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TRANSACTIVE MEMORY SYSTEMS, KNOWLEDGE INTEGRATION, AND TEAM PERFORMANCE IN GEOGRAPHICALLY DISPERSED TEAMS

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Abstract

This study proposes and tests a model that explains the mediating mechanism through which the transactive memory system (TMS) of a team impacts on team performance under varying levels of team geographic dispersion. The model proposes that the relationship between TMS and team performance is mediated by the extent of knowledge integration among team members. The model further proposes that the degree of team geographic dispersion moderates the effect of TMS and knowledge integration on team performance. Survey data from 54 project teams in a major telecommunication company were collected to test the model. The study develops a deeper understanding of the mechanism through which TMS affects team performance and highlights the need to explicitly theorize team geographic dispersion, an important characteristic of contemporary project teams, in TMS research.

Keywords: transactive memory system, knowledge integration, virtual teams, dispersion, survey method

1 Introduction

Geographically distributed teams have become commonplace in contemporary business practice. IT service delivery is provided in form of interdisciplinary teams that comprise representatives from headquarters, branch-office and client (Siakas and E. Siakas, 2008). Geographically distributed teams are specifically deployed to address complex and idiosyncratic business problems that require extended engagement between the team and its clients. The composition of these teams is largely focused on covering the diverse knowledge domains required to address the focal problem (Dainty, Raidén and Neale, 2009) and team members are expected to seamlessly integrate their relevant expertise. The involvement of diverse team-members and their dynamic allocation creates a working environment which makes it difficult for teams to go through traditional team formation stages (Klein et al., 2009) and limits the team member's ability to integrate their expertise (Alavi and Tiwana, 2002).

As these geographically distributed teams are specifically set up to pool the necessary expertise (Boutellier et al., 1998) it is important to explore the mechanisms which allow the team members to purposefully integrate their expertise despite their difficult team environments. The theory of transactive memory systems (TMS) provides a particularly valuable lens for investigating and explaining variations in the performance of teams. The TMS literature argues that a team's shared cognitive structure and cognitive interdependence among its members have an impact on team performance (Lewis, 2003). Despite its ability to explain team performance, a large part of dedicated TMS research is based on laboratory settings (Kanawattanachai and Yoo, 2007; Lewis, Lange and Gillis, 2005; Lewis, 2004) with a limited number of studies testing its applicability in actual business scenarios (Choi, Lee and Yoo, 2010; Jarvenpaa and Majchrzak, 2008).

The complex problems and dynamic nature that characterize the work of today's geographically distributed teams allow us to put TMS theory under the test and challenge its relevance for investigating contemporary collaboration scenarios. Our study seeks to extend TMS theory by integrating two new concepts into the TMS model: *geographic dispersion* and *knowledge-integration*. The results show that a team with a well developed TMS is able to overcome the difficulty of geographic distribution and perform well even when team members are highly distributed.

2 Theoretical Background

A transactive memory system (TMS) captures the cognitive interdependence and shared cognitive structure among individuals (Lewis, 2003). In the team context, the TMS depicts how members establish a common meta-knowledge of who knows what. "Group transactive memory consists of both the pool of individual members' transactive memory (memory influenced by what other members know) as well as members' understanding of who possesses what knowledge" (Lewis, 2003, p.588). A TMS describes a team-based cognitive capability. The TMS construct (Lewis, 2003) does not capture the actual utilization of the individual expertise but a team-based cognitive capability in form of a meta-knowledge that is formed between team members and the relational structure that bridge their individual expertise.

The literature conceptualizes the TMS construct along three components (e.g., Moreland and Myaskovsky, 2000; Liang, Moreland and Argote, 1995): (1) *knowledge specialization* as the differentiation among team members' expertise. (2) *credibility* as the trust in the team members' expertise. (3) *coordination* as the team member's ability to work together efficiently. The focus on specialization, credibility, and coordination as the core components and indicators of a team's TMS is widely accepted (e.g. Lewis, 2003) and several studies show how a team's TMS significantly complements the extant knowledge base and contributes to task performance (e.g. Liang et al., 1995). An existing TMS even enables collaboration among team members in the absence of extensive communication among them (Moreland and Myaskovsky, 2000).

Although a range of studies confirm the positive impact of TMS on performance, an uncertainty about the underlying mechanisms remains (Austin, 2003). Explanations provided for this positive impact of a well-developed TMS, such as efficiencies in knowledge processes and communication flows (Austin, 2003), often lack empirical evidence. While the positive impact of a team's TMS on its performance is generally accepted, an understanding of the underlying mechanisms enabling this relationship is still developing. In the next section we build upon earlier studies to theorize the role of knowledge integration as mediator between a team's TMS and performance.

