Utilizing Expertise in Work Teams: The Role of Transactive Memory Systems

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Abstract

Transactive memory system (TMS) theory has attracted a lot of attention in understanding expertise recognition and utilization in work teams in recent years. However, the literature has been mainly focusing on the direct effects of TMS on team performance, leaving the effects on other team outcomes as well as the contingent factors of these effects largely unknown (Lewis, 2003). In addition, according to a recent review by Kozlowski and Ilgen (2006), the literature, featuring an emerging field, needs development on clarifying the definition of the construct and identifying antecedents that contribute to the establishment of TMS. To address these limitations and to advance our understandings of TMS, in this dissertation, I first clarified and synthesized the divergent dimensions of TMS by proposing a two-higher-order-component framework, i.e. TMS structure and TMS manifestation. Based on a revised model, I argued that TMS structure is captured by TMS *specialization, sharedness, and accuracy*, and TMS manifestation captured by TMS *credibility and coordination*. Using this framework, I tried to answer three questions: (1) What relationships does TMS structure (specialization, sharedness, accuracy) have with team outcomes (*performance, innovation, commitment*) and are these relationships mediated by TMS manifestation (credibility and coordination)? (2) Do the relationships between TMS manifestation and team outcomes differ among teams with different task characteristics (i.e. *task interdependence, task routineness,* and *alignment of task assignment*)? And (3) Do *functional diversity*, status characteristics (i.e. *average levels of task-related* and *non-task-related status characteristic cues*), and interpersonal

connections (*closeness* and *communication frequency*) in teams predict TMS structure and TMS manifestation?

Using a sample of 92 charter school boards and 90 school directors, I conducted hierarchical ordinary least square (OLS) regressions. Results showed that, as predicted, TMS credibility and coordination mediated the positive relationships between TMS specialization and board performance and innovation rated by both the charter school directors and the board chairs as well as board commitment. In addition, TMS credibility mediated the positive relationships between TMS sharedness and school director-rated board performance and innovation as well as board commitment. Also as predicted, task interdependence moderated the relationships between TMS credibility and director- and chair-rated performance, director-rated innovation, and board commitment such that the positive relationships were stronger when task interdependence was high than when it was low. Task interdependence moderated the relationships between TMS coordination and director-rated performance and innovation and board commitment in the same fashion. Task routineness moderated the relationships between TMS credibility and director-rated performance and innovation such that the relationships were positive when the tasks were highly routine and negative when the tasks were non-routine. Task routinesness also moderated the relationships between TMS credibility and board commitment in the same fashion as task interdependence does. The average levels of task-related status cues positively predicted TMS specialization, the average levels of non-task-related status cues positively predicted TMS sharedness, and both status characteristics predicted TMS accuracy. Additionally, the levels of interpersonal

closeness among board members were positively related to TMS accuracy as well as TMS credibility and coordination. Contributions, practical implications, limitations and future research are discussed.

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Chapter 1 Introduction

Understanding how to make good use of expertise and share knowledge in work teams has raised a lot of interest in both research and practical fields in recent years due to the wide use of teams and groups in today's organizations. In fact, with increasing levels of competition, decision making, problem solving, and performance enhancing becomes more complex, knowledge-intensive, and often requires diverse expertise and knowledge. Teams and groups, thus, are often formed with a goal of utilizing members' skills, experience, and knowledge, aiming for wiser decisions, higher quality of solutions, and better performance.

Among different theoretical perspectives addressing the issue of utilizing expertise in teams, *transactive memory system* (TMS) has attracted a lot of attention during the past decade. The *transactive memory systems (TMS)* literature focuses on shared knowledge of "who knows what" in teams and has shown that the existence of TMS has positive effects on team performance (e.g., Wegner, Erber, & Raymond, 1991; Moreland & Myaskovsky, 2000; Austin, 2003). A transactive memory system (TMS) refers to a collective memory system of the location and distribution of the expertise/knowledge among team members. It is a cognitive division of labor which facilitates encoding, storage, and retrieval of knowledge in teams or work groups (Hollingshead, 2001). Ever since the notion of TMS was first introduced by Wegner (1985) in the context of intimate relationships, this construct has been increasingly adopted and developed in the research of team processes, especially those related to knowledge management and information sharing during the most recent decade (see

Liang, Moreland, & Argote, 1995; Hollingshead, Fulk, & Monge, 2001; Moreland & Argote, 2003 for reviews). Defined as a collective awareness of who knows what in teams, TMS has been found to have positive effects on team outcomes, including task performance (Austin, 2003; Moreland & Myaskovsky, 2000; Pearsall & Ellis, 2006; Rau, 2005; Zhang, Hempel, Han, & Tjosvold, 2007), decision-making speed and quality (Cruz, Perez, & Ramos, 2007; Ren, Carley, & Argote, 2006), team learning (Akgün, Byrne, Keskin, & Lynn, 2006; Lewis, Lange, & Gillis, 2005), speed to market (of newly developed product) (Akgün et al., 2006), team satisfaction (Pearsall & Ellis, 2006), as well as outcomes of virtual teams (Kanawattanachai & Yoo, 2007).

The consistent findings of the positive effects of TMS underscore the importance of TMS for making successful teams. However, despite the significant contributions of previous researchers, given the limited number of existing studies (Austin, 2003), our understanding of TMS is still far from satisfying in several ways. First, contextual factors such as organizational environment and task characteristics that influence the effects of TMS on team outcomes are still, to a large extent, unknown. The field of TMS research has been mostly focused on finding out what effects TMS has on team outcomes, but, with a few notable exceptions, has yet to extend to uncover conditions or circumstances under which such effects would (or would not) take place or even change in nature (Lewis, 2003). Not knowing the conditions needed for work teams to benefit from TMS and the potential drawbacks of TMS could put them at risk. Second, in contrast to the emphasis on the outcomes of TMS in most of the studies, fewer studies have looked at precursors of TMS. It is now time to take the next steps, as Kozlowski and Ilgen (2006) called in their recent review of work group and team research that initial research on transactive memory is still promising, particularly for the needs of identify factors that contribute to transactive memory system. Understanding the precursors would help work teams to foster and develop TMS when they need to. Third, the conceptualization of TMS is still evolving and requires clarifications and refinement – which is the other area that Kozlowski and Ilgen (2006) pointed out as an emphasis for future research in TMS. Several authors have made great efforts to clarify the concept by identifying dimensions of TMS (Moreland, 1999; Austin, 2003; Brandon & Hollingshead, 2004; Lewis, 2003), differentiating different content of TMS, and comparing and contrasting TMS with other similar constructs (Austin, 2003; Kozlowski & Ilgen, 2006). However, there is lack of consistency among their conclusions.

In light of the limitations and taking Kozlowski and Ilgen (2006)'s call, the present study aims to: (1) Examine contingent factors in the way TMS is related to team outcomes; (2) Explore precursors of TMS; and (3) Clarify and refine the construct of TMS.

In addition, studies of effects of TMS have been predominantly focused on various measures of team performance. To understand what TMS does to teams more comprehensively and in a broader way, other central outcomes of teams such as team attitudes would be valuable to look at. Also, the empirical data in the field of TMS research has largely relied on lab experiments and student samples. A very limited number of studies of TMS have been conducted in the field. The difficulty of getting organizational access to large number of teams is obviously a major reason. While acknowledging the advantages of lab experiments on initial understandings of a new phenomena and the value of student samples, field studies with work teams are still needed to verify findings of TMS in a more dynamic context in organizations. Therefore, the present study also contributes to the literature by conducting a field study.

To summarize, the current study contributes to the literature in the following ways: First, it advanced our understanding of contingent factors of the relationships between TMS and team performance and attitude outcomes. Second, it explored the precursors of TMS. Third, it clarified and refined the construct of TMS by differentiating TMS structure and TMS manifestation. Fourth, it examined how TMS is related to other central team outcomes. Lastly, it tested the theoretical framework in a field context.

By making the aforementioned contributions, this study intends to answer the following research question on:

How does transactive memory system work as a mechanism for making use of members' expertise in work teams?

Before diving into the TMS literature, it helps to compare and contrast TMS theory with two alternative theoretical perspectives that have provided insight into the issue of expertise utilization, namely, expertise recognition (Libby, Trotman, & Zimmer, 1987; Bunderson, 2003) and distributed knowledge (information sampling) (Stasser & Titus, 1985).

The *expertise recognition perspective* focuses on what factors predict probability of recognizing others' expertise in teams. The basic theoretical argument is that team outcomes such as team performance, decision making, etc. benefit from the recognition of expertise. One assumption of this argument is that team members will naturally act according to the expertise they recognized. Findings from laboratory studies indicate that team members are not good at identifying each other's expertise in general; they use all signals available to form their perceptions of expertise. For example, the more dominant and assertive members get identified as the most expert (Littlepage, Robison, & Reddington, 1997; Littlepage, Schmidt, Whisler, & Frost, 1995) and feedback on members' performance help teams better recognize expertise (Henry, Strickland, Yorges, & Ladd, 1996). A field study by Bunderson (2003) shows that task-related and physical status characteristics are also important signals for expertise recognition, as both the types of status characteristics were positively related to the probability of being recognized as an expert.

The *distributed knowledge approach* focuses on members' unique knowledge in teams and tries to reveal under what conditions members can pool or reflect upon the *unshared* information when knowledge is distributed in the teams. The major finding in this literature is that team members usually focus on shared information more than unshared information (which is usually referred to as "sampling bias") in the process of group discussion or retrieving information (Stasser, Stewart, & Wittenbaum, 1995). This sampling bias or failure of making use of unshared information and unique knowledge have negative effects on quality of group decisions and hinder individual learning of new information (Brodbeck, Kerschreiter, Mojzisch, & Schulz-Hardt, 2007) and other outcomes (Gigone & Hastie, 1997). However, some interventions can help team members access (or activate) the unshared information. For example, expert-role assignment, i.e.

publicly identifying members' expertise, is found to reduce sampling bias of favoring shared information significantly (Stasser, Vaughan, & Stewart, 2000).

I took the transactive memory system (TMS) approach in this study for two key reasons. First, TMS explores a more complete *process* of making use of team members' expertise. TMS theory highlights factors contributing to expertise recognition and portrays the transition process from recognition to utilization of expertise. I suggest that this can better be captured by formation and manifestation of TMS which capture both expertise recognition and utilization. In contrast, the other two aforementioned perspectives tend to only focus on one or another part of the process. Second, TMS is a relatively new theory and research in this area is very promising (Kozlowski & Ilgen, 2006). A lot is still unknown, for example, about contingent factors upon which TMS facilitates or impedes expertise utilization and coordination in teams.

The rest of the dissertation is organized in the following order: I first review the origin and development of the construct of TMS in Section 2, with an integrated framework of TMS proposed. Then, in Section 3 I focus on the effects of TMS on team performance and attitude outcomes, and the contingent factors that influence the nature or the strength of the effects. In Section 4, I explore three sets of precursors of TMS by drawing upon the expertise recognition theory. Lastly, Section 5 covers the method including sample and participants, measures, analysis strategy and a brief discussion.

Chapter 2 The Evolving Construct of TMS

2.1 Definition of TMS

The notion of transactive memory was first introduced by Wegner (1985) who was trying to understand how people in close relationships, such as married or dating couples, utilize each other's memory to perform a word-memorizing task (Wegner, 1985). He described transactive memory as a combination of the two persons' memory/knowledge, and a shared awareness of who knows what. Wegner (1986) extended the concept of transactive memory to group settings where there is a *system* of transactive memory, i.e. transactive memory system (TMS). He sees a transactive memory system in groups as "a set of individual memory systems" and explained in detail the process through which TMS operates by drawing upon theory of individual memory systems. An individual memory system theory says that individuals go through three stages when they process and try to remember information: *encoding, storage,* and *retrieval,* and they use not only their own but external storage during these transactions. In transactive memory, an individual connects his/her memory system with those of others' by treating others' memory as an external *storage* and using it during processes of *encoding* and *retrieval*. Specifically, *transactive encoding* involves discussing and determining for the incoming information "where and in what form it is to be stored in the group"; *transactive retrieval* "requires determining the location of information and sometimes entails the combination or interplay of items coming from multiple locations." (p. 190). Wegner (1995) further described the process of TMS with a metaphor of computer networks with shared-directories: *directory updating*, i.e., learning who has what knowledge in the group; *information allocation*, i.e., passing the information to the individual with the relevant expertise for storage; and *retrieval coordination,* i.e., searching information in an organized way so that the needed information can be located from the right person and most quickly.

Wegner's definition and conceptualization of TMS has been supported and adopted by other researchers in small group research (see Moreland, 1999; Hollingshead, 2000; Rulke & Rau, 2000; Lewis, 2003; Austin, 2003 for examples). In general, researchers have agreed that a transactive memory system is (1) knowledge of who knows what within a team and (2) a cognitive of division of labor that facilitates encoding, storage, and retrieval of information among team members. As such, there has been good consistency about the meaning of TMS in the literature. It is for the dimensionality of the construct, however, that the consistency is absent.

2.2 Other Similar Constructs

Before going into the dimensions of the construct, it helps to compare and contrast TMS with some other similar constructs for a better understanding of the conceptualization.

Team mental model. Team mental model (TMM), originally introduced by Cannon-Bowers, Salas and Converse (1990), is a cognitive structure in teams with which team members make sense of their surroundings and interpretations (Klimoski & Mohammed, 1994). It has been described as a shared, organized knowledge framework about the task-related and team's relevant environment through which team members understand the functioning of the systems within the team (Mohammed & Dumville, 2001; Lim & Klein, 2006). Cannon-Bowers and Salas (2001) have clarified the specific content of the construct: TMM is a shared cognition; what is shared in this cognition include task-specific information, task-related knowledge, and knowledge of each other and others' attitudes/beliefs.

As both team mental model and transactive memory systems are cognitive structures of certain knowledge in teams, they seem to resemble each other to some extent. However, they are distinctive in the sense that TMM is "the knowledge structures or information held in common" whereas TMS is "knowledge of information distribution within a team" (Kozlowski & Ilgen, 2006; p.83). They both contain shared knowledge about certain aspects of the teams, but TMM focuses on the shared knowledge of team's *task environment*, whereas TMS focuses on the shared knowledge of teammates' knowledge/skills/expertise. In this sense, the domain of TMM is broader than TMS, and TMS is very specific. Ellis (2006) included both TMM and TMS at the same time in a study of 97 teams in a lab experiment and found that each of the two constructs accounted for a unique portion of the co-variance between acute stress and team performance.

Collective cognition/Team cognition. Collective cognition is a set of "minds" that are located and connected in certain patterns between individuals (Lewis, Belliveau, Herndon, & Keller, 2007; Wong & Sitkin, 2000; Gibson & Earley, 2007; Morgeson & Hofmann, 1999). Gibson (2001) defined collective cognition as a process with four phases: accumulation (perceiving, filtering, and storing), interaction (retrieving, exchanging, and structuring), examining (negotiating, interpreting, and evaluating), and accommodation (integrating, deciding, and acting).

As TMS focuses on the cognition of expertise distribution, it has been viewed as a kind of collective cognition (He, Butler, & King, 2007), so that theory of collective cognition should be applicable to TMS.

2.3 Dimensions of TMS

Researchers have identified different typologies of TMS dimensions in the literature for better understanding as well as properly testing TMS (See Table 1). I review these typologies of TMS dimensions in this section and propose an integrated framework.

Insert Table 1 about here

Wegner (1986) originally defined transactive memory with two parts: combination of individuals' knowledge and shared awareness of other's expertise. Moreland (1999) focused on the second part and specified three what he called "indices" when measuring group members' knowledge of others' expertise: *complexity* of members' belief about one another's expertise, *accuracy* of the beliefs, and *agreement* about the distribution of expertise.

Austin (2003) addressed the importance of considering both parts to cover the whole concept and thus identified four dimensions of transactive memory based on Wegner's definition and Moreland (1999)'s dimensions. Specifically, he included a dimension of *knowledge stock*, together with three other dimensions derived from Moreland (1999), *specialization (*similar to *complexity)*, *consensus (agreement)*, and *accuracy*. He articulates knowledge stock as a pool of individual knowledge elements within a group, which is important for group success in the sense that it determines the total amount of knowledge resources available within the group. *Specialization* captures team members' perceptions of the distribution of the expertise/knowledge or the unique information in the teams. *Consensus* speaks to the degree to which members agree upon the distribution of the specialization, and *Accuracy* tells if members' perceptions on specialization of expertise are actually correct. Austin's four-dimension framework has been adopted by other researchers (e.g., Cruz et al., 2007).

Brandon and Hollingshead (2004) proposed another three-dimension typology, *accuracy*, *sharedness*, and *validation*, with a new aspect of TMS, i.e. *validation*, which captures the degree to which team members "validate" or participate in the TMS. They argued that TMS was built with many task-expertise-person (TEP) units, and high levels of accuracy, sharedness and validation would indicate an optimal state of TMS. Their concept of TEP units actually incorporates the idea of specialization, and in this sense, their dimensions include specialization, accuracy, sharedness and validation.

Lewis (2003), while developing a survey measure of TMS, identified three dimensions that diagnose the existence and operation of TMS: *specialization*, *credibility*, and *coordination*. The specialization and credibility dimensions are along the same line with previous dimensions, with specialization being team members' perception of others' expertise, and credibility, similar to the validation dimension of Brandon and Hollingshead (2004), i.e., the extent to which they trust or believe in other's expertise. The coordination dimension, on the other hand, gets at something different from previous dimensions. It indicates the evidence that TMS is operating (the coordination actions through which TMS is manifested) or members are coordinating based on the TMS in teams. Lewis's three-dimension terminology has been widely used recently. For example, Majchrzak, Jarvenpaa, and Hollingshead (2007) argued for the need to extend TMS theory for emergent groups responding to disasters in the three aspects: "reconceptualizing the role of expertise specialization as a basis for task assignment, assessing credibility in emergent response groups and coordinating knowledge process without a shared metastructure" (p.152). Kanawattanachai and Yoo (2007) studied the three behavioral dimensions – expertise location (i.e., specialization), task-knowledge coordination (i.e., coordination), and cognition-based trust (i.e., credibility)—when trying to understand effects of TMS on performance in virtual teams.

Lastly, Ren et al. (2006) examined the density and accuracy of TMS in a study using a computational model. The density dimension was modeled as the amount of useful knowledge exists in TMS, which resembles the knowledge stock dimension of Austin (2003).

2.4 Contents of TMS

TMS is also domain-specific. In addition to the dimensions of TMS, content of TMS is also an important feature of the construct. As one part of TMS is about the combination of the individual knowledge according to Wegner's original definition, TMS can vary based on the knowledge domain it is formed within. As Austin (2003) stated, "groups can have multiple transactive memory systems dealing with separate knowledge domains." (p. 868). The theoretical foundation is that how people use knowledge inherently depends on the content of the knowledge (Schank & Abelson, 1977; Walsh, 1995; Austin, 2003). As the knowledge content involved in the TMS may change across different environments, the content of TMS may also change accordingly. Austin (2003) identified two different contents of TMS: *task* TMS and *external relationship* TMS. Task TMS can be viewed as a shared awareness of who knows what about the *task*, and external relationships TMS can be conceptualized as members' shared perceptions of others' relationship with members outside the team, or other's *external* resources. It is important to differentiate TMS with different contents as TMS focusing on different knowledge domains may have different effects on team outcomes. In Austin (2003)'s study, he found a significant positive relationship between group's external relationship TMS and the goal attainment and member-rated evaluations, respectively, and a marginally significant relationship between external relationship TMS and external evaluation of team success. I will focus on task TMS in this study due to the centrality of this content to core team processes.

2.5 Types of TMS

When he discussed the application of TMS in organizations, Wegner (1986) suggested that there can be two types of TMS in organizations, differentiated TMS and integrated TMS. A differentiated TMS occurs when "different items of information are stored in different individual memory stores, but the individuals know the general labels and locations of items they do not hold personally" (p. 204). In other words, in differentiated TMS, there's little overlap between individual members' expertise or knowledge domains. Integrated TMS, on the other hand, is a TMS where "the same items of information are held in different individual memory stores, and the individuals are aware of the overlap because they share label and location information as well" (p. 204). He emphasized the importance of differentiating the two structures of TMS because the effectiveness of TMS of different structures may differ significantly given different types of tasks. For example, for teams where members each have different functions and need to rely on others to perform the tasks, such as production or R&D teams, a differentiated TMS would be useful; whereas an integrated TMS would be appropriate when members each perform all the functions and need to independently complete the tasks, such as a team with sales force or customer service representatives. This study will focus on the differentiated TMS in teams that have a certain level of task interdependence.

2.6 Toward an Integrated Framework of TMS.

Based on the review above, a total of six unique dimensions have been identified as important aspects of TMS in the literature to date: *knowledge stock*, *specialization*, *sharedness* (agreement, consensus), *accuracy*, *credibility* (validation), and *coordination*. These dimensions are getting at different attributes of TMS, and were addressed in different studies. Clearly, researchers have advanced the conceptualization of TMS significantly by identifying these dimensions. However, the lack of consistency among the sets of dimensions adds confusion, and is an impediment for fully understanding the construct and how it is related to other constructs. Therefore, drawing on Lewis et al.'s (2007) perspective, in this dissertation I propose an integrated framework for clarifying and refining the construct of transactive memory systems. (See Figure 1)

Insert Figure 1 about here

Specifically, I argue for a distinction between TMS structure and TMS manifestation and treat them as two higher-order components of TMS dimensions. Lewis et al. (2007) first brought up the concepts of TMS structure and TMS process as two aspects of TMS. They define TMS structure as a representation of members' shared understanding of location of information, and TMS process as a set of transactive processes that are used to coordinate learning and knowledge retrieval. Adopting these concepts, I propose two higher-order components of TMS, i.e., TMS structure and TMS manifestation, as one way to synthesize the dimensions of TMS. (As illustrated in Figure 1). TMS structure concerns the cognitive representation of knowledge, and describes the extent to which team members share accurate knowledge of one another's expertise and trust on the expertise. It is represented by specialization, sharedness, accuracy and credibility. TMS manifestation refers to the actual demonstration of coordination when team members act upon the established cognitive division of labor through information seeking, knowledge sharing, etc., to coordinate and complete tasks. TMS manifestation is represented by coordination. The remaining dimension knowledge stock determines the scope and content of the TMS.

Specialization is a state when team members realize one another's specialty or expertise, including both themselves' and others'. Here the specialization refers to the actual task specialization and is "more finely graded expertise distinctions than just functional affiliation" (Van der Vegt & Bunderson, 2005; p. 533). It is likely to be closely related to "dominant function diversity" and resembles the concept of "functional assignment diversity" defined by Bunderson and Sutcliffe (2002), but is different from both in two important ways. First, although specialization is likely to happen more naturally in teams with functional diverse members, it can also happen in teams of members all sharing the same functional background. For example, an implantable medical device development team may be composed of all electronic engineers, but the engineers may differ in their technical specializations in terms of performing specific tasks, as some may work on the hardware design of the outside-body parts of the device, while others may work on the hardware design of the parts inside body. Second, specialization contains a component of *perceptions* or *awareness* of the locations of others' expertise, which is different from the *actual* distribution of expertise. As Harrison, Price, Gavin and Florey (2002) have found in their study, diversity and *perception* of diversity are two different constructs and mean different things.

The *sharedness* and *accuracy* are two aspects of specialization, capturing the extent to which the specialization structure is agreed upon among team members, and the extent to which the perceptions of the specialization structure are actually correct.

Credibility is the extent to which team members trust others' expertise and feel comfortable accepting their suggestions. The process is similar with the forming of team trust (Jehn & Mannix, 2001), but is not the same, as credibility focuses on the aspects of others' expertise particularly.

Coordination, manifestation of TMS structure, is a process through which TMS is operating or manifested such that members' expertise get utilized. It is the process that members' cognition (i.e. perceptions of the distribution of expertise) translates into actions, i.e. the actual behaviors of coordinating the expertise, knowledge and information. It can include both implicit coordination (Rico, Sanchez-Manzanares, Gil, & Gibson, 2008) and explicit coordination. According to Rico et al., implicit coordination refers to "act in concert by predicting the needs of the task and the team members and adjusting behavior accordingly" (p. 165). For example, a member only paying attention to his/her specialized domain when encoding and storing new information and anticipating others to focus on their domain is an example of implicit coordination. In contrast, explicit coordination requires "communicating with fellow members, articulating plans… and seeking information to undertake common task" (p. 165). Retrieving information from fellow members who hold relevant expertise is an example of explicit coordination.

It is important to specify the relationships between specialization, credibility and coordination. First, specialization can be viewed as the initial stage of the emergence of a TMS. In a newly formed team, specialization can be achieved by members' gradually specializing in different domains and identifying one another's domains (i.e., expertise) based on their functional background, their task-related status, their communication and interactions (Moreland & Argote, 2003). At the same time, with the emergence of specialization, members evaluate others' expertise, and develop their perceived credibility of the expertise. These two processes are closely related, with specialization likely to happen a little before credibility. The presence of both specialization and credibility can then enable members to presumably act on the TMS structure and coordinate accordingly. The findings of Kanawattanachai and Yoo's (2007) study that effects of specialization and credibility on team outcomes were mediated by the coordination behaviors supports the sequential relationship of specialization and credibility to coordination.

On the other hand, during the coordination, members get to learn more about others' expertise, get more sense of the reliability of the expertise, and thus increase the level of specialization and its sharedness and accuracy, as well as the credibility. As such, coordination can also lead to specialization and credibility. The reciprocal relationship between specialization and credibility and coordination are illustrated in Figure 1. Therefore,

Proposition 1: A TMS is composed of shared and accurate specialization and credibility (TMS structure) and coordination (TMS manifestation).

Proposition 2: TMS structure (shared and accurate specialization and credibility) will increase the likelihood of TMS manifestation (coordination); Vice versa, TMS manifestation will also result in better TMS structure.

These theoretical relationships are elaborated for the purpose of construct understanding and will only be used as assumptions for hypotheses development later in the dissertation. Testing the reciprocal relationships is outside the domain of the current study.

One last dimension of TMS, the knowledge stock, defines the scope of a TMS, or how sophisticated a TMS is and how much knowledge/expertise the TMS covers. The knowledge stock is likely to be determined by the composition of the team members as well as each member's knowledge domain.

The proposed conceptual framework of the TMS dimensions contributes to the literature in three important ways. First, it clarifies the construct with a synthesis of framework and resolves the inconsistency in the dimensionality of the construct. Second, the separation between TMS structure and manifestation facilitates study of the specific components of TMS and their relationships to team outcomes as well as contextual factors on the effects of TMS. Third, this framework helps better identify predictors of TMS and understand how they are related to TMS.

Chapter 3 TMS and Team Outcomes

3.1 TMS and Team Performance

The relationship between TMS and team performance has been the central question that researchers have been trying to answer since the construct was introduced by Wegner (1985). Grounded on its conceptualization, TMS is expected to have positive effects on team performance as it is a shared cognition that facilitates the encoding, storage, and retrieval of information embedded in the knowledge sharing and coordination process of team members, which usually are positively related to teams' performance.

Empirical studies have provided good evidence for a positive relationship between TMS and performance (as measured through several indices such as speed of work, quality of decision making, goal attainment, etc.) Laboratory settings were most commonly adopted in early stages, followed by more field studies recently. I review the experimental and field studies in this section, and then develop hypotheses about relationships between TMS dimensions and team performance.

Experimental Studies.

Wegner et al. (1991) first tested the effects of TMS among dyads in an experiment of memory performance with intimate couples. They found that natural couples recalled more items than artificial pairs due to the TMS established among the natural couples. Extending the settings to work groups, Liang, Moreland, and Argote (1995) conducted a radio assembly experiment with work groups and explored the mediating role of TMS in group training and team task performance. They proposed a theoretical argument that group training is more effective than individual training because group members who are trained together are likely to form a TMS, which in turn has positive effects on team task performance. They invited 90 undergraduate students who enrolled in business courses and randomly assigned half of them to a group training condition and the other half to individual training condition. They first trained the subjects how to assemble a radio, either in groups or individually. In the group training condition, individuals were randomly assigned to a 3-person group and trained together. One week later, all subjects were tested again. Those trained individually were randomly re-assigned to 3-person groups and those trained in groups remained in their groups. Each group was first asked to recall the procedures of assembling the radio together in seven minutes, and then to actually assemble a radio within 30 minutes. Task performance was measured by the correctness of the recalled procedures, the number of misplaced or misconnected pieces, and the speed the radio was assembled. Results showed that transactive memory system (reflected by three cognitive factors that were coded from video-tapes of teams) had a direct effect on team performance, controlling for the differences in training, and TMS mediated the effects of training on team performance. Moreland and Wingert (1995) did a similar follow up experiment to replicate the findings and address several remaining issues. The procedures were basically the same, only that individuals were all trained together regardless of the conditional group they were in, but were not allowed to communicate during the training. The findings replicated the previous findings and showed that groups that could not build up TMS (members were trained individually) or whose TMS was disabled (members were re-assigned to other groups) couldn't improve their performance even with techniques of group development and strategic learning. So the poor performance was ascribed to the lack of TMS in the groups since training methods didn't change performance without a TMS.

Pearsall and Ellis (2006) did a command-and-control simulation with 64 student teams to examine effects of critical members' dispositional assertiveness on team performance and satisfaction. They randomly assigned each individual to a four-person team and asked them to work on the Distributed Dynamic Decision-Making Program on computer and try to maximize their team score. The results showed that critical team members' assertiveness is positively related to team performance and satisfaction by improving their transactive memory system. Cruz, Perez and Ramos (2007) conducted an experiment with 44 business student teams on a business game of decision-making. Participants were asked to play a Business Strategy Game where they acted as the CEO team of a company and made decisions on marketing, production, human resources and finance on a yearly basis for five hypothetical years. The authors tested how knowledge stock, specialization, consensus and accuracy of TMS each affects teams' decision making quality separately, and found a positive relationship between specialization (i.e., understanding and developing each other's areas of expertise) and team performance.

Lewis, Lang and Gillis (2005), viewing TMS as a learning mechanism, did a comprehensive experiment on electronic assembly tasks to test if TMS predicts team learning, and facilitates learning transfer when performing tasks in different domains. They found, in essence, that learning transfer was more likely to happen in teams with established TMS and shared experience on tasks in the same domain.

Ren, Carley, and Argote (2006) developed a computational model to examine effects of TMS on team performance with simulated teams of different characteristics. Specifically, they found that TMS was particularly beneficial to small groups on their decision-making quality, whereas more beneficial to large groups on the speed of their decision making in dynamic and volatile knowledge environments.

Lastly, Kanawattanachai and Yoo (2007) did a web-based business simulation game with 38 MBA student teams to test how TMS is related to performance in virtual teams over a period of eight weeks. They showed that TMS was especially important for team performance (as measured by stock price) toward the end of the project, and that TMS was essential for task performance once it was developed in virtual teams.

In sum, the experimental studies demonstrated that TMS benefited team performance.

Field studies

The number of field studies on TMS has increased significantly in the past few years. Faraj and Sproull (2000) were among the earliest who conducted a field study on

TMS. Framing TMS as an expertise coordination process, they studied 69 software development teams and found that teams' expertise coordination was associated with team effectiveness, and its effects were above and beyond the effects of team characteristics such as presence of expertise, professional experience and software development methods. Austin (2003) examined the relationship between TMS and team performance with continuing work teams from an apparel and sporting goods company. Twenty-seven product line teams were surveyed with items generated from several semi-structured interviews, and teams' task TMS and external relationship TMS were measured. The performance variables, i.e. goal attainment, external group evaluations, and internal evaluations were assessed by an evaluation team two months later after the first survey. He tested the effects of task TMS and external relationships TMS on team performance as well as the role of each of the four TMS dimensions, and found that task TMS was positively related to team's goal achievement, task TMS accuracy was positively related to all three measures of team performance, and task specialization was positively related to internal and external evaluations. Austin's study advanced the field of TMS research by identifying four individual dimensions of TMS as well as differentiating task TMS and external relationship TMS. Rau (2005) used a sample of commercial bank top management teams and investigated how the expertise composition dimension and location dimension of TMS (i.e., specialization) influence team's performance, and how team relationship conflict and trust affect the relationships. The top management teams' performance was measured with the firms' performance as measured by the average assets of banks at the end of the year the survey was taken. The findings indicate that location of expertise was positively related to team performance, and this relationship was much stronger in teams with low relationship conflict than those with high relationship conflict.

Lastly, Akgun, Byrne, Keskin and Lynn (2006) explored how TMS is related to new product success in new product development teams, through its effects on team learning and speed of new product to the market. They demonstrated that TMS was positively related to both team learning and speed-to-market, by enhancing the teams' ability to detect and resolve product problems, facilitating collective learning, and launching the product faster.

In summary, both theory and empirical evidence support the positive effects of TMS on team performance. The literature is suggestive that a transactive memory system with shared and accurate specialization and credibility facilitates coordination among team members which in turn benefits team performance. Based on the TMS structure-TMS manifestation framework proposed in the previous section, I argue that effects of TMS structure will be realized through TMS manifestation. That is, specialization, sharedness, accuracy, credibility, and coordination will each have positive effects on team performance and explain a unique proportion of the variance, and the effects of specialization, sharedness, accuracy and credibility (TMS structure) will be mediated by coordination (TMS manifestation).

Hypothesis 1: TMS structure will be positively related to team performance; and this relationship will be mediated by TMS manifestation.

3.2 TMS and Other Team Outcomes

In addition to the different aspects of team performance reviewed above, there are still a lot of important team outcomes whose relationships with TMS are unknown. Hackman (1987) has defined three criteria of team effectiveness as (1) productive team output that meets or exceeds standards (i.e., team performance), (2) withdrawal behaviors and team member desire to work together again, and (3) team member satisfaction. While the objective performance outcomes have been the major focus in TMS studies, the subjective attitude outcomes are left unaddressed. To present a more comprehensive model of effects of transactive memory system, I consider a less-studied objective outcome, i.e., team innovation, and team attitudes (team satisfaction and team commitment) (Jehn & Bendersky, 2003).

