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The Influence of Subgroup Dynamics on Knowledge Coordination in Distributed Teams: A Transactive Memory System and Group Faultline Perspective

Yide Shen
Georgia State University, yshen@cis.gsu.edu

Mike Gallivan
Georgia State University, mgallivan@gsu.edu

Xinlin Tang
Florida State University, xtang2@fsu.edu

The Influence of Subgroup Dynamics on Knowledge Coordination in Distributed Teams: A Transactive Memory System and Group Faultline Perspective[1]

L'influence des dynamiques de groupes sur la distribution de connaissance dans les équipes distribuées: La perspective de la théorie de la mémoire transactionnelle et des divisions de groups

Completed Research Paper

Yide Shen
CIS Department
Robinson College of Business
Georgia State University
Box 4015, Atlanta, GA, USA 30302
yshen@cis.gsu.edu

Mike Gallivan
CIS Department
Robinson College of Business
Georgia State University
Box 4015, Atlanta, GA, USA 30302
mgallivan@gsu.edu

Xinlin Tang
College of Business
Florida State University
Tallahassee, FL 32306-1110
xtang2@fsu.edu

Abstract

With the rapid growth of globalization, distributed teams have become increasingly common in organizations. This research investigates the impact of inter-subgroup dynamics on knowledge coordination in distributed teams. To address this research question, we extend and apply theory from two primary sources – Transactive Memory Systems (TMS) theory and the faultline model. The paper uses data collected from 22 distributed MBA student teams to provide several novel insights into how perceived faultlines impact team processes (knowledge coordination) and outcomes (team performance and member satisfaction). First, perceived faultlines reduce knowledge coordination, which is an important antecedent of team performance and member satisfaction. Second, knowledge coordination fully mediates the negative effect of perceived faultines on team performance and member satisfaction. Third, low levels of TMS not only impair performance, but also reduce member satisfaction in distributed teams. Implications for research and practice are discussed together with potential avenues for future research.

Keywords: distributed teams, subgroup dynamics, knowledge coordination, Transactive Memory Systems, faultline

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Résumé

Nous analysons l'influence des divisions au sein des équipes sur les processus de distribution de connaissance dans les équipes distribuées et obtenons trois résultats : 1) les perceptions de divisions limitent les échanges de connaissance. 2) l'impact des divisions sur la performance de l'équipe et la satisfaction de ses membres est modéré par la distribution de connaissance. 3) Une faible distribution implique une faible satisfaction au sein de l'équipe.

Introduction

With the rapid growth of globalization, distributed teams have become increasingly common in organizations (Jarvenpaa and Leidner 1999). Such teams perform key functions in organizations such as product development, software development and strategic planning (Kotlarsky and Oshri 2005; Majchrak et al. 2000; Maznevski and Chudoba 2000). For distributed projects to be effective, managers need to focus on social factors (e.g., trust, social ties, formal and informal communication) which are crucial to these projects (Orlikowski 2002), because information technologies alone are not sufficient to bridge temporal, geographic, and cultural differences in distributed teams (Kotlarsky and Oshri 2005; Yoshioka,Yates and Orlikowski 2002). Among various social aspects that are essential to the success of distributed projects, the focus of this research is the impact of *inter-subgroup dynamics on knowledge coordination*. Specifically, we investigate:

RQ1: Do subgroup dynamics affect team members' knowledge coordination?

RQ2: Does knowledge coordination benefit team effectiveness, in terms of performance and member satisfaction?

There are three reasons why this is an important area of research. First, coordination is a crucial activity that integrates various elements together to generate high team effectiveness (Khazanchi and Zigurs 2005). However, knowledge coordination in distributed environments is especially challenging due to discrepancies among team members in terms of time, space, location, and both organizational and national culture (Cramton 2001; Espinosa,Slaughter,Herbsleb and Kraut 2007; Griffith and Neale 2001; Hollingshead 1998).

Second, while distributed teams utilize a wide range of communication tools such as groupware and codified KMS, coordination breakdowns still occur (Kotlarsky and Oshri 2005). This suggests that technology alone is not enough to solve knowledge coordination problems. Teams need to develop *distributed organizing*[2] capabilities to complement existing technical solutions, in order to deal effectively with knowledge coordination challenges in dispersed environments (Orlikowski 2002).

Lastly, inter-subgroup dynamics – the relationships among subgroups within the overall project team – affect distributed teams' ability to share knowledge, because subgroups often emerge within larger groups (i.e., the notion of group faultlines), which can have negative consequences on member trust, information-sharing, and overall coordination. This has been widely shown in laboratory experiments of members charged with performing a task requiring overall group coordination (Li and Hambrick 2005). Researchers have advocated more focus on subgroup dynamics within teams because of their impact on team processes and outcomes (Cramton 2001; Cramton and Hinds 2004; Fiol and O'Connor 2005).

To address this important area of research, this study extends and applies theory from two primary sources. First, we draw from Transactive Memory Systems (TMS) theory (Brandon and Hollingshead 2004; Lewis 2003; Wegner 1987; Wegner 1995) to study the group-level cognition involved in knowledge coordination. Second, we utilize the faultline model developed by Lau and Murnighan (1998) to examine whether subgroup dynamics impact knowledge coordination in distributed teams. We distinguish the concept of faultines based on objective characteristics from *perceived* faultlines (Greer and Jehn 2007; Jehn and Bezrukova 2006), and propose that perceived faultlines will better explain the inconsistent results reported in prior studies of group faultlines.

[2] Distributed organizing is defined as "the capability of operating effectively across the temporal, geographic, political, and cultural boundaries routinely encountered in global operations" (Orlikowski 2002, p. 249).