2.1 Team-based knowledge integration

Knowledge integration describes the synthesizing of individual expertise (Tiwana and Mclean, 2005). The diverse expertise held by different team members is recombined at the project level. The mechanisms that facilitate knowledge integration are diverse. Rich dialogue and direct negotiation allow individuals to articulate their expertise and to formulate the gaps in the expertise available (Mitchell, 2006; Okhuysen and Eisenhardt, 2002). Rico et al (2008) emphasize how team-based knowledge integration is facilitated by implicit coordination instead of communication: individuals anticipate the knowledge needs of colleagues and provide the available knowledge without the need for extensive planning and direct communication. In addition, several authors (e.g., Alavi and Tiwana, 2002; Newell, Tansley and Huang, 2004; Tiwana and Mclean, 2005) have elaborated on the importance of team-based qualities, such as social capital or absorptive capacity, as facilitators of knowledge integration.

Several studies elaborate on the importance of knowledge integration and show how team-based knowledge integration supports team performance. Mitchell (2006) and Tiwana (2004) establish that the level of knowledge-integration among team-members has a direct impact on project completion and quality. Knowledge integration leads to a shared understanding and stimulates novel associations among project team members.

2.2 Teams and geographic dispersion

Geographic dispersion has been frequently theorized with its implication on teams and teamwork. Early research has identified that physical proximity contributes to the frequency and quality of communication among team members (Burke et al., 1999; Conrath, 1973; Monge and Kirste, 1980). Geographic distance decreases the likelihood of face-to-face interaction and hereby reduces spontaneous communication (O'Leary and Cummings, 2007). Despite today's abundance of communication and collaboration technology, geographic dispersion remains an important team characteristic with critical implications for team processes (O'Leary and Cummings, 2007). We will next develop a research model which proposes a multi-varied impact of the geographic dispersion on the knowledge integration processes and the way knowledge integration relates to a team's shared cognitive structure and performance.

3 Research Model

Our research model integrates the concepts of TMS, geographic dispersion, knowledge integration, and team performance (see figure 1). TMS is conceptualized to have a positive impact on a team's knowledge-integration process (H1), which, in turn, positively contributes to team performance (H2). Our model further stipulates a multi-faceted impact of geographic dispersion on the TMS-knowledge integration-performance chain. Geographic dispersion is hypothesized to have a direct impact on the knowledge-integration process (H3a) of a team, but is also believed to moderate the relationship between

TMS and knowledge integration (H3b), as well as between knowledge integration and team performance (H3c). The individual hypotheses are subsequently outlined in detail.

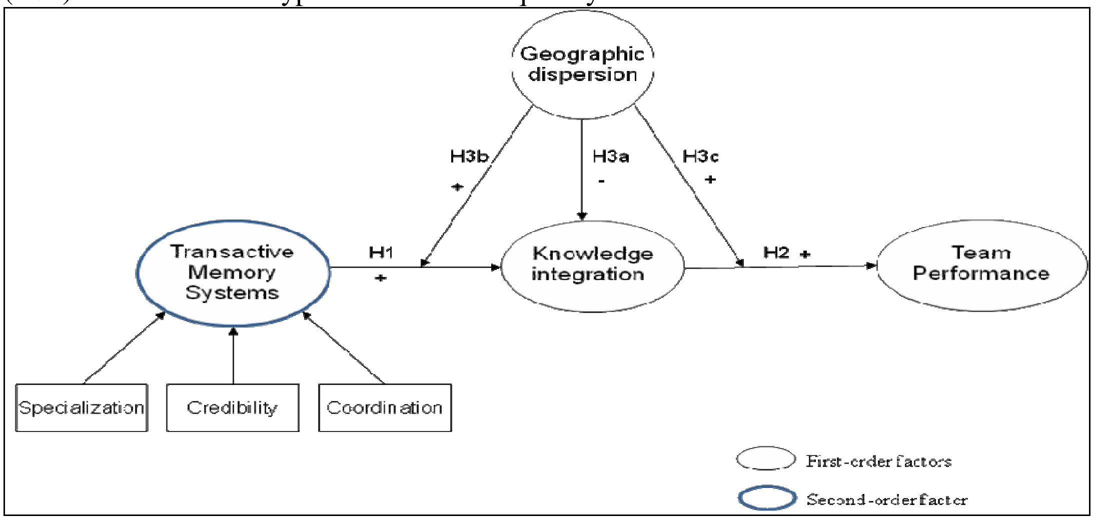

Figure 1. Research Model

Knowledge integration is based on a complex interplay between knowledge held on the individual level and its recombination on the team level (Tiwana and Mclean, 2005). Knowledge integration requires bonding among team members (Newell, Tansley and Huang, 2004) and is facilitated by communication structures and internal processes (Okhuysen and Eisenhardt, 2002). The TMS of a team characterizes its existing meta-knowledge (Lewis, 2003), which allows team members to identify the location of the required expertise ,judge its credibility and coordinate its use. Existing meta-knowledge even allows team members to anticipate required expertise (Rico et al., 2008) and to signal its availability. In a recent study, Choi et al. (2010) show how a team's TMS facilitates knowledge application, of which knowledge integration forms an important part. Considering the importance of a team's meta-knowledge for its knowledge-integration process, we can hypothesize:

H1: A higher TMS level leads to higher levels of knowledge integration.