Team Innovation. Team innovation has been recognized as a critical competitive advantage of organizations (Gibson & Gibbs, 2006). It has been defined as "the intentional introduction and application within a team, of ideas, processes, products, or procedures new to the team, designed to significantly benefit the individual, the team, the organization, or wider society" (West & Wallace, 1991; p. 303). The process of innovation generally includes two aspects: (1) generation of creative and useful ideas, and (2) implementation of the ideas (West & Anderson, 1996; Taylor & Greve, 2006). Based on social information theory and other research on group cognition and process (Woodman, 1993; West & Anderson, 1996), these two aspects require identifying appropriate and useful knowledge of team members to apply to problem solving and deep mastery of the knowledge domain to push the boundaries (Taylor & Greve, 2006). It is also important for team members to have access to others' knowledge as resources to augment their own knowledge and to actively participate in the interactive process.

Transactive memory systems provide a cognitive structure of each member's skills and knowledge and a mechanism that facilitates knowledge sharing and collective collaboration by utilizing the whole stock of the knowledge available in the team or "tapping into the diverse knowledge of a team's members" (Taylor & Greve, 2006; p. 724). The shared and accurate awareness of team members' specialization and the trust on the specialization thus provide an appropriate environment and conditions for generation of creative ideas. In addition, the cognitive and behavioral coordination based on the transactive memory system also facilitates the implementation of the creative ideas on task procedures and practices. Empirical findings also showed that team composition (e.g., diversity), team process (e.g., social information processing), collective learning, and team collaboration were all factors that promote team innovation (Woodman, et al, 1003; Drach-Zahavy & Somech, 2001). Therefore, I propose:

Hypothesis 2: TMS structure will be positively related to team innovation; and this relationship will be mediated by TMS manifestation.

Team Attitudes. Team members' attitudes such as team satisfaction and commitment have been shown that they can be influenced by the tasks and interpersonal interactions among team members. For example, Jehn and Bendersky (2003) have argued that differences in ideas and opinions about the content of the tasks, disagreement in approaches the team perform tasks, and incompatibilities in interpersonal relations within teams can all reduce team members' satisfaction and commitment (Amason, 1996;

Amason & Schweiger, 1994). Transactive memory system, i.e., shared and accurate specialization and credibility with the formation of TMS, and manifestation of the cognitive division of labor in coordination, is likely to reduce disagreement related to task content or approaches. Teams with TMS established and implemented well are more likely to experience smooth and pleasant coordination and less conflict which in turn increases team members' satisfaction and commitment.

Hypothesis 3: TMS structure will be positively related to team satisfaction; and this relationship will be mediated by TMS manifestation.

Hypothesis 4: TMS structure will be positively related to team commitment; and this relationship will be mediated by TMS manifestation.

3.3 Moderators of Effects of TMS on Team Outcomes

Thus far, research on how TMS affects team outcomes has been predominantly focused on the main effects of TMS. The boundary conditions of the positive effects, however, are unclear. Particularly, whether and when TMS would (or would not) have the expected effects on teams are unknown. As Lewis (2003) noted, "Establishing the limits of the TMS construct as well as its applicability in different types of organizational teams are key areas for future research." (p. 602) So far only a limited number of studies have addressed the issue. Ren et al. (2006) have tested the moderating effects of group size and task and knowledge environment on how TMS is related to decision quality and speed. They found that depending on the performance measure, TMS can be beneficial particularly to small groups' decision quality or large groups' decision speed in dynamic task and volatile knowledge environment. Rau (2005) examined the moderating effect of relationship conflict on TMS-performance relationship and found that the effect of TMS was significantly stronger in teams with low relationship conflict. Lewis et al. (2007) have shed light on the conditions under which TMS can potentially harm team effectiveness. They explored the benefits and detriments of TMS in teams experiencing membership change with a lab experiment. The results showed that TMS developed previously in the original team can be detrimental to the team after a partial membership change occurred due to the inefficient TMS process it created.

Despite the advancement in the understanding of the contingency of TMS effects reviewed above, still little is known about the “limits” of TMS in teams with stable membership. Research has shown that features of tasks and the context within which work teams are operating play important roles as moderators of the effects of team mechanism on team outcomes (e.g., Barrick, Bradley, Kristof-Brown, & Colbert, 2007; Rico et. al, 2008; Jehn & Bendersky, 2003). Theoretical and empirical work suggest that the extent to which team mechanisms such as communication, cohesion, conflict, etc. function and impact team performance depends on the characteristics of the tasks teams are performing, such as task interdependence and task routineness (e.g., Barrick et al., 2007; Jehn, 1995), and the context of the teams like structure of task assignment (e.g., Wegner, 1991; Brandon & Hollingshead, 2004; Lewis, 2007). Transactive memory system, as one kind of team mechanism through which members process and coordinate knowledge, is also likely influence team outcomes contingent upon these factors. Specifically, I explore the moderating role of task interdependence, task routineness, and task assignment on the effects of TMS, which have not been empirically examined.

Task interdependence. Task interdependence is defined as the extent to which team members interact and exchange information or take actions for other members' in order to complete their jobs (Wegeman, 1995; Van der Vegt, Emans & Van De Vliert, 2000; Thompson, 1967). In teams with high task interdependence, members actively share with and acquire from others their knowledge, information and resources. In contrast, in teams where task interdependence is low, tasks can be easily divided and members can complete their jobs independently.

Task interdependence may affect the effects of transactive memory system on team performance and innovation and team member attitudes (satisfaction and commitment). Specifically, transactive memory system is expected to particularly benefit teams with high task interdependence. When team members must rely on each other and coordinate actively, they need to know not only their own domain of tasks, but what others know, what resources they have, and what roles others play in the big picture of the whole job. Having and using a transactive memory system will facilitate the process of encoding, storage and retrieval of information, help teams to utilize knowledge and skills of every member, to make higher quality decisions and faster, and to coordinate efficiently. In contrast, when individual members do not need to connect with one another to complete their tasks, transactive memory system is less likely to come into play and affect team outcomes. Likewise, in teams with high level of task interdependence and interaction, team members are more likely to encounter conflict with tasks, and the existence of TMS will makes bigger difference for team members' attitudes such as satisfaction and commitment. For example, Barrick, et al. (2007) found in a study of top management teams that the effects of team mechanism including communication and cohesion is strong and positive when task interdependence is high and slightly negative when task interdependence is low. Therefore, I propose,

Hypothesis 5: Task interdependence will moderate the relationship between TMS manifestation and (a) team performance (b) team innovation (c) team member attitudes (satisfaction and commitment) such that the positive relationship between TMS and team performance, innovation, and attitudes will be stronger in teams with high level of task interdependence.

Task routineness. Following Rico et al.'s (2008) conceptualization, task routineness is defined as the extent to which tasks are well defined, certain, structured, predictable, and can be resolved using standard procedures. It is conceptualized as a continuum, and the higher the task routineness, the better the tasks defined and the more likely procedures of the tasks can be standardized and repeated. The level of task routineness may affect how team mechanism or process is related to team outcomes. For example, Jehn (1995, 1997) studied task routineness as a moderator of the relationship between task conflict and team performance, and found that task conflict benefit team performance in teams performing nonroutine tasks. Pelled, Eisenhardt, and Xin (1999) examined the interaction of task routineness and functional diversity on predicting task conflict, and found that functional diversity is more likely to be related to task conflict when tasks were routine than were nonroutine. The theoretical work of Rico and the co-authors' (Rico et al., 2008) also suggests task routineness as a moderator of the relationship between implicit coordination and team performance.

Effects of TMS on team outcomes may also vary depending on the level of routineness of the tasks within the teams. When tasks are well defined and straightforward, team members are more likely to stick with the TMS based on which the coordination patterns are established. When tasks are uncertain and nonroutine, with the changing task requirements, the demand on team members to exchange information increases and the habitual functioning of the team may be challenged. Team members need to increase their communication and make adjustments in coordinating their actions. Under such dynamic situations, only relying on the established TMS may actually harm team performance and team members' attitudes as teams need to modify or generate new coordination patterns (Rico, et al., 2008). Therefore, I propose:

Hypothesis 6: Task routineness will moderate the relationship between TMS manifestation and (a) team performance (b) team innovation (c) team attitudes (satisfaction and commitment) such that TMS will benefit team performance, innovation, and attitudes when task routineness is high, and harm these outcomes when task routineness is low.

Alignment of task assignment with specialization. Task assignment has been shown to influence how TMS affects team performance. Early in Wegner's (1991) experimental study of dating couples' memory performance, they found that natural couples who had TMS remembered *fewer* items than artificial pairs (where TMS did not exist) when memorizing responsibility was pre-assigned randomly. Specifically, it was found that natural couples failed to recall the items from their own area of expertise when they were assigned those items to recall. In other words, individuals in natural couples performed worse when implicit assignments determined by the TMS were made explicit by the task assignment, whereas artificial couples without TMS was hardly affected by the assignment structure. The authors proposed a couple of explanation for the ill effect of task assignment. First, making implicit assignment explicit may "introduce uncertainty about task assignment or perhaps instills over-confidence that leads to a tendency to ignore the task at hand" (p. 928). Second, making implicit task explicit may "has the effect of cognitive disrupting the flow of an otherwise fluid performance" (p. 928). This study indicates that TMS may benefit or harm performance depending on if assignment is imposed. Specifically, making firm, explicit task assignment may not be as effective or beneficial as one may expect when there is an established transactive memory system.

On the other hand, some researchers have proposed that transactive memory system should be used as a basis for assigning tasks. For example, Majchrzak et al. (2007) applied TMS to emergence response groups and suggested that we should reconceptualize the role of expertise specialization as a basis for task assignment. Brandon and Hollingshead (2004) also suggested that task assignment structure should be connected with the expertise in the TMS. In addition, Lei (2006) and Lewis (2007) argued that transactive memory system would work as the basis that decides team members' distribution of task responsibility, or "transactive memory responsibility", which in turn determines the assignment structure. In situations of assigning tasks explicitly, alignment of task assignment with the expertise structure in the transactive memory system may play an important role. When explicit task assignments are not consistent with the implicit assignment based on the TMS, the conflict between the two will be likely to distract and confuse team members, to interfere with the coordination as well as hurt members' satisfaction and commitment.

Therefore, I propose:

Hypothesis 7: Alignment of task assignment with specialization will moderate the relationship between TMS manifestation and (a) team performance (b) team innovation (c) team attitudes (satisfaction and commitment) such that TMS will be positively relate to these team outcomes when task assignment is consistent with specialization and negatively related to the team outcomes when task assignment is not consistent with specializations.

Chapter 4 Precursors of TMS

The consistent evidence of positive effects of TMS on team outcomes has encouraged research on precursors of TMS. So far, it has been shown that group training (Liang et al., 1995; Moreland & Myaskovsky, 2000), communication (Hollingshead, 1998a, 1998b; Hollingshead & Brandon,2003; Lewis, 2004; Ren et al., 2006), and shared experience (Moreland & Argote, 2003) are some of the major factors that predict the emergence or development of transactive memory systems. Liang, Moreland and colleagues (Liang et al., 1995; Moreland & Wingert, 1995) have done a series of laboratory experiments to examine how training team members together affect team performance compared to training them individually. They found that group training improved team performance whereas individual training didn't, and the effects of group training was mediated by the transactive memory system established during the group training. Moreland and Myaskovsky (2000) further confirmed this finding by demonstrating that the improved performance indeed resulted from the TMS developed during training instead of the improved communication. Prichard and Ashleigh (2007) also tested a generic team-skills training program as a method to develop TMS and they found that teams that were trained on skills such as problem solving, interpersonal relationship, roll allocation, etc. had higher level of TMS than those who weren't.

Parallel to the line of research on group training as a way to develop TMS, some researchers focused on the role of communication. Hollingshead (1998a, b) demonstrated in a series of lab experiments that communication has important effect on how knowledge is learned and retrieved in TMS. Palazzolo, Serb, She, Su, and Contractor (2006) found in a computational model study that communication plays an important role in development of TMS. Lewis (2004) and Ren et al. (2006) both found that face-to-face communication predicts emergence of TMS in a field study with MBA consulting teams and a study using computational model, respectively.

Moreland and Argote (2003) suggested that shared experience and familiarity is another important predictor of emergence of TMS, because "As they spend more time together, engaging in a wider variety of activities, team members naturally come to learn more about who knows what." (p. 138).

Other factors that have been shown to influence TMS include acute stress which negatively affects TMS (Ellis, 2006) and critical team member's assertiveness which is positively related to TMS.

Despite the advancement in our initial understanding of what predict emergence and development of TMS, it is still an area that needs more exploration, as Kozlowski and Ilgen (2006) called for in their recent review on TMS research. As such, this study will investigate some other important predictors of TMS.

Wegner's (1986) original definition of TMS suggests that a transactive memory system includes two parts: (1) awareness of one another's knowledge (shared and accurate specialization) and (2) a combination of individual members' knowledge (knowledge stock) (Austin, 2003). For part one, recognizing expertise can be viewed as the underlying process that takes place. Therefore, strong predictors of TMS should be variables that facilitate expertise recognition/specialization and/or enlarge knowledge stock. Drawing upon expertise recognition approach, I consider three sets of predictors, i.e., functional diversity, status characteristics, and interpersonal connection.

Functional diversity. Not very much is known about how team composition, especially, functional diversity, is related to a team's transactive memory system. Drawn from Bunderson and Sutcliffe's (2002) conceptualization, I define functional diversity in this study as what they conceptualized as "dominant functional diversity", distinct from "functional background diversity" and "functional assignment diversity". Dominant functional diversity is described as the "the extent to which team members differ in the functional areas within which they have spent the greater part of their careers." (Bunderson & Sutcliffe, 2002; p.879). It focuses on the different functional experience. The specialization can be viewed as "more finely graded expertise distinctions than just functional affiliation" (Van de Vegt & Bunderson, 2005; p.533). It also has the component of perception and awareness of the distribution of the "finely graded expertise".

I propose that functional diversity can facilitate TMS formation through two ways, i.e., specialization and knowledge stock. As discussed earlier, specialization is a process during which members *recognize* self and others' area of knowledge and skill domain, and share, store, and seek information/knowledge based on the distribution of expertise. The diversity literature has suggested that functional diversity is positively related to the recognition of expertise and information sharing process, which helps team members to know each other better and speed up the specialization process. For example, Homan, van Knippenberg, Van Kleef and De Dreu (2007) found that groups with more diverse information (informational diversity) elaborated more information than groups with less information diversity. Baumann and Bonner (2004) found that variability in member expertise positively predicted recognition of expertise. Bunderson and Sutliffe (2002) showed that dominant function diversity was positively related to information sharing. Van Knippenberg and Schippers (2007) summarized in their review of research on group diversity that social categorization process based on the functional diversity may stimulate information processing in teams: "Informationally diverse teams are more likely to make effective use of their information diversity than those more homogeneous groups, presumably because dissimilarity alerts the group to potential associated differences in information." (p. 529). Informational diversity is likely to be closed related to functional diversity. Based on the previous discussion of the concept of specialization and the findings of Harrison, Price, Gavin and Florey (2002) that actual diversity predicts the perceptions of diversity, I predict that functional diversity will be positively related to specialization of transactive memory system and its sharedness and accuracy.

Functional diversity will also be positively related to knowledge stock, as individuals with heterogeneous dominant functions are more likely to have different knowledge domains and less knowledge in common (Reagans & McEvily, 2003) which provides broader knowledge stock than homogeneous groups.

Based on the typologies of diversity defined by Harrison and Klein (2007), functional diversity here falls into the variety type, which describes differences in categories of knowledge or experience, with the diversity being maximum when each member has a different dominant function and minimum when everyone have the same dominant function. Therefore, I propose:

Hypothesis 8: Variety in dominant function of team members will be positively related to TMS structure.

Status characteristics. Status characteristics theory explains how team members' characteristics affect their interactions in teams (Berger, Cohen, & Zeldith, 1972; Berger, Rosenholtz & Zelditch, 1980). Bunderson (2003) extends the theory and provides a status framework to understand how members recognize and utilize expertise in teams. As transactive memory system requires recognition of expertise and operates as a mechanism to facilitate expertise utilization, the status characteristics framework can be useful for understanding emergence and development of transactive memory system.

Status characteristic cues have been categorized into two types, i.e. task-related or specific status cues, and non-task related or diffused status cues (Bunderson, 2003). Specific status cues often signals the ability, competence, experience, task-related education or training of the persons whereas diffused status cues reflect individuals' physical characteristics such as gender, ethnicity, and age. Status characteristics theory suggests that individuals make inferences about other's expertise based on their specific and diffused cues by associating certain categories of status with higher or lower degree of expertise. For example, male members with longer task-specific experience tend to be perceived with higher level of expertise, or are more likely to be viewed as experts. In Bunderson (2003)'s study of work teams in high-tech industry, he found that both specific and diffused status cues were positively related to the possibility of being recognized as an expert. The higher the status cue scores one has, the higher the possibility that others see him/her as an expert. Hollingshead and Fraidin (2003) and Wegner (1991) both found that gender stereotypes affected recognition of expertise in transactive memory systems.

As discussed previously, specialization can be viewed as the first step of establishment of transactive memory system. It is a process of members' recognizing each other's expertise and specializing in different domains. In teams, each member has a specific and diffused status cues score which is determined by his/her professional and physical characteristics, and these status cues inform other members about his/her potential expertise in a specific domain. In teams where members' have high status cue scores, it is easier to recognize each other's expertise and thus easier for members to decide their own and other's specialized domain. In contrast, in teams where members' status cue score is low, it may take longer for the team to found out who is good at what. At the same time, inferences based on the status cues are likely to be shared among team members because the characteristics information is usually stable and public. Therefore, high mean level of status cue scores should be positively related to specialization and its sharedness among the team.

In addition, status characteristics theory also suggests that recognizing one as an expert simultaneously impose high performance expectation of that person. “When members of a group share high performance expectations for a particular member, they defer to that group member in making decisions and taking collaborative action under the assumption that doing so will help them accomplish the group’s goals.” (Bunderson, 2003; p 560). As such, status cues that hint recognition of expertise will also lead to credibility of the specialization.

Hypothesis 9a: The average level of specific (task-related) status cues will be positively related to TMS structure.

Hypothesis 9b: The average level of diffused (nontask-related) status cues will be positively related to TMS structure.

In addition, consistent with Bunderson’s (2003) findings, effects of specific status cues and those of diffused status cues should be different. Specifically, specific status cues should play more important roles than diffused status cues, given that the former is more directly related to task and the latter has longer “path to task” (Berger, Fisek, Norman, & Zelditch, 1977; Bunderson, 2003). Also, the accuracy of specialization should be higher when based on specific status than on diffused status. Therefore, I propose:

Hypothesis 10: Effects of specific status cues will be stronger than diffused status cues on TMS structure.

Interpersonal connections. Regans and McEvily (2003) have suggested in their study that tie strength is positively related to ease of knowledge transfer. Individuals who are close to each other or who communicate very often are more likely to share knowledge (Szulanski, 1996; Uzzi, 1997; Hansen, 1999). Knowledge sharing and transfer is a key mechanism through which TMS structure is transitioned to TMS manifestation. In addition, individuals who are emotionally attached are also more likely to recognize each other's expertise. Therefore, interpersonal connection will facilitate both TMS structure and TMS manifestation.

Hypothesis 11: Interpersonal connection (closeness and communication frequency) will be positively related to TMS structure and TMS manifestation.

To summarize, I first address the ambiguity in the conceptualization of transactive memory system and integrated and synthesized the divergent dimensions of TMS into two parts, i.e. TMS structure (shared, accurate specialization, and credibility) and TMS manifestation (coordination) (See Figure 1). I then proposed interrelationships between these two parts (Proposition 1-2). Second, I proposed relationships between TMS and team performance, innovation, and attitudes (satisfaction and commitment) based on the newly integrated model of TMS dimensions (Hypothesis 1-4) (See Figure 2). Third, I identified several contingent factors that affect the relationships between TMS and team performance, innovation, and satisfaction and commitment (Hypothesis 5-7). Lastly, I explored predictors that contribute to the emergence of TMS structure (Hypothesis 8-11). I tested these hypotheses with a field study. Table 2 shows a summary of the hypotheses.

Insert Figure 2 and Table 2 about here

Chapter 5 Method

5.1 Sample and participants

In order to test the hypotheses, I need a sample of teams that satisfy several important conditions. First, the sample needs to show enough variance on the studied variables. This means that there needs to be heterogeneity across the teams in terms of how they come about their tasks and function as a team, which in turn would lead to variances on team member profiles, team composition, TMS, task characteristics, and team outcomes. The teams cannot all work in the same way. Second, teams in the sample need to be comparable in a reasonable number of aspects. In other words, there can not be too many distinguished external factors that contribute to the functioning and outcomes of the teams. This means that the sample should ideally require a minimum number of variables that need to be controlled for. Third, the membership of the teams needs to be stable, which means that turnover of team members need to be low. As some team outcomes such as team performance and team innovation are evaluated over a certain period of time, I would want little changes in membership during this time frame in order to have an accurate estimate of proposed relationships between TMS and team outcomes. Furthermore, members may tend to care more about their teams and tasks when they work on the team for a relatively long period of time (Shaw, et al. 2009). When team membership is short-term, such as a student project team for a course during one semester, members may tend to care less and may behave differently.

Following the criteria described above, I pursued leads with multiple organizations before I became aware of a sample of charter school boards which in context work together in ways parallel to work teams. This sample fits the criteria nicely as each charter school board has the autonomy to operate in its own way (allowing adequate variances) but is subject to the same state law and legislation (restricting number of potential variables to control). All charter school boards in the study were sampled from the state of Minnesota to eliminate potential effects of any state-specific legislation on board process and functioning.

Charter schools are public schools that receive per-pupil funding from a state and are accountable for academic achievement. Charter schools are believed to bring to people more choices for their children's education, innovative teaching and learning environment. It is very common to see charter schools with special features such as emphasizing certain foreign languages (e.g. German, French, Chinese, etc.) or subjects (e.g., math, arts, etc.) as well as for children with speech disabilities. Getting involved in charter school governance is also viewed as entrepreneurial opportunity by many. With the rapid growing popularity of charter schools in the state of Minnesota (StarTribune, June 4, 2009), school oversight and board governance becomes more critical and strikes more attention.

A charter school board of directors is responsible for all school management-related issues that range from school strategy, financial planning, and budgeting, staffing and personnel, law compliance, curriculum and school policy to compensation, real estate/construction development and fundraising, etc. Decisions made by boards on these aspects have direct consequences for school reputation, attractiveness to parents, fiscal wellness, and eventual survival or success. Bad decisions on financial planning and low student enrollment, for example, can cause the closing down of a school (Independent, March 3, 2009).

Charter school boards are normally composed of parents (whose child or children go to the school), teachers (employed by the school), and local community members. The parents and teachers are often viewed as “insiders” and other directors are viewed as “outsiders”. Directors are elected to govern the school. The size of the charter school boards is required to be a minimum of five members. In each charter school board there are different functional positions such as board chair, vice chair, treasurer, lawyer, secretary, and member at large. Most school boards meet regularly on a monthly basis (rarely some schools meet twice a month) to discuss all kinds of issues related to school operation, such as curriculum, fundraising, school facilities, etc., and make governance decisions. Board meetings are open to public by law in Minnesota. Board members normally have terms, ranging from two years to three years, aligning with either academic year or calendar year. After the finishing of the terms, one can be re-elected or leave the board. School directors, who are responsible for day-to-day management and public relations of the schools, report to the board.

5.2 Procedure

There are two parts of the data collection, 1) interview and case studies and 2) survey of charter school boards.

Interviews and case studies

I first conducted ten thorough phone interviews with randomly picked school board chairs and school directors to understand the context of the teamwork in the charter school boards and roles of board chairs, board members, and school directors. I then asked a series of questions to help me construct measures of some of the key variables. First, I asked them to list the criteria of performance evaluation for both the board and the school (What are the things you look at when evaluating your board's performance? What about for the school's performance?). Second, I asked them to list the knowledge areas/skills (competencies, expertise, abilities, proficiencies, capabilities) that are important for a board to fulfill its objectives/achieve its goals. Third, I also verified the applicability of the key studied constructs in the charter school board context such as TMS, diversity, status characteristics cues, interpersonal connection, task interdependence, task routineness, and task assignment structure. (See Appendix A for interview questions). Each interview took 30-45 minutes. I took extensive notes during the interviews to record each interviewee's answers.

I then visited ten schools to observe their board meetings. Each meeting lasted between 2-4 hours. I took notes on team members' interaction during each meeting. I used the qualitative data from the interviews and case studies to develop and customize the survey questionnaires described below (e.g. the criteria of performance, the expertise profile that is important for working on the board, the possible indicators of team member's expertise (status cues).

Survey and procedure

Getting access to the school boards involved several steps. First, I identified a charter school expert in the University of Minnesota who helped me connect with 5 to 6 major charter school sponsors (i.e. Audubon Society, Volunteers of America, Pillsbury-United, Friends of the Ascension, Minneapolis Public Schools, and St. Paul Public Schools) in the state. These sponsors each support from 5 to 15 schools. I sent an email to each sponsor about the study and asked them to forward the study invitation to the schools they sponsor. To encourage participation, I informed the schools during all communications that they would receive a $100 visa gift card as well as a summary report from me at the end of the study if all the board members completed the survey. I contacted and invited about 20 schools in this manner. Second, I obtained a complete list of charter school sponsors in the state from the internet and contacted each of the sponsors that hadn't already been contacted. Nine more schools were identified and invited via email. Third, after exhausting the sponsor avenue, I obtained a list of all charter schools in the state with phone number, email address, and school address from the Department of Education in the state. I then did three rounds of invitation with the list in the following order:

1. Sent group emails to all the schools. Three rounds of reminders were sent with a 2-3 week interval. For undelivered emails, I identified valid email addresses from each school's website.

2. For non-respondent schools in #1, I sent a study invitation letter in the mail to school directors, and followed up with phone calls a week later. This was done in three batches with around 15 schools per batch and one week lag between batches to allow prompt follow up with schools that received the letter.
3. For non-respondent schools in #2, I sent emails to board chairs and asked for participation a last time.

During any of the rounds mentioned above, once a school agreed to participate, a list of the current voting board members (board member roster) was requested immediately to customize the survey questionnaire for the school.

There were two parts of the survey, a board member survey (Appendix B) and a school director survey (Appendix C). The board member survey was customized for each individual school with board members' names specified for communication and closeness measures (described later). All explanatory (predicting) and board member attitude (satisfaction and commitment) variables were measured in the board member survey. A set of outcome measures (performance and innovation) were also included in the board member survey for the board chair to complete. To ensure multi-source of the data, the performance and innovation measures were also put in a separate survey for school directors who work outside of school boards but have close relations with and good insights on the board. The board member and director survey were then conducted in three major ways.

1. Board visit. I visited board meetings for some schools to present the study and hand out the surveys with return envelopes. They either completed the survey right away or returned them later in the envelopes.

2. Online survey. Those who preferred to complete the survey online received a web link which the director or the board chair forwarded to all their board members. The director got a different link to the director survey.

3. Mail package. Those who preferred the paper version in the mail or were geographically further than 2-hours driving distance received a package of the surveys with pre-paid return envelopes which they distributed at their board meetings.

A consent form was included at the front page of each (board member and director) survey to declare that participation is voluntary and information collected in the survey was completely confidential. The consent form also included details on incentives and my as well as IRB office's contact information for participants in case they had questions.

The whole population of the charter schools (i.e. n=140) in the state were targeted. However, a total of 986 individuals (board members and school directors) across 109 schools were eventually surveyed (31 schools were never successfully contacted due to invalid email or phone number), 811 individuals from 105 schools responded, providing a response rate of 82%. Among the 105 school boards, 92 boards (673 board members) had higher than fifty percent of their board members turn in usable responses to be kept in the sample. The average within-board response rate was 92% across the schools.

Among the 92 schools, 90 school directors completed the Director survey and 81 board chairs completed the performance and innovation ratings. So the final sample consists of 673 board members (including 81 board chairs) of 92 schools, and 90 school directors. Sixty percent of the board members were female, 87% were Caucasian, 45% had a master's degree or higher, and their average age was 42.6 years old. Forty-eight percent of the board members were employees of the schools and 36% had their child(ren) going to the schools. The size of the boards ranged from 5 to 16, with an average of 8 members per board, and the members had been serving on the board for an average of 26 months.

Sample selection bias. To determine whether participating schools are systematically different from non-participating schools (sample selection bias), I compared the two groups on school population and the prior year's financial performance (indicated by the year-end unreserved fund balance per student) to see if participating schools are significantly bigger or smaller or had significantly better or worse financial performance in the past year. These two types of school-level information were selected for the comparison because they are publicly available online from the current year's and last year's "school report cards[1]" released by the state Department of Education annually, and good indicators of school boards' scope of responsibilities (student population) and performance (financial performance). Results indicate that participating schools did not differ significantly from non-participating schools either in student population (t=-1.61, p=.11) or last year's unreserved fund balance per student (t=-.65, p=.52).

[1] Examples of charter school report cards can be found on http://education.state.mn.us/ReportCard2005/index.do.

5.3 Measures

Transactive Memory System

I adopted Austin's (2003) procedure to measure the first three dimensions of TMS structure. I indentified a list of 15 knowledge and skill areas that are key for working on the board during the interviews and case studies mentioned previously (i.e. School operation, Financial planning and budgeting, Real Estate/Construction Development, Fundraising, Marketing, General Business Management, Strategic Planning, Education, HR/Personnel, Legal, Communication skill, Research skill, Coordination skill, Leadership, and Organizing skill). In the survey, each board member was asked to indicate which of their peer members (including themselves) "is (are) most knowledgeable in each of the listed areas of knowledge/skill". Following Bunderson (2003), they were instructed to list one or multiple members as they see appropriate.

TMS specialization. Austin's (2003) procedures were adopted to calculate this dimension. Appendix B illustrates the details for the calculation. TMS specialization was measured by comparing identified expertise across the skill list. A standard deviation score of the number of times a focal member was identified as an expert by fellow members (divided by the number of members providing the ratings) across the fifteen expertise areas on the list was used to indicate the level of the specialization for that individual. Individual standard deviation scores were then averaged to generate a board-level specialization score. In boards that had high levels of specialization, members tended to identify different individuals as the experts on different expertise areas. (As a result, each member had high scores on some expertise and low scores on others.) The group-level specialization score ranged from .12 to .31 (SD = .04), a higher score means a higher level of the specialization in the board.

TMS sharedness refers to the extent to which team members agree on the expertise distribution within the team. I adopted Austin's (2003) procedure to measure this dimension.

Appendix B illustrates the details for the calculation. Sharedness of transactive memory system was calculated by the level of agreement within the board on who was the expert for each of the expertise areas. James, Demaree, and Wolf's (1984) inter-rater agreement index for multi-item scale $r_{wg(j)}$ was computed for each expertise area – the board members were viewed as a set of parallel "items" that were rated on a given expertise area on a 0-1 scale (0 = not an expert, 1 = nominated as an expert), and the responding board members were viewed as raters or judges who identified the experts on the given expertise. The sharedness scores for individual expertise areas were then averaged to the board level. Board-level sharedness ranged from -5.11 to 1.64 (SD = .72), a higher scores means a higher level of agreement or sharedness of recognition of expertise in the board. Although James et al. (1984) argued for restricting negative values of $r_{wg(j)}$ to zero, other researchers have argued against it as it eliminates the difference between zero and negative values (Lindell, Brandt, & Whitney, 1999)[2]. There are also researchers who criticize the $r_{wg(j)}$ index for being subject to two limitations: (a) it assumes a uniform distribution and (b) it is likely to be affected by sample size (i.e. number of raters) (e.g. Lindell, Brandt, & Whitney, 1999; Brown & Hauenstein, 2005).

[2] I also ran the analyses after restricting negative rwg(j) values to zero, results pattern involving sharedness were substantially the same.

However, compared to other alternatives such as Lindell, Brandt, and Whitney (1999)'s adjusted r_{wg}^* index, Brown & Hauenstein's (2005) $\alpha_{wg(j)}$ index, or Cohen's Kappa, James et al.'s $r_{wg(j)}$ index is the most suitable and appropriate one for the study.

TMS accuracy. Austin's (2003) procedure was used to measure this dimension. Board members were first asked to rate their own level of expertise on each of the 15 expertise areas on a 5-point scale (1 = Very low, 2 = Low, 3=Average, 4 = High, and 5 = Very high). Appendix B illustrates the details for the calculation. Accuracy of transactive memory system was measured by matching peer's expertise identification and the identified person's self rating on the expertise. Measure of perceived expertise accuracy for each board member was first calculated. Perceived expertise accuracy was determined by matching board member identification of expertise with self-report ratings of the expertise. For example, if Member A identified Member B as an expert in financial planning and budgeting, and Member B rated himself as 4 (out of 5 points) on financial planning and budgeting, then Member A's score of perceived expertise accuracy is 4 (Member B's self-rating). Individual members' accuracy scores were then averaged to the board level. The procedure was done for each expertise area, and the accuracy scores of the expertise areas were lastly aggregated as an overall board-level accuracy score. Board-level accuracy scores ranged from 2.75 to 4.57 (SD = .30), a higher score means a more accurate recognition of the expertise in the board.

TMS credibility and TMS coordination. Lewis's (2003) scale was used to measure these two dimensions. There were five items for each dimension. Board members were asked to respond on a 1-5 Likert Scale from 1 = strongly disagree to 5 = strongly agree.

Sample items for credibility include “I was comfortable accepting procedural suggestions from other board members”, “I was confident relying on the information that other board member brought to the discussion”, etc. Sample items for coordination include “Our board worked together in a well-coordinated fashion”, “Our board has very few misunderstandings about what to do”, etc. A complete set of items are included in the Appendix B. Individual scores were aggregated to board level for both dimensions. Higher scores mean higher credibility and better coordination, respectively.

Contextual and Moderating Variables

Task interdependence. Task interdependence was assessed with four items adapted from Pearce and Gregersen’s (1991) job reciprocal interdependence scale. Individual members were asked to respond on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Sample items include “The way I perform my job on the board has a significant impact on other board members.” See Appendix B for a complete list of the items.

Task routineness. Task routineness was measured with four items drawn from Dewar, Whetten and Boje’s (1980) technology-degree of task routineness scale on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Sample items included “We have new issues to discuss every month in the board meeting.” See Appendix B for a complete list of the items.