Theory Building and Hypotheses Development

Knowledge Coordination in Distributed Environments

Prior studies have identified many factors contributing to collaborative work (Kotlarsky and Oshri 2005), such as social ties (Storck and Hill 2000), formal and informal communication (Kraut and Streeter 1995; Perry,Staudenmayer and Votta 1994), trust (Jarvenpaa and Leidner 1999), and rapport (Kiesler and Cummings 2002). Research on traditional co-located teams has found that expertise coordination plays a major role in team performance, above and beyond the mere presence of expertise and professional experience of its members (Faraj and Sproull 2000). However, knowledge coordination is never an easy task, especially when teams operate across temporal, geographic, and cultural boundaries (Herbsleb and Moitra 2001; Kotlarsky and Oshri 2005; Orlikowski 2002). Among other challenges, the problem of where to locate project knowledge when needed is a major challenge (Herbsleb and Mockus 2003). When knowledge is distributed among various stakeholders, each member must know where to look for information before he or she is able to find and apply that knowledge. Field studies have identified that problems requiring timely solution occur frequently in distributed teams (Paasivaara and Lassenius 2003); however, few projects are proactive in planning for the kind of knowledge-sharing ahead of time, causing team members to spend much time trying to find someone with the necessary knowledge, wasting both time and energy (Paasivaara and Lassenius 2003).

In distributed teams, geographical distance, time-zone differences and organizational or national culture differences make it even more challenging to coordinate knowledge (Alavi and Tiwana 2002; Griffith and Neale 2001; Hertel,Geister and Honradt 2005). Research shows that members of distributed teams find it more difficult to identify distant colleagues with needed expertise and to communicate with them effectively, compared to co-located teams (Herbsleb and Mockus 2003). Herbsleb et al. (2000, p.3) described how one project team faced this challenge of identifying who knows what – so that "difficulties of knowing who to contact about what, of initiating contact, and of communicating effectively across sites, led to a number of serious coordination problems."

Transactive Memory and TMS in Distributed Teams

This social aspect of "knowing who knows what" – the knowledge that a person has about what *another* person knows – is called transactive memory. A transactive memory system (TMS) is a group-level concept, referring to "the operation of the memory systems of the individuals and the processes of communication that occur within the group" (Wegner 1987, p.191). It describes the active use of members' transactive memories to complete a group task cooperatively. According to TMS literature, researchers generally agree on three facets that reflect the presence of TMS (Lewis 2003; Liang,Moreland and Argote 1995; Moreland and Myaskovsky 2000): *specialization* (the existence of specialized team knowledge), *credibility* (members' trust and reliance on each other's knowledge) and *coordination* (coordinated processes to combine knowledge). By convention, TMS researchers also agree that the higher the levels of these three facets of TMS, the more developed is the group's TMS – and the more value this TMS has for effective knowledge coordination. Both laboratory and field studies have specified the antecedents and consequences of TMS. Table 1 lists the antecedents of an effective TMS both in traditional, co-located teams and in distributed teams, while Table 2 summarizes research on the consequences of TMS.

Of the studies listed in these tables, only one quantitatively examined the levels of TMS and their antecedents in distributed teams (Kanawattanachai and Yoo 2007). It showed that the three TMS dimensions have different effects on distributed team performance. *Specialization* and *credibility* (these dimensions are labeled *expertise location* and *cognition-based trust* in that study) have no direct impact on performance; instead, their effect is fully mediated by *coordination*. In addition, the latter effect occurred only in the final stages of the project, once members had learned to work together (Kanawattanachai and Yoo 2007). A case study of two globally distributed system projects by Kotlarsky and Oshri (2005) found that TMS is a key contributor to successful collaboration.

Another quantitative study by Faraj and Sproull (2000) did not explicitly mention TMS; however it introduced the concept of *expertise coordination* which overlaps with TMS to a large extent.[3] These authors studied traditional, co-

[3] Compared to the three facets of TMS (specialization, credibility and coordination), two dimensions of Faraj and Sproull's expertise coordination construct (knowing the location of expertise and recognizing the need for expertise) map to the

located software teams, finding that *expertise coordination* had a positive effect on team performance. Members' ability to coordinate expertise exerted a strong effect on performance, above and beyond the mere *presence* of member expertise. Based on these prior results, we propose that[4]:

Hypothesis 1: The coordination dimension of TMS will be positively related to performance in distributed teams.

Table 1. Antecedents of TMS Development	
Factors facilitate (+) or hinder (-) TMS development	**Prior literature**
In Traditional Co-located Teams	
Group training (+)	(Liang et al. 1995; Moreland 1999; Moreland et al. 1996,1998; Moreland and Myaskovsky 2000)
Performance feedback about one another's training performance (+)	(Moreland and Myaskovsky 2000)
Membership change (-)	(Lewis,Belliveau,Herndon and Keller 2007; Moreland and Argote 2003)
Distributed expertise (also moderated by member familiarity) (during project planning phase) (+)	(Lewis 2004)
Face-to-face communication (during project planning phase) (+)	(Lewis 2004)
Face-to-face communication (during project implementation phase) (+)	(Lewis 2004)
Non face-to-face communication (moderated by TMS developed in planning phase) (during project implementation phase) (+)	(Lewis 2004)
In Distributed Teams	
Task-oriented communication (email, etc. message) (early project stage) (+)	(Kanawattanachai and Yoo 2007)

Table 2. Consequences of TMS in Teams	
TMS's impact on teams	**Prior literature**
Individual-level learning	(Lewis,Gillis and Lange 2003)
Team-level learning	(Lewis et al. 2003)
Viability	(Austin 2003; Lewis 2004; Liang et al. 1995; Moreland and Myaskovsky 2000; Yoo and Kanawattanachai 2001)
Team performance	(Austin 2003; Kanawattanachai and Yoo 2007; Lewis 2004; Lewis 2005; Liang et al. 1995; Moreland 1999; Moreland,Argote and Krishnan 1996; Moreland,Argote and Krishnan 1998; Moreland and Myaskovsky 2000)
Successful collaboration	(Kotlarsky and Oshri 2005)

specialization facet of TMS; their third expertise coordination dimension (bringing expertise to bear) maps to the coordination facet of TMS. Faraj and Sproull do not consider any construct analogous to credibility.

[4] We do not form a hypothesis that states "Coordination will mediate the influence of specialization and credibility on team performance" because this mediating relationship has been tested and received full support in (Kanawattanachai and Yoo 2007).