Knowledge integration contributes to team work and team performance on a number of levels. The on-demand characteristics of the knowledge-integration processes minimize unnecessary duplication of knowledge resources (Grant, 1996; Tiwana and Mclean, 2005). Integrating diverse knowledge resources improves the quality of decision making (Robert Jr, Dennis and Ahuja, 2008) and the development of superior solutions as individuals contribute insights "which might not be known in their entirety to any single individual in the team" (Tiwana and Mclean, 2005, p. 20). Team members link newly created associations back to their individually held expertise that impacts on the level of creativity of the output (Tiwana and Mclean, 2005). Following studies that have examined the effect of knowledge integration on team performance (Lin and Chen, 2006; Tiwana, 2004), we formulate the following hypothesis:

H2: A team's level of knowledge integration impacts positively on its project performance.

The geographic dispersion of a team is expected to impact its knowledge integration process. Physical distance minimizes the frequency of communication among individuals (Conrath, 1973; Monge and Kirste, 1980), and even today's abundance of information and communication technology has not been able to fully overcome this effect (Cramton and Webber, 2005; Cramton, 2001). Technology-mediated communication limits the provision of interaction cues and contextual information (Kiesler and Sproull, 1992). Geographic dispersion prevents team members from being exposed to the struggles of other team members or from overhearing background conversation detailing current issues (Hinds and Mortensen, 2005). Knowledge integration benefits from social interactions (Mitchell, 2006) and is facilitated by team members directly questioning each other (Okhuysen and Eisenhardt, 2002). Rich and iterative communication is required to pool the knowledge among team members (Anand, Manz and Glick, 1998). Consequently, we hypothesize:

H3a: High geographic dispersion among team members has a negative impact on the knowledge-integration practices of a team.

Dispersion of team member's locations can be expected to moderate the positive relationship between TMS and knowledge integration. Robert Jr. et al. (2008) show how the structural and cognitive capital of a team minimizes the negative impact of a lean communication system and enables knowledge integration. Established routines and coordinated working arrangements constitute efficient alternatives to direct communication and facilitate knowledge integration (Grant, 1996). For highly virtual teams, such forms of implicit coordination among members are much more important than face-to-face teams as the members have limited ability to rely on communication to coordinate (Rico et al., 2008). Hence, when communication among team members is more challenging (high geographic dispersion), the need for a shared cognitive structure among team members to integrate their knowledge sources is higher. In contrast, when communication among team members is more straightforward (low geographic dispersion), the cognitive structure is less important for the knowledge-integration process. As the need for extensive interaction seems to be reduced for teams that have established a high level of TMS (Moreland and Myaskovsky, 2000) the following impact of geographic dispersion can be hypothesized:

H3b: Geographic dispersion positively moderates the positive effect of TMS on KI.

As suggested by Hypothesis 3a, co-location of team members facilitates knowledge integration, while high levels of geographic dispersion limit knowledge integration. In addition, Cramton (2001) shows how geographic dispersion increases the differences in the context of team members: dispersed team members find it more difficult to establish common ground or shared social identity. Considering these impediments, the positive impact of good team practices is higher for dispersed teams than it is for collocated teams. As a consequence, Hoegl et (2007) can show how the quality of teamwork among dispersed teams has a more pronounced effect on team performance than for collocated teams. Although distributed teams may be limited in their knowledge-integration process (H3a), the remaining integration is of disproportionally high importance for team performance. Hence, for highly distributed teams, knowledge integration (albeit less prominent) is of higher relative importance for team performance than for collocated teams:

H3c: Geographic dispersion positively moderates the positive effect of KI on team performance.

4 Methodology

A survey was conducted on IT service teams in a major telecom firm in China. The selection of these service teams to investigate the impact of a team's TMS under varying levels of team geographic dispersion was justified by the dynamic and project based working context in which the firm and its teams operate. The service projects normally lasted for a given period only, ranging from several months to three years. Screening criteria were employed to ensure that teams had been in service for more than three months and the projects were still ongoing or would be completed within one month.

Two sets of questionnaires were administered separately to team members and their project supervisors. The team members received a questionnaire on how they performed the team task and the interactions with other members, together with a letter of introduction and a return envelope. Their project supervisors were asked to complete a separate questionnaire regarding the team performance. Collecting data of independent and dependent variables from different sources can alleviate the concern of common method bias to some extent (Podsakoff et al., 2003). Teams with less than three member responses or less than half of the number of key members were removed. Finally 188 team member and their corresponding team manager responses from 54 teams were obtained and used for further analysis. This sample size is comparable to those reported in the team-level managerial studies in general (e.g. Homan et al., 2008; Kirkman et al., 2004) and the research on TMS or knowledge integration in particular (Kanawattanachai and Yoo, 2007; Robert Jr, Dennis and Ahuja, 2008; Tiwana and Mclean, 2005). Team sizes varied from 3 to 5 people. The mean age of respondents was 31.7 years (s.d. = 6.14), and the mean tenure was 7.9 years (s.d. = 7.1). 83 percent of the respondents were male.