Alignment of task assignment. One item created for this study was used to measure alignment between expertise and task assignment. Individuals were asked to indicate “To what extent do you think that board members’ (including yourself) expertise is consistent with the assignment or the committees (if any) they are on?" (1 = Completely inconsistent, 2 = Somewhat inconsistent, 3 = Neutral, 4 = Somewhat consistent, 5 = Completely consistent).

Precursors

Functional diversity. Functional diversity was computed based on board members' primary disciplinary areas, i.e. the functional areas in which they have spent the greatest part of their careers. This information was obtained from the board member survey by asking each member to indicate the area in which they "have spent the greater part of their career in" from a list of 24 occupational categories obtained from O'NET (i.e. Occupational Information Network; a primary source of occupational information which provides detailed description of hundreds of jobs; well-known as a career searching and exploring tool) or to specify the area in an open-ended box. Two trained undergraduate and one graduate student coded the "open-ended" functional areas. They were instructed to place the functional areas into one of the 24 categories provided in the answer choices or create new categories if needed. I then aggregated the 24 categories to nine categories that were most relevant and important for working on the board which were identified both from the interviews mentioned previously and from professional expertise profile recommended by charter school board governance resources available online. These nine categories included: (1) Arts, design, entertainment, sports, and media, (2) Business operations and management (full function), (3) Community and social science, (4) Education, training, and library, (5) Healthcare practitioners and healthcare support, (6) Legal and law, (7) Office and administrative support, (8) Homemaker and no career, and

(9) Other. The Blau (1977) index, $1 - \sum p^2_i$ was used to calculate the diversity, where p_i represents the proportion of a board in the *i*th category. The diversity score ranged from 0 to .86, a higher index score indicates higher functional diversity among board members.

Status characteristics. Bunderson's (2003) procedure was used to calculate status cue scores for both specific and diffused status.

Specific status cues, signaling for task-related status, was calculated using Bunderson (2003)'s method. Three most relevant task-related characteristics that would signal a board member's expertise were identified during the semi-structured interviews and case studies described earlier. The three characteristics included: years of work experience, highest degree of education, and job level with the current employer.

The three characteristics were combined to form a single specific-status-cue score for each board member using the procedure presented in Bunderson (2003). In Step 1, each board member was assigned a *cue strength* score for cue j, $s(c_j)$, by dividing his or her score (i.e. years, education, job level) on cue j by the maximum member score on cue j. This way cue strength was scaled in the interval (0,1) and 1 represents maximum strength. Step 2, an *expert status value* for cue j, $e(c_j)$ was computed by multiplying cue j's strength score by the weight assigned to cue j, $w(c_j)$, that is, $e(c_j) = s(c_j) * w(c_j)$. I assigned an equal weight to each of the three cues (i.e. 1/3 for each cue). Step 3, the expert status values for all the characteristic cues were aggregated to form an overall specific-status-cue score using the following formula by Berger et al. (1977):

$$SSC_i = [1 - (1-e(c_{1i}))*(1 - e(c_{2i}))*(1-e(c_{3i}))], \quad (1)$$

where SSC_i = the specific status cue score for member i, $e(c_{1i})$ = the expert status value of a first characteristic (e.g., years of working experience) for member i, $e(c_{2i})$ = the expert status value of a second characteristic (e.g., highest degree of education) for member i, and $e(c_{3i})$ = expert status value of a third characteristic (e.g., job level with the current employer). Individual status cue scores were then averaged to the board level. The average level of specific status cues in the charter school boards ranged from .28 to .53 (SD = .05). Higher scores mean higher levels of average specific status cues in the board, where for example a board with a higher score has members with more work experience, higher degree of education, and higher job levels with their current employers.

Diffused status cues, signaling for nontask-related status, were based on gender and ethnicity which have been shown to affect perceptions of competence (Bunderson, 2003). As it is argued by Bunderson (2003), influence of gender and ethnicity on perceptions of competency depends on the proportion of the female or ethnic minority in the team. The smaller the proportion, the more salient the gender and ethnicity are likely to be. Therefore, the weight assigned to gender and ethnicity was determined by the proportion of female and ethnic minority in a focal board and differs across boards. In boards that had smaller proportion of female than ethnic minority groups, a weight of 2/3 was assigned to gender and 1/3 was assigned to ethnicity.

Gender and ethnicity were both measured by board members' self-reports from the board member survey. All non-Caucasians were coded in one category as ethnic minorities due to the low representation of ethnic groups in and the small sizes of these boards.

The weighted gender and ethnicity were combined using the similar procedure for specific status cues, with the exception that cue strength is not necessary to compute since these variables are dichotomous. So, a diffused status cue score was calculated with the following formula:

$$DSC_i = [1 – (1\text{-}e(c_{4i}))*(1 – e(c_{2i}))*(1\text{-}e(c_{5i}))], \quad (2)$$

where DSC_i = the diffused status cue score for member i, $e(c_{4i})$ = the expert status value of gender for member i, $e(c_{5i})$ = the expert status value of ethnicity for member i. Individual diffused status cue scores were then averaged to the board level. The average level of diffused status cues in the board ranged from .35 to .76 (SD = .09). A higher score means a higher level of diffused status cues in the board, where for example a board with a higher score has higher proportion of males and/or Caucasians.

Interpersonal connection. Interpersonal connection was indicated by two variables, i.e. *closeness* and *communication frequency*, which were assessed with Reagans and McEvily's (2003) scales. Individuals were asked to rate each member on two questions, i.e., "How close are you with this person?" (1= distant, 2= less than close, 3= close, 4= especially close) for closeness and "On average, how often do you talk to each other (any social discussion)?" (1=daily, 2=weekly, 3=twice a monthly, 4=monthly, 5=less often/never) for communication frequency. A higher score on closeness means that the board members are more psychologically close to each other, whereas a higher score on communication frequency means that the board members communicate with each other more frequently.

Outcome variables

Board performance. Board performance was measured with nine items adapted from Brown (2007) and Caldwell (1992). Following Kearney, Gebert, and Voelpel (2009), both the school director and board chair were asked to rate their board's performance in the last six months on each of the nine aspects, including "evaluating or selecting the school director", "serving member interests and needs", "marketing and promoting the school", etc. on a 5-point scale (1 = very poor, 5 = excellent).

Board innovation. Board innovation was measured from school directors and board chairs with 3 items adopted from Drach-Zahavy and Somech (2001). School director and board chairs were asked to rate the level of agreement with the items provided on a 5-point Likert scale from 1 = strongly disagree to 5 = strongly agree. Sample items included "[In the last 12 months,] our board initiated new procedures and methods for completing the work".

Board satisfaction was measured with five items adapted from the global job satisfaction scale in the Michigan Organizational Assessment Questionnaire (MOAQ) (Cammann, Fichman, Jenkins, & Klesh, 1983). Board members were asked to rate their own level of satisfaction with regard to the board they were working on. Sample items included "All in all, I am satisfied with the board." A 5-point Likert scale was used to obtain responses, where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree.)

Board commitment. Commitment to the board was measured with six items adapted from Mowday, Steers, and Porter's (1982) 9-item shortened scale. Sample items included: "I am willing to put in a great deal of effort beyond that normally expected in order to help this school be successful.", "I talk up the work on this school board to my friends as a great thing to do", etc. Board members were asked to rate their level of commitment on a 7-point Likert scale (1 = strongly disagree, 2 = moderately disagree, 3 = slightly disagree, 4 = neither disagree nor agree, 5 = slightly agree, 6 = moderately agree, and 7 = strongly agree.)

Control variables. Consistent with the transactive memory system literature and the charter school context, communication (Hollingshead, 1998a, b; Lewis, 2004; Ren et al., 2006) and shared experience (Moreland & Argote, 2003) were controlled as they had been demonstrated to be significantly related to the emergence and development of transactive memory system and would potentially affect board performance. *Communication frequency* was measured as one variable of interpersonal connection that was described above. *Shared experience* was measured by asking the members how often they talked to or spent time with each of the peer members before they worked on the board (1 = daily, 2 = weekly, 3 = twice a month, 4 = monthly, and 5 = less often/never, reverse coded). Tenure on the board was also important to control as it could affect the salience of status cues on signaling expertise (Bunderson, 2003) as well as board performance. *Board tenure* was measured by asking members to report how many months they had been working on the board. In addition, team size had also long been suggested as an important predictor of team performance, so the number of board members (i.e. *board size*) was also controlled. (Austin, 2003; Ren, et al, 2006).

5.4 Analysis

Level of Analysis and Level of Measurement. The level of analysis for testing the hypotheses is the charter school board, whereas for many of the constructs the level of measurement is the individual. Chan (1988) defined five composition models for constructing group-level constructs from individual level scores, i.e. (1) additive, (2) direct consensus, (3) referent-shift consensus, (d) dispersion, and (e) process composition. Direct consensus model where "the meaning of higher level construct is in the consensus among lower level unit" (pp. 236) is the most appropriate in this study for the variables including TMS credibility, TMS coordination, task interdependence, task routineness, alignment of task assignment, board satisfaction, and board commitment. TMS specialization, TMS sharedness, and functional diversity fall into the dispersion model where the group level construct is operationalized as the within-group variance or dispersion among individuals. Finally, TMS accuracy, the average level of status characteristics, closeness, communication frequencies, board size, and board tenure all suit the additive model where the group level construct is composed of a summation (operationalized as averaging) of the individual level scores regardless of the variance. Aggregation criteria need to be accessed for the variables employing direct consensus model.

Aggregation criteria. As Chan (1988) suggested in his typology of composition models, two criteria need to be assessed for variables composed with direct consensus model in order to justify for aggregation of individual level measures to group level, i.e., within-group agreement and validity of the aggregated scores. James, Demaree, and Wolf

(1984, 1993) developed a now-widely used within-group interrater agreement index for multi-item scales, $r_{wg(j)}$. A median value of .70 on $r_{wg(j)}$ usually indicates a good level of consensus among group members (Chen, Mathieu, & Bliese, 2004). The validity of aggregated scores can be assessed by variability and reliability of the group means (Chan, 1988). These are often indicated by two types of intraclass correlation coefficients, i.e. between-group variance relative to total variance or reliability of a single assessment of the group mean (ICC(1)) and reliability of the group means (ICC(2)) (Bryk & Raudenbush, 1982; James, 1982; McGraw & Wong, 1996; Bliese, 2000; Chen, Mathieu, & Bliese, 2004). Although Glick (1985) suggested that ICC(2) values of .60 would indicate a good level of group-mean reliability, Bliese (1998) demonstrated that ICC(2) values are affected by group size in that when group sizes are smaller, aggregate scores tend to be less reliable. Thus, I expect lower ICC(2) values for the study variables given the relatively small sizes of the groups. According to Bliese (1998), the likely effect of low ICC(2) values is an underestimate of group-level relationships. One-way analysis of variance (ANOVA) was used to test the significance of between-group variance and to calculate ICC(1) and ICC (2).

Exploratory and Confirmatory Factor Analysis. To ensure the validity of the measurement, I did two sets of factor analyses to check the dimensionality of the scale items and discriminative validity of the constructs being measured. First, I ran an exploratory factor analysis (principle component analysis) for each variable to verify that the items used to measure the variable all load on a single factor, indicating the unidimensionality of the scale.

Second, to test potential overlap between constructs, and also to check common variance caused by using the same data collection method (survey questionnaire), I conducted confirmatory factor analysis (CFA) on the studied variables that were measured with multi-item scales (Kline, 1998), including TMS credibility, TMS coordination, task interdependence, task routineness, board performance, board innovation, board satisfaction, and board commitment (eight variables) to test the discriminant validity of the constructs. The goal was to compare the default model (i.e. model with eight separate but correlated factors) to alternative and nested models which had fewer factors. As there can be many ways to combine factors to form the alternative models, my strategy was to use theoretical rationale as well as factor intercorrelations as indicators for combining factors that are most likely to have overlaps, i.e. factors that theoretical or conceptually shared certain domain of the constructs or that have high intercorrelations (higher than .70) was combined in different ways to form alternative models. Lastly, a one-factor model was fitted to detect if the observed relationships between items are purely due to the fact that they were assessed with survey questionnaires (common method). When letting all the items load on one factor, this one latent factor can be viewed as the common method variance. If the one-factor model fits well, it means that the observed relationships between items are indeed due to the common method. If the model fits poorly, it means that common method bias is not a concern. . I used Amos 17.0 (Kline, 1998) to perform the CFAs.

EFA and CFA are two approaches of factor analysis commonly used to understand measurement structures. I acknowledge that there are limitations to using both techniques on one data set. Nevertheless, both used in sequence can help a researcher get a solid grasp on a data's factor structure. The general purpose of EFA includes to determine how many underlying factors are needed to explain most of the correlation and variance in the data as well as to propose a structure for CFA; whereas CFA is often used to examine whether or not the existing data are consistent with a pre-specified structure suggested by theory or previous research. An EFA is more suitable for examining the unidimensionality of each variable, and CFA is more appropriate for testing the discriminant validity.

Hypotheses tests. Hierarchical ordinary least squares (OLS) regression was used to test the mediating and moderating relationships predicted in the hypotheses (Kutner, Nachtsheim, & Neter, 2004), with charter school boards as the unit of analysis. The Baron and Kenny method (Baron & Kenny, 1986) and Sobel test (Sobel, 1982; MacKinnon, Krull, & Lockwood, 2000; MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002) were used to test the mediation relationships. Fritz and MacKinnon (2007) demonstrated that the direct relationship between independent variable (IV) and dependence variable (DV) requires a significantly larger sample size to be detected. As a result, the relationship between IV and DV can be nonsignificant due to low power even if there are significant mediating effects. Hence, for cases where the direct relationship between IV and DV are nonsignificant, I used the Sobel (1982) test (which tests the product of relationship of IV→mediator and mediator → DV) to determine the mediating effect. Although structural equation modeling (SEM) has an advantage of testing multiple linear relationships simultaneously (Kline, 1998) as well as providing an alternative method for mediation test (James, Mulaik, & Brett, 2006), it is inappropriate for studies with small sample size which is the case in the present study (N=90 and 81, for director and chair-rated outcomes, respectively) where the number of parameters to be estimated would exceed the number of unique component provided by the data should I run a SEM model.

Chapter 6 Results

6.1 Exploratory and Confirmatory Factor Analysis

As discussed in the previous chapter, before constructing each variable, I first ran a principle component analysis with varimax rotation on each variable to confirm that the items were loaded on a single factor as intended. This analysis revealed that items of task routineness and director-rated performance each loaded on two factors. Table 3 shows the factor analysis results of these two variables. Specifically, item "We discuss similar issues every month in the board meeting" was loading on a second factor by itself for task routineness. Also, the items of board performance, "providing financial oversight", "adherence to schedules", and adherence to budgets" loaded on a second factor. A further check on the four items confirmed that they were correctly coded and had appropriate means and standard deviations, hence, I removed the four items with low loadings on their corresponding core factor and used a 3-item version for task routineness and a 6-item version for director-rated performance. To be consistent, I used the same 6-item version measure for chair-rated performance as well even though the EFA indicated a single factor extraction. The alpha coefficients for the revised measures are included in Table 9.

Insert Table 3 about here

I, then, conducted a confirmatory factor analysis with the items of all eight multi-item scale variables, i.e. TMS credibility, TMS coordination, task interdependence, task routineness, director-rated performance, director-rated innovation, satisfaction, and commitment entered into a model with either separate but correlated factors. (For performance and innovation, I only selected director ratings rather than chair ratings as the sample size of the former is bigger than the latter and also for purpose of parsimony.) I then ran a set of alternative models with potentially overlapping constructs or highly correlated factors combined in a variety of ways.

Chi-square statistics were report for each model as a basic indicator of goodness of fit. The closer to zero the chi-square, the better fit. A nonsignificant χ^2 is desirable for a good fit. However, as it's sensitive to sample size and inflated with large sample, χ^2 is almost always significant. The χ^2 divided by degree of freedom ratio is also commonly used, with values less than 2.5 considered favorable. This ratio, however, is also subject to sample size and the threshold level may vary (Kline, 1998). In addition, I also used a few other commonly used fit indices to evaluate the models, i.e. normed fit index (NFI) which is an absolute model fit index adjusted for sample size, the comparative fit index (CFI), and root mean square error of approximation (RMSEA). NFI and CFI closer to 1 and RMSEA closer to 0 indicate better model fit, and typically, NFI and CFI >.90 and RMSEA <.10 indicate a good fit (Bollen & Long, 1993). For comparison between nested models, χ^2 difference ($\Delta\chi^2$) test was used to determine whether the full model fits significantly better than the reduced model (after eliminating some paths or factors). (Kline, 1998)

Table 4 lists the results of the model estimates. First, as expected, the 8-factor model (model *l*) where the items loaded on the variables they were measuring fit well (χ^2 (601) = 1347.66, p<.001, χ^2/df = 2.24, NFI = .86, CFI=.92, RMSEA=.043. Standardized factor loadings of model *l* are reported in Table 5. A close look at factor loadings revealed that while all other items loaded nicely on their corresponding factors, one item of task interdependence, i.e. "My own performance on the board is dependent on receiving accurate information from other board members" had a low loading of .148. A double check on the coding and descriptive statistics of the item confirmed that the low loading was not due to error in the data processing. I then ran an alternative 8-factor model with the item dropped (model *m* in Table 4) and it produced significantly better fit than the original 8-factor model ($\Delta\chi^2$ (35) = 70.03, p<.01, NFI = .87, CFI=.92, RMSEA=.043). Therefore, I dropped the item from task interdependence. New factor loadings are reported in Table 6.

Insert Table 4, Table 5, and Table 6 about here

To determine the alternative models that were computed in Table 4, I looked at the factor intercorrelations which are listed in Table 7. As shown, several pairs of factors had very high correlations, i.e. TMS credibility and TMS coordination (.75), TMS credibility and satisfaction (.74), TMS coordination and satisfaction (.80), director-rated performance and director-rated innovation (.81), and satisfaction and commitment (.72). To test the discriminant validity of these variables, accordingly, I ran five 7-factor models with one of the pairs combined at a time (model g – k); one 6-factor model with TMS credibility, TMS coordination and satisfaction combined (model f); two 5-factor models with (1) TMS credibility, TMS coordination, satisfaction, and commitment combined (model e), and (2) TMS credibility and TMS coordination, satisfaction and commitment, director-rated performance and innovation combined (model d); two 4-factor models with (1)TMS credibility, TMS coordination, satisfaction, and commitment combined and performance and innovation combined (model c), and (2) satisfaction, commitment, performance, and innovation combined (model b); one 2-factor model with the independent variables combined and dependent variables combined (model a); and lastly, I ran a one-factor model to test the common method bias.

Insert Table 7 about here

Results in Table 4 showed that the 2-factor, 4-factor, 5-factor and 6-factor models all fit poorly, with χ^2/df greater than 3 and NFI and CFI significantly lower than .90. Although some of the 7-factor models produced reasonable fit indices, for example, model *j*, Chi-square difference tests also indicate that the 7-factor models fit significantly worse than the 8-factor model m ($\Delta\chi^2(28)$ were all significant). Lastly, the one-factor model also fit poorly (χ^2/df =6.75, NFI=.59, CFI=.62, RMSEA=.09), indicating that the covariance among these eight variables are not likely due to the common method (survey questionnaire) used to collect the data.

6.2 Aggregation

As discussed in the previous chapter, group-level variables formed by aggregating individual-level board member scores to the board level need to have (a) high within-group agreement among the members, (b) a good amount of between-group variance compared to the total variance (ICC(1)) and reliability of the group means (ICC(2)) (Chan, 1988). I followed James et al.'s (1984) formula to calculate the within group agreement index for multi-item scales, $r_{wg(j)}$, and conducted one-way analysis of variance (ANOVA) to compute ICC(1) and ICC(2).

Results are shown in Table 8. All the variables had high levels of within-group agreement except alignment of task assignment (.67) slightly below the .70 threshold. According to Chen et al. (2004), it is an acceptable value for aggregation. Although ICC(1) values of task interdependence and commitment were relatively low (.04 and .09, respectively), the F-tests for between-group variance and within-group variance were both significant (F = 1.31 and 1.67, $p < .01$ and .001, respectively), showing that there was significant between-group variance (variability of group mean) on both variables. A low ICC(1) means that a single rating from an board member is not likely to provide a reliable estimate of the group mean (because of the small proportion of between-group variance to the total variance), and ratings from multiple members are necessary (Bliese, 2000). As discussed previously, ICC(2) values, which is influenced by ICC(1) values and group sizes, were expected to be smaller given the rather small group sizes in the study

(Bliese, 1998). Even so, noticeably, the ICC(2) value of task interdependence was still rather small, .24, indicating a rather unreliable group mean. However, the significant between-group variance, high within-group agreement (median r_{wg}=.85), and the fact that group mean scores tend to be unreliable when group sizes are small (Bliese, 1998), did not prevent aggregation of task interdependence (Shaw, et al., 2009). A result of the low group mean reliability, though, is that group-level relationships involving task interdependence will likely to be underestimated.

Insert Table 8 about here

6.3 Descriptives and Bivariate Correlations.

Table 9 provides the descriptive statistics, scale reliabilities and correlations between study variables. A few observations of the correlation patterns are worth noting. Among the TMS dimensions, TMS sharedness and accuracy was positively correlated ($r = .30$, $p<.01$). This was consistent with the literature where, for example, Austin (2003) found a correlation of .34 between the two dimensions. Noticeably, Austin (2003) also found a correlation of .65 between specialization and sharedness which did not show up here. This might be related to different coding and computation of sharedness which will be discussed in more detail in the next chapter. TMS specialization was positively correlated with credibility ($r = .26$, $p<.05$) and coordination ($r = .25$, $p<.05$). Consistent with the hypotheses on precursors of TMS structure, the average level of specific status characteristic cues with charter school board was positively related to TMS accuracy (r

= .36, p<.01), credibility (r = .27, p<.01), and coordination (r = .25, p<.05); Additionally, the average level of diffused status cues (proportion of males and/or Caucasians) was positively correlated with TMS sharedness (.30, p<.01). Interestingly, the average specific status cue scores had a negative correlation with communication frequency (r = -.32, p<.01), indicating charter school boards with higher specific status cue scores (more work experience, higher education, and higher job levels) tended to communicate less.

Insert Table 9 about here

With regard to the relationships between TMS and outcomes, TMS accuracy, credibility, and coordination were all positively correlated with charter school board performance and innovation; TMS specialization had a positive correlation with chair-rated performance and innovation as well board commitment; credibility and coordination also showed positive correlations with board commitment.

Regarding the task characteristic variables, task interdependence was positively correlated with TMS specialization (r = .24, p<.05), TMS accuracy (.22, p<.05), and closeness (r = .42, p<.01), indicating that charter school boards with higher task interdependence had a more dispersed expertise distribution, more accurate recognition of the expertise, and their members were more close to each other. Task routineness, on the other hand, had a negative correlation with TMS specialization (r = -.25, p<.05), TMS credibility (r = -.21, p<.05), TMS coordination (r = -.24, p<.05), and task interdependence (r = -.37, p<.05). Alignment of task assignment was positively correlated with TMS specialization (r = .21, p<.05), credibility (r = .40, p<.01), and coordination (r = .33, p<.01).

The size of the charter school boards was positively correlated with TMS accuracy (r=.28, p<.01) and task routineness (r =.24, p<.05), and negatively correlated with communication (r = -.25, p<.05) and TMS coordination (r = -.23, p<.05), indicating tasks in larger charter school boards were more routine, and members of such boards had less communication and coordination. The positive correlation with TMS accuracy is surprising, as one would expect that the accuracy of expertise recognition would lower in larger boards. The strong negative correlation between board size and TMS specialization (r=-.44, p<.01), on the other hand, is very likely to be due to the fact that TMS specialization computation was weighted on (divided by) the number of board members who responded to the survey. Board tenure was positively correlated with closeness (r=.38, p<.01), communication (r=.25, p<.05), TMS accuracy (r=.21, p<.05), coordination (r=.34, p<.01), and alignment of task assignment (r=.21, p<.05), which are all consistent with what I expected.

Lastly, it is worthwhile to point out a few very high correlations. First, dependent variable (DV) board satisfaction was very highly correlated with independent variables (IV) credibility (r=.74) and coordination (r=.80). Although CFA conducted earlier support the separation of these constructs (see model h, model i, and model f in Table 4), the high correlations indicate that practically, there is insufficient distinction among the measurement of the DV and the IVs. Therefore, hypotheses involving board satisfaction were not tested. Second, shared experience was very highly correlated with communication (r=.84), therefore, I only kept communication as a control and excluded shared experience. Third, independent variables TMS credibility and TMS coordination were highly correlated with each other at .74, causing a multicollinearity issue in the hypothesis testing. I discuss this issue further later in the results, but essentially I have chosen to run the analyses as originally illustrated in Figure 2 first, followed by revised models where each variable is included on its own as an indicator of TMS manifestation.

Overall, the correlation patterns are largely consistent with what was expected indicating the measurement of the variables functioned well and the hypothesized relationships were promising.

6.4 Hierarchical Regression Results of the Original Model

In this section I present the hierarchical ordinary least square (OLS) regression results of the original model (as illustrated in Figure 2). As I show in this set of results, the high correlation between TMS credibility and TMS coordination produces a multicollinearity problem that results in switching beta weights in the regression results. The results also revealed a drawback of the original theoretical model. So, to deal with the multicollinearity issue and to improve the theoretical model, I ran a second set of analyses with a revised model where credibility and coordination was separately examined as TMS manifestation (mediator). The second set of results of the revised model, which I will present following this section, are what the final discussion and conclusion are based on.

Table 10-13 present the results. For the mediation tests, I first tested the relationships between the IVs (TMS specialization, sharedness, accuracy, credibility) and

DV (outcome variables), second the IV and the mediator (coordination), and third the mediator and DV. For cases where the direct and indirect relationships were all significant, I did a fourth test with both the IV and the mediator in the equation to predict the DV, following Baron and Kenny's (1986) procedure. For cases where the direct relationship between IV and DV were not significant, but the other relationships were significant, I performed a Sobel (1982) test to examine partial mediating effects. For each of the relationship tests, I first entered the control variables, and then the main predictors.

For the moderation test, I entered the control variables and the main predictors in a first step, and the interactions in a second step.

Direct effect and Mediation. Hypothesis 1 to Hypothesis 4 predict that TMS structure (TMS specialization, sharedness, accuracy, and credibility) will be positively related to manager-rated performance, team innovation, team satisfaction and team commitment, respectively, and these relationships will be mediated by TMS manifestation (TMS coordination). Results of Model 2 in Table 10 show that TMS specialization ($\beta = 3.25$, $p<.09$), accuracy ($\beta = .61$, $p<.014$), and credibility ($\beta = .61$, $p<.02$) were all positively related to director-rated performance, but TMS sharedness was not significant ($\beta = -.092$, n.s.), so the first part of Hypothesis 1 was mostly supported. To establish mediation according to Baron and Kenny's (1986) three-step procedure or Sobel (1982) test, the following relationships (i.e., TMS specialization, sharedness, accuracy, and credibility → TMS coordination, and TMS coordination → Director-rated performance) need to be tested. Model 4 from Table 10 shows that, surprisingly, sharedness was negatively related to coordination ($\beta = -.12$, $p<.05$) and credibility was positively related to coordination (β = 1.13, $p<.001$, respectively) as expected. Model 5 shows that coordination was positively related to director-rated performance (β = .67, $p<.001$). When including all TMS structure dimensions (specialization, sharedness, accuracy, credibility) and coordination (see Model 6) in the regression equation, the effect of credibility on director-rated performance completely disappeared (β = -.26, n.s.). Hence, the mediation relationship was supported for credibility, i.e., coordination fully mediated the relationship between credibility and director-rated performance. Further, Sobel test was computed for indirect effects sharedness→coordination (β = -.12, s.d. = .051) and coordination →director-rated performance (β = .67, s.d. = .14). Sobel statistic was significant (-2.13, *p* =.03), indicating that coordination partially mediated the negative relationship between sharedness and director-rated performance which was in the opposite of predicted direction. Therefore, Hypothesis 1 was partially supported for director-rated performance.

Insert Table 10 about here

Results on chair-rated performance are quite similar as are shown on the right-hand side of Table 10. Specifically, TMS accuracy and credibility both had a direct positive relationship with chair-rated performance (see Model 10; β = .40, $p<.10$, and β = .86, $p<.001$, respectively). The equation for the relationship between TMS structure (specialization, sharedness, accuracy, and credibility) and TMS manifestation (coordination) remained the same (see Model 4) – i.e. as mentioned in the paragraph above, sharedness negatively (β = -.12, $p<.05$) and credibility positively (β = 1.13, $p<.001$) predicted coordination, respectively. Model 11 shows that coordination positively predicted chair-rated performance (β = .83, $p <.001$). When including coordination and the four TMS structure dimensions together in the regression equation, the coefficient of credibility became nonsignificant (see Model 12; β = .049, n.s.). Therefore, coordination fully mediated the relationship between credibility and chair-rated performance. In addition, Sobel test on the two indirect effects, i.e. sharedness→coordination (β = -.12, s.d. = .051), and coordination →chair-rated performance (β = .83, s.d. = .12) showed that coordination partially mediated the relationship between sharedness and chair-rated performance (Sobel statistic = -2.23, p = .026). Again, Hypothesis 1 was partially supported for chair-rated performance.

Table 11 presents the results for Hypothesis 2 for the DV of board innovation. As the results are similar for director-rated and chair-rated innovation, I present them simultaneously. Model 2 and Model 10 show that among the four dimensions of TMS structure, credibility was positively related to director-rated and chair-rated innovation (β = .64, $p<.05$, β = .46, $p<.10$, respectively). Sharedness and credibility were again negatively and positively related to coordination, respectively (see Model 4 in Table 11, which is reprinted for the reader's convenience from Model 4 in Table 10). Coordination was also positively related to both director- and chair-rated innovation (see Model 5 and Model 11, β = .6, $p<.001$, β = .30, $p<.10$, respectively). Model 6 shows that when including all TMS dimensions in the regression equation, the coefficient of credibility became nonsignificant (β = .065, n.s.). Hence, coordination fully mediated the relationship between credibility and director-rated innovation. However, such mediation was not supported for chair-rated innovation. As shown in Model 12, none of the TMS dimensions was significant when they were included in the equation together. Furthermore, Sobel test was computed for the following relationships, i.e. sharedness→coordination (β = -.12, s.d. = .051), and coordination→director-rated innovation (β = .60, s.d. = .17) and chair-rated innovation (β = .30, s.d. = .17). The Sobel statistic was -1.96 (*p* = .05) for director-rated innovation, and -1.41 (*p* = .16) for chair-rated innovation. Therefore, coordination partially mediated the relationship between sharedness and director-rated innovation, but not the relationship between sharedness and chair-rated innovation. Thus, Hypothesis 2 was partially supported for director-rated innovation and not supported for chair-rated innovation.

Insert Table 11 about here

Hypothesis 3 was not tested due to high correlations between board satisfaction and credibility and coordination as discussed earlier.

With regard to the DV board commitment, results are shown in Table 12. Model 2 shows that sharedness was negatively (β = -.098, $p<.10$) and credibility was positively (β = .53, $p<.001$) associated with board commitment. The equation for the relationship between sharedness and credibility and coordination remain the same as above (Model 4, β = -.12, $p <.05$ and 1.13, $p<.001$ respectively). Coordination was positively related to commitment (see Model 5, β = .42, $p<.001$). When including all dimensions of TMS in the equation together, the coefficient of sharedness and credibility both became nonsignificant (Model 6, β = -.058 and .15, n.s, respectively). Therefore, coordination fully mediated the negative relationship between sharedness and board commitment (opposite of predicted direction) and the positive relationship between credibility and board commitment. Thus, Hypothesis 4 was partially supported.

Insert Table 12 about here

Moderation. Hypothesis 5 to Hypothesis 7 predicted that the relationship between TMS manifestation and (a) team performance, (b) team innovation, (c) team satisfaction and commitment will be moderated by task interdependence (Hypothesis 5), task routineness (Hypothesis 6), and alignment of task assignment (Hypothesis 7). Table 10-Table 12 provide these results.

Table 10 reports the moderation results for board performance. Model 8 and Model 14 in Table 10 show that task interdependence moderated the relationship between TMS coordination and director-rated performance (β = 1.05, $p<.05$). Figure 4 plots the interaction. As predicted, the relationship between TMS coordination and director-rated performance was stronger when task interdependence was high than when it was low. No moderating effects were found on task routineness or alignment of task assignment. Nor did any of the three moderators show interaction effects for chair-rated performance. Thus, Hypothesis 5(a) was supported for director-rated performance, but Hypothesis 6 and 7 were not supported for this outcome.

Insert Figure 4 about here

Table 11 presents the moderation results for board innovation. As shown in Model 8 and Model 14, task interdependence moderated the relationship between coordination and director-rated innovation ($\beta = 1.2$, $p<.05$). Figure 5 illustrates the interaction. As predicted, coordination was more strongly related to director-rated innovation in boards with high level of task interdependence than in boards with low levels of task interdependence. Task routineness and alignment of task assignment did not moderate the relationship. In addition, no interaction effects were found for chair-rated innovation. Therefore, Hypothesis 5(b) was supported for director-rated innovation, but Hypothesis 6 and 7 were not supported for this outcome.

Insert Figure 5 about here

Results for board commitment are reported in Table 12. Model 8 shows that task interdependence moderated the relationship between coordination and board commitment ($\beta = .44$, $p<.10$). As plotted in Figure 6, the positive relationship between TMS coordination and board commitment was stronger when task interdependence was high than when it was low. Neither task routineness nor alignment of task assignment moderated the relationship. Therefore, Hypothesis 5(c) was supported for board commitment, but Hypothesis 6 and 7 were not supported for this outcome.

Insert Figure 6 about here

Overall for the moderation tests across the outcome variables, Hypothesis 5 was fully supported and Hypothesis 6 and 7 were not supported.