Gaps in Transactive Memory Systems Literature

Additional Outcome Variable for TMS's Impact on Team

Another important team effectiveness variable is member satisfaction. Team literature defines team effectiveness in terms of team outputs and the consequences that team participation has on its members (Cohen and Bailey 1997; Guzzo and Dickson 1996; Hackman 1987; Sundstrom,DeMuse and Futrell 1990). Hackman suggested that there are three aspects contributing to overall team effectiveness (Hackman 1990; Hackman and Oldham 1980): 1) the team's ability to deliver outputs that meet the standards of those who receive or review it; 2) the capabilities of team members to work together in the future; 3) how the team's experience contributes to the growth and psychological well-being of its members. In a review of past IS project performance studies, Aladwani (2002) criticized the narrowly defined project performance in terms of process efficiency and process effectiveness, and advocate that the quality of working life of members is another important factor to be considered in IS project performance research.

On the other hand, in a literature review of virtual teams research, individual member satisfaction, together with team performance, is identified as one of the most examined outcome variables (Powell,Piccoli and Ives 2004). However, as stated by the author, "most of the work looking at satisfaction of team members has … concentrated on who is most satisfied (virtual team versus traditional team, women versus men) and very little has been done on what makes team members satisfied or changes their degree of satisfaction with the virtual team experience" (p. 13-14). In our research, we suspect that knowledge coordination will be one of the factors that would impact members' satisfaction.

Thus, we include *member satisfaction* with the team as a second outcome variable. Member satisfaction refers to the degree to which members are satisfied with the interaction that occurs among team members. Studies of distributed teams suggest that teams who overcome coordination barriers are more likely to be satisfied with each other (Maznevski and Chudoba 2000; Piccoli,Powell and Ives 2004). Thus, we posit that:

Hypothesis 2: The coordination dimension of TMS will be positively related to member satisfaction in distributed teams.

Hypothesis 2a: Coordination will mediate the influence of specialization and credibility on member satisfaction.

Lack of Research on Subgroup Dynamics' Influences on TMS

While providing insightful perspectives of TMS development in teams, the prior TMS studies have the limitation that they focus on teams (either face-to-face teams or distributed teams) that treat each member as an "independent actor" (Li and Hambrick 2005) contributing his/her profile to the overall team diversity. From a group diversity perspective, prior TMS research has examined member heterogeneity and homogeneity among *individuals*, but has not addressed how patterns of difference between *subgroups within a larger group* might influence TMS development. Researchers observe that the way that a team is configured (the number of sites where team members are located, the number of members in each site, etc.) can significantly affect team outcomes such as coordination complexity, members' awareness of others' activities, and intragroup conflict (Cramton and Hinds 2004; O'Leary and Cummings 2007). Empirical studies have shown that in distributed teams, differences between subgroups based on location, culture, and possibly language, will have stronger negative effects on knowledge-sharing and member behavior than overall member heterogeneity (Li and Hambrick 2005).

For example, it is not uncommon to see a student project teams splitting into one subgroup with international students versus another comprised of domestic students. In a distributed team environment, for example, location differences become salient as the team engages in its task. In turn, these salient location differences can affect team dynamics such as trust, conflict (Hinds and Bailey 2003), identification (Fiol and O'Connor 2005) and communication patterns (Polzer,Crisp,Jarvenpaa and Kim 2006), which in turn lead to problems with team performance. For instance, one field study found that hybrid teams composed of two or three subgroups of co-located members experienced more conflict and less trust than fully-distributed teams[5] (Polzer et al. 2006). Polzer et al. (2006) compared hybrid teams where some members were co-located to fully-distributed teams. While the latter had to rely on listservs for sharing information, those teams with some co-located members were able to substitute face-to-face

[5] Fully-distributed teams are those where each individual member works in a separate location (Polzer et al. 2006).

communication for some messages that would otherwise have been sent via listserv to all members. While this had obvious benefits (i.e., in terms of saving time), it also had the undesirable consequence that co-located members started behaving as a faction – making statements such as "the three of us would like to" and "we at [Australian university] decided to" take some action (Polzer et al. 2006, p.688). This led to a reduction in the level of information-sharing across all team members; ultimately, communication was reduced to communication between the subgroups. Panteli and Davison observed this phenomenon in their virtual student teams where the volume of communication that reached *all* member was lowest in the teams with strong, co-located subgroups (Panteli and Davison 2005).

Thus, when obvious subgroups emerge within a given team (due to locational or other factors – such as gender, race or ethnicity), this has negative effects on team performance and other outcomes (Li and Hambrick 2005). While this effect has been labeled group *faultlines* and widely studied in the groups literature, the notion of subgroup dynamics and group faultlines have not explicitly been linked to the research stream on TMS. To make this link explicit and to explore its implications for distributed teams, we leverage the notion of faultlines to theorize about how such faultlines that emerge in distributed teams can impair overall team performance and satisfaction via reductions in the level of TMS.

Group Faultlines – Subgroup Dynamics in Distributed Teams

Concept of Group Faultlines

Faultlines are "hypothetical dividing lines that may split a group into subgroups based on one or more attributes" (Lau and Murnighan 1998, p. 328). For example, when only considering two individual attributes, race and age, a group comprised of two Asians in their 20s and two Caucasians in their 50s (Group 1 in Figure 1) has the potential to split into subgroups consisting of young Asian vs. mid-age Caucasian members. Group 1 is defined as a group where strong faultlines occur. Group 2's potential faultlines are weaker, because members A and C (or members B and D) share race similarities, but they have age difference; and members A and B (or members C and D) share age similarities, but they differ in terms of race. In Groups 3 and 4, faultlines are not likely to emerge because all the members of the group are rather similar (the same race and age) in Group 3, and all the members of Group 4 are quite different. By definition, in the example of Group 1 to 4, Group 1 has a strong faultine, Group 2 has medium fautlines, and Groups 3 and 4 have low fautlines.