4.1 Measures

All survey items are listed in Appendix A. We measured knowledge integration (KI) using four items developed by Tiwana and McLean (2005). Although the researchers regarded their measure as an outcome rather than mechanisms by which knowledge could be integrated, the conceptualization of the construct *expertise integration* in their paper, did tap into "the extent to which a team's members … synthesized various members' tacit knowledge and expertise in developing project concepts, understood the project from a systemic perspective, and synthesized their own expertise with such project-level knowledge" (Tiwana and Mclean, 2005, p. 26). An example item was: "Members of this team competently blend new project-related knowledge with what they already know" (1, "strongly disagree" to 5, "strongly agree"). Geographic dispersion was assessed using the four items developed by Kerr and Jermier (1978). Respondents were asked to rate to which extent team members are collocated, have direct interaction, and are distributed among various locations, hereby considering several aspects of geographic dispersion (O'Leary and Cummings, 2007). One of our four items was dropped in order to improve the construct reliability. We adopted the measures of transactive memory system (TMS) with three dimensions indicated by five items each (Lewis, 2003). Following prior studies (Lewis, Lange and Gillis, 2005; Lewis, 2004), the three TMS dimensions were then used as indicators to create a second-order formative construct of TMS.

Knowledge integration, geographic dispersion, and TMS were measured at the individual level and aggregated to the team level. Being consistent with the prior research, TMS and geographic dispersion were measured on a 7-point Likert scale (1, "strongly disagree" to 7, "strongly agree"). Five items for team performance (TPF) were adopted from Van der Vegt and Bunderson (2005). The supervisor of each project team was asked to rate the performance of his or her team with the performance of teams that performed similar tasks. Sample items included "The efficiency of this team is…" and "The productivity of this team is …" (1, "far below average," to 7, "far above average"). To rule out plausible alternative explanations, we controlled for the effects of team size, length of team formation, the degree of ICT usage for team coordination, and the difficulty level of the projects based on the evaluation of the team supervisors.

5 Results

We conducted our analysis in the following steps. First, we performed statistical tests to examine the measurement model. Second, we tested the reliability and validity of the formative construct, i.e., the TMS. Third, the appropriateness of aggregating individual-level responses into a team-level score was examined. Finally, we validated the hypotheses by testing the proposed path model using a principle component-based structural equation modeling tool, partial least square (PLS). Interaction terms were constructed by following the product-indicator approach suggested by Chin et al. (2003).

5.1 Measurement Model

To validate the measurement model, reliability, discriminant validity and convergent validity were assessed for the reflective indicators. In Table 1 we can observe that the Cronbach's alpha (α) of all factors achieved high reliability (greater than 0.7, the recommended cutoff). We further examined discriminant validity using the square root of the average variance extracted (Fornell and Larcker, 1981). As shown in Table 1, all square roots of the average variance extracted were greater than the correlations among the constructs, indicating acceptable discriminant validity.

Constructs	**Mean**	**S.D.**	**Cronbach's α**	**1**	**2**	**3**	**4**	**5**	**6**
1. Knowledge Integration (KI)	3.99	0.71	0.83	0.82[a]					
2. Geographic Dispersion (GD)	3.40	1.45	0.82	-0.27	0.78				
3. TMS Specialization	4.75	1.39	0.87	0.60	-0.18	0.89			
4. TMS Credibility	5.80	0.72	0.76	0.46	0.06	0.17	0.83		
5. TMS Coordination	5.59	1.06	0.79	0.35	-0.07	0.07	-0.00	0.85	
6. Team Performance	5.59	0.90	0.95	0.07	-0.10	0.26	-0.13	-0.19	0.92

Table 1 Correlation Matrix

[a] Square root of average variance extracted.

Following (Podsakoff and Organ, 1986), a Harman's one-factor test was conducted on the variables TMS, geographic dispersion, and knowledge integration. The result suggested that common method bias is not a threat to the validity of our study. To establish the validity of the formative construct we first created the superordinate second-order construct (TMS) using factor scores for the first-order constructs: specialization, credibility, and coordination (Chin, Marcolin and Newsted, 2003). In effect, we treated the TMS as a second-order construct with three formative indicators. All item weights (Petter, Straub and Rai, 2007)of the three formative indicators were significant, indicating sound construct validity. To evaluate the reliability of the formative construct, multicollinearity among the first-order sub-constructs of TMS were examined (Diamantopoulos and Siguaw, 2006). The results showed that VIF values range from 1.004 to 1.032, which all exceed the threshold of 3.3, indicating satisfactory reliability (Diamantopoulos and Siguaw, 2006).