Precursors. Hypothesis 8 to Hypothesis 11 predicted that dominant functional diversity, average levels of specific and diffused status cues will be positively related to TMS structure; and tie strength (i.e. closeness and communication) will be positively related to TMS structure and TMS manifestation. Results are shown in Table 13. Model 2, Model 4, Model 6, Model 8 and Model 10 show that functional diversity did not predict any dimension of TMS structure, thus Hypothesis 8 was not supported. Average specific status cues was positively related to specialization ($\beta = .15$, $p = .08$), accuracy ($\beta = 1.65$, $p < .01$), but not to sharedness ($\beta = -.10$, n.s.), thus, Hypothesis 9a was partially supported. Also, average diffused status cues was positively related to sharedness ($\beta = .27$, $p < .01$) and accuracy ($\beta = .74$, $p < .05$), but not to specialization ($\beta = -.033$, n.s.), hence Hypothesis 9b was partially supported. Model2 and Model 6 together show that effect sizes of specific status cues were bigger than effect sizes of diffused status cues on specialization ($\beta = .15$, $p = .08$ v.s. -.033, n.s.) and accuracy ($\beta = 1.65$ v.s. .74), partially supporting Hypothesis 10. Finally, closeness was positively related to accuracy ($\beta = .28$, $p = .059$), credibility ($\beta = .38$, $p < .05$), and coordination ($\beta = .58$, $p < .05$) (see Model 6, Model 8, and Model 10), partially supporting Hypothesis 11.

Insert Table 13 about here

6.5 Multicollinearity Issue and A Revision on the Role of Credibility and Coordination in the Conceptual Model

The first set of results suggests, in general, that the TMS structure-TMS manifestation framework proposed in the central part of Figure 2 was not very well supported (i.e., the TMS structure→TMS manifestation relationship was mainly only supported for credibility→coordination). I draw this conclusion based on the following two reasons. First, as mentioned in section 6.4, one issue emerged in these analyses was that credibility and coordination were very highly correlated (r = .74), which creates a multicollinearity problem. Although multicollinearity does not affect the inference about mean or predictions of new observations, the estimated regression coefficients tend to have large standard errors. As a result, the coefficient estimation and the t-test are imprecise. It is usually not a problem in large samples with thousands of observations, but in fields where sample sizes are small, it can be problematic. The symptoms of multicollinearity normally includes a significant coefficient becomes insignificant and flips signs after including the problematic variable, which is exactly what happened to credibility after including coordination in the models presented in Table 10 – Table 12. A diagnosis on the two variables indicates that the multicollinearity problem is serious, with VIF (variance inflation factor) values being 2.5 and 2.6, respectively, both significantly bigger than 1 (Kutner, Nachtshein, & Neter, 2004). The most commonly recommended solutions for multicollinearity include taking one correlated predictor variable out of the regression or combining the two variables together (Kline, 1998; Kutner, Nachtshein, & Neter, 2004.)

Second, a further investigation on the role of credibility and coordination suggests that credibility functions more on the "manifestation" side than the "structure" side of TMS. Particularly, credibility is defined as the extent to which team members trust each other's expertise. This is highly likely to take place along with the coordination process—during the interaction and coordination with each other, board members become familiar with one another's expertise, get chances to evaluate the credentials of the expertise, and eventually build trust on the expertise. Although certain level of credibility may exist solely based on the recognition of expertise (i.e. specialization, sharedness and accuracy) at the initial stage, high levels of credibility can not be achieved without involving in coordination. From this aspect, credibility can be viewed as the cognitive demonstration of *manifestation* of TMS structure, whereas coordination can be viewed as the behavioral demonstration of manifestation. Drawing on Marks, Mathieu, & Zaccaro (2001)'s team process taxonomy, credibility and coordination fall into the *team monitoring and backup* and *coordination* dimensions of Action phase processes. Therefore, I revised the theoretical model so that credibility and coordination are two dimensions of TMS manifestation and specialization, sharedness, and accuracy are dimensions of TMS structure. See Figure 3a and Figure 3b.

Insert Figure 3a and 3b about here

6.6 Hierarchical Regression Results (*Treating Credibility & Coordination Separately as Mediators)*

To deal with the multicollinearity issue and to improve the theoretical model by examining the role of credibility and coordination each as an indicator of TMS manifestation, I re-ran the analyses while treating credibility and coordination both as mediators but keeping them separate. Results are shown in Table 14 to Table 18.

Direct effect and Mediation. Hypothesis 1 to Hypothesis 4 predicted that TMS structure (specialization, sharedness, and accuracy) will be positively related to board outcomes and the relationships will be mediated by TMS manifestation (credibility and coordination). Consistent with the procedures described earlier, to examine the mediation, I first tested the direct relationships between IV (TMS structure -- specialization, sharedness, accuracy) and DV (outcome variables); I then tested the relationships between IV and the mediators (TMS manifestation--credibility and coordination). Third, I tested the relationships between the mediators and the outcome variables. For cases where all the three relationships tested above were significant, I did a fourth set of tests with all dimensions of TMS (IV and the mediator) in the equation together to predict the outcome variables, following Baron and Kenny's (1986) procedure. For cases where the direct relationship between IV and DV was not significant, but both indirect relationships were significant, I performed a Sobel (1982) test to examine the mediating effects (MacKinnon et al., 2002). For each of the relationship tests, I first entered the control variables, and then the main predictors.

Table 14 present the results for director-rated performance. As Model 2 shows, TMS specialization and accuracy both had a positive relationship with director-rated performance (β = 4.14, $p<.05$ and β = .7, $p<.01$, respectively), but sharedness was not related to director-rated performance (β = -.043, n.s.). So the first part of Hypothesis 1 was partially supported. Model 4 shows that TMS specialization (β = 2.19, $p<.05$) and sharedness (β = .09, $p<.10$) were positively related to credibility, and Model 6 shows that specialization was positively related to coordination (β = 2.64, $p<.10$). Accuracy was not related to either credibility or coordination as shown in the two models (β = .16 and .23, n.s., respectively). Model 7 and Model 8 show that both credibility (β = .67, $p<.01$) and coordination (β = .67, $p<.001$) were positively related to director-rated performance. To test the mediating effects of credibility and coordination (separately), two additional regressions were run as shown in Model 9 and Model 10. In Model 9, when credibility was included in the equation along with the three dimensions of TMS structure, the coefficient of specialization decreased from 4.14 to 3.25 ($p <.10$). In Model 10, when coordination was included together with the three TMS structure dimensions in the equation, the coefficient of specialization became nonsignificant (β = 2.82, n.s.). Therefore, credibility and coordination (partially and fully, respectively) mediated the relationship between specialization and director-rated performance. In addition, as there was a significant relationship between sharedness and credibility (β = .09, s.d. = .048), and a significant relationship between credibility and director-rated performance (β = .67, s.d. = .22), a Sobel test was performed to examine the indirect effect of sharedness on director-rated performance through credibility. Specifically, Sobel statistic was 1.60 (p

= .11), statistically nonsignificant, thus the mediating effect of credibility on the sharedness→director-rated performance relationship was not supported. Therefore, Hypothesis 1 was partially supported.

Insert Table 14 about here

Results on chair-rated performance are listed in Table 15. Very similarly, the positive effects of TMS structure on chair-rated performance were supported for specialization (Model 2; $\beta = 4.49$, $p<.05$) and accuracy (Model 2; $\beta = .53$, $p<.05$), but not for sharedness (Model 2; $\beta = -.055$, n.s.). Hence, the first part of Hypothesis 1 was partially supported. Same as described above, specialization was positively related to credibility (Model 4, $\beta = 2.19$, $p<.05$) and coordination (Model 6, $\beta = 2.64$, $p<.10$), and sharedness was positively related to credibility (Model 4, $\beta = .09$, $p<.10$). Model 7 and Model 8 show that credibility and coordination was each positively related to chair-rated performance ($\beta = .94$ and .83, $p<.01$, respectively). Furthermore, Model 9 and Model 10 show that the coefficient of specialization decreased from 4.49 to 2.67 (n.s.) and 2.52 ($p<.10$) after including the mediator credibility and coordination respectively in the equation. Hence, credibility and coordination both mediated the relationship between specialization and chair-rated performance, with the former a full mediation and the latter a partial mediation. In addition, a Sobel test was performed on the two indirect relationships, i.e. sharedness→credibility ($\beta = .09$, s.d = .048) and credibility→chair-rated performance ($\beta = .94$, s.d = .18). The Sobel statistic was 1.76 ($p = .08$), supporting the mediating effect of credibility on the relationship between sharedness and chair-rated performance. Thus, Hypothesis 1 was again partially supported.

Insert Table 15 about here

Table 16 present the results for director-rated innovation. Partially supporting the first part of Hypothesis 2, Model 2 shows that TMS sharedness ($\beta = .24$, $p<.05$) and accuracy ($\beta = .54$, $p =.07$) were both positively related to director-rated innovation. Same as presented above, specialization and sharedness were positively related to credibility (Model 4, $\beta = 2.19$, $p<.05$ and $\beta =.09$, $p =.06$, respectively), and specialization was positively related to coordination (Model 6, $\beta = 2.64$, $p = .07$). Model 7 and Model 8 show that credibility and coordination was each positively associated with director-rated innovation ($\beta = .86$ and .6, respectively, $p<.001$ for both). Furthermore, Model 9 indicates that when credibility was included together with the three TMS structure dimensions in the equation, the coefficient of sharedness decreased from .24 to a nonsignificant .18. Therefore, credibility fully mediated the relationship between sharedness and director-rated innovation. Because only specialization was related to coordination (Model 6) but it did not have a direct relationship with director-rated innovation, the last step of Baron and Kenny's (1986) procedure wasn't conducted for coordination. Sobel tests were performed, instead, on the indirect effects of specialization→credibility ($\beta =2.19$, s.d. = .09) and credibility → director-rated innovation ($\beta = .86$, s.d. = .25), as well as the indirect effects of specialization→coordination ($\beta = 2.64$, s.d. = 1.41) and coordination→director-rated innovation (β = .60, s.d. = .17). Sobel statistics were 3.40 (p <.000) and 1.65 (p = .10) for credibility and coordination, respectively. Therefore, credibility and coordination both mediated the relationship between specialization and director-rated innovation. Thus, Hypothesis 2 was partially supported.

Insert Table 16 about here

Results on chair-rated innovation are reported in Table 17. Partially supporting the first part of Hypothesis 2, TMS specialization was positively related to chair-rated innovation (see Model 2, β = 4.17, p<.05), while the other two TMS structure dimensions (sharedness and accuracy) were not. Same as presented above, specialization and sharedness were positively related to credibility (Model 4, β = 2.19, p<.05 and β = .09, p = .06, respectively), and specialization was positively related to coordination (Model 6, β = 2.64, p = .07). Model 7 and Model 8 show that credibility (β = .54, p<.05) and coordination (β = .3, p = .08) was each positively related to chair-rated innovation. Furthermore, Model 9 and Model 10 show that when including credibility and coordination with the three TMS structure dimensions in the equation one at a time, the coefficient of specialization decrease from 4.17 to 3.2 (n.s.) and 3.61 (p = .10), respectively. Therefore, credibility fully mediated the relationship between specialization and chair-rated innovation, and coordination partially mediated the relationship. In addition, a Sobel test was conducted on the indirect effects of sharedness→credibility (β = .09, s.d = .048) and credibility → chair-rated innovation (β = .54, s.d. = .23). Result indicates that credibility did not mediate the relationship between sharedness and chair-rated innovation (Sobel statistic = 1.47, $p = .14$). Thus, Hypothesis 2 was again partially supported.

Insert Table 17 about here

As mentioned earlier, Hypothesis 3 was not tested due to high correlations between board satisfaction and credibility and coordination.

Table 18 presents the results for board commitment. As Model 2 shows, none of the TMS structure dimensions (i.e. specialization, sharedness, accuracy) predicted board commitment. Hence, the first part of Hypothesis 4 was not supported. Same as presented above, specialization and sharedness were both positively related to credibility (Model 4, $\beta = 2.19$, $p<.05$ and $\beta = .09$, $p = .06$, respectively), and specialization was positively related to coordination (Model 6, $\beta = 2.64$, $p = .07$). Model 7 and Model 8 show that credibility and coordination was each positively related to board commitment ($\beta = .51$ and .42, respectively, $p<.001$ for both). As no direct effect was found in Model 2, Baron and Kenny's procedure for mediation test was not performed. Instead, Sobel tests were run on three sets of indirect effects, i.e. (1) specialization→credibility (β =2.19, s.d. = .09) and credibility→board commitment (β =.51, s.d. = .11), (2) sharedness → credibility (β = .09, s.d = .048) and credibility →board commitment, as well as (3) specialization →coordination (β =2.64, s.d. = 1.41) and coordination→board commitment (β =.42, s.d. = .069). Results show that Sobel statistic was 4.55 ($p < .000$), 1.74 ($p = .08$), and 1.78 (p

= .07), respectively. Therefore, credibility and coordination were supported for mediating the relationship between specialization and board commitment, and credibility also mediated the relationship between sharedness and board commitment. Thus, Hypothesis 4 was partially supported.

Insert Table 18 about here

Moderation. Hypothesis 5 to Hypothesis 7 predicted that task interdependence, task routineness, and alignment of task assignment will moderate the relationship between TMS manifestation (credibility and coordination) and the board outcomes. To test the moderations, I entered the main predictors in a first step, and then the moderators in a second step. The results are summarized in the right hand side of Table 14 to Table 18.

Table 14 presents the results for director-rated performance. Model 12 and Model 14 show that task interdependence moderated both the relationship between TMS credibility and director-rated performance ($\beta = 1.88$, $p<.05$) and that between TMS coordination and director-rated performance ($\beta = 1.03$, $p<.05$). Figure 7a and Figure 7b depict the two interactions, respectively. In Figure 7a, the relationship between TMS credibility and director-rated performance was positive and strong when task interdependence was high, as expected, but surprisingly, the relationship was slightly negative when task interdependence was low. Whereas in Figure 7b, as predicted, the positive relationship between TMS coordination and director-rated performance was dramatically stronger when task interdependence was high, and much weaker when task interdependence was low. Also shown in Model 12, task routineness moderated the relationship between TMS credibility and director-rated performance ($\beta = 2.94$, $p<.001$). Figure 8 shows the interaction. As predicted, TMS credibility was positively associated with director-rated performance when task routineness was high, but negatively associated with director-rated performance when task routinenesss was low. Alignment of task assignment was not supported as a moderator for director-rated performance. Thus, Hypothesis 5 and Hypothesis 6 were both supported for (a) director-rated performance, while Hypothesis 7 was not supported for this outcome variable.

Insert Figure 7a and 7b and Figure 8 about here

Table 15 presents the moderating results for chair-rated performance. As shown in Model 12, task interdependence, task routineness, and alignment of task assignment all moderated the relationship between TMS credibility and chair-rated performance ($\beta = 1.41$, $p<.05$, $\beta = 1.66$, $p<.01$, and $\beta = -.69$, $p<.05$, respectively). Figure 9, 10, and 11 plot the three interactions, respectively. In Figure 9, the positive relationship between TMS credibility and chair-rated performance was stronger when task interdependence was high than when it was low, as predicted. In Figure 10, TMS credibility was positively related to chair-rated performance when task routineness was high, and unrelated to chair-rated performance when task routineness was low, partially consistent with predicted. In Figure 11, opposite to what was expected, TMS credibility was positively related to chair-rated performance when the alignment between task assignment and expertise was low, and the positive relationship was much weaker when the alignment between task assignment and expertise was high. Thus, Hypothesis 5 and Hypothesis 6 were both supported for (a) chair-rated performance whereas Hypothesis 7 was not supported for this outcome.

Insert Figure 9, Figure 10, and Figure 11 about here

The moderating results for director-rated innovation appear in Table 16. Model 11 and Model 13 show that task interdependence moderated both the relationship between TMS credibility and director-rated innovation ($\beta = 2.0$, $p<.05$) and that between TMS coordination and director-rated innovation ($\beta = 1.22$, $p<.05$). Figure 12a and 12b plot the two interactions, respectively. As the interaction patterns were highly similar, I present them here together. Specifically, the positive relationship between TMS credibility (and TMS coordination) and director-rated innovation was significantly stronger when the level of task interdependence was high than when it was low, as predicted in Hypothesis 5. Also shown in Model 11, task routineness moderated the relationship between TMS credibility and director-rated innovation ($\beta = 3.3$, $p<.001$). Figure 13 depicts this interaction. Specifically, TMS credibility was positively related to director-rated innovation when task routineness was high but was negatively related to director-rated innovation when task routineness was low, as predicted. Alignment of task assignment was not supported as a moderator. Thus, Hypothesis 5 and Hypothesis 6 were supported for (b) board innovation, but Hypothesis 7 was not supported for this outcome variable.

Insert Figure 12a and 12b and Figure 13 about here

Table 17 reports the moderating results for chair-rated innovation. As shown in Model 12 and Model 14, no moderating effects were found. Therefore, none of Hypothesis 5, Hypothesis 6 and Hypothesis 7 was supported for (b) chair-rated innovation.

Hypotheses involving board satisfaction were again not tested due its high correlations with both credibility and coordination. Results for board commitment are presented in Table 18. As shown in Model 10, task routineness moderated the relationship between TMS credibility and board commitment ($\beta = .87, p<.05$). Figure 14 depicts the interaction. Partially as predicted, TMS credibility was positively related to board commitment when task routineness was high, and the positive relationship was weaker when task routineness was low. Although a negative relationship was not found in the condition of low task routineness, the reduction in the strength of the relationship is in the same direction of what was hypothesized. Model 12 shows that task interdependence moderated the relationship between TMS coordination and board commitment ($\beta = .44, p<.10$). As depicted in Figure 15, the positive relationship between TMS coordination and board commitment was stronger when task interdependence was high than when it was low. Thus, Hypothesis 5 was supported and Hypothesis 6 was partially supported for (c) board commitment, but Hypothesis 7 was not supported for this outcome variable.

Insert Figure 14 about here

Chapter 7 Discussion

This study involved a comprehensive examination of the role of transactive memory systems in making good use of expertise in work teams and conditions under which a transactive memory system would or would not benefit team outcomes. To achieve this goal, I first synthesized the different typologies of TMS dimensions and, based on the revised theoretical model presented in section 6.5, proposed that a TMS is composed of TMS structure (i.e. shared and accurate specialization) and manifestation of TMS structure on both a cognitive (credibility) and behavioral (coordination) level. Using a sample of 92 boards of directors of charter schools with multisource data, I then examined the relationship between TMS structure (specialization, sharedness, accuracy) and key team outcomes (i.e. performance, innovation, and commitment) and the mediating effects of TMS manifestation (credibility and coordination) on these relationships. I further tested the moderating effects of task interdependence, task routineness, and alignment of task assignment on the relationships between TMS manifestation (credibility and coordination) and the team outcomes.

7.1 Summary of Major Findings

The first purpose of the study was to clarify the divergent typologies of TMS dimensions existing in the literature and to test a synthesized higher-order framework, i.e. TMS structure-TMS manifestation on an extended team outcome domain. The first sets of findings focus on the relationships between TMS structure (specialization, sharedness, and accuracy) and the charter school board outcomes, as well as the mediating effects of TMS manifestation (credibility and coordination). Findings suggest that charter school boards where expertise was more dispersed than centralized (i.e. high level of specialization) and where members more accurately recognized one another's expertise (i.e. high level of accuracy) had better performance rated by school director (external evaluation) and board chair (internal evaluation), after controlling for the effects of board size, length of time board members had been working together, and the frequency of communications within boards. The degree to which board members share the perception of "who is the expert on what" (sharedness), on the other hand, did not show a relationship with either external- or internal-ratings of board performance. This finding is consistent with Austin (2003) where the author found significant positive effects of both specialization and accuracy on both external and internal evaluation of group performance, but no effect of sharedness.

Extending the understanding of outcomes of TMS structure beyond team performance, I found that the charter school boards where members had an accurate recognition of peer members' expertise (high accuracy) and agreed on the recognition (high sharedness) were more likely, rated by school directors, to initiate new procedures and methods for completing the work, develop innovative ways of accomplishing work objectives, and develop new skills in order to foster innovations. Interestingly, the results differed when innovation was rated by the internal leaders (i.e., board chairs). Specifically, boards with more dispersed expertise (high specialization) were rated higher on innovation criteria by the board chairs, whereas sharedness and accuracy didn't seem to matter. Across the two ratings of board innovation (i.e., provided by school directors and board chairs), I found evidence that TMS structure has a positive relationship with team innovation. However, I did not find support for the linkage between TMS structure and team attitude, i.e., expertise distribution and members' recognition of the expertise did not seem to be related to the level of commitment to the school board.

On the other hand, TMS manifestation (credibility and coordination) showed more persistent positive relationships with the different charter school board outcomes. I found that charter school boards where members had high trust of peers' expertise (high credibility) or worked smoothly in a well-coordinated fashion (high coordination) were rated higher by both school director and board chair on board performance and board innovation. In addition, such boards also had higher overall levels of commitment to their respective boards.

To understand the process through which group members' cognitive structure of expertise distribution boosted group outcomes, I proposed mediating effects of TMS manifestation on TMS structure→team outcomes relationships. The study revealed that charter school boards that benefited from having dispersed expertise (high specialization) in both director- and chair-rated performance realized this positive effect through giving trust to peers' expertise, willing to receiving task-related suggestions from peers and feeling comfortable relying on the knowledge peer members brought to the board (high credibility), as well as through engaging in more coordination (high coordination). These mediation effects indicate that having members good at different areas of expertise may make it easier for them to trust each other's expertise and in turn engage in implicit coordination (where members mindfully focus on the tasks that fit their expertise and avoid tasks that others have expertise on) as well as to behaviorally coordinate more in an effective way which further leads to better performance. Additionally, having a well-shared understanding of who knows what among members also helped members to build trust toward one another's expertise and in turn facilitate performance.

The same mechanism worked for board innovation. Specifically, the study shows that one reason why charter school boards with well dispersed expertise (high specialization) were rated (by school director and board chair) better at initiating new methods to complete the work and making innovations is because such boards had high levels of trust on one another's expertise which provide a fostering environment for generating new ideas, and because they engaged in more coordination which facilitate implementation of the new ideas. In other words, the positive effects of specialization on director- and chair-rated innovation were mediated by credibility and coordination. In addition, charter school boards with high levels of sharedness on who hold what expertise also had higher director-rated innovation through high credibility.

As for commitment, Sobel test revealed that there existed an indirect effect of specialization on commitment carried through credibility and coordination, and an indirect effect of sharedness carried through credibility. This means that charter school boards with a perceived distributed expertise composition and high levels of agreement on the locations of the expertise tended to have high levels of trust toward each other's expertise and coordinate more which in turn leads to higher levels of board commitment.

The second purpose of the study was to examine the contingent factors that influence the relationships between TMS manifestation and team outcomes. The second set of findings portrays the moderating effects of task characteristics (i.e. task interdependence, task routineness, and alignment of task assignment) on the relationship between TMS manifestation (i.e. credibility and coordination) and team outcomes. Quite consistently and robustly, I found that task interdependence and task routineness moderated the relationships between TMS credibility and director- and chair-rated performance, director-rated innovation, and board commitment. Furthermore, task interdependence also moderated the relationship between TMS coordination and director-rated performance, director-rated innovation, and board commitment. I elaborate on each of these moderating relationships below.

Task interdependence has long been identified as an important moderator of team mechanism/process in team literature (e.g. Barrick et al., 2007). In this study, I found that charter school boards with high levels of trust in their fellow members' expertise performed and innovated on a higher level as rated by both the school directors and the board chairs when tasks were highly interdependent; the relationships between TMS credibility and board performance and innovation were much weaker or became not significant when task interdependence level was low. Interestingly, credibility even displayed a negative relationship with director-rated performance when task interdependence was low. These findings indicate that when tasks are highly interdependent and need a great degree of collaboration to be completed, building trust on peer members' expertise is an effective way to improve performance and innovation. On the other hand, when tasks are quite independent and can be accomplished without much interaction among members, having a high trust on peer members' expertise does not help much for or even hurt charter school boards' performance and innovation. One explanation for the negative relationship is that credibility may convey some degree of implicit coordination (defined by Rico, et al, 2008), where members skip the work that they believe others have the expertise on and only focus on the work that they think they are good at. This cognitive activity may harm team performance when tasks are independent and members have to be responsible for their work.

A similar moderating effect was found on coordination→ director-rated team performance/innovation relationships as well, i.e. a high level of coordination based on the recognized expertise in the charter school boards was highly associated with better director-rated performance and innovation when task interdependence was high, but the positive relationship was much weaker when task interdependence was low. No moderating effect was found on coordination, though, when predicting chair-rated performance, which indicates that engaging in good coordination persistently lead to better (chair-rated) performance regardless of the level of task interdependence. In addition, no moderating effects were found on either credibility or coordination when predicting chair-rated innovation. The discrepancy in the findings of moderating effects between director and chair ratings may suggest that the team leader (board chair) and the external evaluator (school director) had slight different perceptions on the team performance and innovation.

As for predicting board commitment, the moderating effect of task interdependence was similar. Specifically, the positive relationship between coordination and board commitment was stronger in charter school boards with higher levels of task interdependence.

Task routineness is another task characteristic variable that team researchers have found to be important in understanding the nature of team processes (e.g. Jehn, 1995; Pelled, et al., 1999). Particularly, Rico et al. (2008) have argued theoretically that task routineness should moderate the relationship between implicit coordination and team performance such that team performance will only benefit from implicit coordination when task is routine and suffer when task is non-routine. Serving as the first empirical evidence to this argument, this study demonstrated a positive effect of TMS credibility on director-rated performance and innovation when task routineness was high, and a negative effect when task routineness was low. This confirms the theoretical argument that reliance on an established TMS and forming habitual functioning based on TMS (i.e. trusting one another's expertise and engaging in implicit coordination based on the expertise) would only benefit teams when tasks are highly defined, predictable and the procedures of completing tasks can be easily repeated or standardized. When tasks are highly changeable and involves high levels of uncertainty, however, a strong reliance on TMS may harm teams' performance and innovation. For chair-rated performance, this moderating effect of task routineness mostly held, with the exception that credibility became non-related to performance instead of displaying a negative effect when tasks were non-routine. No moderating effects were found on credibility or coordination when predicting chair-rated innovation.

It is interesting to note that task routineness showed a negative main effect on director-rated performance (Model 11 in Table 14, $\beta = -.69$, $p<.01$) and chair-rated innovation (Model 11 in Table 17, $\beta = -.72$, $p<.05$), which can also be verified by the interaction plots in Figure 8. Although nonsignificant, the coefficients of task routineness on chair-rated performance and director-rated innovation were also negative ($\beta = -.23$ and -.43, n.s., respectively). The negative main effect and the moderating effects of task routineness together suggest that charter school boards where tasks were routine and predictable were viewed to have lower performance by school director and less innovation by board chair than school boards where tasks were more uncertain and changeable. On the other hand, low performing/innovating charter school boards with routine tasks benefited more from trusting members' expertise (credibility) than those high performing/innovating boards with non-routineness tasks.

Task routineness also moderated the relationship between credibility and board commitment in the way that credibility favor members' commitment more when tasks were better defined and more predictable than when tasks were uncertain and changeable. However, task routineness also showed a non-significant but positive main effect on board commitment, indicating that board members were more committed when the tasks were more routine.

The third proposed moderator, alignment of task assignment, was not well supported across the outcomes. Although it showed a significant moderating effect on credibility→chair-rated performance relationship, it's in the opposite of the predicted direction. Specifically, as depicted in Figure 11, although charter school boards with better alignment between expertise and task assignment were rated significantly higher on performance by board chairs (a positive main effect), credibility had a stronger positive relationship with chair-rated performance when the alignment between expertise and task assignment was low, and a weaker positive relationship when the alignment was high. One possible explanation of this finding is that when task assignments are well aligned with team members' expertise, having trust on other members' expertise or not doesn't matter much any more. It is when task assignments are poorly aligned with the expertise that having trust on peer members' expertise really come into play and help the team perform better. In other words, good alignment almost always means high credibility—an indication of good alignment by board members may well convey the fact that they have trust on other members' expertise (alignment was also positively correlated with credibility at .40); However, high credibility doesn't necessarily guarantee good alignment.

The third purpose of the study was to explore and identify precursors of TMS which contribute to the formation and establishment of TMS structure. The study demonstrated that charter school boards with higher average levels of specific status cues (i.e. members have longer working experience, higher degree of education, and higher job levels) had higher levels of specialization (expertise were more dispersed across members). Average level of diffused status characteristic cues, meaning higher proportion of males and/or Caucasians, was associated with higher agreement on "who has what expertise" among the members. This indicates that gender and ethnicity were two prevalent status cues that charter school board members used to draw their perceptions on expertise. Furthermore, both average levels of specific status cues (task-related) and diffused status cues (non-task-related) were positively related to accuracy of the recognition of expertise on the board level, with specific status cues having a bigger effect size than diffused status cues. This indicates that although relying on non-task-related cues for recognizing expertise showed some validity, task-related status cues were more compelling than non-task-related status cues in aiding recognizing expertise. These findings are consistent with Bunderson (2003)'s finding on effects of status cues on individual expertise recognition.

In addition, charter school boards with members who had stronger interpersonal connection (i.e. were more close to each other) recognized each other's expertise more accurately, as predicted. They also trusted one another's expertise and coordinated on a higher level.

Functional diversity, surprisingly, did not show any relationship with TMS structure. This might be due to that fact that many of the boards consisted of a good number of licensed teachers, which lead to limited variations in members' functional diversity.

Overall, the study conveys that groups with high task-related status members (e.g., more work experience, high education, and high job level) who also have close interpersonal connections are likely to have dispersed expertise distribution and form a shared and accurate cognitive structure of the expertise distribution. Having dispersed expertise and agreement on the expertise distribution facilitates group performance, innovation, and elevates group members' commitment, because they feel comfortable relying on peer members' expertise and work in a well-coordinated fashion. However, relying on and utilizing the cognitive structure of expertise only benefits group performance and innovation when tasks are highly interdependent and well-defined and predictable. When tasks are independent or less predictable, manifestation of transactive memory system, either cognitively or behaviorally, does little good or even hurt the group outcomes.

7.2 Contributions

This study contributes to the transactive memory system literature in five important ways. First, the conceptualization of transactive memory system is still evolving and typologies of dimensions of TMS lack consistency in the literature (Kozlowski & Ilgen, 2006). This study clarified the conceptualization of TMS by integrating and synthesizing different typologies of dimensions of TMS and proposed a higher-order framework, i.e. TMS structure- TMS manifestation, where TMS structure is captured by specialization, sharedness and accuracy, and TMS manifestation captured by credibility and coordination. This clarification can help us better understand the internal development of TMS, the predictors as well as the effects of TMS. Specifically, the study partially demonstrated that TMS structure had positive effects on team performance, innovation and attitude (commitment), and these positive relationships were mediated by TMS manifestation. Second, while the literature has been predominantly focusing on the effects of TMS, little is known about contextual factors that influence the effects of TMS on team outcomes. This study identified two important moderating effects of task characteristics, namely task interdependence and task routineness on the effects of TMS on team outcomes and advanced our understanding of effects of TMS. Specifically, it shed light on how task interdependence and task routineness affect the relationship between TMS credibility and coordination and team performance, innovation, and attitudes (commitment). Third, the literature lacks attention on precursors of TMS. This study identified task-related and non-take-related status characteristics and interpersonal connections as two sets of precursors that contribute to the formation of TMS. Fourth, the study extended our understanding of effects of TMS on two other major team outcomes, i.e., team innovation and team commitment. Lastly, the empirical evidence in the literature has been dominated by student and laboratory samples thus far. This study used a sample of charter school boards which in context are parallel to work teams and thus contribute to the generalizabililty of the findings. The findings of the study provide both theoretical and practical implications.

7.3 Practical Implications

The findings of the study have some implications for practice. First, promoting and fostering transactive memory system in work teams can improve teams' performance and innovation when team members work in a highly interdependent way. Team management can try to help members recognize one another's expertise in some creative ways, such as distribute or make available a list of each member's expertise and emphasize the importance of understanding peers' expertise during group training. In addition, pairing team members who have more work experience in the organization with the less experienced and pairing gender and ethnic minority groups with the majority groups would also help accelerate the expertise recognition within teams.

Previous studies have shown positive relationship between transactive memory system and team performance. In this study, I reiterate the importance of TMS in teams by connecting it to innovation and board commitment. This encourages the HR managers to work closely with teams to ensure they understand each other's expertise and coordinate in order to facilitate innovation and increase board commitment.

However, when the tasks are routine, team management may want to focus on horning each member's own knowledge and skill on the tasks instead of directing members' attention to one another's expertise.

For studies or research on TMS, it will be beneficial to look at TMS structure and TMS manifestation separately, and to understand the role of each component in the studied relationships. There potentially can be multiple ways to capture TMS manifestation, and the process or mechanism of manifestation will be key to understand in order to uncover the black box between TMS structure and outcomes.

7.4 Limitations and Future Research

As with every study, this study has some limitations. First, the predicting variables and the outcomes were measured at the same time. Hence, no causal inferences can be made among the studied variables, and there could be argument for the reversed relationships. For example, one can argue that task interdependence may serve as a predictor of formation of TMS structure instead of a moderator, as working interactively increases members' opportunities to learn about one another's expertise. Indeed, Zhi-Xue et al. (2007) found a main effect of task interdependence on transactive memory system and in turn to team performance in their study. With the current study design, it is impossible to tease apart the two kinds of effects of task interdependence. In addition, the charter school boards in the study sample have been working together for a little more than two years on average. As they conduct annual evaluations both internally by themselves and by public regulations, it is very likely that they have had some feedback from previous performance evaluations which could affect their levels of TMS. Future research should try to track and assess teams as close to the beginning of forming of the teams as possible to reduce the concern of spiral effects.

Second, although the performance and innovation measures have external ratings from school directors to alleviate single source bias, no usable objective measures of team performance were available during the course of the study. As part of charter school boards' job is to make financial plans and management school expenditure, charter schools' fiscal wellness would be a good objective measure of the board performance. School finance information, provided by the state Department of Education annually in school report cards, is not released yet at this time, thus can not be included in the study. However, as an extension to this dissertation, I will incorporate this part of information with the analyses later once the data is available.

Third, the sample size was rather small, especially for chair-rated performance and innovation ($N = 81$), providing limited power to detect small effect sizes. Future research should try to use bigger samples to test the relationships.