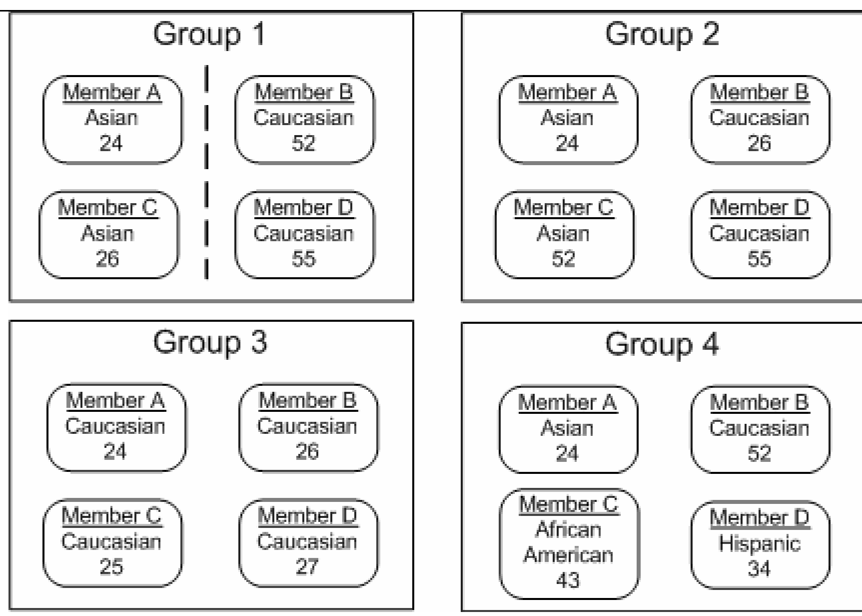

Figure 1. Groups with Different Faultline Strength Levels

The stronger the faultlines, the more likely the team will split into factions, leading to the potential for intergroup conflict (Jehn 1995) and the risk that members will share information within their subgroups rather than with all team members (Lau and Murnighan 1998). Empirical studies generally report that strong faultlines impair group processes and outcomes (see Table 3) (with the exception of (Lau and Murnighan 2005)). Some authors reject a simple linear relationship between faultlines and group outcomes, instead positing a curvilinear relationship between faultlines and various outcomes (Gibson and Vermeulen 2003; Thatcher,Jehn and Zanutto 2003) (see Table 4).

Table 3. Direct Impacts of Strong Faultlines

Prior Literature	Faultline Base[a]	Direct Effect of Strong Faultlines (+: positive impact; -: negative impact)	
Earley and Mosakowski (2000) (study 2)[b]	Nationality	-	worse processes (team identity, group efficacy, role expectations, intrateam communication) worse outcomes (team performance, satisfaction with team's performance)
Lau and Murnighan (2005)	Ethnicity and sex	+	less relationship conflict better group outcomes (psychological safety, group satisfaction)
Molleman (2005)	Gender, age and having a part-time job	-	lower group cohesion higher team conflict
Li and Hambrick (2005)	Age, tenure, gender and ethnicity	-	higher emotional conflict higher task conflict
Polzer, Crisp, Jarvenpaa, Kim (2006)	Geographic location	-	higher conflict lower trust
Rico, Molleman, Sanchez-Manzanares, Van der Vegt (2007)	Educational background and conscientiousness	-	worse performance lower level of social integration

a. We define the attribute or set of attributes based on which group faultlines are formed as faultline base.

b. This paper reported results from three studies that examined the effect of heterogeneity in nationality on effective performance. Only one study (study 2) specifically examined the effect of faultlines on performance.

Table 4. Curvilinear Relationship between Faultline and Outcome Variables

Prior Literature	Faultline Base	Faultline Strength		
		Low	**Medium[a]**	**High**
Thatcher, Jehn, Zanutto 2003	Work experience, functional background, major, sex, age, race and country of origin	Group with very diverse members	Between low and high	Groups split into two homogeneous subgroups
	Impact of faultline strength on outcome variables (H: high; L: low)			
	Relationship conflict	H	L	H
	Process conflict	H	L	H
	Morale	L	H	L
	Performance	L	H	L
Prior Literature	**Faultline Base**	**Faultline Strength**		
		Low	**Medium[a]**	**High**
Gibson and Vermeulen 2003	Sex, ethnicity, functional background, team tenure and age	Low subgroup strength	Medium subgroup strength	High subgroup strength
	Impact of faultline strength on outcome variables (H: high; L: low)			
	Team learning behavior	L	H	L

a. In both research, groups with medium faultline strength refer to those similar to Group 2 in Figure 1.

Instead of using objective attributes (such as age, gender, race, location, etc.) as the basis to measure faultlines in groups, the most recent studies have proposed capturing the *subjective* feelings of group members as the basis for measuring faultlines (Jehn and Bezrukova 2006). This is because faultlines based on "objective" characteristics don't necessarily mean that team members will perceive a true faultline in practice (Jehn and Bezrukova 2006). For example, member A and B of Group 1 in Figure 1 may share a similar work style and personality (which are different from C and D). In this case, it is possible that A and B may feel that they are "in the same camp," regardless of race and age differences between them. When researchers ignore the subjective feelings of group members and only focus on objective characteristics such as gender, age or race, they may miss the real reasons why faultlines emerge in groups. It is only when faultlines based on "objective" characteristics *do* manifest themselves as a divide among members that teams are likely to experience inter-subgroup conflict (Greer and Jehn 2007), coalition formation, and group conflict (Jehn and Bezrukova 2006).

We believe it is critical to distinguish the notion of *perceived* faultlines[6] (or actual faultlines) from faultlines that are merely based on member attributes (Greer and Jehn 2007; Jehn and Bezrukova 2006), because the latter (e.g., race, age, or gender differences) are not a sufficient condition for actual, *perceived* faultlines to occur – that is, faultlines perceived by members as causing a rift or divide. Of course, faultlines may have nothing at all to do with visible attributes – but may emerge due to personality, cognitive style, or even location differences among team members.

The stronger the perceived faultline in a team, the more likely it will split into discrete subgroups, which leads to the potential for intergroup conflict (Jehn and Bezrukova 2006) and the likelihood that members will communicate and share information only within their subgroups rather than with all team members (Lau and Murnighan 1998). Recent work that advocates measuring *perceived* faultlines has not studied the direct link between faultlines and outcomes (such as team performance and member satisfaction). On the other hand, researchers reported inconsistent findings about faultlines based on objective characteristics (see Table 3 and Table 4). Given subgroup dynamics' impact on team processes and outcomes (Cramton 2001; Cramton and Hinds 2004; Fiol and O'Connor 2005), and the important effects of TMS on team outcomes (e.g., Kanawattanachai and Yoo 2007; Lewis 2004; Liang et al. 1995; Moreland 1999), in the next section, we develop hypotheses that develop conceptual linkages among perceived faultlines, TMS, and team outcomes (team performance and member satisfaction). **Error! Reference source not found.** shows our overall research model.