We calculated the ICC(1) and ICC(2) for each construct (James, 1982) and, respectively, found values of .10 and .27 for knowledge integration and .42 and .72 for geographic dispersion. The values of ICC(1) and ICC(2) for knowledge integration were relatively low, but comparable to the median or recommended ICC values of group-level constructs reported in the literature (Bliese and Hanges, 2004; Bliese, 2000). Moreover, the aggregation should not be avoided if it is justified by theory and supported by a high Rwg and significant between-group variance (Kozlowski and Hattrup, 1992). We computed the Rwg of each construct for each team, and found a mean value of .94 for knowledge integration and a mean value of .77 for geographic dispersion, providing further support to data aggregation.

5.2 Structural Model

Figure 2 presents the results of the hypotheses testing. The model explains 57.1% of variance of team performance and 64.8% of variance of knowledge integration. Hypothesis 1, which stated that higher TMS level would lead to higher level of knowledge integration, was strongly significant, $\beta=0.623$, $p<0.001$. Thus, Hypothesis 1 was supported. Hypothesis 2 was also supported, $\beta=0.114$, $p<0.1$, indicating that the performance of project teams was positively related to knowledge integration. As proposed, geographic dispersion of a team negatively impacted knowledge integration, $\beta=-0.192$, $p<0.01$ (Hypothesis 3a supported). Meanwhile, geographic dispersion could moderate the effects of TMS on knowledge integration ($\beta=0.175$, $p<0.001$, thus Hypothesis 3b supported) and knowledge integration on team performance ($\beta=0.263$, $p<0.001$, thus Hypothesis 3c supported).

The approach by Baron and Kenny (1986) was adopted to test the mediating effect of knowledge integration. In the first step, we examined the direct effect of TMS on team performance, but didn't find any significant impact (path coefficient=-.386, t=.929, n.s.). Second, using knowledge integration as an outcome variable and TMS as a predictor, we found a significant impact (path coefficient=.768, t=17.652, p<0.001). In the third step, the relationship between knowledge integration and team performance was found to be insignificant when TMS was controlled (path coefficient=-.066, t=.394), while the TMS had a positive (but insignificant) effect on team performance (path coefficient=.320, t=.935). In this case, it is possible that knowledge integration acts as a suppressor variable that mediates the relationship between TMS and team performance (MacKinnon, Fairchild and Fritz, 2007).

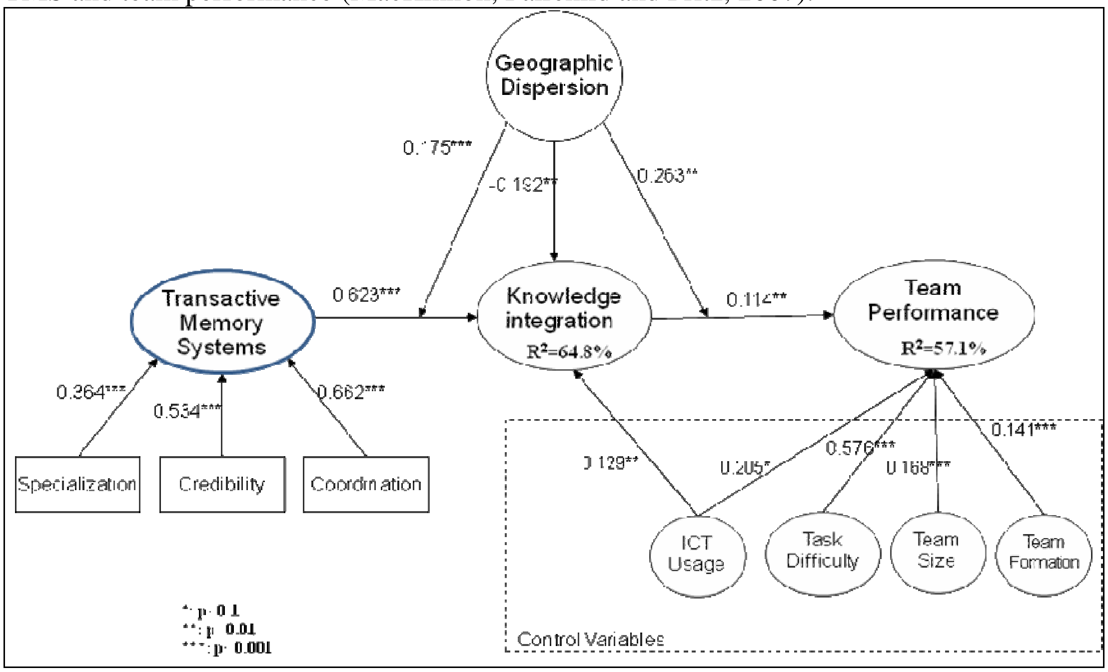

Figure 2. Structural Model

Next, we calculated the effect size of the moderating effect of geographic dispersion on the relationship between knowledge integration and team performance. The results showed strong moderating effects on the relationship, with an increase of explained variance on team performance by 10.6% (R-square change was .106, f^2=.12), thus indicating a medium effect size. We found that the control variables showed significant impacts on team performance: task difficulty (β=0.605, p<0.001), team size (β=0.168, p<0.001), team formation (β=0.141, p<0.001), ICT usage (β=0.205, p<0.1). A team's ICT usage for coordination was found to have significantly positive effect on knowledge integration (β=0.129, p<0.01).