Fourth, although charter school board of directors work collectively as work teams and bear real consequences of their performance, they are not paid for working on the board, which differs from typical works teams in organizations. Thus, we need to be cautious about generalizing the findings to all other types of teams.

Fifth, a few measurements can be improved in future research. For example, the alignment of task assignment was measured by only one item asking respondents' perceptions on the degree of alignment. This measurement contains some information on credibility. It would be worthy for future research to assess the alignment directly, such as comparing the real assignment structure with the expertise distribution. In addition, in the current study, TMS manifestation was captured by credibility and coordination which are adopted from Lewis's (2003) scale. As they came from a same large scale, the two variables were highly correlated. Hence, I was not able to test them as mediators simultaneously. Future research should explore alternative indicators of manifestation, such as mindful implicit coordination suggested by Rico et al (2008) and the actual information-seeking behaviors.

Lastly, the ICC(2) value was relatively low on task interdependence (ICC(2) = .24), meaning that the group mean of this variable was not very reliable. Although the ICC(2) level was quite consistent with those reported in the literature (e.g., Zhang et al. 2007 reported ICC(2) = .34 for task interdependence), low group mean reliability would conservatively bias the relationships with task interdependence. Further research can try alternative measures of task interdependence which has higher ICC(2) values.

7.5 Conclusions

This study contributed to the emerging body of literature on transactive memory system by clarifying the construct, exploring the mechanism through which TMS is related to team outcomes, specified contextual factors which influence the effects of TMS on team outcomes, and identified precursors that contribute to the formation of TMS. Results indicate that TMS structure has positive effects on team performance, team innovation, and team commitment, and TMS manifestation mediated these relationships. In addition task interdependence and task routineness moderated the relationship between TMS manifestation and performance and innovation. Further, task-related and non-task related status characteristics and interpersonal closeness predicted the formation of TMS structure. Future research should try to explore more the contextual factors of TMS effects as well as the formation and functioning processes of TMS.

References

Akgün, A. E., Byrne, J. C., Keskin, H., & Lynn, G. S. (2006). Transactive memory system in new product development teams. *IEEE Transactions on Engineering Management, 53*(1), 95-111.

Akgün, A. E., Byrne, J., Keskin, H., Lynn, G. S., & Imamoglu, S. Z. (2005). Knowledge networks in new product development projects: A transactive memory perspective. *Information & Management, 42*(8), 1105-1120.

Akgün, A. E., & Lynn, G. S. (2002). Antecedents and consequences of team stability on new product development performance. *Journal of Engineering & Technology Management, 19*(3), 263.

Amason, A. (1996). Distinguishing effects of functional and dysfunctional conflict, strategic decision making: Resolving a paradox for top management teams. *Academy of Management Journal*, 39, 123-148.

Amason, A., & Schweiger, D. (1994). Resolving the paradox of conflict, strategic decision making, and organizational performance. International Journal of Conflict Management, 5, 239-253.

Anand, V., Clark, M. A., & Zellmer-Bruhn, M. (2003). Team knowledge structures: Matching task to information environment. *Journal of Managerial Issues, 15*(1), 15.

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

Argote, L. (1982). Input uncertainty and organizational coordination in hospital emergency units. *Administrative Science Quarterly*, 27: 420–434.

Argote, L., McEvily, B., & Reagans, R. (2003). Managing knowledge in organizations: An integrative framework and review of emerging themes. *Management Science, 49*(4), 571-582.

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.

Bachrach, D. G., Powell, B. C., Bendoly, E., & Richey, R. G. (2006). Organizational citizenship behavior and performance evaluations: Exploring the impact of task interdependence. *Journal of Applied Psychology, 91*(1), 193-201.

Bachrach, D. G., Powell, B. C., Collins, B. J., & Richey, R. G. (2006). Effects of task interdependence on the relationship between helping behavior and group performance. *Journal of Applied Psychology, 91*(6), 1396-1405.

Baron, R. M., & Kenny, D. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, 51:1173–1182.

Barrick, M. R., Bradley, B. H., Kristof-Brown, A. L., & Colbert, A. E. (2007). The moderating role of top management team interdependence: implications fro real teams and working groups. *Academy of Management Journal*, 50, 544-557.

Baumann, M. R., & Bonner, B. L. (2004). The effects of variability and expectations on utilization of member expertise and group performance. *Organizational Behavior and Human Decision Processes*, 93, 89-101.

Berger, J., B. P. Cohen, and M. Zelditch, Jr. (1972). Status characteristics and social interaction. *American Sociological Review*, 37: 241–255.

Berger, J., M. H. Fisek, R. Z. Norman, and M. Zelditch, Jr. (1977). *Status Characteristics and Social Interaction: An Expectation- States Approach*. New York: Elsevier.

Berger, J., S. J. Rosenholtz, and M. Zelditch, Jr. (1980). Status organizing processes. *Annual Review of Sociology*, 6: 479–508.

Blau, P. (1977). *Inequality and heterogeneity*. New York: Free Press.

Black, J. S., & Gregersen, H. B. (1991). Antecedents to cross-cultural adjustment for expatriates in pacific rim assignments. *Human Relations, 44*(5), 497-515.

Bliese, P. D. (1998). Group size, ICC values, and group-level correlations: A simulation. *Organizational Research Methods,* 1, 355-373.

Bliese, P. D. (2000). Within-group agreement, non-independence, and reliability: Implications for data aggregation and analysis. In K. J. Klein & S. W. J. Kozlowski (Eds.), Multilevel theory, research, and methods in organizations (pp. 349-381). San Francisco, CA: Jossey-Bass.

Boh, W. F., Slaughter, S. A., & Espinosa, J. A. (2007). Learning from experience in software development: A multilevel analysis. *Management Science, 53*(8), 1315-1331.

Bollen, K. A. & Long, J. S. (1993). Testing structural equation models. Newbury Park, CA: Sage.

Borgatti, S. P., & Cross, R. (2003). A relations view of information seeking and learning in social networks. *Management Science*, 49, 432-445.

Brandon, D. P., & Hollingshead, A. B. (2004). Transactive memory systems in organizations: Matching tasks, expertise, and people. *Organization Science, 15*(6), 633-644.

Brodbeck, F. C., Kerschreiter, R., Mojzisch, A., & Schulz-Hardt, S. (2007). Group decision making under conditions of distributed knowledge: The information asymmetries model. *Academy of Management Review*, 32, 459-479.

Brown, W. A. (2007). Board development practices and competent board members-Implications for performance. *Nonprofit Management & Leadership*, vol. 17(3), 301-317.

Brown, R. D., & Hauenstein, N. M. A. (2005). Interrater agreement reconsidered: An alternative to the rwg indices. *Organizational Research Methods*, 8, 165-184.

Bunderson, J. S. (2003). Recognizing and utilizing expertise in work groups: A status characteristics perspective. *Administrative Science Quarterly, 48*(4), 557-591.

Bunderson, J. S., & Sutcliffe, K. M. (2002). Comparing alternative conceptualizations of functional diversity in management teams: Process and performance effects. *Academy of Management Journal*, 45: 875–894.

Burt, R. S. (1992). Structural holes: The social structure of competition. Cambridge, MA: Harvard University Press.

Cammann, C., Fichman, M., Jenkins, D. & Klesh, J. R. 1983. *The Michigan Organizational Assessment Questionnaire*. New York: Wiley.

Cannon-Bowers, J.A.,& Salas, E. (2001). Reflections on shared cognition. *Journal of Organizational Behavior*, 22, 195-202.

Cannon-Bowers, J, A., Salas, E., & Converse, S.A. 1990. Cognitive psychology and team training: Shared mental models in complex systems. *Human Factors Bulletin*, 33, 1-4.

Carson, J. B., Tesluk, P. E., & Marrone, J. A. (2007). Shared leadership in teams: An investigation of antecedent conditions and performance. *Academy of Management Journal, 50*(5), 1217-1234.

Chan, D. (1998). Functional relations among constructs in the same content domain at different levels of analysis: A typology of composition models. *Journal of Applied Psychology*, 83, 234-246.

Chatman, J. A., & Spataro, S. E. (2005). Using self-categorization theory to understand relational demography--based variations in people's responsiveness to organizational culture. *Academy of Management Journal, 48*(2), 321-331.

Chen, G., Mathieu, J. E., & Bliese, P. D. (2004). A framework for conducting multi-level construct validation. In F. Dansereau & F. Yamarino (Eds.), *Multi-level issues in organizational behavior and processes, 3*, 273-303.

Child, J. T., & Shumate, M. (2007). The impact of communal knowledge repositories and people-based knowledge management on perceptions of team effectiveness. *Management Communication Quarterly, 21*(1), 29-54.

Cohen, J. (1992). A power primer. *Psychology Bulletin*, 112, 155-159.

Contractor, N. S., Wasserman, S., & Faust, K. (2006). Testing multitheoretical, multilevel hypotheses about organizational networks: An analytic framework and empirical example. *Academy of Management Review, 31*(3), 681-703.

Cronin, M. A., & Weingart, L. R. (2007). Representational gaps, information processing, and conflict in functionally diverse teams. *Academy of Management Review, 32*(3), 761-773.

Cruz, N. M., Perez, V. M., & Ramos, Y. F. (2007). Transactive memory processes that lead to better team results. *Team Performance Management, 13*(7), 192-205.

Daft, R. L., Conlon, E. J., Austin, J., & Buenger, V. (1996). Competing values in organizations: Contextual influences and structural consequences. *Organization Science, 7*(5), 557-576.

Dahlin, K. B., Weingart, L. R., & Hinds, P. J. (2005). Team diversity and information use. *Academy of Management Journal, 48*(6), 1107-1123.

De Dreu, C. K. W., & West, M. A. (2001). Minority dissent and team innovation: The importance of participation in decision making. *Journal of Applied Psychology*, 86, 1191-1201.

Dewar, R. D., Whetten, D. A., & Boje, D. (1980). An examination of the reliability and validity of the Aiken and Hage scales of centralization, formalization, and task routineness. *Administrative Science Quarterly, 25*(1), 120.

Dooley, K. J., Corman, S. R., & McPhee, R. D. (2002). A knowledge directory for identifying experts and areas of expertise. *Human Systems Management, 21*(4), 217.

Drach-Zahavy, A., & Somech, A. (2001). Understanding team innovation: The role of team process and structure. *Group Dynamics: Theory, Research, and Practice*, 5, 111-123.

Dunlap, W. P., Burke, M. J., Smith-Crow, K. (2003). Accurate test of statistical significant for rwg and average deviation interrater agreement indexes. *Journal of Applied Psychology*, 88, 356-362.

Egan, T. M. (2005). Creativity in the context of team diversity: Team leader perspectives. *Advances in Developing Human Resources, 7*(2), 207-225.

Ellis, A. P. J. (2006). System breakdown: The role of mental models and transactive memory in the relationship between acute stress and team performance. *Academy of Management Journal, 49*(3), 576-589.

Espinosa, J. A., Slaughter, S. A., Kraut, R. E., & Herbsleb, J. D. (2007). Team knowledge and coordination in geographically distributed software development. *Journal of Management Information Systems, 24*(1), 135-169.

Faraj, S., & Sproull, Lee. (2000). Coordinating expertise in software development teams. *Management Science, 46*(12), 1554.

Faraj, S., & Yan Xiao. (2006). Coordination in fast-response organizations. *Management Science, 52*(8), 1155-1169.

Faul, F., Erdfelder, E., Lang, A.-G. & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39, 175-191.

Fay, D., Borrill, C., Amir, Z., Haward, R., & West, M. A. (2006). Getting the most out of multidisciplinary teams: A multi-sample study of team innovation in health care. *Journal of Occupational and Organizational Psychology*, 79, 553-567.

Fiore, S. M., Salas, E., Cuevas, H. M., & Bowers, C. A. (2003). Distributed coordination space: Toward a theory of distributed team process and performance. *Theoretical Issues in Ergonomics Science, 4*(3), 340.

Fraidin, S. N. (2004). When is one head better than two? interdependent information in group decision making. *Organizational Behavior & Human Decision Processes, 93*(2), 102.

Fritz, M. S., & MacKinnon, D. P. (2007). Required sample size to detect the mediated effect. *Psychological Science*, 18(3), 233-239.

Gassman, O. (2001). Multicultural teams: Increasing creativity and innovation by diversity. *Creativity & Innovation Management, 10*(2), 88.

Gigone, D. and Hastie, R. (1997). The impact of information on small group choice. *Journal of Personality and Social Psychology*, 72: 132-140.

Gibson, C. B. (2001). From accumulation to accommodation: The chemistry of collective cognition in work groups. *Journal of Organizational Behavior*, 22: 121–134.

Gibson, C. B., & Earley, P. C. E. (2007). Collective cognition in action: Accumulation, interaction, examination, and accommodation in the development and operation of group efficacy beliefs in the workplace. *Academy of Management Review*, 32, 438-458.

Gibson, C. B., & Gibbs, J. L. (2006). Unpacking the concept of virtuality: The effects of geographic dispersion, electronic dependence, dynamic structure, and national diversity on team innovation. *Administrative Science Quarterly, 51*(3), 451-495.

Gilson, L. L., Mathieu, J. E., Shalley, C. E., & Ruddy, T. M. (2005). Creativity and standardization: Complementary or conflicting drivers of team effectiveness? *Academy of Management Journal, 48*(3), 521-531.

Gladstein, D. L. (1984). Groups in context: A model of task group effectiveness. *Administrative Science Quarterly*, 29, 499-517.

Glick, W. H. (1985). Conceptualizing and measuring organizational and psychological climate: Pitfalls in multilevel research. *Academy of Management Review*, 10, 601-616.

Griffith, T. L., & Neale, M. A. (2001). Information processing in traditional, hybrid, and virtual teams: From nascent knowledge to transactive memory. *Research in Organizational Behavior, 23*, 379.

Hansen, M. T., Mors, M. L., & Løvås, B. (2005). Knowledge sharing in organizations: Multiple networks, multiple phases. *Academy of Management Journal, 48*(5), 776-793.

Harrison, D. A., & Klein, K. J. (2007). What's the difference? Diversity constructs as separation, variety, or disparity in organizations. *Academy of Management Review, 32*(4), 1199-1228.

Harrison, D. A., Price, K. H., Gavin, J. H., & Florey, A. T. (2002). Time, teams, and task performance: Changing effects of surface- and deep-level diversity on group functioning. *Academy of Management Journal, 45*(5), 1029-1045.

Hayne, S. C., Smith, C. A. P., & Vijayasarathy, L. R. (2005). The use of pattern-communication tools and team pattern recognition. *IEEE Transactions on Professional Communication, 48*(4), 377-390.

He, J., Butler, B. S., & King, W. R. (2007). Team cognition: Development and evolution in software project teams. *Journal of Management Information Systems, 24*(2), 261-292.

Henry, R. A., O. J. Strickland, S. L. Yorges, and D. Ladd. (1996). Helping groups determine their most accurate member: The role of outcome feedback. *Journal of Applied Social Psychology*, 26: 1153–1170.

Hirschfeld, R. R., Jordan, M. H., Feild, H. S., Giles, W. F., & Armenakis, A. A. (2006). Becoming team players: Team members' mastery of teamwork knowledge as a predictor of team task proficiency and observed teamwork effectiveness. *Journal of Applied Psychology, 91*(2), 467-474.

Hollingshead, A. B. (1998a). Retrieval processes in transactive memory systems. *Journal of Personality & Social Psychology, 74*(3), 659-671.

Hollingshead, A. B. (1998b). Communication, learning, and retrieval in transactive memory systems. *Journal of Experimental Social Psychology*, 34, 423–442.

Hollingshead, A. B. (2000). Perceptions of expertise and transactive memory in work relationships. *Group Processes & Intergroup Relations, 3*(3), 257.

Hollingshead, A. B. (2001). Cognitive interdependence and convergent expectations in transactive memory. *Journal of Personality and Social Psychology*, 1080–1089.

Hollingshead, A. B., & Brandon, D. P. (2003). Potential benefits of communication in transactive memory systems. *Human Communication Research, 29*(4), 607-615.

Hollingshead, A. B., & Fraidin, S. N. (2003). Gender stereotypes and assumptions about expertise in transactive memory. *Journal of Experimental Social Psychology*, 39, 355-363.

Hollingshead, A. B., Fulk, J., & Monger, P. (2002). Fostering intranet knowledge sharing: An integration of transactive memory and public goods approach. In P. J. Hinds & S. Kiesler (Eds.), *Distributed Work* (pp. 137-162). Cambridge, MA: MIT Press.

Homan, A. C., van Knippenberg, D., Van Kleef, G. A., & De Dreu, C. K. (2007). Bridging faultlines by valuing diversity: Diversity beliefs, information elaboration, and performance in diverse work groups. *Journal of Applied Psychology*, 92, 1189-1199.

Ilgen, D. R., & Klein, H. J. (1989). Organizational behavior. *Annual Review of Psychology*, 40: 327–351.

Independent-Southwestern Minnesota's Daily Newspaper. (March 3, 2009). Yankton school closed. Online newspaper.

Jackson, P., & Klobas, J. (2008). Transactive memory systems in organizations: Implications for knowledge directories. *Decision Support Systems, 44*(2), 409-424.

James, L.R., Demaree, R.G., & Wolf, G. (1984). Estimating within-group interrater reliability with and without response bias. *Journal of Applied Psychology*, 69, 85-98.

James, L. R., Mulaik, S. A., & Brett, J. M. (2006). A tale of two methods. *Organizational Research Methods*, 9, 233-244.

Jehn, K. A. (1995). A multimethod examination of the benefits and detriments of intragroup conflict. *Administrative Science Quarterly*, 40, 256-282.

Jehn, K. A. (1997). A qualitative analysis of conflict types and dimensions in organizational groups. *Administrative Science Quarterly*, 42(3), 530-557.

Jehn, K. A., & Bendersky, C. (2003). Intragroup conflict in organizations: A contingency perspective on the conflict-outcome relationship. *Research in Organizational Behavior*, 25, 187-242.

Jehn, K. A., & Mannix, E. (2001). The dynamic nature of conflict: A longitudinal study of intragroup conflict and group performance. *Academy of Management Journal*, 44, 238–251.

Kanawattanachai, P., & Yoo, Y. (2007). The impact of knowledge coordination on virtual team performance over time. *MIS Quarterly, 31*(4), 783-808.

Katz-Navon, T. Y., & Erez, M. (2005). When collective- and self-efficacy affect team performance: The role of task interdependence. *Small Group Research, 36*(4), 437-465.

King, A. (1999). Retrieving and transferring embodied data: Implications for the management of interdependence within organizations. *Management Science, 45*(7), 918-935.

Kikrman, B. L., Rosen, B., Tesluk, P. E., & Gibson, C. B. (2004). The impact of team empowerment on virtual team performance: The moderating role of face-to-face interaction. *Academy of Management Journal, 47*(2), 175-192.

Kirkman, B. L., Rosen, B., Tesluk, P. E., & Gibson, C. B. (2006). Enhancing the transfer of computer-assisted training proficiency in geographically distributed teams. *Journal of Applied Psychology, 91*(3), 706-716.

Klein, K. J., & Kozlowski, S. W. J. (2000). *Multilevel theory, research, and methods, in organizations: Foundations, extensions, and new directions*. San Francisco, CA: Jossey-Bass.

Klimoski, R. J., and Mohamed, S. (1994).Team Mental Model: Construct or Metaphor? *Journal of Management,* 20, 403-437.

Kline, R. B. (1998). *Principles and practice of structural equation modeling*. New York, NY: Guilford Press.

Kozlowski, S. W. J., & Ilgen, D. R. (2006). Enhancing the effectiveness of work groups and teams. *Psychological Science in the Public Interest*, 7, 77-124.

Kutner, M. H., Nachtsheim, C. J. & Neter, J. (2004). Applied Linear Regression Models. 4th.ed. New York, NY: Mc-Graw-Hill.

Lei, Z. (2006). Identify errors for continuous learning: Toward a model of error identification for transactive memory system teams. Unpublished working paper.

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., Belliveau, M., Herndon, B., & Keller, J. (2007). Group cognition, membership change, and performance: Investigating the benefits and detriments of collective knowledge. *Organizational Behavior & Human Decision Processes, 103*(2), 159-178.

Lewis, K., Lange, D., & Gillis, L. (2005). Transactive memory systems, learning, and learning transfer. *Organization Science, 16*(6), 581-598.

Liang, D. W., Moreland, R., & Argote, L. (1995). Group versus individual training and group performance: The mediating role of transactive memory. *Personality and Social Psychology Bulletin, 21*(4), 384-393.

Libby, R., Trotman, K. T., Zimmer, I. (1987). Member variation, recognition of expertise, and group performance. *Journal of Applied Psychology*, 72, 81-87.

Liden, R. C., Wayne, S. J., & Bradway, L. K. (1997). Task interdependence as a moderator of the relation between group control and performance. *Human Relations, 50*(2), 169-182.

Lim, B., & Klein, K. J. (2006). Team mental models and team performance: A field study of the effects of team mental model similarity and accuracy. *Journal of Organizational Behavior*, 27, 403-418.

Lindell, M. K., Brandt, C. J., & Whitney, D. J. (1999). A revised index of interrater agreement for multi-item ratings of a single target. *Applied Psychological Measurement*, 23, 127-135.

Littlepage, G., W. Robison, and K. Reddington. (1997). Effects of task experience and group experience on group performance, member ability, and recognition of expertise. *Organizational Behavior and Human Decision Processes*, 69: 133–147.

Littlepage, G. E., G. W. Schmidt, E. W. Whisler, and A. G. Frost. (1995). An input-process-output analysis of influence and performance in problem-solving groups. *Journal of Personality and Social Psychology*, 69: 877–889.

Marks, M. A., Mathieu, J. E., & Zaccaro, S. J. (2001). A temporally based framework and taxonomy of team processes. *Academy of Management Review*, 26, 356-376.

McGraw, K. O., & Wong, S. P. (1996). Forming inferences about some intraclass correlation coefficients. *Psychological Methods*, 1, 30-46.

MacKinnon, D. P., Krull, J. L., & Lockwood, C. M. (2000). Equivalence of the mediation, confounding and suppression effects. *Prevention Science*, 1: 173–181.

MacKinnon, D. P., Lockwood, C. M., Hoffman, J. M., West, S. G., & Sheets, V. (2002). A comparison of methods to test mediated and other intervening variable effects. Psychological Methods, 7(1), 83-104.

Majchrzak, A., Jarvenpaa, S. L., & Hollingshead, A. B. (2007). Coordinating expertise among emergent groups responding to disasters. *Organization Science*, 18, 147-161.

Ming-Huei Chen. (2006). Understanding the benefits and detriments of conflict on team creativity process. *Creativity & Innovation Management, 15*(1), 105-116.

Mohammed, S., & Dumville, B. C. (2001). Team mental models in a team knowledge framework: Expanding theory and measurement across disciplinary boundaries. *Journal of Organizational Behavior*, 22, 89–106.

Moreland, R. L. (1999). Transactive memory: Learning who knows what in work groups and organizations. In L. Thompson, D. Messick & J. Levine (Eds.), *Shared Cognition in Organizations: The Management of Knowledge.* : Mahwah, NJ: Lawrence Erlbaum.

Moreland, R. L., & Argote, L. (2003). Transactive memory in dynamic organizations. In R. S. Peterson, & E. A. Mannix (Eds.), *Leading and managing people in the dynamic organization* (pp. 135-162). Mahwah, NJ: Lawrence Erlbaum.

Moreland, R., Hogg, M. A., & Hanes, S. C. (1994). Back to the future: Social psychological research on groups. *Journal of Experimental Social Psychology*, 30: 527–555.

Moreland, R. L., & Myaskovsky, L. (2000). Exploring the performance benefits of group training: Transactive memory or improved communication? *Organizational Behavior & Human Decision Processes, 82*(1), 117-133.

Moreland, R. L., & Wingert, M. (1995). Training people to work in groups: The role of transactive memory. Paper presented at the annual meeting of the Midwestern Psychological Association., Chicago.

Morgeson, F. P., & Hofmann, D. A. (1999). The structure and function of collective constructs: Implications for multilevel research and theory development. *Academy of Management Review, 24*(2), 249-265.

Morgeson, F. P., Johnson, M. D., Campion, M. A., Medsker, G. J., & Mumford, T. V. (2006). Understanding reactions to job redesign: A quasi-experimental investigation of the moderating effects of organizational context on perceptions of performance behavior. *Personnel Psychology, 59*(2), 333-363.

Mowday, R. T., Porter, L. W., & Steers, R. M. (1982). Employee-organization linkages: The psychology of commitment, absenteeism, and turnover. New York: Academic Press.

Nevoa, D., & Wand, Y. (2005). Organizational memory information systems: A transactive memory approach. *Decision Support Systems, 39*(4), 549-562.

Olivera, F. (2000). Memory systems in organizations: An empirical investigation of mechanisms for knowledge collection, storage and access. *Journal of Management Studies, 37*(6), 811.

Palazzolo, E. T. (2005). Organizing for information retrieval in transactive memory systems. *Communication Research, 32*(6), 726-761.

Palazzolo, E. T., Serb, D. A., She, Y., Su, C., & Contractor, N. S. (2006). Coevolution of communication and knowledge networks in transactive memory systems: Using computational models for theoretical development. *Communication Theory*, 16, 223-250.

Pearce, J. L., & Gregersen, H. B. (1991). Task interdependence and extra role behavior: A test of the mediating effects of felt responsibility. Journal of Applied Psychology, 76, 838-844.

Pearsall, M. J., & Ellis, A. P. J. (2006). The effects of critical team member assertiveness on team performance and satisfaction. *Journal of Management, 32*(4), 575-594.

Pelled, L.H., Eisenhardt, K.M., & Xin, K.R. (1999). Exploring the black box: An analysis of work group diversity, conflict, and performance. *Administrative Science Quarterly*, 44, 1-28.

Peltokorpi, V. (2004). Transactive memory directories in small work units. *Personnel Review, 33*(4), 446-467.

Pirola-Merlo, A., & Mann, L. (2004). The relationship between individual creativity and team creativity: Aggregating across people and time. *Journal of Organizational Behavior, 25*(2), 235-257.

Podsakoff, P. M, & Organ, D. W. (1986). Self-report in organizational research: Problems and prospects. *Journal of Management*, 12, 531-544.

Polzer, J. T., Crisp, C. B., Jarvenpaa, S. L., & Kim, J. W. (2006). Extending the faultline model to geographically dispersed teams: How colocated subgroups can impair group functioning. *Academy of Management Journal, 49*(4), 679-692.

Prichard, J. S., & Ashleigh, M. J. (2007). The effects of team-skills training on transactive memory and performance. *Small Group Research, 38*(6), 696-726.

Ramamoorthy, N., & Flood, P. C. (2004). Individualism/collectivism, perceived task interdependence and teamwork attitudes among Irish blue-collar employees: A test of the main and moderating effects. *Human Relations, 57*(3), 347-366.

Rau, D. (2005). The influence of relationship conflict and trust on the transactive memory performance relation in top management teams. *Small Group Research, 36*(6), 746-771.

Rau, D. (2006). Top management team transactive memory, information gathering, and perceptual accuracy. *Journal of Business Research, 59*(4), 416-424.

Reagans, R., Argote, L., & Brooks, D. (2005). Individual experience and experience working together: Predicting learning rates from knowing who knows what and knowing how to work together. *Management Science, 51*(6), 869-881.

Reagans, R., McEvily, B. (2003). Network structure and knowledge transfer: The effects of cohesion and range. *Administrative Science Quarterly*, 48, 240-267.

Reich, B. H. (2007). Managing knowledge and learning in it projects: A conceptual framework and guidelines for practice. *Project Management Journal, 38*(2), 5-17.

Ren, Y., Carley, K. M., & Argote, L. (2006). The contingent effects of transactive memory: When is it more beneficial to know what others know? *Management Science, 52*(5), 671-682.

Rico, R., Sanchez-Manzanares, M., Gil, F., & Gibson, C. (2008). Team implicit coordination processes: A team knowledge-based approach. *Academy of Management Review*, 33, 163-184.

Rulke, D. L., & Rau, D. (2000). Investigating the encoding process of transactive memory development in group training. *Group & Organization Management, 25*(4), 373.

Sauer, J., Felsing, T., Franke, H., & Rüttinger, B. (2006). Cognitive diversity and team performance in a complex multiple task environment. *Ergonomics, 49*(10), 934-954.

Schank, R. C., & Abelson, R. P. (1977). *Scripts, plans, goals, and understanding*. Hillsdale, NJ: Erlbaum.

Schilling, M. A., Vidal, P., Ployhart, R. E., & Marangoni, A. (2003). Learning by doing something else: Variation, relatedness, and the learning curve. *Management Science, 49*(1), 39-56.

Schwarz, N. (1998). Warmer and more social: Recent developments in cognitive social psychology. *Annual Review of Sociology, 24*(1), 239.

Sethi, R., Smith, D. C., & Park, C. W. (2001). Cross-functional product development teams, creativity, and the innovativeness of new consumer products. *Journal of Marketing Research (JMR), 38*(1), 73-85.

Sethi, R., Smith, D. C., & Park, C. W. (2002). How to kill a team's creativity. *Harvard business review, 80*(8), 16-17.

Sharma, R., & Yetton, P. (2003). The contingent effects of management support and task interdependence on successful information systems implementation. *MIS Quarterly, 27*(4), 533-555.

Sharma, R., & Yetton, P. (2007). The contingent effects of training, technical complexity, and task interdependence on successful information systems implementation. *MIS Quarterly, 31*(2), 219-238.

Shaw, J. D., Duffy, M. K., Johnson, J. L., & Lockhart, D. E. (2005). Turnover, social capital losses, and performance. *Academy of Management Journal, 48*(4), 594-606.

Shaw*, J. D., Zhu*, J., Duffy, M. K., Scott, K. L., Shih, H-A., & Susanto, E. (2009). A contingency model of conflict and team effectiveness. Manuscript under third review for publication. (* listed alphabetically.)

Smith-Jentsch, K. A., Mathieu, J. E., & Kraiger, K. (2005). Investigating linear and interactive effects of shared mental models on safety and efficiency in a field setting. *Journal of Applied Psychology, 90*(3), 523-535.

Sobel, M. E. (1982). Asymptotic confidence intervals for indirect effects in structural equation models. In S. Leinhardt (Ed.), *Sociological methodology*: 290–312. San Francisco: Jossey-Bass.

Sole, D., & Edmondson, A. (2002). Situated knowledge and learning in dispersed teams. *British Journal of Management, 13*, S17.

StarTribune. (June 4, 2009). The reins get tighter for charter schools. Minneapolis, St. Paul.

Stasser, G., Stewart, D. D., & Wittenbaum, G. M. (1995). Expert roles and information exchange during discussion: The importance of knowing who knows what. *Journal of Experimental Social Psychology*, 31, 244–265.

Stasser, G., & Titus, W. (1985). Pooling of unshared information in group decision-making: Biased information sampling during discussion. *Journal of Personality and Social Psychology*, 48, 1467-1478.

Stasser, G., Vaughan, S. I., & Stewart, D. D. (2000). Pooling unshared information: the benefits of knowing how access to information is distributed among group members. *Organizational Behavior and Human Decision Processes*, 82, 102-116.

Taylor, A., & Greve, H. R. (2006). Superman or the fantastic four? knowledge combination and experience in innovative teams. *Academy of Management Journal, 49*(4), 723-740.

Thomas-Hunt, M. C., Ogden, T. Y., & Neale, M. A. (2003). Who's really sharing? Effects of social and expert status on knowledge exchange within groups. *Management Science, 49*(4), 464-477.

Thompson, J. D. (1967). *Organizations in action*. New York: McGraw-Hill.

Uzzi, B. (1996). The sources and consequences of embeddedness for the economic performance of organizations: The network effect." *American Sociological Review*, 61: 674-698.

Uzzi. B. (1999). Social relations and networks in the making of financial capital. *American Sociological Review*, 64: 481-505.

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

Van der Vegt, G. S., Bunderson, J. S., & Oosterhof, A. (2006). Expertness diversity and interpersonal helping in teams: Why those who need the most help end up getting the least. *Academy of Management Journal, 49*(5), 877-893.

Van der Vegt, G., Emans, B., & Van de Vliert, E. (2000). Team members' affective responses to patterns of intragroup interdependence and job complexity. *Journal of Management*, 26: 633–655.

Van Knippenberg, D., De Dreu, C. K. W., & Homan, A. C. (2004). Work group diversity and group performance: An integrative model and research agenda. *Journal of Applied Psychology, 89*(6), 1008-1022.

Van Knippenberg, D., & Schippers, M. C. (2007). Work group diversity. *Annual Review of Psychology*, 58, 515-541.

Vera, D., & Crossan, M. (2005). Improvisation and innovative performance in teams. *Organization Science, 16*(3), 203-224.

Walsh, J. P. (1995). Managerial and organizational cognition: Notes from a trip down memory lane. *Organization Science*, 6, 280–321.

Wageman, R. (1995). Interdependence and group effectiveness. *Administrative Science Quarterly*, 40: 145–180.

Wegner, D. M. (1986). Transactive memory: A contemporary analysis of the group mind. In B. Mullen & G. R. Goethals (Eds.), *Theories of group behavior* (pp. 185-208). New York: Springer-Verlag.

Wegner, D. M. (1995). A computer network model of human transactive memory. *Social Cognition*, 13(3), 319-339.

Wegner, D. M., Giuliano, T., & Hertel, P. (1985). Cognitive interdependence in close relationships. In W J. Ickes (Ed.), *Compatible and incompatible relationships* (pp. 253-276). New York: Springer-Verlag.

Wegner, D. M., Erber, R., & Raymond, P. (1991). Transactive memory in close relationships. *Journal of Personality & Social Psychology, 61*(6), 923-929.

Weick, K. E., & Roberts, K. H. (1993). Collective mind in organizations: Heedful interrelating on flight decks. *Administrative Science Quarterly, 38*(3), 357-381.

West, M. A., & Anderson, N. R. (1996). Innovation in top management teams. *Journal of Applied Psychology*, 81: 680–693.

West, M. A., & Wallace, M. (1991). Innovation in health care teams. *British Journal of Social Psychology*, 21, 303-315.

Wilson, J. M., Goodman, P. S., & Cronin, M. A. (2007). Group learning. *Academy of Management Review, 32*(4), 1041-1059.