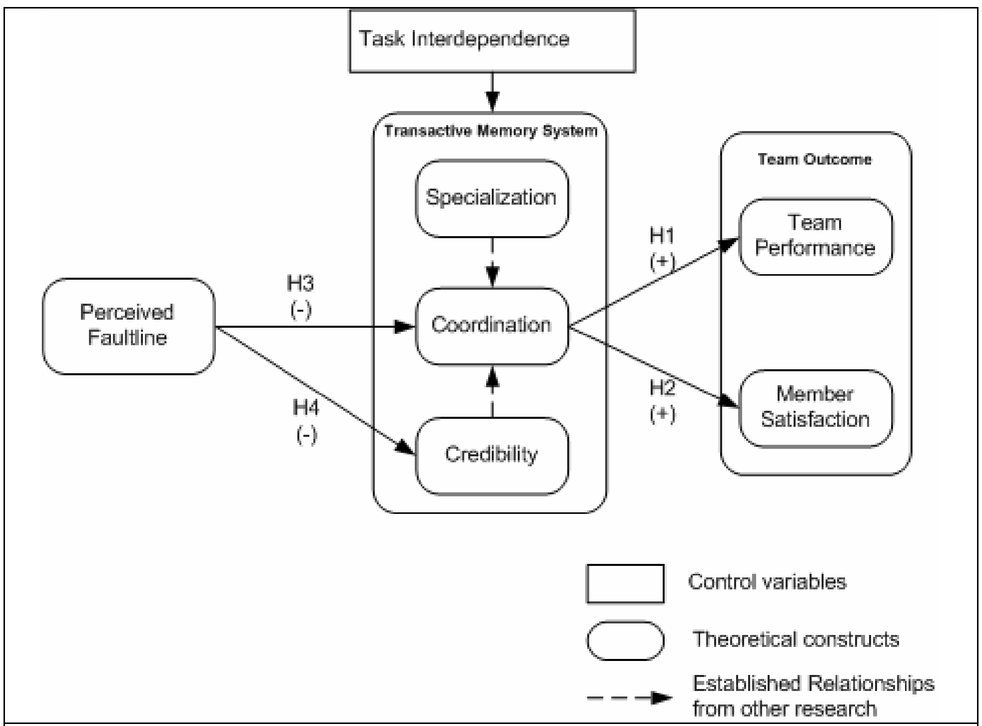

Figure 2. Research Model

[6] Jehn and Bezrukova (2006, p. 6) define a perceived faultline "when members actually perceive these divisions and the group behaviorally splits into two subgroups based on the alignment of two or more demographic attributes".

Impacts of Perceived Faultlines on Distributed Teams' TMS

The coordination dimension of TMS emphasizes the team's ability to smoothly and effectively coordinate and combine knowledge with little confusion or misunderstanding (Wegner 1987). The next few paragraphs discuss perceived faultlines' impacts on the coordination dimension of TMS.

In distributed environments, location differences become salient as the team engages in its task. Such location differences may, in turn, shape team dynamics and outcomes – including trust, conflict and communication patterns. In field settings, researchers observed that subgroups tend to withhold information from each other (Cramton 2001) or share knowledge only within their subgroups, with rare collaboration with other subgroups (Gratton,Voigt and Erickson 2007). These studies suggest that strong perceived faultlines cause the team to disintegrate into subgroups – with members communicating and sharing knowledge only within their subgroups (Cramton 2001). This leads to the existence of uniquely-held information among one or a few members of the team. Such uniquely held information is less likely to be salient to other members, causing knowledge gaps and misunderstanding (Stasser and Titus 1985). In other words, inadequate knowledge exchange due to perceived faultlines has two negative consequences: first, it leads to the existence of uniquely held information in distributed teams that is not salient to others, which becomes a source of confusion and misunderstanding that could adversely affect knowledge coordination.

Second, even when all members of a team have the same information regarding *certain* areas of the project, the problem of salience may still occur due to lack of information in *other* project aspects. That is, people may be aware of the existence of knowledge distributed among team members, but they do not realize the *importance* of this knowledge because of their different schema (resulting from uniquely held information). They fail to use that information or they use it in a way that, again, creates misunderstanding or confusion. For example, research on product development teams found that members who lack a shared understanding of their domain activities often fail to take advantage of each other's knowledge due to differences in skills and experience (Dougherty 1992). Due to these differences, members often lack cues that can help them judge the credibility and quality of knowledge from their remote colleagues, which in turn leads them to ignore or misunderstand that knowledge (Carlile 2002).

In addition, the knowledge management literature recognizes that effective coordination through electronic media depends on having a common understanding about the problems at hand, clear norms of behavior, and a context for interpreting knowledge (Davenport and Prusak 1997; Dougherty 1992; Krauss and Fussell 1990). However, when team members work in different locations, they are more likely to "experience different exogenous events, physical settings, constraints and practices, resulting in their having different information, assumptions, preferences and constraints" (Cramton and Hinds 2005, p. 236). When members of distributed teams have different schema, they are more likely to filter out or misconstrue useful information held by others (Carlile 2002; Dougherty 1992), which is problematic for developing a common understanding of the project scenario.

In summary, when members perceive faultlines in their team, they are more likely to communicate information only within their subgroups. This leads to uniquely held information among team members that are not salient to others, which introduces knowledge gaps and misunderstanding that will hurt effective knowledge coordination. Based on this logic, we anticipate a negative relationship between perceived fautlines and the coordination dimension of TMS:

Hypothesis 3: Perceived fautlines will be inversely related to the coordination dimension of TMS in distributed teams.

Hypothesis 3a: Coordination dimension of TMS will mediate the influence of perceived faultline on team performance in distributed teams.

Hypothesis 3b: Coordination dimension of TMS will mediate the influence of perceived faultline on member satisfaction in distributed teams.