6 Discussion and implications

The abovementioned findings create a range of implications for theory and practice. While the relationship between TMS and team performance has been well established in a range of studies (e.g., Lewis, 2004; Liang, Moreland and Argote, 1995; Moreland and Myaskovsky, 2000), little is known about the underlying processes through which the cognitive structure is used and performance benefits are created. By confirming that knowledge integration mediates this relationship, our study complements current research on the mediating effect of the knowledge sharing or knowledge-application process (Choi, Lee and Yoo, 2010) and confirms prior research that has focused on aspects of the knowledge-integration process (Tiwana and Mclean, 2005).

In identifying knowledge integration as a crucial process that mediates the relationship between a team's TMS and its performance, the study opens up opportunities to better understand the complex influences of geographic dispersion. Our study shows that geographic dispersion of a team affects the importance of TMS in shaping team performance. A more geographically dispersed team is in a stronger need of a well-developed TMS to improve knowledge integration, which in turns has stronger impact on team performance than a less geographically dispersed team. In other words, the importance of TMS is particularly high when a project requires distributed working arrangements.

By verifying the multifaceted impact that TMS and geographic dispersion have on the knowledge-integration process, our findings contribute to the emerging body of research that focuses on team characteristics in order to consolidate the contradicting evidence of prior virtual team research. The fact that some teams perform well in a virtual context is traditionally explained by factors such as the choice of communication tools (Daft and Lengel, 1986) or the formalization of work processes and strategies (Lurey and Raisinghani, 2001). By focusing on the TMS of a team, our study contributes to this emerging appreciation and understanding of team capabilities.

Our findings have implications for management practice. The selection of project team members is largely focused on drawing together required expertise with less consideration on the effects of team composition (Dainty, Raidén and Neale, 2009). However, our study shows that ,managers would be advised to consider a team's TMS to assess the viability of particular team compositions, ability to perform the important knowledge integration when operating in a geographically distributed context.

To foster knowledge integration, decision makers are advised to bring together staff members who already have an existing TMS. The pre-existence of a TMS, even when limited to subsections of the team, substantially accelerates the TMS development for the whole team (Lewis, 2004). Managers should explore the opportunities of fostering TMS development through specific intervention techniques and the provision of particular communication technologies (Choi, Lee and Yoo, 2010).

7 Conclusion

Our research set out to investigate the impact of TMS and geographic dispersion on knowledge integration and team performance. Survey data from IT service teams of a Chinese telecommunication provider allowed us to validate our research model and confirmed the importance of TMS in overcoming the negative effects of geographic dispersion.

However, our research design has limitations that create opportunities for future research to address. As a team's TMS develops over time (Lewis, Lange and Gillis, 2005), it would be of great interest to investigate the impact of TMS and geographic dispersion on knowledge integration on a longitudinal basis. Further studies that extend our model to include the affordances of particular communication tools, such as Wiki technology (Wagner and Schroeder, 2010), can be expected to further advance our understanding of project teams.

Although research on the TMS phenomenon is well established in the behavioral sciences (Lewis, 2003), it has only recently created wider interest in the IS domain by considering its implications in the context of virtual teams (e.g., Choi, Lee and Yoo, 2010; Kanawattanachai and Yoo, 2007). We hope our model and findings will help drive and facilitate further important research in the field.

References

Alavi, M. and Tiwana, A. (2002). Knowledge integration in virtual teams: The potential role of KMS. Journal of American Society for Information Science and Technology, 53(12), 1029-1037.

Anand, V., Manz, C.C. and Glick, W.H. (1998). An organizational memory approach to information management. The Academy of Management Review, 23(4), 796-809.

Austin, J.R. (2003). Transactive memory in organizational groups: The effects of content, consensus, specialization, and accuracy on group performance. Journal of Applied Psychology, 88(5), 866-878.

Baron, R.M. and Kenny, D.A., 1986. The moderator–mediator variable distinction in social psychological research. Journal of personality and social psychology, 51(6), 1173-1182.

Bliese, P.D. (2000). Within-group agreement, non-independence, and reliability. In: K. J. Klein and S. W. J. Kozlowski (eds.) Multilevel theory, research, and methods in organizations: Foundations, extensions, and new directions. San Francisco, CA: CA Jossey-Bass, 349-381.

Bliese, P.D. and Hanges, P.J. (2004). Being both too liberal and too conservative: The perils of treating grouped data as though they were independent. Organizational Research Methods, 7(4), 400-417.