Woodman, R. W., Sawyer, J. E., & Griffin, R. W. (1993). Toward a theory of organizational creativity. *Academy of Management Review, 18*(2), 293-321.

Wooldridge, J. M. (2002). Econometric analysis of cross section and panel data. Cambridge, MA: The MIT Press.

Wong, S., & Sitkin, S. B. (2000). Shaping collective cognition and behavior through collective learning. *Academy of Management Proceedings,* , 1.

Yoo, Y., & Kanawattanachai, P. (2001). Developments of transactive memory systems and collective mind in virtual teams. *International Journal of Organizational Analysis (1993 - 2002), 9*(2), 187.

Yuan, Y. C., Fulk, J., & Monge, P. R. (2007). Access to information in connective and communal transactive memory systems. *Communication Research, 34*(2), 131-155.

Zaheer, S., Albert, S., & Zaheer, A. (1999). Time scales and organizational theory. *Academy of Management Review*, 24, 725-741.

Zellmer-Bruhn, M. E. (2003). Interruptive events and team knowledge acquisition. *Management Science, 49*(4), 514-528.

Zhang, Z., Hempel, P. S., Han, Y., & Tjosvold, D. (2007). Transactive memory system links work team characteristics and performance. *Journal of Applied Psychology, 92*(6), 1722-1730.

Table 1

Dimensions of Transactive Memory System

Articles	**Dimensions**
Moreland, 1999	Complexity, Accuracy, Agreement
Austin, 2003	Knowledge stock , Specialization, Consensus, Accuracy,
Brandon & Hollingshead, 2004	Accuracy, Sharedness, Validation
Lewis, 2003	Specialization, Credibility, Coordination
Kanawattanachai & Yoo, 2007	Expertise location, Task-knowledge coordination, Cognition-based trust
Ren, Carley, & Argote, 2006	Density, Accuracy

Table 2

Summary of Hypotheses

Hypothesis 1:	*TMS structure will be positively related to team performance; and this relationship will be mediated by TMS manifestation.*
Hypothesis 2:	*TMS structure will be positively related to team innovation; and this relationship will be mediated by TMS manifestation.*
Hypothesis 3:	*TMS structure will be positively related to team satisfaction; and this relationship will be mediated by TMS manifestation.*
Hypothesis 4:	*TMS structure will be positively related to team commitment; and this relationship will be mediated by TMS manifestation.*
Hypothesis 5:	*Task interdependence will moderate the relationship between TMS manifestation and (a) team performance (b) team innovation (c) team member attitudes (satisfaction and commitment) such that the positive relationship between TMS manifestation and team performance, innovation, and attitudes will be stronger in teams with higher level of task interdependence.*
Hypothesis 6:	*Task routineness will moderate the relationship between TMS manifestation and (a) team performance (b) team innovation (c) team attitudes (satisfaction and commitment) such that TMS manifestation will benefit team performance, innovation, and attitudes when task routineness is high, and harm these outcomes when task routineness is low.*
Hypothesis 7:	*Alignment of task assignment with specialization will moderate the relationship between TMS manifestation and (a) team performance (b) team innovation (c) team attitudes (satisfaction and commitment) such that TMS manifestation will be positively relate to these outcomes when task assignment is consistent with specialization and negatively related to the team outcomes when task assignment is not consistent with specialization.*
Hypothesis 8:	*Variety in dominant function of team members (functional diversity) will be positively related to TMS structure.*
Hypothesis 9a:	*The average level of specific (task-related) status cues will be positively related to TMS structure.*
Hypothesis 9b:	*The average level of diffused (nontask-related) status cues will be positively related to TMS structure.*
Hypothesis 10:	*Effects of specific status cues will be stronger than diffused status cues on TMS structure.*
Hypothesis 11:	*Interpersonal connections will be positively related to TMS structure and TMS manifestation.*

Table 3

Factor Analysis on Task routineness and Director-rated Performance

Task routineness	Component	
	1	2
We discuss similar issues every month in the board meeting	.044	**.955**
We have new issues to discuss every month in the board meeting (reverse coded)	**.809**	.151
Our board has tackled challenging issues every month (reverse coded)	**.650**	-.298
There is something different to discuss in the board meeting every month (reverse coded)	**.846**	.096

Director-rated performance	Component	
	1	2
Evaluating or selecting the school director	**.665**	.123
Serving member interests and needs	**.756**	.273
Marketing and promoting the school	**.721**	.051
Setting mission, policies, and long-range strategy	**.761**	.362
Ensuring consistency and high-quality leadership	**.802**	.310
Providing financial oversight	.252	**.857**
Adherence to schedules	.296	**.691**
Adherence to budgets	.128	**.845**
Overall performance	**.787**	.405

Note: Extraction method: Principal component analysis.

Rotation method: Varimax with Kaiser Normalization.

Table 4

CFA Model Fit Indices

Model	χ^2	*df*	χ^2/df	$\Delta\chi^2$	NFI	CFI	RMSEA
One factor	4016.17	595	6.75		.59	.62	.093
Two factors[a]	3498.47	593	5.90		.64	.68	.085
Four factors[b]	2643.57	588	4.50		.73	.77	.072
Four factors[c]	2824.76	588	4.80		.71	.75	.075
Five factors[d]	2262.05	584	3.87		.77	.82	.065
Five factors[e]	2793.44	584	4.78		.71	.76	.075
Six factors[f]	1957.31	579	3.38		.80	.85	.060
Seven factors[g]	1603.72	573	2.80	326.09***	.84	.89	.052
Seven factors[h]	1662.15	573	2.90	454.05***	.83	.88	.053
Seven factors[i]	1641.51	573	2.87	454.05***	.83	.88	.053
Seven factors[j]	1311.16	573	2.29	33.53***	.87	.92	.044
Seven factors[k]	1902.24	573	3.32	624.61***	.81	.85	.059
Eight factors[l]	1347.66	601	2.24	70.03**	.86	.92	.043
Eight factors[m]	1277.63	566	2.26		.87	.92	.043

Note: NFI = normed fit index; CFI = comparative fit index; RMSEA = root-mean-square error of approximation. All χ^2 were significant at .001 level.

$\Delta\chi^2$ were all compared to Eight factors[m].

Performance and innovation are both director ratings.

[a] Two factors: (1) credibility, coordination, task interdependence, & task routineness, (2) performance, innovation, satisfaction, & commitment.

[b] Four factors: (1) credibility & coordination, (2) task interdependence, (3) task routineness, (4) performance, innovation, satisfaction, & commitment.

[c] Four factors: (1) credibility, coordination, satisfaction, & commitment, (2) task interdependence, (3) task routineness, (4) performance & innovation.

[d] Five factors: (1) credibility & coordination, (2) task interdependence, (3) task routineness, (4) satisfaction & commitment, (5) performance & innovation.

[e] Five factors: (1) credibility, coordination, satisfaction & commitment, (2) task interdependence, (3) task routineness, (4) performance, (5) innovation.

[f] Six factors: (1) credibility, coordination, satisfaction, (2) task interdependence, (3) task routineness, (4) performance, (5) innovation, (6) commitment.

[g] Seven factors: (1) credibility & coordination, (2) task interdependence, (3) task routineness, (4) performance, (5) innovation, (6) satisfaction, (7) commitment.

[h] Seven factors: (1) credibility & satisfaction, (2) coordination, (3) task interdependence, (4) task routineness, (5) performance, (6) innovation, (7) commitment.

[i] Seven factors: (1) credibility, (2) coordination & satisfaction, (3) task interdependence, (4) task routineness, (5) performance, (6) innovation, (7) commitment.

[j] Seven factors: (1) credibility, (2) coordination, (3) task interdependence, (4) task routineness, (5) performance & innovation, (6) satisfaction, (7) commitment.

[k] Seven factors: (1) credibility, (2) coordination, (3) task interdependence, (4) task routineness, (5) performance, (6) innovation, (7) satisfaction & commitment.

[l] Eight factors: (1) credibility, (2) coordination, (3) task interdependence (4 items), (4) task routineness, (5) performance, (6) innovation, (7) satisfaction, (8) commitment.

[m] Eight factors: (1) credibility, (2) coordination, (3) task interdependence (3 items), (4) task routineness, (5) performance, (6) innovation, (7) satisfaction, (8) commitment.

** p<.01, *** p<.001

Table 5

CFA Factor Loadings of Eight-Factor Model l (Four Items on Task Interdependence)

	TMS Credibility	TMS Coordination	Task Interdependence	Task Routineness
TMS credibility1	.560			
TMS credibility2	.836			
TMS crediblity3	.821			
TMS crediblity4r	.369			
TMS crediblity5r	.712			
TMS coordination1		.811		
TMS coordination2		.717		
TMS coordination3r		.699		
TMS coordination4		.789		
TMS coordination5r		.784		
task interdependence1			.148	
task interdependence2			.755	
task interdependence 3			.472	
task interdependence 4			.930	
task routineness2r				.747
task routineness3r				.388
task routineness4r				.759

Table 5 (Continued)

	Director-rated Performance	Director-rated Innovation	Board Satisfaction	Board Commitment
director performancea	.592			
director performanceb	.780			
director performancec	.614			
director performanced	.828			
director performancee	.839			
director performancei	.867			
director innovationa		.634		
director innovationb		.894		
director innovationc		.834		
satisfactiona			.828	
satisfactionb			.782	
satisfactioncr			.685	
satisfactiond			.674	
satisfactione			.843	
commitmenta				.507
commitmentb				.613
commitmentc				.704
commitmentd				.877
commitmente				.858
commitmentf				.534

Table 6

CFA Factor Loadings of Eight-Factor Model m (Three Items on Task Interdependence)

	TMS Credibility	TMS Coordination	Task Interdependence	Task Routineness
TMS credibility1	.559			
TMS credibility2	.836			
TMS crediblity3	.820			
TMS crediblity4r	.369			
TMS crediblity5r	.712			
TMS coordination1		.811		
TMS coordination2		.718		
TMS coordination3r		.699		
TMS coordination4		.789		
TMS coordination5r		.784		
task interdependence2			.730	
task interdependence 3			.461	
task interdependence 4			.963	
task routineness2r				.745
task routineness3r				.388
task routineness4r				.761

Table 6 (Continued)

	Director-rated Performance	Director-rated Innovation	Board Satisfaction	Board Commitment
director performancea	.592			
director performanceb	.781			
director performancec	.614			
director performanced	.828			
director performancee	.839			
director performancei	.867			
director innovationa		.634		
director innovationb		.894		
director innovationc		.834		
satisfactiona			.828	
satisfactionb			.782	
satisfactioncr			.685	
satisfactiond			.674	
satisfactione			.843	
commitmenta				.507
commitmentb				.613
commitmentc				.704
commitmentd				.877
commitmente				.858
commitmentf				.534

Table 7

Factor Intercorrelations of the Eight Variables

	TMS Credibility	TMS Coordination	Task Interdependence	Task Routineness	Director-rated Performance	Director-rated Innovation	Board Satisfaction	Board Commitment
TMS Credibility	--							
TMS Coordination	.75***	--						
Task Interdependence	.13**	.21***	--					
Task Routineness	-.25***	-.41***	-.26***	--				
Director-rated Performance	.34**	.51***	.10	-.33**	--			
Director-rated Innovation	.41***	.51***	.21 †	-.19	.81***	--		
Board Satisfaction	.74***	.80***	.24***	-.32***	.27*	.27*	--	
Board Commitment	.49***	.54***	.24***	-.24***	.19 †	.19†	.72***	--

† $p<.10$, * $p<.05$, ** $p<.01$, *** $p<.001$

Table 8

One-Way Analysis of Variance (ANOVA), Within-Group Agreement, ICC(1) and ICC(2)

	ANOVA (F values)	Rwg (median)	ICC(1)	ICC(2)
TMS Credibility	2.86^{***}	.94	.21	.65
TMS Coordination	5.36^{***}	.94	.38	.81
Task Interdependence3item	1.31^{*}	.85	.04	.24
Task Routineness	2.73^{***}	.92	.16	.58
Alignment of Task Assignment	2.00^{***}	.67	.12	.50
Board Satisfaction	2.70^{***}	.95	.19	.63
Board Commitment	1.67^{***}	.96	.09	.40

* p<.05, ** p<.01, *** p<.001

Table 9

Descriptives, Correlations, and Coefficient Alphas

Variables	N	Mean	SD	1	2	3	4	5	6	7	8	9	10
1.Board Size	92	7.95	1.8										
2.Board Tenure (months)	92	25.85	13.55	-.13									
3.Functional Diversity	92	.57	.17	.11	-.12								
4.Average Specific Status Cue	92	.4	.05	.07	.16	.17							
5.Average Diffused Status Cue	92	.65	.09	-.04	-.22*	-.10	.00						
6.Closeness	92	2.58	.27	-.19	.38**	-.10	.02	-.05					
7.Communication Frequency	92	2.14	.58	-.25*	.25*	-.11	-.32**	.01	.69**				
8.TMS Specialization	92	.21	.04	-.44**	.02	-.10	.20	-.03	.00	-.14			
9.TMS Sharedness	92	.65	.72	.15	.02	-.05	-.01	.30**	-.09	-.10	-.12		
10.TMS Accuracy	92	3.92	.3	.28**	.21*	-.01	.36**	.16	.21*	-.02	-.06	.30**	
11.TMS Credibility	92	4.	.33	-.12	.17	-.05	.27**	-.10	.20	.02	.26*	.20	.20
12.TMS Coordination	92	3.88	.51	-.23*	.34**	.05	.25*	-.12	.33**	.16	.25*	-.03	.14
13.Task Interdependence	92	3.61	.29	-.15	.14	-.07	-.06	-.12	.42**	.20	.24*	-.01	.22*
14.Task Routineness	92	2.26	.29	.24*	.14	-.20	-.18	.06	-.19	.07	-.25*	.13	.00
15.Alignment of Task Assignment	92	3.86	.52	-.06	.21*	-.10	.16	.17	.29**	.19	.21*	.14	.20
16.Director-rated Performance	90	3.89	.66	-.04	.13	.06	.20	-.13	.30**	.17	.19	.00	.30**
17.Chair-rated Performance	81	3.92	.63	-.05	.24*	.15	.31**	-.01	.25*	.06	.27*	-.02	.27*
18.Director-rated Innovation	90	3.46	.77	.00	.07	.00	-.01	-.08	.20	.19	.05	.25*	.26*
19.Chair-rated Innovation	81	3.57	.71	-.09	.22	.03	.19	-.17	.15	.09	.22*	-.04	.13
20.Board Satisfaction	92	4.36	.36	-.18	.11	.05	.11	-.08	.23*	.12	.15	-.03	.02
21.Board Commitment	92	6.27	.37	-.17	.09	.25*	.26*	-.13	.28**	.05	.21*	-.10	.06

Table 9 (Continued)

Variables	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
1.Board Size											
2.Board Tenure (months)											
3.Functional Diversity											
4.Average Specific Status Cue											
5.Average Diffused Status Cue											
6.Closeness											
7.Communication Frequency											
8.TMS Specialization											
9.TMS Sharedness											
10.TMS Accuracy											
11.TMS Credibility	.78										
12.TMS Coordination	.74**	.87									
13.Task Interdependence	.12	.13	.73								
14.Task Routineness	-.21*	-.24*	-.37**	.61							
15.Alignment of Task Assignment	.40**	.33**	.17	.05	---						
16.Director-rated Performance	.33**	.49**	0.2	-.30**	.25*	.87					
17.Chair-rated Performance	.52**	.64**	.10	-.16	.39**	.40**	.80				
18.Director-rated Innovation	.35**	.37**	.27*	-.20	.15	.70**	.29*	.82			
19.Chair-rated Innovation	.29**	.26*	.22*	-.30**	.24*	.17	.38**	.14	.80		
20.Board Satisfaction	.74**	.80**	.13	-.19	.28**	.32**	.50**	.28**	.11	.87	
21.Board Commitment	.46**	.56**	.30**	-.17	.32**	.29**	.55**	.21*	.15	.68**	.84

Note: Entries on the diagonals are coefficent alphas.

* p<.05, ** p<.01,

Table 10

Hierarchical OLS Regression Results for Director-rated and Chair-rated Performance (Original Model) -- H1, H5, H6, H7

Variables	Model 1 Director-rated Performance[a]	Model 2 Director-rated Performance	Model 3 TMS Coordination	Model 4 TMS Coordination	Model 5 Director-rated Performance	Model 6 Director-rated Performance	Model 7 Director-rated Performance	Model 8 Director-rated Performance
Intercept	3.39 ***	-1.85	3.9 ***	-.91	.84	-1.15	1.8	1.05
Controls								
Board size	.003	.024	-.05 †	-.021	.034	.037	.055	.041
Board tenure	.005	-.001	.12 **	.007 **	-.003	-.006	-.003	-.006
Communication Frequency	.17	.21 †	.034	.061	.12	.17	.18	.19
Predictors								
TMS Specialization		3.25 †		.17		2.99 †	2.64	3.32 †
TMS Sharedness		-.092		-.12 *		-.012	.011	.013
TMS Accuracy		.61 *		.044		.58 *	.5 *	.64 *
TMS Credibility		.53 *		1.13 ***		-.26	-.3	-.24
TMS Coordination					.67 ***	.7 ***	.64 **	.5 *
Task interdependence							-.026	-.002
Task routineness							-.56 *	-.48 †
Alignment of task assignment							.065	-.05
Moderators								
TMS Coordination × Task interdependence								1.05 *
TMS Coordination × Task routineness								.61
TMS Coordination × Alignment								.12
R^2	.036	.23 **	.15 **	.64 ***	.25 ***	.34 ***	.38 ***	.42 ***
Adjusted R^2	.002	.16 **	.12 **	.61 ***	.22 ***	.27 ***	.29 ***	.31 ***
ΔR^2	---	.19 ***	---	.48 ***	.22 ***	.11 ***	---	.04

Table 10 (Continued)

Variables	Model 9 Chair-rated Performance	Model 10 Chair-rated Performance	Model 11 Chair-rated Performance	Model 12 Chair-rated Performance	Model 13 Chair-rated Performance	Model 14 Chair-rated Performance
Intercept	3.72 ***	-1.95 †	.65	-1.11	2.81 †	2.66 †
Controls						
Board size	-.007	.024	.027	.037	.031	.025
Board tenure	.011 *	.005	.003	.002	.001	.001
Communication Frequency	-.012	.042	-.10	-.047	-.11	-.093
Predictors						
TMS Specialization		2.67		2.48	1.69	2.04
TMS Sharedness		-.13		-.049	-.057	-.047
TMS Accuracy		.40 †		.34 †	.29	.33
TMS Credibility		.86 ***		.049	-.087	-.1
TMS Coordination			.83 ***	.72 ***	.75 ***	.64 **
Task interdependence					.023	.14
Task routineness					-.034	.023
Alignment of task assignment					.25 *	.2
Moderators						
TMS Coordination × Task interdependence						.63
TMS Coordination × Task routineness						.36
TMS Coordination × Alignment						-.21
R^2	.058	.37 ***	.43 ***	.48 ***	.51 ***	.53 ***
Adjusted R^2	.022	.31 ***	.40 ***	.42 ***	.43 ***	.43 ***
ΔR^2	---	.31 ***	.37 ***	.11 ***	---	.02

Note:
[a] Variables listed at the top of each column refer to dependent variables (DV).
N = 90 for DV = Director-rated Performance; N = 92 for DV=TMS coordination; N=81 for DV = Chair-rated Performance.
† p<.10, * p<.05, ** p<.01, *** p<.001

Table 11

Hierarchical OLS Regression Results for Director-rated and Chair-rated Innovation (Original Model) – H2, H5, H6, H7

Variables	Model 1 Director-rated Innovation[a]	Model 2 Director-rated Innovation	Model 3 TMS Coordinati	Model 4 TMS Coordinati	Model 5 Director-rated	Model 6 Director-rated	Model 7 Director-rated Innovation	Model 8 Director-rated Innovation
Intercept	2.72 ***	-1.85	3.9 ***	-.91	.44	-1.33	.91	-.26
Controls								
Board size	.02	.015	-.05 †	-.021	.047	.024	.044	.03
Board tenure	.002	-.004	.12 **	.007 **	-.005	-.007	-.006	-.009
Communication Frequency	.25 †	.29 *	.034	.061	.21	.26 †	.24 †	.26 †
Predictors								
TMS Specialization		1.34		.17		1.14	.55	1.45
TMS Sharedness		.18		-.12 *		.24 *	.27 *	.27 *
TMS Accuracy		.43		.044		.41	.27	.43
TMS Credibility		.64 *		1.13 ***		.065	.12	.24
TMS Coordination					.6 ***	.51 *	.51 *	.32
Task interdependence							.45	.47
Task routineness							-.33	-.22
Alignment of task assignment							-.13	-.27
Moderators								
TMS Coordination × Task interdependence								1.2 *
TMS Coordination × Task routineness								.88
TMS Coordination × Alignment								.17
R^2	.038	.22 **	.15 **	.64 ***	.17 **	.26 ***	.31 ***	.36 ***
Adjusted R^2	.004	.15 **	.12 **	.61 ***	.13 **	.19 ***	.22 ***	.24 ***
ΔR^2	---	.18 **	---	.48 ***	.13 ***	.04 *	---	.05

Table 11 (Continued)

Variables	Model 9 Chair-rated Innovation	Model 10 Chair-rated Innovation	Model 11 Chair-rated Innovation	Model 12 Chair-rated Innovation	Model 13 Chair-rated Innovation	Model 14 Chair-rated Innovation
Intercept	3.43 ***	-.061	2.33 **	-.14	.44	.16
Controls						
Board size	-.021	.018	-.009	.017	.041	.036
Board tenure	.01 †	.007	.007	.008	.012 †	.011 †
Communication Frequency	.022	.087	-.009	.096	.099	.11
Predictors						
TMS Specialization		3.2		3.22	2.34	2.68
TMS Sharedness		-.078		-.086	-.053	-.049
TMS Accuracy		.17		.18	.04	.093
TMS Credibility		.46 †		.54	.42	.44
TMS Coordination			.3 †	-.07	-.16	-.25
Task interdependence					-.007	.063
Task routineness					-.76 *	-.69 *
Alignment of task assignment					.17	.13
Moderators						
TMS Coordination × Task interdependence						.52
TMS Coordination × Task routineness						.37
TMS Coordination × Alignment						-.096
R^2	.051	.15 †	.09	.15	.24 *	.25
Adjusted R^2	.014	.072 †	.04	.06	.12 *	.09
ΔR^2	---	.1 †	.04 †	.001	---	.009

Note:
[a] Variables listed at the top of each column refer to dependent variables (DV).
N = 90 for DV = Director-rated Innovation; N = 92 for DV=TMS coordination; N=81 for DV = Chair-rated Innovation.
† p<.10, * p<.05, ** p<.01, *** p<.001

Table 12

Hierarchical OLS Regression Results for Board Commitment (Original Model) – H4 , H5, H6, H7

Variables	Model 1 Board Commitment[a]	Model 2 Board Commitment	Model 3 TMS Coordinati	Model 4 TMS Coordinati	Model 5 Board Commitment	Model 6 Board Commitment	Model 7 Board Commitment	Model 8 Board Commitment
Intercept	6.49 ***	4.04 ***	3.9 ***	-.91	4.84 ***	4.35 ***	6.73 ***	6.44 ***
Controls								
Board size	-.033	-.016	-.05 †	-.021	-.012	-.009	-.016	-.02
Board tenure	.002	.00	.12 **	.007 **	-.003	-.003	-.004	-.005 †
Communication Frequency	-.007	.005	.034	.061	-.021	-.015	-.092	-.086
Predictors								
TMS Specialization		2.82		.17		.22	-.77	-.48
TMS Sharedness		-.098 †		-.12 *		-.058	-.069	-.068
TMS Accuracy		.058		.044		.43	-.052 *	.001
TMS Credibility		.53 ***		1.13 ***		.15	.094	.11
TMS Coordination					.42 ***	.34 **	.38 ***	.31 **
Task interdependence							.41 **	.44 **
Task routineness							.17	.22 †
Alignment of task assignment							.11	.068
Moderators								
TMS Coordination × Task interdependence								.44 †
TMS Coordination × Task routineness								.35
TMS Coordination × Alignment								-.014
R^2	.032	.26 ***	.15 **	.64 ***	.32 ***	.34 ***	.43 ***	.46 ***
Adjusted R^2	.00	.2 **	.12 **	.61 ***	.29 ***	.27 ***	.36 ***	.36 ***
ΔR^2	---	.22 ***	---	.48 ***	.29 ***	.081 **	---	.025

Note:

[a] Variables listed at the top of each column refer to dependent variables (DV).

N = 92.

† p<.10, * p<.05, ** p<.01, *** p<.001

Table 13

Hierarchical OLS Regression Results for Precursors—H8, H9, H10, H11

Variables	Model 1 TMS Specialization[a]	Model 2 TMS Specialization	Model 3 TMS Sharedness	Model 4 TMS Sharedness	Model 5 TMS Accuracy	Model 6 TMS Accuracy	Model 7 TMS Credibility	Model 8 TMS Credibility	Model 9 TMS Coordination	Model 10 TMS Coordination
Intercept	.29 ***	.29 ***	.11	-.87	3.73 ***	1.64 ***	4.05 ***	3.42 ***	4.00 ***	2.83 ***
Controls										
Board size	-.01 ***	-.011 ***	.061	.063	.051 **	.053 ***	-.018	-.02	-.053 †	-.05 †
Board tenure	.00	.00	.002	.008	.005	.004	.004	.002	.012 **	.009 *
Precursors to TMS										
Functional Diversity		-.027		-.092		-.053				
Avergae Specific status cues		.15 †		-.10		1.65 **				
Average Diffused status cues		-.033		2.70 **		.74 *				
Closeness		.013		-.083		.28 †		.38 *		.58 *
Communication Frequency		-.018 †		-.13		-.036		-.14 †		-.14
R^2	.19 ***	.31 ***	.024	.14 †	.14 **	.32 ***	.038	.089 †	.15 ***	.2 ***
Adjusted R^2	.18 ***	.25 ***	.002	.073 †	.12 **	.26 ***	.017	.047 †	.13 ***	.16 ***
ΔR^2	---	.11 *	---	.12 *	---	.19 ***	---	.05 †	---	.05 †

Note:

[a] Variables listed at the top of each column refer to dependent variables (DV).

N = 92.

† p<.10, * p<.05, ** p<.01, *** p<.001

Table 14

Hierarchical OLS Regression Results for Director-rated Performance (Revised Model—Credibility and Coordination Separately as Mediators)—H1, H5, H6, H7

Variables	Model 1 Director-rated Performance[a]	Model 2 Director-rated Performance	Model 3 TMS Credibility	Model 4 TMS Credibility	Model 5 TMS Coordination	Model 6 TMS Coordination	Model 7 Director-rated Performance	Model 8 Director-rated Performance
Intercept	3.39 ***	-.3	4.12 ***	2.82 ***	3.9 ***	2.27 **	.69	.84
Controls								
Board size	.003	.018	-.02	-.008	-.05 †	-.03	.015	.034
Board tenure	.005	.00	.004	.003	.12 **	.01 **	.002	-.003
Communication Frequency	.17	.23 †	-.03	.021	.034	.084	.17	.12
Predictors								
TMS Specialization		4.14 *		2.19 *		2.64 †		
TMS Sharedness		-.043		.09 †		-.014		
TMS Accuracy		.7 **		.16		.23		
TMS Credibility							.67 **	
TMS Coordination								.67 ***
Task interdependence								
Task routineness								
Alignment of task assignment								
Moderators								
TMS Credibility × Task interdependence								
TMS Credibility × Task routineness								
TMS Credibility × Alignment								
TMS Coordination × Task interdependence								
TMS Coordination × Task routineness								
TMS Coordination × Alignment								
R^2	.036	.18 **	.04	.17 *	.15 **	.21 **	.13 *	.25 ***
Adjusted R^2	.002	.12 **	.008	.11 *	.12 **	.15 **	.09 *	.22 ***
ΔR^2	---	.14 **	---	.13 **	---	.05	.095 **	.22 ***

Table 14 (Continued)

Variables	Model 9 Director-rated Performance	Model 10 Director-rated Performance	Model 11 Director-rated Performance	Model 12 Director-rated Performance	Model 13 Director-rated Performance	Model 14 Director-rated Performance
Intercept	-1.85	-1.64	.33	-.11	.69	.11
Controls						
Board size	.024	.036	.047	.055	.055	.042
Board tenure	-.001	-.005	.002	.00	-.003	-.005
Communication Frequency	.21 †	.17	.23 †	.24 †	2.51 †	3.28 †
Predictors						
TMS Specialization	3.25 †	2.82	2.89	4.24 *	2.51 †	3.28 †
TMS Sharedness	-.092	-.038	-.055	.023	-.015	-.009
TMS Accuracy	.61 *	.56 *	.53 *	.56 *	.49 *	.63 **
TMS Credibility	.53 **		.39 †	.41 †		
TMS Coordination		.58 ***			.51 ***	.4 **
Task interdependence			-.11	-.026	-.021	-.008
Task routineness			-.69 **	-.54 *	-.55 *	-.47 †
Alignment of task assignment			.095	-.01	.04	-.071
Moderators						
TMS Credibility × Task interdependence				1.88 *		
TMS Credibility × Task routineness				2.94 ***		
TMS Credibility × Alignment				-.085		
TMS Coordination × Task interdependence						1.03 *
TMS Coordination × Task routineness						.68
TMS Coordination × Alignment						.15
R^2	.23 **	.33 ***	.29 ***	.41 ***	.37 ***	.42 ***
Adjusted R^2	.16 **	.27	.2 ***	.31 ***	.29	.32
ΔR^2	.05 *	.15 ***	---	.12 **	---	.04

Note:
[a] Variables listed at the top of each column refer to dependent variables (DV).
N = 90 for DV = Director-rated Performance; N = 92 for DV=TMS credibility and coordination.
† p<.10, * p<.05, ** p<.01, *** p<.001

Table 15

Hierarchical OLS Regression Results for Chair-rated Performance (Revised Model—Credibility and Coordination Separately as Mediators)—H1, H5, H6, H7

Variables	Model 1 Chair-rated Performance[a]	Model 2 Chair-rated Performance	Model 3 TMS Credibility	Model 4 TMS Credibility	Model 5 TMS Coordination	Model 6 TMS Coordination	Model 7 Chair-rated Performance	Model 8 Chair-rated Performance
Intercept	3.72 ***	.48	4.12 ***	2.82 ***	3.9 ***	2.27 **	-.076	.65
Controls								
Board size	-.007	.02	-.02	-.008	-.05 †	-.03	.01	.027
Board tenure	.011 *	.008	.004	.003	.12 **	.01 **	.007	.003
Communication Frequency	-.012	.067	-.03	.021	.034	.084	.008	-.1
Predictors								
TMS Specialization		4.49 *		2.19 *		2.64 †		
TMS Sharedness		-.055		.09 †		-.014		
TMS Accuracy		.53 *		.16		.23		
TMS Credibility							.94 ***	
TMS Coordination								.83 ***
Task interdependence								
Task routineness								
Alignment of task assignment								
Moderators								
TMS Credibility × Task interdependence								
TMS Credibility × Task routineness								
TMS Credibility × Alignment								
TMS Coordination × Task interdependence								
TMS Coordination × Task routineness								
TMS Coordination × Alignment								
R^2	.058	.19 **	.04	.17 *	.15 **	.21 **	.3 ***	.43 ***
Adjusted R^2	.022	.13 **	.008	.11 *	.12 **	.15 **	.26 ***	.4 ***
ΔR^2	---	.14 **	---	.13 **	---	.05	.24 ***	.37 ***

Table 15 (Continued)

Variables	Model 9 Chair-rated Performance	Model 10 Chair-rated Performance	Model 11 Chair-rated Performance	Model 12 Chair-rated Performance	Model 13 Chair-rated Performance	Model 14 Chair-rated Performance
Intercept	-1.95 †	-1.03	1.66	1.44	2.45 *	2.24 *
Controls						
Board size	.024	.037	.026	.028	.03	.024
Board tenure	.005	.002	.006	.004	.001	.001
Communication Frequency	.042	-.049	.024	.048	-.1	-.085 †
Predictors						
TMS Specialization	2.67	2.52 †	2.22	2.95 †	1.67	2.02 †
TMS Sharedness	-.13	-.044	-.13	-.098	-.064	-.056
TMS Accuracy	.4 †	.34 †	.38 †	.41 †	.29	.33 **
TMS Credibility	.86 ***		.71 **	.53 **		
TMS Coordination		.75 ***			.7 ***	.59 ***
Task interdependence			-.18	-.013	.019	.13
Task routineness			-.23	-.049	-.033	.028
Alignment of task assignment			.22 †	.18	.24 *	.19
Moderators						
TMS Credibility × Task interdependence				1.41 *		
TMS Credibility × Task routineness				1.66 **		
TMS Credibility × Alignment				-.69 *		
TMS Coordination × Task interdependence						.63
TMS Coordination × Task routineness						.37
TMS Coordination × Alignment						-.2
R^2	.37 **	.48 ***	.4 ***	.49 ***	.51 ***	.53 ***
Adjusted R^2	.31 **	.43 ***	.32 ***	.39 ***	.44 ***	.44 ***
ΔR^2	.18 ***	.28 ***	---	.08 *	---	.02

Note:
[a] Variables listed at the top of each column refer to dependent variables (DV).
N = 81 for DV = Chair-rated Performance; N = 92 for DV=TMS credibility and coordination.
† $p<.10$, * $p<.05$, ** $p<.01$, *** $p<.001$

Table 16

Hierarchical OLS Regression Results for Director-rated Innovation (Revised Model—Credibility and Coordination Separately as Mediators)—H2, H5, H6, H7