The credibility dimension of TMS refers to individuals' belief about whether other members' knowledge is reliable (Wegner 1987). The next few paragraphs discuss the impact of perceived faultlines on the credibility dimension.

Groups with strong faultlines have higher levels of conflict, which causes members to avoid communicating and sharing information with other subgroup members. When discussing the two negative outcomes of uniquely held information, we cited studies showing that schema differences among team members (which resulted from uniquely held information) mean that members lack cues to judge the credibility and quality of others' knowledge (Carlile 2002; Dougherty 1992). This is the first reason why faultlines reduce the level of credibility among team members.

Perceived faultlines may also damage members' attitudes toward each other, especially in distributed environment. When they are geographically dispersed, members usually cannot observe remote sites' situational information that are important to team project; thus, they primarily rely on information exchange to obtain this information (Cramton,Orvis and Wilson 2007). As discussed earlier, strong faultlines reduce information sharing across subgroups (Cramton 2001; Gratton et al. 2007), which makes it harder for members to obtain information, especially from remote members. According to attribution theory, when people lack situational information due to insufficient information exchange, they tend to explain others' behavior as resulting from individual disposition, rather than due to the situation (Nisbett,Caputo,Legant and Marecek 1973). This causes people to draw negative conclusions about others, particularly members of other subgroups.

Based on this logic, we suspect that groups with strong faultlines will be less likely to have high levels of member credibility, compared to teams with no perceived faultlines (or only weak ones).

Hypothesis 4: Perceived fautlines will be inversely related to the credibility dimension of TMS in distributed teams.

Research Method

Data Collection

We conducted a survey study to evaluate our research model. Data were collected from an online MBA course in a southeastern university. The course was administrated virtually through Blackboard and there was no face to face class meeting. A total of 82 MBA students (49 male, 33 female) participated in the study and all of them completed our survey (100% response rate). On average, these students have 6.6 years of working experience. 63% of the participants were located in different cities in the same state where the university is, with the rest of them located in other states of the United States or in other countries such as Italy and Japan.

As a major component of the online course, group case analysis accounts for 30% of the final grade. Students were asked to form four-member teams by their own at the beginning of the semester. Because some of the students dropped the course during the semester, we ended up with 22 teams for data analysis, with 17 four-member teams, four three-member teams, and one two-member team.

The teams then were allowed to pick three cases to analyze and submit during the semester. To conduct the case analysis, students need to identify the major issues presented in the cases, use the reading materials to guide their data analysis, make recommendations to the major players, and prepare an action plan to carry their recommendations forward. Because of the different locations and working schedules, most teams have to use virtual communication tools, such as email, telephone, and group communication tools (e.g., discussion board, file exchange and chat) provided by Blackboard, to coordinate their efforts on these case analyses. This course setting thus gave us a good opportunity to examine the proposed research model.

We administrated the survey right after students finished their last case analysis. By that time, teams were able to get over 95% of their work done virtually.

Instrument development

Whenever possible, validated measures from previous studies are adapted for this research. The instrument was pilot tested and modified before it was administrated for data collection. Appendix summarizes the measurement items used for each construct and their sources.

Analyses and Results

We conducted data analyses in the following three steps. First, we assessed measurement properties and common method bias to ensure the quality of our data. Second, since we collected data from individual team members and would test the research model at team level, we statistically tested the appropriateness of aggregating individual level data to team level. Third, we used structural equation modeling employed in Smart PLS to test the hypotheses.

Measurement Validation

We followed the procedures prescribed by the literature to evaluate internal consistency (Fornell and Larcker 1981; Nunnally and Bernstein 1994), convergent validity and discriminant validity (Gefen and Straub 2005) for all constructs. The results presented in Table 5 and Appendix collectively indicate good measurement validity for our data, which were then used to test the structural model.

Common Method Bias

First, Harmon's one factor test was conducted to investigate the common method variance (Podasakoff and Organ 1986). As expected, six factors were extracted from the dataset, accounting for 81.6 percent of variance in the data. The first factor contributed 42.1 percent of total variance. The results show no sign of one factor accounting for the majority of the covariance. Next, following the statistical approach suggested by Podasakoff et al. (2003) and its application in PLS (Liang,Saraf,Hu and Xue 2007), we insert into the analysis a common method factor (the marker variable *personal innovativeness with IT* (Agarwal and Prasad 1998) in this study). As the average common method-based variance is only 0.005, compared to 0.760 that can be explained by the average substantive indicators, we can draw the conclusion that common method bias is not a major concern in the dataset.

Aggregation Analysisz

We calculated r_{wg} (James,Demaree and Wolf 1984) for each model construct for all 22 teams to assess intragroup agreement. A total of 90 percent of the r_{wg} values (119 of the 132 values) were above the 0.7 cutoff value (George 1990; James 1988). Multilevel researchers recommend that data should not be aggregated to the group level if low r_{wg} values exist (Castro 2002). Thus, we aggregated the individual level data to the team level for each team for those constructs with a r_{wg} values exceeding 0.7,; for those groups and constructs with r_{wg} values less than 0.7, we did not aggregate them to team level, instead, we treated the specific construct as missing data for a specific group.

Table 5. Means, SD, Composite Reliability, AVE and Inter-Construct Correlations

	Mean (SD)	Composite Reliability	AVE	1	2	3	4	5	6	7
1. Perceived Faultline	2.75 (1.54)	0.92	0.69	**0.85**						
2. Specialization	4.88 (1.22)	0.95	0.86	0.01	**0.86**					
3. Credibility	6.09 (0.84)	0.98	0.93	-0.34**	0.24*	**0.93**				
4. Coordination	5.76 (0.97)	0.93	0.73	-0.40**	0.34**	0.64**	**0.83**			
5. Team Performance	4.84 (1.15)	0.94	0.75	-0.48**	0.36**	0.42**	0.63**	**0.94**		
6. Member Satisfaction	9.35 (2.00)	0.86	0.61	-0.40**	0.25*	0.50**	0.60**	0.59**	**0.96**	
7. Task Interdependence	4.71 (1.04)	0.98	0.89	-0.16	0.17	0.37**	0.18	0.24*	0.10	**0.78**

Legend: * $p < 0.05$, ** $p < 0.01$ (2-tailed tests); Bold figures on diagonal are values of square root of the AVE

Test of Hypotheses

We performed hypotheses testing using aggregated team level data. Figure 3 shows unstandardized path coefficients and the explained construct variances. The R^2 values of 0.804 for team performance and 0.369 for member satisfaction indicate that the model explained a substantial amount of variance for team outcomes. Details of hypotheses testing are reported below.