Boutellier, R. et al. (1998). Management of dispersed product development teams: The role of information technologies. R&D Management, 28(1), 13–25.

Burke, K. et al. (1999). A Study of Partially Distributed Work Groups. Small Group Research, 30(4), 453-490.

Chin, W.W., Marcolin, B.L. and Newsted, P.R. (2003). A partial least squares latent variable modeling approach for measuring interaction effects: Results from a Monte Carlo simulation study and an electronic-mail emotion/adoption study. Information Systems Research, 14(2), 189-217.

Choi, Y.S., Lee, H. and Yoo, Y. (2010). The impact of information technology and transactive memory systems on knowledge sharing, application, and team performance. MIS Quarterly, 34(4), 855-870.

Conrath, D.W., 1973. Communications environment and its relationship to organizational structure. Management Science, 20(4), 586-603.

Cramton, C.D. (2001). The Mutual Knowledge Problem and Its Consequences for Dispersed Collaboration. Organization Science, 12(3), 346-371.

Cramton, C.D. and Webber, S.S. (2005). Relationships among geographic dispersion, team processes, and effectiveness in software development work teams. Journal of Business Research, 58(6), 758-765.

Daft, R.L. and Lengel, R.H. (1986). Organizational Information Requirements, Media Richness and Structural Design. Management Science, 32(5), 554-571.

Dainty, A.R.., Raidén, A.B. and Neale, R.H. (2009). Incorporating employee resourcing requirements into deployment decision making. Project Management Journal, 40(2), 7-18.

Van Der Vegt, G.S. and Bunderson, J.S. (2005). Learning and performance in multidisciplinary teams: The importance of collective team identification. Academy of Management Journal, 48(3), 532-547.

Diamantopoulos, A. and Siguaw, J.A. (2006). Formative versus reflective indicators in organizational measure development. British Journal of Management, 17(4), 263-282.

Faraj, S. and Sproull, L. (2000). Coordinating expertise in software development teams. Management Science, 46(12), 1554-1568.

Fornell, C. and Larcker, D.F. (1981). Evaluating structural equation models with unobservable variables and measurement error. Journal of Marketing Research, 18(1), 39-50.

Grant, R.M. (1996). Toward a knowledge-based theory of the firm. Strategic Management Journal, 17(Winter special issue), 109-122.

Hinds, P.J. and Mortensen, M. (2005). Understanding Conflict in Geographically Distributed Teams: The Moderating Effects of Shared Identity, Shared Context, and Spontaneous Communication. Organization Science, 16(3), 290-307.

Hoegl, M., Ernst, H. and Proserpio, L. (2007). How Teamwork Matters More as Team Member Dispersion Increases*. Journal of Product Innovation Management, 24(2), 156-165.

Homan, A.C. et al. (2008). Facing differences with an open mind: Openness to experience, salience of intragroup differences, and performance of diverse work groups. The Academy of Management Journal, 51(6), 1204–1222.

James, L.R. (1982). Aggregation bias in estimates of perceptual agreement. Journal of Applied Psychology, 67(2), 219-229.

Jarvenpaa, S.L. and Majchrzak, A. (2008). Knowledge collaboration among professionals protecting national security. Organization Science, 19(2), 260-276.

Kanawattanachai, P. and Yoo, Y. (2007). The impact of knowledge coordination on virtual team performance over time. Management Information Systems Quarterly, 31(4), 783-808.

Kerr, S. and Jermier, J.M. (1978). Substitutes for leadership: Their meaning and measurement. Organizational Behavior and Human Decision Processes, 22(3), 375-403.