Variables	Model 1 Director-rated Innovation[a]	Model 2 Director-rated Innovation	Model 3 TMS Credibility	Model 4 TMS Credibility	Model 5 TMS Coordination	Model 6 TMS Coordination	Model 7 Director-rated Innovation	Model 8 Director-rated Innovation
Intercept	2.72 ***	.03	4.12 ***	2.82 ***	3.9 ***	2.27 **	-.74	.44
Controls								
Board size	.02	.008	-.02	-.008	-.05 †	-.03	.035	.047
Board tenure	.002	-.002	.004	.003	.12 **	.01 **	-.002	-.005
Communication Frequency	.25 †	.32 *	-.03	.021	.034	.084	.25 †	.21
Predictors								
TMS Specialization		2.42		2.19 *		2.64 †		
TMS Sharedness		.24 *		.09 †		-.014		
TMS Accuracy		.54 †		.16		.23		
TMS Credibility							.86 ***	
TMS Coordination								.6 ***
Task interdependence								
Task routineness								
Alignment of task assignment								
Moderators								
TMS Credibility × Task interdependence								
TMS Credibility × Task routineness								
TMS Credibility × Alignment								
TMS Coordination × Task interdependence								
TMS Coordination × Task routineness								
TMS Coordination × Alignment								
R^2	.038	.16 *	.04	.17 *	.15 **	.21 **	.15 **	.17 **
Adjusted R^2	.004	.099 *	.008	.11 *	.12 **	.15 **	.11 **	.13 **
ΔR^2	---	.12 **	---	.13 **	---	.05	.12 ***	.13 ***

Table 16 (Continued)

Variables	Model 9 Director-rated Innovation	Model 10 Director-rated Innovation	Model 11 Director-rated Innovation	Model 12 Director-rated Innovation	Model 13 Director-rated Innovation
Intercept	-1.85	1.16	.7	1.37	.7
Controls					
Board size	.015	.038	.047	.044	.029
Board tenure	-.004	-.002	-.004	-.006	-.009
Communication Frequency	.29 *	.28 †	.29 *	.24 †	.25 †
Predictors					
TMS Specialization	1.34	.75	2.23	.6	1.48
TMS Sharedness	.18	.22 †	.3 **	.28 *	.29 **
TMS Accuracy	.43	.29	.32	.27	.44
TMS Credibility	.64 *	.66 *	.69 *		
TMS Coordination				.56 **	.43 *
Task interdependence		.38	.48 †	.44	.47
Task routineness		-.43	-.26	-.33	-.23
Alignment of task assignment		-.11	-.22	-.12	-.25
Moderators					
TMS Credibility × Task interdependence			2. *		
TMS Credibility × Task routineness			3.3 ***		
TMS Credibility × Alignment			-.14		
TMS Coordination × Task interdependence					1.22 *
TMS Coordination × Task routineness					.81
TMS Coordination × Alignment					.14
R^2	.22 **	.27 **	.38 ***	.31 ***	.36 ***
Adjusted R^2	.15 **	.18 **	.28 ***	.22	.25
ΔR^2	.058 *	---	.11 **	---	.04

Note:
[a] Variables listed at the top of each column refer to dependent variables (DV).
N = 90 for DV = Director-rated Innovation; N = 92 for DV=TMS credibility and coordination.
† p<.10, * p<.05, ** p<.01, *** p<.001

Table 17

Hierarchical OLS Regression Results for Chair-rated Innovation (Revised Model—Credibility and Coordination Separately as Mediators)—H2, H5, H6, H7

Variables	Model 1 Chair-rated Innovation[a]	Model 2 Chair-rated Innovation	Model 3 TMS Credibility	Model 4 TMS Credibility	Model 5 TMS Coordination	Model 6 TMS Coordination	Model 7 Chair-rated Innovation	Model 8 Chair-rated Innovation
Intercept	3.43 ***	1.24	4.12 ***	2.82 ***	3.9 ***	2.27 **	1.26	2.33 **
Controls								
Board size	-.021	.016	-.02	-.008	-.05 †	-.03	-.012	-.009
Board tenure	.01 †	.009	.004	.003	.12 **	.01 **	.008	.007
Communication Frequency	.022	.1	-.03	.021	.034	.084	.034	-.009
Predictors								
TMS Specialization		4.17 *		2.19 *		2.64 †		
TMS Sharedness		-.037		.09 †		-.014		
TMS Accuracy		.24		.16		.23		
TMS Credibility							.54 *	
TMS Coordination								.3 †
Task interdependence								
Task routineness								
Alignment of task assignment								
Moderators								
TMS Credibility × Task interdependence								
TMS Credibility × Task routineness								
TMS Credibility × Alignment								
TMS Coordination × Task interdependence								
TMS Coordination × Task routineness								
TMS Coordination × Alignment								
R^2	.051	.11	.04	.17 *	.15 **	.21 **	.11 †	.09
Adjusted R^2	.014	.04	.008	.11 *	.12 **	.15 **	.067 †	.042
ΔR^2	---	.062	---	.13 **	---	.05	.063 *	.039 †

Table 17 (Continued)

Variables	Model 9 Chair-rated Innovation	Model 10 Chair-rated Innovation	Model 11 Chair-rated Innovation	Model 12 Chair-rated Innovation	Model 13 Chair-rated Innovation	Model 14 Chair-rated Innovation
Intercept	-.061	.81	2.3 †	2.11	2.19	2.
Controls						
Board size	.018	.021	.042	.04	.043	.038
Board tenure	.007	.007	.011 †	.009	.011 †	.011 †
Communication Frequency	.087	.067	.071	.083	.065	.076
Predictors						
TMS Specialization	3.2	3.61 †	2.23	2.7	2.46	2.76
TMS Sharedness	-.078	-.034	-.038	-.01	-.016	-.01
TMS Accuracy	.17	.19	.021	.054	.032	.074
TMS Credibility	.46 †		.26	.19		
TMS Coordination		.21			.061	-.022
Task interdependence			.036	.088	.015	.092
Task routineness			-.72 *	-.61 †	-.77 *	-.71 *
Alignment of task assignment			.18	.15	.21	.18
Moderators						
TMS Credibility × Task interdependence				.88		
TMS Credibility × Task routineness				.95		
TMS Credibility × Alignment				-.11		
TMS Coordination × Task interdependence						.49
TMS Coordination × Task routineness						.32
TMS Coordination × Alignment						-.12
R^2	.15 †	.13	.24 *	.25 †	.23 *	.24
Adjusted R^2	.07 †	.049	.13 *	.11 †	.12 *	.088
ΔR^2	.04 †	.019	---	.016	---	.009

Note:
[a] Variables listed at the top of each column refer to dependent variables (DV).
N = 81 for DV = Chair-rated Innovation; N = 92 for DV=TMS credibility and coordination.
† p<.10, * p<.05, ** p<.01, *** p<.001

Table 18

Hierarchical OLS Regression Results for Board Commitment (Revised Model—Credibility and Coordination Separately as Mediators)—H4, H5, H6, H7

Variables	Model 1 Board Commitment[a]	Model 2 Board Commitment	Model 3 TMS Credibility	Model 4 TMS Credibility	Model 5 TMS Coordination	Model 6 TMS Coordination	Model 7 Board Commitment	Model 8 Board Commitment
Intercept	6.49 ***	5.54 ***	4.12 ***	2.82 ***	3.9 ***	2.27 **	4.41 ***	4.84 ***
Controls								
Board size	-.033	-.021	-.02	-.008	-.05 †	-.03	-.023	-.012
Board tenure	.002	.001	.004	.003	.12 **	.01 **	.	-.003
Communication Frequency	-.007	.016	-.03	.021	.034	.084	.008	-.021
Predictors								
TMS Specialization		1.45		2.19 *		2.64 †		
TMS Sharedness		-.05		.09 †		-.014		
TMS Accuracy		.14		.16		.23		
TMS Credibility							.51 ***	
TMS Coordination								.42 ***
Task interdependence								
Task routineness								
Alignment of task assignment								
Moderators								
TMS Credibility × Task interdependence								
TMS Credibility × Task routineness								
TMS Credibility × Alignment								
TMS Coordination × Task interdependence								
TMS Coordination × Task routineness								
TMS Coordination × Alignment								
R^2	.032	.071	.04	.17 *	.15 **	.21 **	.22 ***	.32 ***
Adjusted R^2	.00	.006	.008	.11 *	.12 **	.15 **	.19 ***	.29 ***
ΔR^2	---	.039	---	.13 **	---	.05	.19 ***	.29 ***

Table 18 (Continued)

Variables	Model 9 Board Commitment	Model 10 Board Commitment	Model 11 Board Commitment	Model 12 Board Commitment
Intercept	6.94 ***	6.81 ***	7.1 ***	6.87 ***
Controls				
Board size	-.021	-.02	-.015	-.019
Board tenure	-.001	-.002	-.005 †	-.005 †
Communication Frequency	-.062	-.055	-.095	-.09
Predictors				
TMS Specialization	-.67	-.34	-.71	-.42
TMS Sharedness	-.11 *	-.088 †	-.061	-.058
TMS Accuracy	-.034	-.018	-.049	.002
TMS Credibility	.5 ***	.43 ***		
TMS Coordination			.42 ***	.36 ***
Task interdependence	.36 *	.4 **	.41 **	.44 **
Task routineness	.084	.15	.16	.21
Alignment of task assignment	.12	.1	.11 †	.078
Moderators				
TMS Credibility × Task interdependence		.65		
TMS Credibility × Task routineness		.87 *		
TMS Credibility × Alignment		-.21		
TMS Coordination × Task interdependence				.44 †
TMS Coordination × Task routineness				.34
TMS Coordination × Alignment				-.024
R^2	.34 ***	.38 ***	.43 ***	.45 ***
Adjusted R^2	.26 ***	.28 ***	.36 ***	.36 ***
ΔR^2	---	.046	---	.024

Note:
[a] Variables listed at the top of each column refer to dependent variables (DV).
N = 92.
† p<.10, * p<.05, ** p<.01, *** p<.001

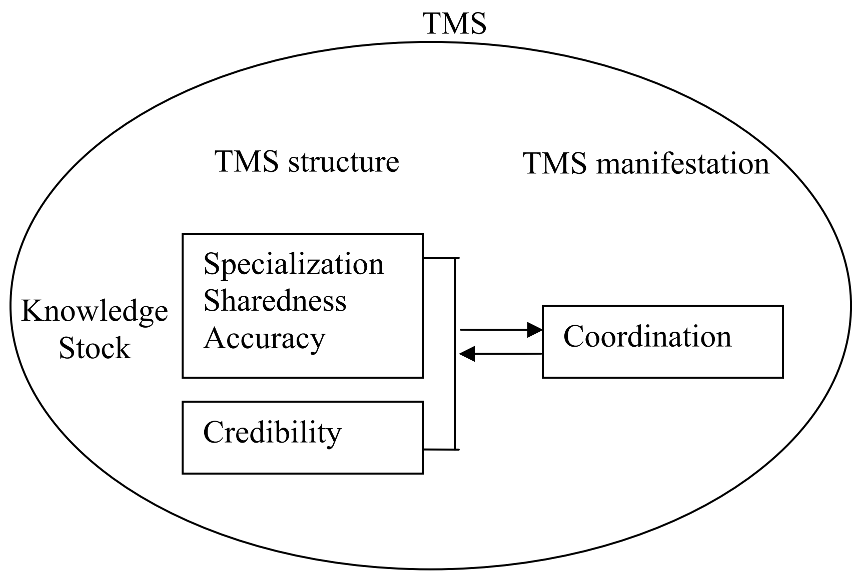
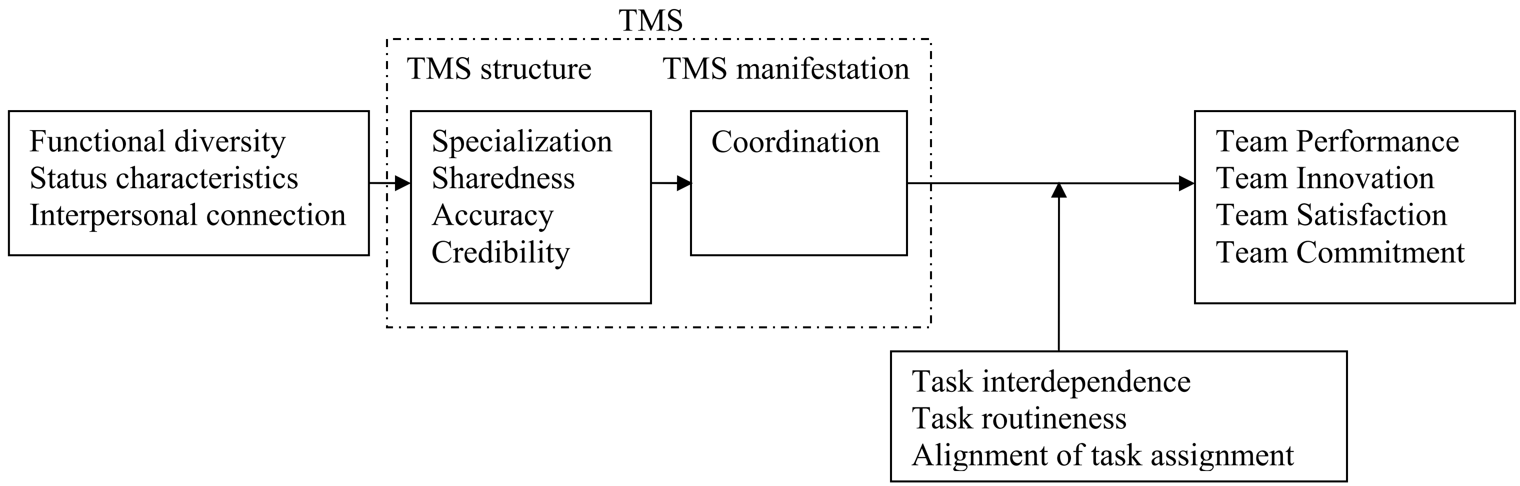


Figure 1. Integrated Framework of Transactive Memory System Construct.



Control variables: communication, team tenure, team size.

Note: TMS-Transactive Memory System

Figure 2. Proposed Model of Dimensions of TMS, Predictors of TMS, Team Characteristics, and Team Outcomes.

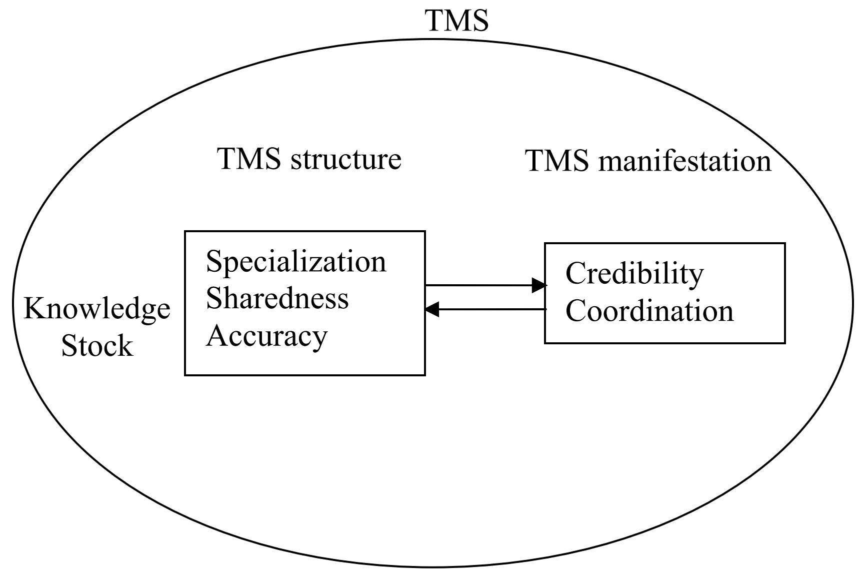
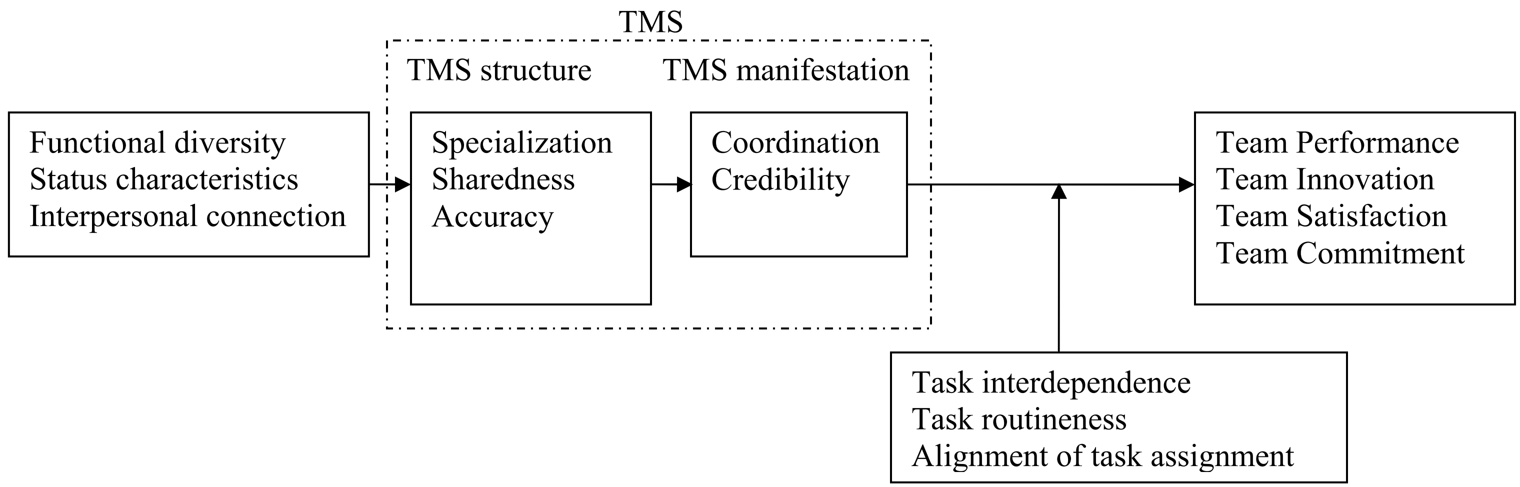


Figure 3a. Revised Framework of Transactive Memory System Construct.



Control variables: communication, team tenure, team size.

Note: TMS-Transactive Memory System

Figure 3b. Revised Model of Dimensions of TMS, Predictors of TMS, Team Characteristics, and Team Outcomes.

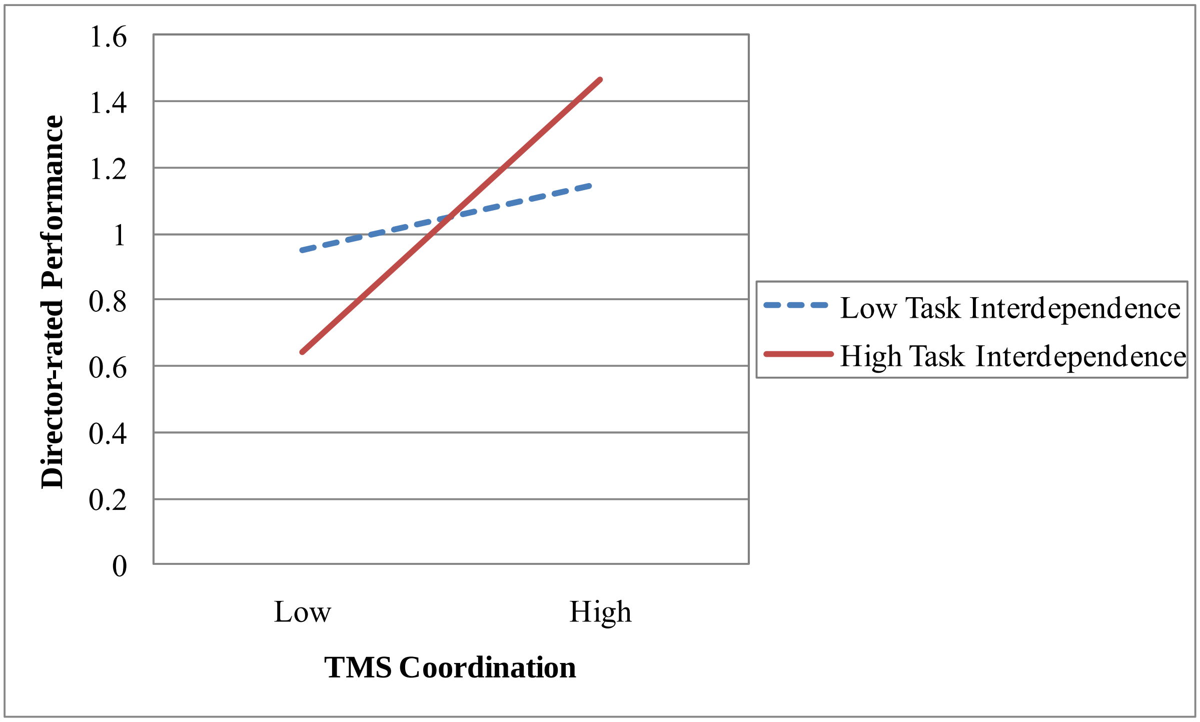


Figure 4. Task Interdependence by TMS Coordination in Predicting Director-rated Performance (Original Model)

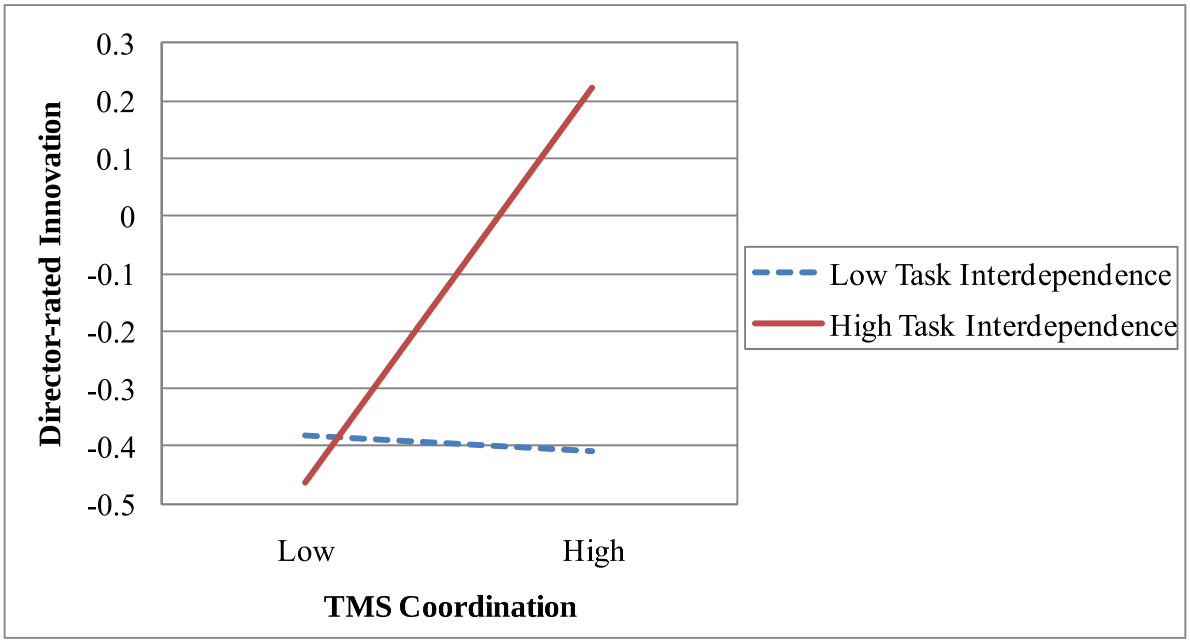


Figure 5. Task Interdependence by TMS Coordination in Predicting Director-rated Innovation (Original Model)

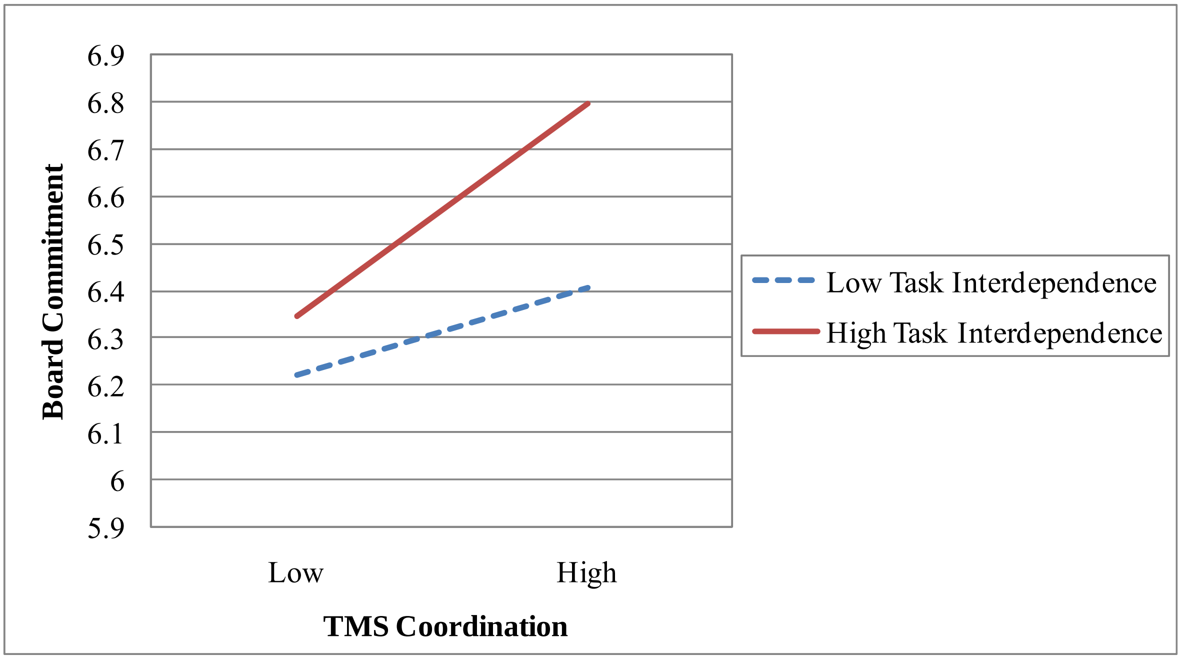


Figure 6. Task Interdependence by TMS Coordination in Predicting Board Commitment (Original Model)

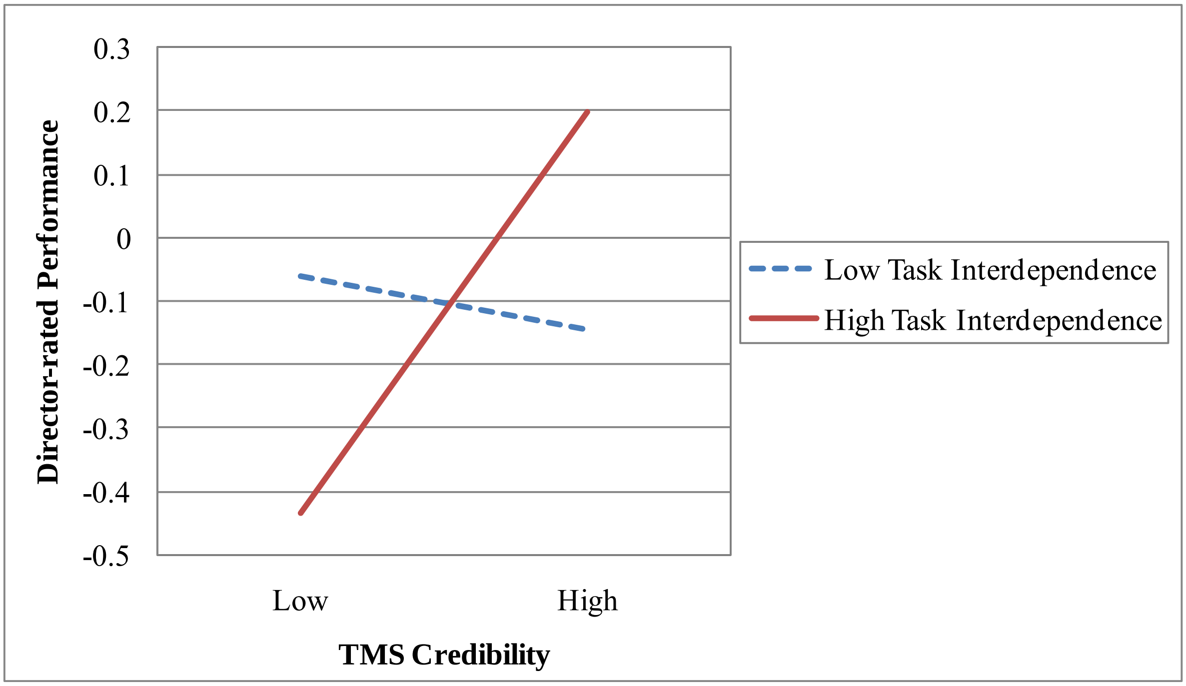


Figure 7a. Task Interdependence by TMS Credibility in Predicting Director-rated Performance (Revised Model—Credibility and Coordination Separately as Mediators)

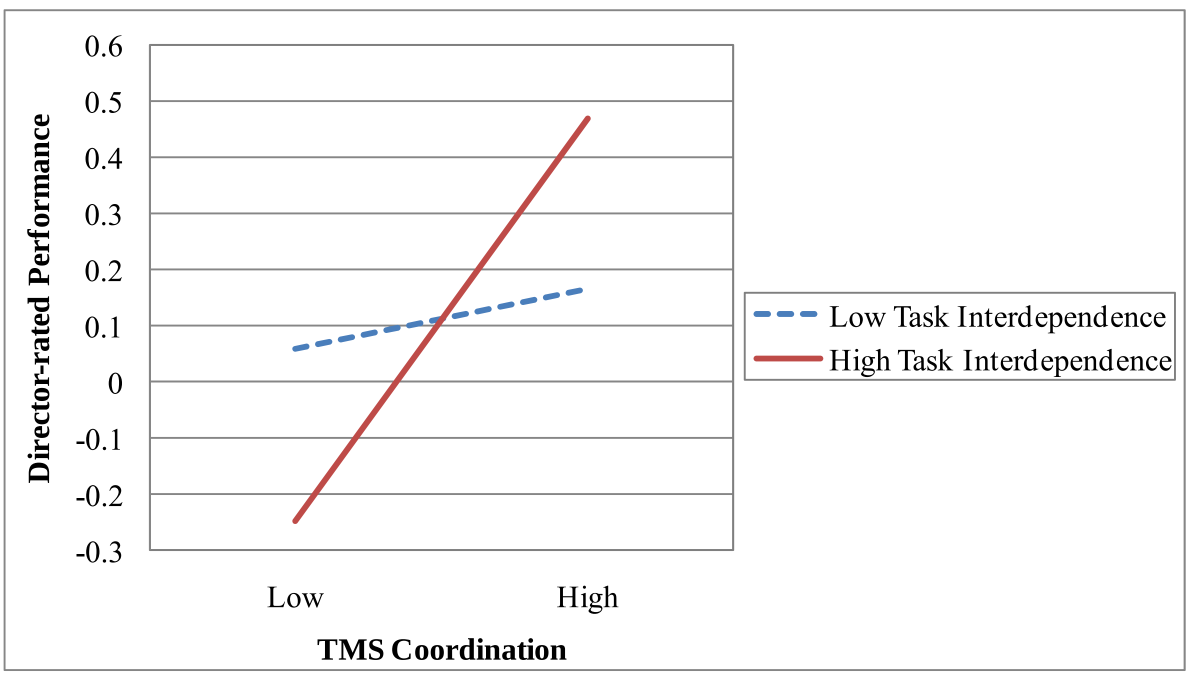


Figure 7b. Task Interdependence by TMS Coordination in Predicting Director-rated Performance (Revised Model—Credibility and Coordination Separately as Mediators)

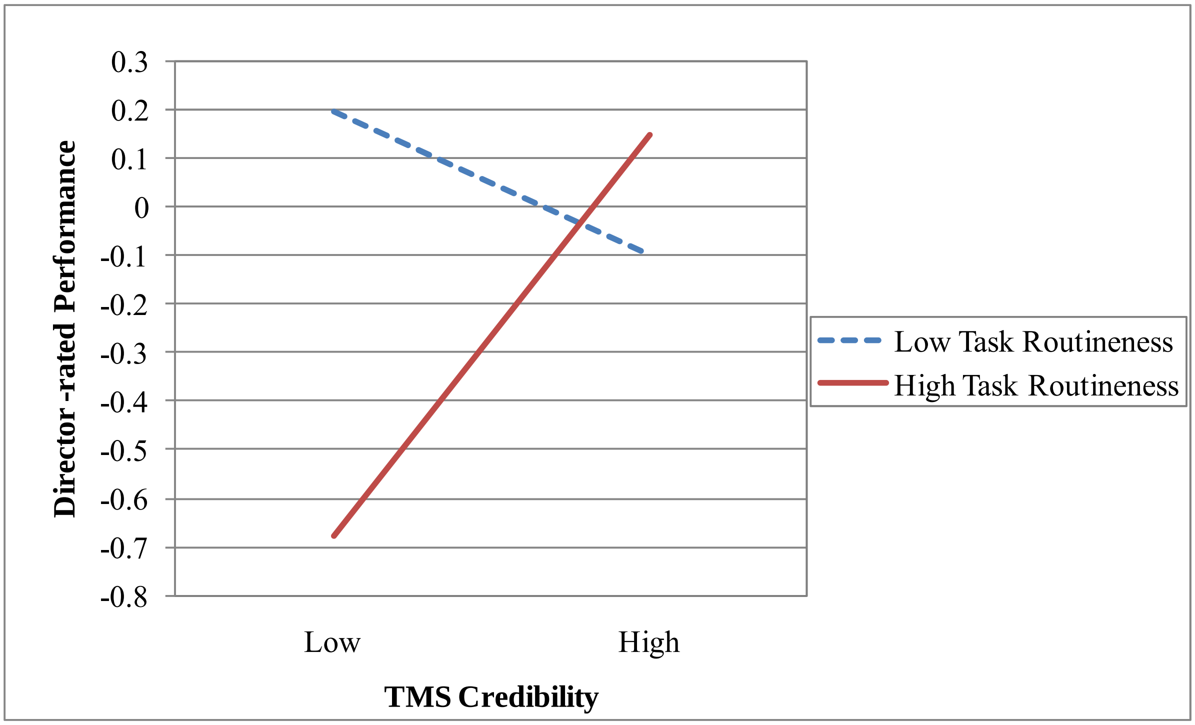


Figure 8. Task Routineness by TMS Credibility in Predicting Director-rated Performance (Revised Model—Credibility and Coordination Separately as Mediators)