Testing Direct Effects

Hypothesis 1, supported: the path from coordination dimension of TMS to team performance (path = 0.897, t = 22.812, p < 0.001) is positive and significant.

Hypothesis 2, supported: the path from coordination dimension of TMS to member satisfaction (path = 0.608, t = 6.493, p < 0.001) is positive and significant.

Hypothesis 3, supported: the path from perceived faultline to coordination dimension of TMS (path = -0.747, t = 6.460, p < 0.001) is negative and significant.

Hypothesis 4, not supported: the path from perceived faultline to credibility dimension of TMS (path = -0.213, t = 1.373, p > 0.1) is negative but insignificant.

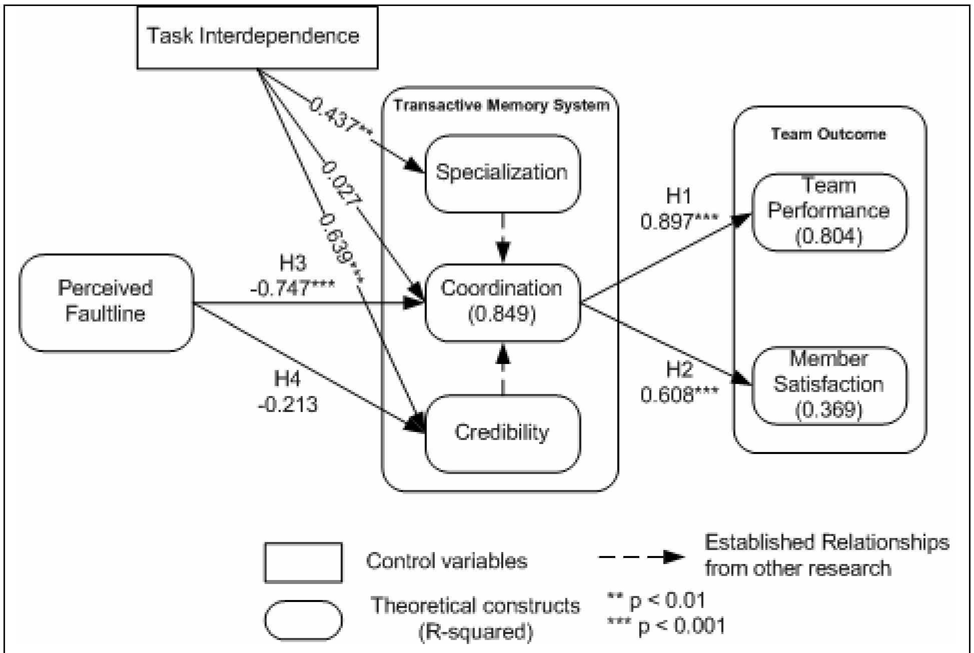

Figure 3. Test of Direct Effects

Testing Mediated Effects

The mediation hypotheses were tested in two complementary ways, following procedures suggested by Subramani (2004). The results of comparing nested models are presented in Table 6, and the results of analyses of individual mediated paths are presented in Table 7.

Table 6. Nested Model Comparison

Direct Path	R^2 in Full Mediation	R^2 in Partial Mediation	f^2 Value	Pseudo F F(1, 16)	Conclusion
Specialization → Member Satisfaction	0.374	0.415	0.070	1.051	Not Sig.
Credibility → Member Satisfaction	0.374	0.383	0.015	0.219	Not Sig.
Perceived Faultline → Team Performance	0.800	0.804	0.020	0.306	Not Sig.
Perceived Faultline → Member Satisfaction	0.374	0.372	-0.003	-0.048	Not Sig.

Table 7. Significance of Mediated Paths

Mediated Path	Path Mag.	Z stat.
Specialization → Coordination → Member Satisfaction	0.500409	3.847096**
Credibility → Coordination → Member Satisfaction	-0.26517	-2.30018*
Perceived Faultline → Coordination → Team Performance	-0.69106	-6.67653**
Perceived Faultline → Coordination → Member Satisfaction	-0.45397	-4.39935**

Legend: * $p < 0.05$, ** $p < 0.01$

Hypothesis 2a, supported: The nested model comparison indicates that the impact of specialization and credibility on member satisfaction is fully mediated by coordination (Table 6 rows 1 and 2). Analyses of individual mediated paths indicate that both mediated paths are significant (Table 7 rows 1 and 2).

Hypothesis 3a, supported: Results of nested model comparison show that the impact of perceived faultline on team performance is fully mediated by coordination (Table 6 row 3). Analyses of individual mediated paths indicate that the mediated paths from perceived faultline to team performance are negative and significant (Table 7 row 3).

Hypothesis 3b, supported: Results of nested model comparison show that the impact of perceived faultline on member satisfaction is fully mediated by coordination (Table 6 row 4). Analyses of individual mediated paths indicate that the mediated paths from perceived faultline to member satisfaction are negative and significant (Table 7 row 4).

Discussion

This research provides several interesting findings regarding how perceived faultlines impact team processes (knowledge coordination) and outcomes (team performance and member satisfaction). First, we found that perceived faultline has a negative impact on coordination, and coordination is an important antecedent of team performance and member satisfaction. In addition, coordination fully mediates the negative effect of perceived faultine on team performance and member satisfaction. This is the first empirical study that tested the impact of perceived faultline on knowledge coordination and team outcomes (performance and member satisfaction) for teams. These findings confirm the proposition that subgroup dynamics have an important impact on both team processes and outcomes (Cramton 2001; Cramton and Hinds 2004; Fiol 2005). While prior research has usually studied the negative consequences of "objective faultlines" for teams (except for Greer and Jehn 2007 and Jehn and Bezrukova 2006 who studied the effect of perceived faultlines on conflict and coalition formation), our study extends prior theory by providing explanations for how perceived faultlines impair team performance and satisfaction, by reducing knowledge coordination.

