact	Single construct (Lewis 2003)	Student teams	Individual creative self-efficacy, innovative behavior, team innovation	TMS facilitates knowledge integration among team members, provides task-related assistance, emotional support and trust; TMS positively affect individual innovative behavior and team innovation.
Jarvenpaa and Majchrzak (2008)	Cross-level	Direct impact	Single construct (Lewis 2003)	Individuals in security network	Individual combinative capability	TMS enables better knowledge coordination with others in an individual's network.
Bachrach et al. (2017)	Cross-level	Moderating effect	Single construct (adapted from Lewis 2003)	Sales teams	Individual sales performance	Team-level TMS moderates individual-level relationships from learning effort to sales performance and from commitment to service quality to sales performance.

Appendix C. Measurement Items and Loadings

Constructs	**Items**	**Loading**
Transactive Memory System: Specialization (Lewis 2003)	(Strongly Disagree/Agree, 1–7 scale)	
	1. Each team member has specialized knowledge of some aspect of our project.	0.78
	2. I have knowledge about an aspect of our project that no other team member has.	0.72
	3. Different team members are responsible for expertise in different areas.	0.83
	4. The specialized knowledge of several different team members was needed to complete our project deliverables.	0.84
	5. I know which team members have expertise in specific areas.	Dropped
Transactive Memory System: Credibility (Lewis 2003)	6. I was comfortable accepting procedural suggestions from other team members.	0.78
	7. I trusted that other members' knowledge about our project was credible.	0.79
	8. I was confident relying on the information that other team members brought to the discussion.	0.76
	9. When other members gave information, I wanted to double-check it for myself.*	Dropped
	10. I did not have much faith in other members' expertise.*	Dropped
Transactive Memory System: Coordination (Lewis 2003)	11. Our team worked together in a well-coordinated fashion.	0.78
	12. Our team had very few misunderstandings about what to do.	Dropped
	13. Our team needed to backtrack and start over a lot.*	0.83
	14. We accomplished the task smoothly and efficiently.	0.84
	15. There was much confusion about how we would accomplish the task.*	0.72
Geographic Dispersion (Kerr and Jermier 1978)	(Strongly Disagree/Agree, 1–5 scale)	
	1.The nature of our teamwork is such that team members are co-located when working.	0.77
	2.Members of this team are in actual contact or direct sight of one another.	0.68
	3.Members of this team vary widely in their physical work locations.	0.87
Creativity (Zhou and George 2001)	This employee . . . (Strongly Disagree/Agree, 1–5 scale)	
	1. suggests new ways to achieve goals or objectives.	0.74
	2. comes up with new and practical ideas to improve performance.	0.79
	3. searches out new technologies, processes, techniques, and/or product ideas.	0.73
	4. suggests new ways to increase quality.	0.81
	5. is a good source of creative ideas.	0.74
	6. is not afraid to take risks. *	Dropped
	8. exhibits creativity on the job when given the opportunity to.	0.78
	10. often has new and innovative ideas.	0.73
	11. comes up with creative solutions to problems.	0.80
	12. often has a fresh approach to problems.	0.77
	13. suggests new ways of performing work tasks.	0.77
Performance (Van Scotter and Motowidlo 1996)	1. Did the ratee exceed, meet, or not meet the standards for job performance? (Didn't meet/Exceeded, 1–7 scale)	0.94
	2. Did the ratee perform at a low, average, or high level in comparison to others of the same rank? (Low/High, 1–7 scale)	0.91
	3. Did the ratee contribute less, an average amount, or more to team effectiveness than others in the same work unit? (Less/More, 1–7 scale)	0.87

* Reverse coded

Appendix D. Item Loadings and Cross-Loadings

Construct	Items	TMS Specialization	TMS Credibility	TMS Coordination	GeoDisp	Creativity	Performance
TMS Specialization	TMS1	0.80	0.01	0.23	0.03	0.09	-0.20
	TMS2	0.71	0.04	-0.03	0.13	0.13	0.16
	TMS3	0.83	0.13	-0.08	-0.09	0.04	0.13
	TMS4	0.82	0.19	-0.00	-0.17	0.01	0.11
TMS Credibility	TMS6	-0.04	0.72	0.26	-0.14	0.08	0.21
	TMS7	0.37	0.71	0.33	0.14	-0.01	-0.10
	TMS8	0.28	0.75	0.29	0.09	0.08	-0.16
TMS Coordination	TMS11	0.16	0.19	0.79	-0.04	-0.02	0.03
	TMS13	-0.02	0.12	0.85	-0.11	0.08	0.02
	TMS14	0.11	0.18	0.82	0.05	-0.10	-0.03
	TMS15	-0.20	0.14	0.72	-0.20	0.14	0.08
Geographical Dispersion (GD)	GD1	-0.14	0.11	-0.09	0.79	-0.14	0.07
	GD2	-0.01	-0.23	-0.07	0.67	0.12	-0.12
	GD3	0.06	0.12	-0.07	0.85	0.09	0.10
Creativity	Creativity1	0.03	0.02	-0.03	0.06	0.73	0.35
	Creativity2	0.15	0.09	0.06	0.07	0.81	0.02
	Creativity3	0.04	0.02	-0.10	-0.03	0.74	0.28
	Creativity4	0.02	-0.07	0.08	0.11	0.83	0.03
	Creativity5	-0.02	0.09	-0.04	-0.01	0.80	0.02
	Creativity8	0.05	0.03	0.08	-0.00	0.80	0.01
	Creativity10	-0.05	0.15	-0.03	0.01	0.81	-0.02
	Creativity11	0.02	0.05	0.08	-0.10	0.81	0.15
	Creativity12	0.08	-0.22	0.12	-0.00	0.76	0.15
	Creativity13	0.03	0.00	-0.10	-0.01	0.83	-0.08
Performance	Perf1	0.18	-0.08	0.09	0.08	0.09	0.89
	Perf2	0.23	0.00	0.09	0.07	0.03	0.91
	Perf3	0.16	0.04	0.08	0.02	0.04	0.90