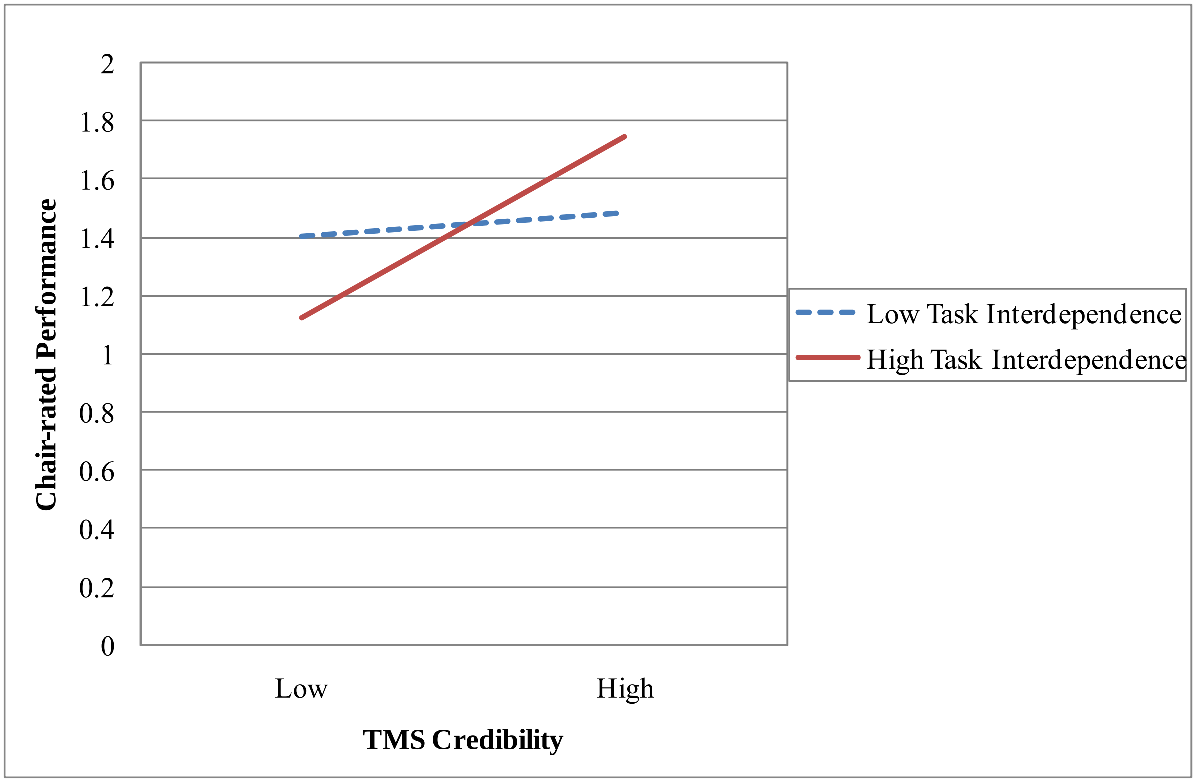


Figure 9. Task Interdependence by TMS Credibility in Predicting Chair-rated Performance (Revised Model—Credibility and Coordination Separately as Mediators)

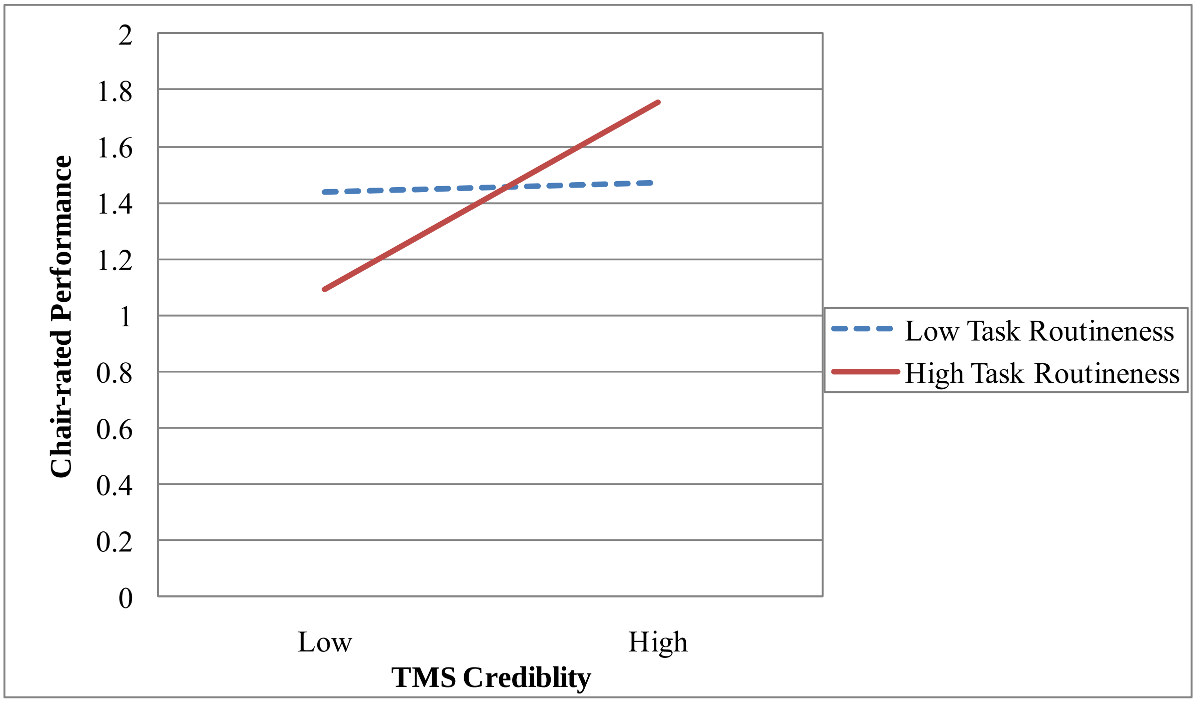


Figure 10. Task Routineness by TMS Credibility in Predicting Chair-rated Performance (Revised Model—Credibility and Coordination Separately as Mediators)

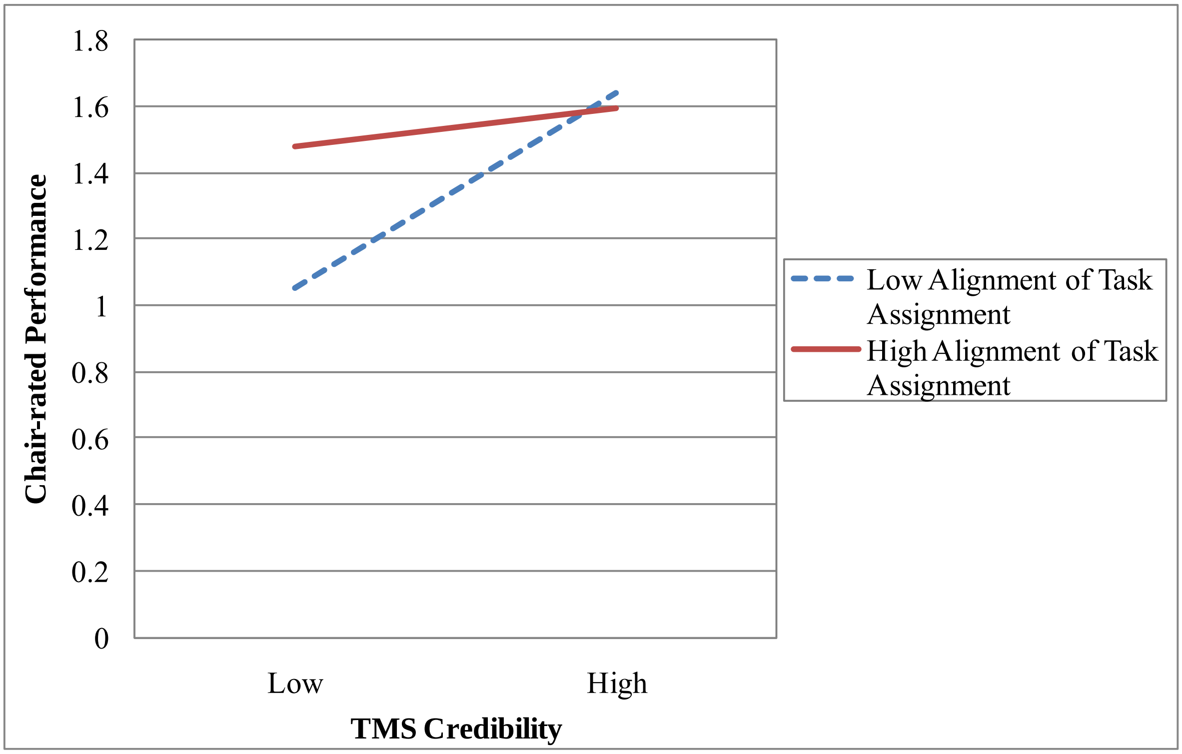


Figure 11. Alignment of Task Assignment by TMS Credibility in Predicting Chair-rated Performance (Revised Model—Credibility and Coordination Separately as Mediators)

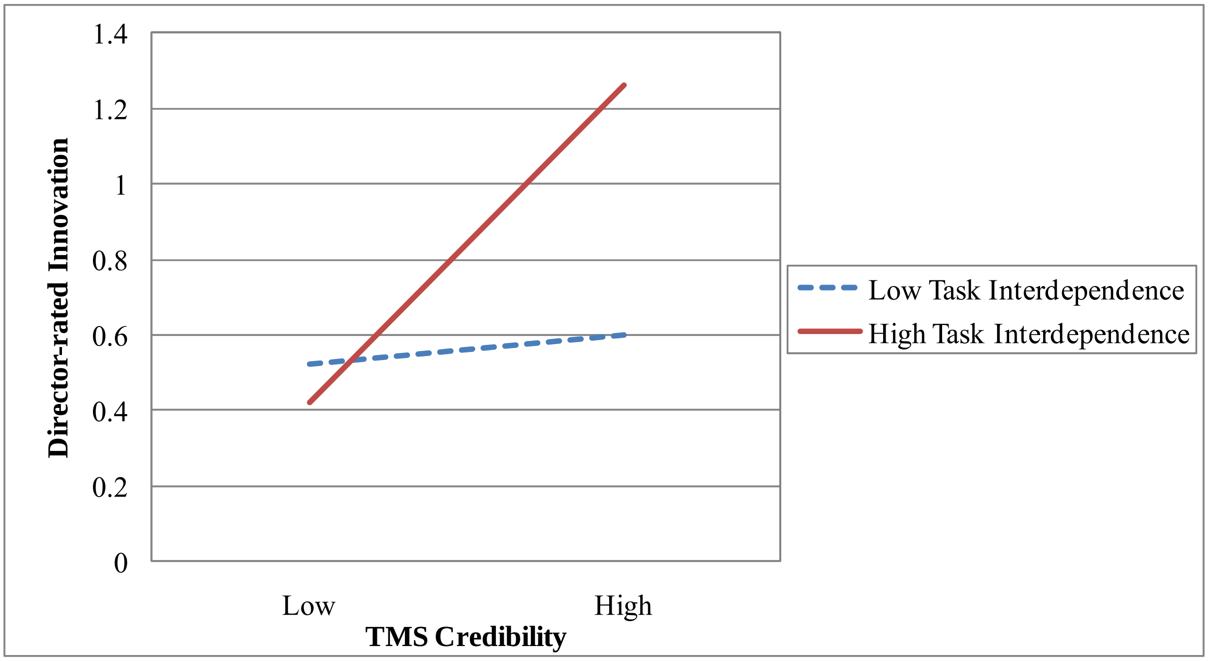


Figure 12a. Task Interdependence by TMS Credibility in Predicting Director-rated Innovation (Revised Model—Credibility and Coordination Separately as Mediators)

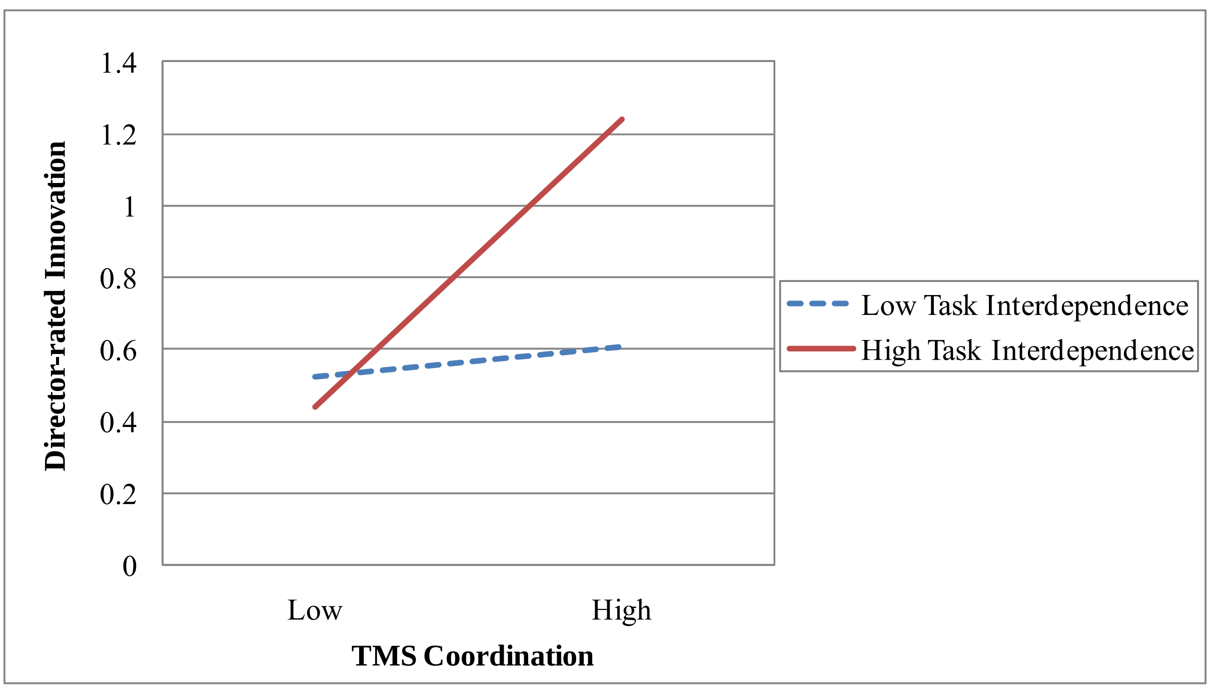


Figure 12b. Task Interdependence by TMS Coordination in Predicting Director-rated Innovation (Revised Model—Credibility and Coordination Separately as Mediators)

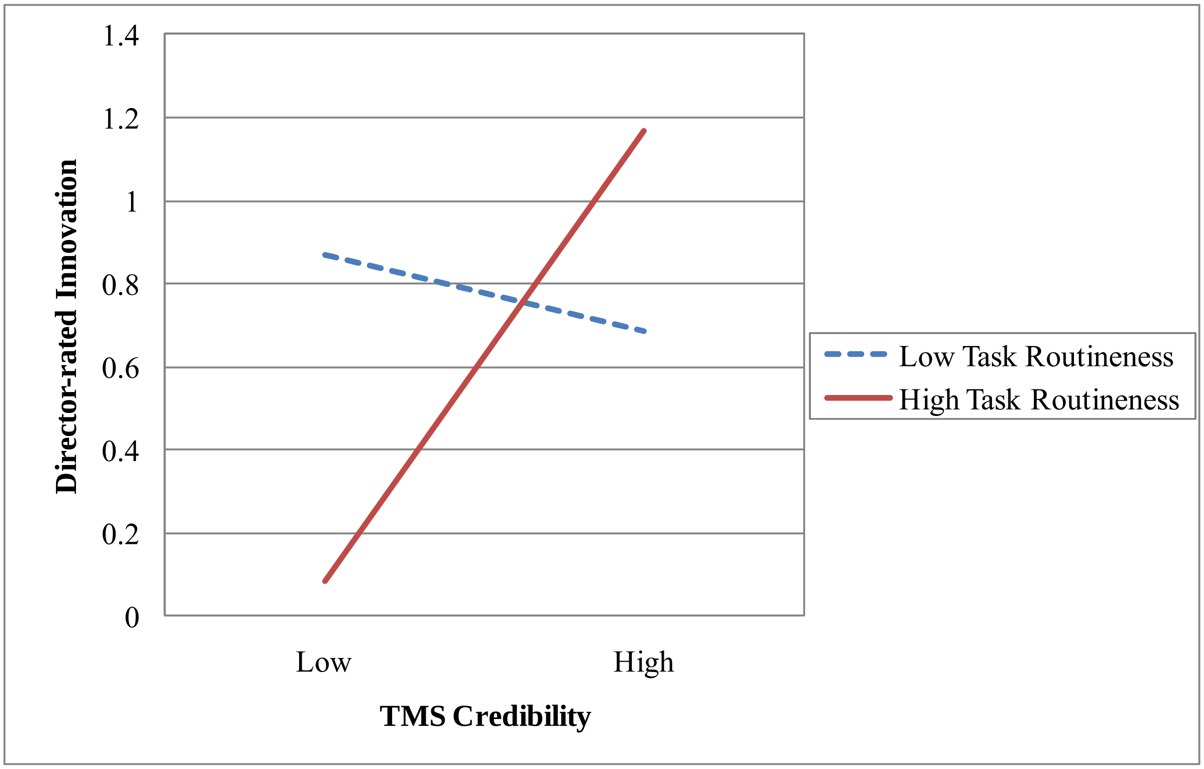


Figure 13. Task Routineness by TMS Credibility in Predicting Director-rated Innovation (Revised Model—Credibility and Coordination Separately as Mediators)

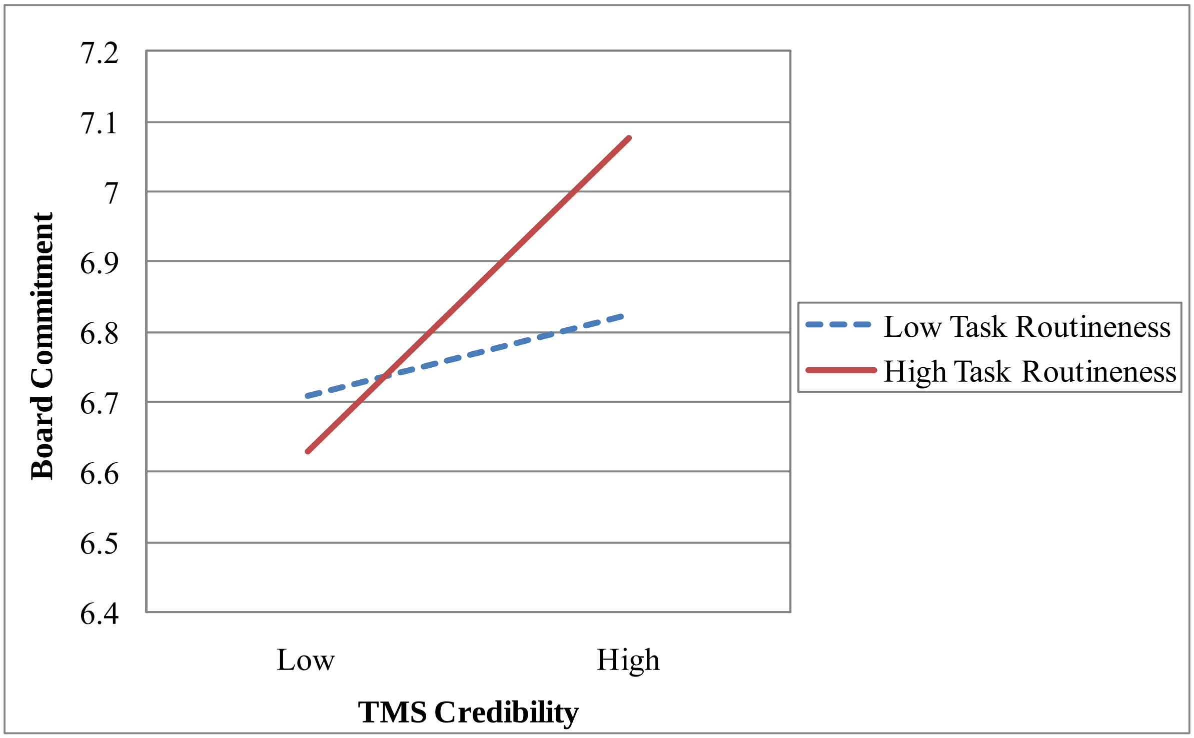


Figure 14. Task Routineness by TMS Credibility in Predicting Board Commitment (Revised Model—Credibility and Coordination Separately as Mediators)

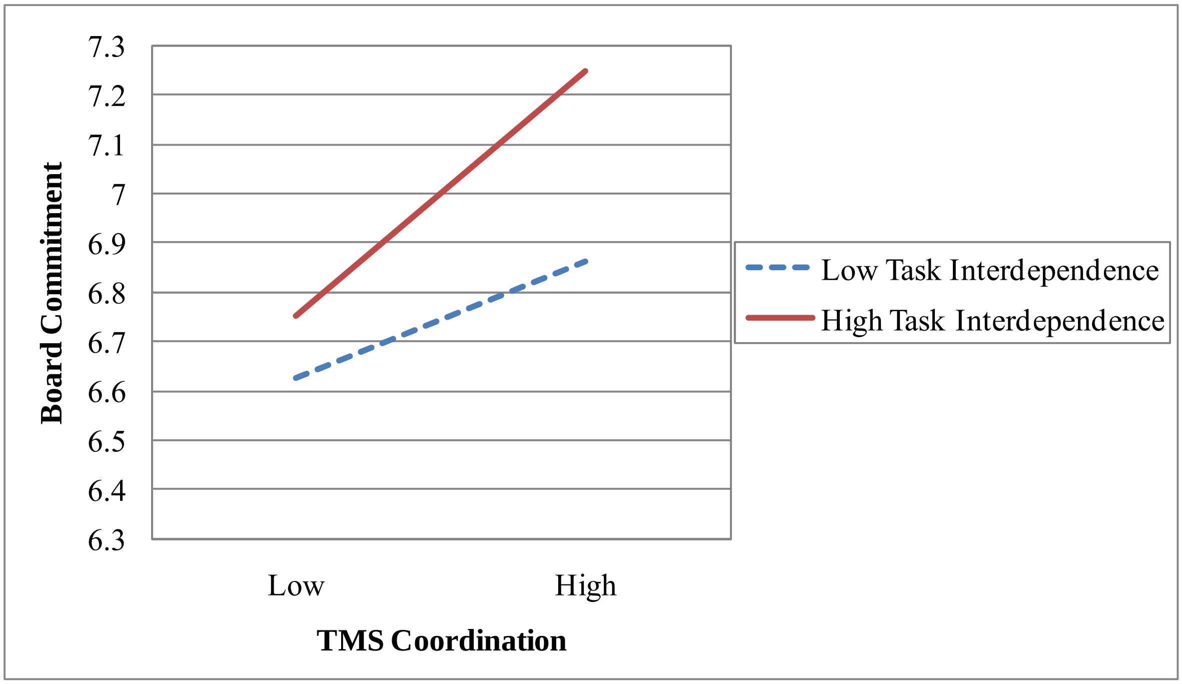


Figure 15. Task Interdependence by TMS Coordination in Predicting Board Commitment (Revised Model—Credibility and Coordination Separately as Mediators)

Appendix A

Semi-Structured Relevant Interview Questions (Drawn from Austin, 2003)

For understanding the context:

What are the key responsibilities of the board?
What is each member's role? Particularly, what are the roles of the chair and vice chair?
What is the role of school director?
How do school director and school board work together?
How often do you have board meetings? What do you usually discuss at the meetings?

For developing the measurement:

What are the things you look at when evaluating board performance? What about for school performance?

Tell me what makes a school board successful? In other words, what kinds of knowledge areas or skills are necessary for a board to fulfill its objectives/ achieve its goals? Clarification of "skill": competencies, expertise, abilities, proficiencies, capabilities.

Describe a problem or striking management issue you recently worked on or are facing now on the board. What tasks did each board member take on?

Do you have functional diversity (i.e., different focus of functional areas among board members) on your board? Can you give me examples?

Do the tasks involved in your board have certain level of interdependence? Can you give me examples?

Appendix B

Board Member Survey

(Relevant measures to this study are presented)

Calculations and Examples of Measure for Three-Person Board (Austin, 2003)

List of expertise:

a. School operation
b. Financial planning and budgeting
c. Real Estate/Construction Development
d. Fundraising
e. Marketing
f. General Business Management
g. Strategic Planning
h. Education
i. HR/Personnel
j. Legal
k. Communication skill
l. Research skill
m. Coordination skill
n. Leadership
o. Organizing skill

1. Transactive Memory Specialization

For each skill or area of knowledge listed below, write the name of the team members(s) that you believe is most knowledgeable in that particular skill or area.

Table A1a. Identified Experts

	Skill			
	1	2	3	4
Member A	Member B	Member C	Member A	Member A, C
Member B	Member B	Member A	Member A	Member C
Member C	Member B	Member A	Member A	Member B

Step 1: For each skill, the data are re-organized into an m by n matrix where m is the number of board members who responded to the survey and n is the number of total board members (board size). The rows are “raters” and columns are “ratees”. The ratings have two values, 0 and 1, where 1 indicates being nominated as an expert, and 0 means not. (Table A1b)

Step 2: The number of times each member is identified as an expert within a board is counted and then divided by the number of “raters” (i.e. weighted count). (Table 1c)

Step 3: A standard deviation score of the "weighted counts" across skills is calculated for each individual.

Step 4: Individual specialization scores (standard deviation scores) are averaged to create a board specialization score.

Table A1b. Identified Expert (data re-organized)

	Skill 1		
	Member A	Member B	Member C
Member A	0	1	0
Member B	0	1	0
Member C	0	1	0

…

	Skill 4		
	Member A	Member B	Member C
Member A	1	0	1
Member B	0	0	1
Member C	0	1	0

Table A1c. Expert Identification Count Divided by Number of Raters

	Member A	Member B	Member C
Skill 1	0/3=0	3/3=1	0/3=0
Skill 2	3/3=1	0/3=0	1/3=.33
Skill 3	3/3=1	0/3=0	0/3=0
Skill 4	1/3=.33	1/3=.33	2/3=.67
SD	.50	.47	.32

Transactive memory specialization = (.50+.47+.32)/3 = .43.

2. *TMS Sharedness*

Using the re-organized data in Table A1b, James et al.'s (1984) inter-rater agreement for multiple items $r_{wg(j)}$ was calculated for measure of sharedness. The rows are "judges" that provide ratings, and the columns are "items" being rated. The choices are "0" (not nominated as an expert) and "1" (nominated as an expert). Sharedness score is calculated for each skill first, and then averaged to create a team-level score.

3. *TMS Accuracy*
Self-report survey question: For each skill/area of knowledge, please record the number that corresponds with your evaluation of your ability in that skill/area of knowledge.

1	2	3	4	5
Very Low	Low	Average	High	Very High

Table A3a. Skill Self-Report Scores

	Skill			
	1	2	3	4
Member A	4	5	5	3
Member B	5	2	4	4
Member C	3	3	2	3

Step 1: Self-report expertise scores (Table A3a) are linked with identified expert scores (Table A1a) to create accuracy of identified experts scores for each individual and skill.

Step 2: For each skill, individual accuracy scores are averaged to create a single skill expertise accuracy score.

Step 3: The skill expertise accuracy scores are averaged to create a team transactive memory accuracy score.

Table A3b. Accuracy of Identified Experts

	Skill			
	1	2	3	4
Member A	5	3	5	(3+3)/2=3
Member B	5	5	5	3
Member C	5	5	5	4
Mean	5.00	4.33	5.00	3.33

Member A identified Member B as expert as Skill 1 (Table A1a). Member B rated his own expertise at Skill 1 as a 5 (Table A3a). Member A's accuracy score for Skill 1 is 5 (Member B's self-rated expertise for Skill 1; Table A3b).

Transactive memory accuracy = (5.00+4.33+5+3.33)/4 = 4.42.

TMS Credibility and Coordination (Lewis, 2003)
Please indicate the degree to which you agree or disagree with each of the following statements regarding your experience with your board. (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree).

4. *Credibility*
a. I am comfortable accepting procedural suggestions from other board members.
b. I trust that other members' knowledge about how we should run the school is credible.
c. I was confident relying on the information that other board members brought to the discussion.
d. When other members gave information, I wanted to double-check it for myself. (reversed)
e. I did not have much faith in other members' "expertise." (reversed)

5. *Coordination*
f. Our board worked together in a well-coordinated fashion.
g. Our board had very few misunderstandings about what to do.
h. Our board needed to backtrack and start over a lot. (reversed)
i. We accomplished the tasks smoothly and efficiently.
j. There was much confusion about how we would accomplish the tasks. (reversed)

6. *Task interdependence (Pearce & Gregersen, 1991)*
Please indicate the extent to which you agree or disagree with each of the following statements about the tasks in your board.

a. I work closely with others in doing my work.
b. Frequently must coordinate my efforts with others.
c. My own performance is dependent on *receiving* accurate information from others.
d. The way I perform my job has a significant impact on others.
e. My work requires me to *consult with others* fairly frequently.

7. *Task routineness (Dewar, Whetten & Boje, 1980)*
Please indicate the extent to which you agree or disagree with each of the following statements about the tasks in your board.

a. Board members here always do the same work in the same way.
b. One thing we like here on the board is the variety of tasks. [reverse scored].
c. Most tasks have something new happening every day. [reverse scored].
d. There is something different to do on the board every day. [reverse scored].

8. Alignment of Task assignment
To what extent do you think that board members' (including yourself) expertise is consistent with the assignment or the committees (if any) they are on?
(1 = completely inconsistent, 2 = inconsistent, 3 = neutral, 4 = consistent, 5= completely consistent).

9. Functional diversity

Which of the following areas best represents the field you have spent the greater part of your career in? (Blau (1997) index, $1 - \sum p^2_i$, was used to calculate the functional diversity.)

a. Architecture and Engineering
b. Arts, Design, Entertainment, Sports, and Media
c. Building and Grounds Cleaning and Maintenance
d. Business and Financial Operations
e. Community and Social Services
f. Computer/Mathematical
g. Construction
h. Education, Training, and Library
i. Farming, Fishing, and Forestry
j. Food Preparation and Service
k. Healthcare Practitioners and Technical
l. Healthcare Support
m. Home Maker
n. Installation, Maintenance, and Repair
o. Legal
p. Life, Physical, and Social Science
q. Management
r. Military
s. Office and Administrative Support
t. Personal Care and Service
u. Production
v. Protective Service
w. Sales and Related
x. Transportation and Material Moving

Status Characteristics (Bunderson, 2003)

10. Specific status cues (task-related)

The top three ranked characteristics were kept and combined to form a single specific-status-cue score for each board member.
a. How many years of full-time work experience do you have? (will be obtained from answers to #11 above.)
b. What is the highest education degree you have obtained? (will be obtained from answers to #10)
c. What is your job position with your current employer? __________

a. Non-supervisory employee	e. Executive management
b. First-level supervisor	f. Business owner
c. Middle-level supervisor	g. Not employed
d. Upper management	

11. Diffused status cues (non-task-related)
Gender and ethnicity were combined to form a single diffused specific-status-cue score for each board member.
a. Your gender: Male Female
b. Your Racial/Ethnic group:

a. African American	b. Asian	c. Caucasian/White American
d. Hispanic/Latino American	e. Native American	f. Other________

Interpersonal Connections (Reagans & McEvily, 2003)

12. Closeness
How close are you with each person?
(1=Especially close, 2= close, 3=less than close, 4=distant) (reverse coded)

13. Communication Frequency
On average, how often do you talk or gather socially outside of formal board meetings (any social discussion)? (1= daily, 2=weekly, 3=twice a week, 4=monthly, 5 = less often/never) (reverse coded)

14. Team Satisfaction (Cammann, Fichman, Jenkins, & Klesh, 1983)
Please indicate the extent to which you agree or disagree with each of the following statements on your feelings about working in this team. (1 = strongly disagree, 2 = moderately disagree, 3 = slightly disagree, 4 = neither disagree nor agree, 5 = slightly agree, 6 = moderately agree, and 7 = strongly agree.)

a. All in all, I am satisfied with my board.
b. I am satisfied with the way I was treated by other board members.
c. In general, I don't like the board.
d. I am satisfied with the friendliness of my board members.
e. In general, I like working with my board.

15. Team Commitment (Mowday, Steers, and Porter, 1982)
Please indicate the extent to which you agree or disagree with each of the following statements on your feelings about working in this team. (1 = strongly disagree, 2 = moderately disagree, 3 = slightly disagree, 4 = neither disagree nor agree, 5 = slightly agree, 6 = moderately agree, and 7 = strongly agree.)

a. I am willing to put in a great deal of effort beyond that normally expected in order to help this school be successful.
b. I talk up the school board to my friends as a great board to work on.
c. I find that my values and the board's values are very similar.
d. I am proud to tell others that I am part of this school board.
e. I am extremely glad that I chose to work on this board.
f. I really care about the fate of this school.

Control Variables

16. Shard experience
Before you were on this board, how often did you talk to or spend your time with each of the following board members (any social or business discussion)? Leave the answer for yourself blank?

(1= daily, 2=weekly, 3=twice a week, 4=monthly, 5 = less often/never) (reverse coded)

17. Board tenure
How long have you been working on the board? # of months_______________

Appendix C

School Director/Board Chair Survey

(Relevant measures to this study are presented)

1. Team performance (Ancona & Caldwell, 1992)
Please rate your board's performance in the last month on each of the following criteria. (1 = very poor; 3 = above average; 5 = excellent)

a. Evaluating and selecting the senior executive
b. Serving member interests and needs
c. Marketing and promoting the school
d. Setting mission, policies, and long-range strategy
e. Ensuring consistency and high-quality leadership
f. Providing financial oversight
g. Adherence to schedules
h. Adherence to budgets
i. Overall performance

2. Team Innovation (Drach-Zahavy & Somech, 2001)
Please think of the teams under your supervisory in the last month, and try to review performance data. For each of the following statements about their performance and innovation, please indicate the extent to which you agree or disagree. (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree).

a. The board initiated new procedures and methods for completing the work.
b. The board developed innovative ways of accomplishing work targets/objectives.
c. The board developed new skills in order to foster innovations.