Second, we found that the impact of specialization and credibility on member satisfaction is fully mediated by the coordination dimension of TMS. This is the first time that member satisfaction is included as an outcome variable in TMS research, in addition to conventional variables such as team performance, individual- and team-level learning. Our results indicate that low level of TMS not only hurts performance, but also damages members' satisfaction with the interaction occurred among team members in distributed teams. Taken together with perceived faultlines' important impact on TMS, this finding suggests that future research on distributed team should consider factors such as perceived faultlines and TMS when they examine member satisfaction.

Third, we failed to detect a significant relationship between perceived faultline and the credibility dimension of TMS. One possible explanation is that this relationship is mediated by other factors such as the existence of uniquely held information. Another possibility is that our sample size was too small to detect this relationship in our dataset.

Limitations

As with any empirical study, our approach has certain limitations. First, ours is a cross-sectional study without considering temporal effects. It will be interesting to investigate the pattern of perceived faultline's impact on TMS and team outcomes as time goes by. Second, our data source was limited to the various constructs in the online survey administrated to students. Thus, we have not analyzed different teams' actual choices and levels of usage of different coordination mechanisms and technologies for collaboration (e.g., email, phone, IM, etc.). Third, we only measured faultlines as perceived by subjects, without capturing information about specific events, experiences, or beliefs that may have contributed to such faultlines. Future research should examine the factors contributing to perceived faultlines, which may inform managers about how to avoid the formation of subgroups in distributed teams – or how to minimize their consequences. These are certainly promising avenue for future research.

Implications

The theoretical contributes of our study are threefold. First, we investigate what impacts TMS development in teams, taking into account subgroup dynamics that occur, due to perceived faultlines. Prior TMS research has studied team heterogeneity and homogeneity among individual members, without considering the dynamics introduced by subgroups that emerge in the overall team. By including the notion of faultlines into research on TMS, our study shows that subgroup dynamics in the form of perceived faultlines *do* impact the development of TMS in distributed teams.

Second, we focus on faultlines that are *perceived* by group members (Greer and Jehn 2007; Jehn and Bezrukova 2006), rather than simply the presence of those faultlines that assumed to occur based on demographic attributes. By measuring the level of group's TMS as a downstream result of actual, perceived faultlines, our study offers insights to open the "black box" that prior researchers posited between faultlines based on objective characteristics and performance. That is, we provide answers to the question: will perceived faultlines trigger negative or positive impacts on team outcomes? Our answers are: first, perceived faultlines do negatively impact team outcomes; second, perceived faultlines directly impair team processes (knowledge coordination), but their negative impacts on team outcomes (performance and satisfaction) are specifically mediated by coordination.

Third, we examine how TMSs in distributed teams influence member satisfaction, an important outcome variable that has not received much attention in TMS research. Our results indicate that low levels of TMS not only hurt performance, but also damage members' psychological well-being in distributed teams. This confirms prior researchers' claims that there is more to team effectiveness and project performance than producing high quality deliverables on time (Hackman 1990; Hackman and Oldham 1980; Powell et al. 2004). We showed that members' psychological well-being is also a very important outcome that researchers should consider in future research.

Our results provide managerial guidance on several fronts. First, we suggest that managers need to pay attention to perceived faultlines that emerge within a group, given their detrimental impact on both team processes (knowledge coordination) and outcomes (performance and satisfaction). Second, distinct from previous research that focuses on the conflicts and coalitions introduced by faultlines, the results from our study encourage project managers to take steps to increase the level of TMS among team members. When TMS is well developed, distributed teams can still achieve high performance and member satisfaction even despite the presence of perceived faultlines.

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Appendix: Measurement items and factor loadings

Construct (Source)	Items	Factor Loading
Perceived Faultline (New scale)	1. Communications (e.g., emails, phone calls) happened only among part of the group.	0.820
	2. I found it easier to communicate (e.g., sending emails, talking on the phone) with certain group members than others.	0.838
	3. I preferred to ask project related information from certain group members over others.	0.814
	4. One or more group members didn't act like part of our group.	0.914
	5. If one or more group members were omitted from our group, it would have been much easier to finish this project.	0.868
TMS-Specialization (Lewis 2003)	1. Each group member has specialized knowledge of some aspect of our project.	0.880
	2. I have knowledge about an aspect of the project that no other group member has.	0.824
	3. Different group members are responsible for expertise in different areas.	0.832
	4. The specialized knowledge of several different group members was needed to complete the project deliverable.	0.908
	5. I know which group members have expertise in specific areas.	0.872
TMS-Credibility (Adapted from Lewis 2003)	1. I was comfortable accepting procedural suggestions from other group members.	0.896
	2. I trusted that other members' knowledge about the project was credible.	0.939
	3. I was confident relying on the information that other group members brought to the discussion.	0.949
TMS-Coordination (Lewis 2003)	1. Our group worked together in a well-coordinated fashion.	0.918
	2. Our group had very few misunderstandings about what to do.	0.820
	3. Our group needed to backtrack and repeat certain parts of the project a lot. (R)	0.570
	4. We accomplished the task smoothly and efficiently.	0.926
	5. There was much confusion about how we would accomplish the task. (R)	0.867
Team Performance (Henderson and Lee 1992)	1. efficiency of team operations.	0.936
	2. amount of work the group produced.	0.949
	3. group's adherence to schedules.	0.912
	4. quality of work the group produced.	0.957
	5. ability to meet the goals of the project.	0.956
Member Satisfaction (Adapted from (Piccoli et al. 2004)	1. To what extent did you enjoy working with group members?	0.975
	2. To what extent did you enjoy working on the group project?	0.951
	3. To what extent would you enjoy working with these group members again?	0.965
Task Interdependence (Adapted from (Campion,Medsker and Higgs 1993)	1. I frequently must coordinate my efforts with others.	0.734
	2. My own performance was dependent on receiving accurate information from others.	0.802
	3. The way I perform my project tasks had a significant impact on other members of my project team.	0.716
	4. My work on the project required me to consult with other members of my project team fairly frequently.	0.859