Kiesler, S. and Sproull, L. (1992). Group decision making and communication technology. Organizational Behavior and Human Decision Processes, 52(1), 96-123.
Kirkman, B.L. et al. (2004). The impact of team empowerment on virtual team performance: The moderating role of face-to-face interaction. The Academy of Management Journal, 47(2), 175–192.
Klein, C. et al. (2009). Does Team Building Work? Small Group Research, 40(2), 181-222.
Kozlowski, S.W.J. and Hattrup, K. (1992). A disagreement about within-group agreement: Disentangling issues of consistency versus consensus. Journal of Applied Psychology, 77(2), 161-167.
Lewis, K. (2003). Measuring transactive memory systems in the field: Scale development and validation. Journal of Applied Psychology, 88(4), 587-604.
Lewis, K. (2004). Knowledge and performance in knowledge-worker teams: A longitudinal study of transactive memory systems. Management science, 50(11), 1519-1533.
Lewis, K., Lange, D. and Gillis, L. (2005). Transactive memory systems, learning, and learning transfer. Organization Science, 16(6), 581-598.
Liang, D.W., Moreland, R. and Argote, L. (1995). Group versus individual training and group performance. Personality and Social Psychology Bulletin, 21(4), 384-393.
Lin, B.W. and Chen, C.J. (2006). Fostering product innovation in industry networks: the mediating role of knowledge integration. The International Journal of Human Resource Management, 17(1), 155-173.
Lurey, J.S. and Raisinghani, M.S. (2001). An empirical study of best practices in virtual teams. Information & Management, 38(8), 523-544.
MacKinnon, D.P., Fairchild, A.J. and Fritz, M.S. (2007). Mediation analysis. Annual Review of Psychology, 58, 593-614.
Malhotra, N. and Morris, T. (2009). Heterogeneity in Professional Service Firms. Journal of Management Studies, 46(6), 895-922.
Mitchell, V.L. (2006). Knowledge integration and information technology project performance. MIS Quarterly, 30(4), 919-939.
Monge, P.R. and Kirste, K.K. (1980). Measuring proximity in human organization. Social Psychology Quarterly, 43(1), 110-115.
Moreland, R. and Myaskovsky, L. (2000). Exploring the Performance Benefits of Group Training. Organizational Behavior and Human Decision Processes, 82(1), 117-133.
Newell, S., Tansley, C. and Huang, J. (2004). Social capital and knowledge integration in an ERP project team: the importance of bridging and bonding. British Journal of Management, 15(S1), 43-57.
O'Leary, M.B. and Cummings, J.N. (2007). The spatial, temporal, and configurational characteristics of geographic dispersion in teams. MIS Quarterly, 31(3), 433-452.
Okhuysen, G.A. and Eisenhardt, K.M. (2002). Integrating knowledge in groups: How formal interventions enable flexibility. Organization Science, 13(4), 370-386.
Petter, S., Straub, D.W. and Rai, A. (2007). Specification and validation of formative constructs in IS research. MIS Quarterly, 31(4), 623-656.
Podsakoff, P.M. and Organ, D.W. (1986). Self-reports in organizational research: Problems and prospects. Journal of management, 12(4), 531-544.
Podsakoff, P.M. et al. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies. Journal of Applied Psychology, 88(5), 879-903.
Rico, R. et al. (2008). Team implicit coordination processes: A team knowledge-based approach. The Academy of Management Review, 33(1), 163-184.
Robert Jr, L.P., Dennis, A.R. and Ahuja, M.K. (2008). Social capital and knowledge integration in digitally enabled teams. Information Systems Research, 19(3), 314-334.
Siakas, K.V. and Siakas, E. (2008). The need for trust relationships to enable successful virtual team collaboration. International Journal of Technology, Policy and Management, 8(1), 59–75.
Tiwana, A. (2004). An empirical study of the effect of knowledge integration on software development performance. Information and Software Technology, 46(13), 899-906.
Tiwana, A. and Mclean, E.R. (2005). Expertise Integration and Creativity in Information Systems Development. Journal of Management Information Systems, 22(1), 13-43.

Wagner, C. and Schroeder, A. (2010). Capabilities and Roles of Enterprise Wikis in Organizational Communication. Technical Communication, 57(1), 68-89.

Appendix A. Survey Items

Construct	**Item**		**Source**
TMS specialization	TMS1	Each team member has specialized knowledge of some aspect of our projects.	Lewis (2003)
	TMS2	I have knowledge about an aspect of our projects that no other team member has.	
	TMS3	Different team members are responsible for expertise in different areas.	
	TMS4	The specialized knowledge of several different team members was needed to complete our project deliverables.	
	TMS5	I know which team members have expertise in specific areas.	
TMS credibility	T MS6	I was comfortable accepting procedural suggestions from other team members.	
	T MS7	I trusted that other members' knowledge about our projects was credible.	
	TMS8	I was confident relying on the information that other team members brought to the discussion.	
	TMS9	When other members gave information, I wanted to double-check it for myself.	
	TMS10	I did not have much faith in other members' "expertise."	
TMS coordination	TMS11	Our team worked together in a well-coordinated fashion.	
	TMS12	Our team had very few misunderstandings about what to do.	
	TMS13	Our team needed to backtrack and start over a lot.	
	TMS14	We accomplished the task smoothly and efficiently.	
	TMS15	There was much confusion about how we would accomplish the task.	
Geographic dispersion	LH1	The nature of our teamwork is such that team members are collocated when working.	Kerr and Jermier (1978)
	LH2	Members of this team are in actual contact or direct sight of one another.	
	LH3	Members of this team vary widely in their physical location of work.	
Knowledge Integration	KI1	Members of this team synthesize and integrate their individual expertise at the project level.	Tiwana and Mc-Lean (2005)
	KI2	Members of this team span several areas of expertise to develop shared project concepts.	
	KI3	Members of this team can clearly see how different pieces of this project fit together.	
	KI4	Members of this team competently blend new project-related knowledge with what they already know.	
Team Performance	TPF1	The efficiency of this team is...	Van der Vegt and Bun-derson (2005)
	TPF2	The quality of this team is …	
	TPF3	The overall achievement of this team is…	
	TPF4	The productivity of this team is ...	
	TPF5	The teams' ability to fulfil the assigned mission is …	