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Empowering teams through social network ties

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ABSTRACT

Effective teamwork and knowledge coordination are becoming increasingly important for all kinds of organizations given the growing use of teams to tackle competitive challenges and sustain competitive advantage. In this study, we develop and validate a model of how two types of social network ties – expressive and instrumental – contribute to team efficacy and performance, mediated by three dimensions of a transactive memory system (TMS) – specialization, credibility and coordination within teams. We test the model in an empirical study drawing on data from 66 teams in a variety of organizations. The results suggest that both instrumental and expressive ties within teams can facilitate the formation of TMS and the three dimensions of TMS are all, even though to different extents, positively related to team efficacy. Team efficacy is also a powerful predictor of team performance. The findings in our study bridge the literature gap about social networks and TMS and explain the underlying process and mechanisms by which social network ties exert their influence on team outcomes. The results have implications for organizations that wish to leverage teams to take advantage of team members' differentiated expertise and coordinate their work more effectively and efficiently.

1. Introduction

In today's rapidly changing and increasingly competitive business environment, teams are widely employed in organizations (Gully, Incalcaterra, Joshi, & Beaubien, 2002), since teams can increase organizational capability, flexibility and responsiveness (Griffith, Sawyer, & Neale, 2003). The increased emphasis on teams has aroused substantial interest in exploring determinants of team performance for both organizational researchers and practitioners (Kozlowski & Ilgen, 2006; Zhang, Hempel, Han, & Tjosvold, 2007). Social network approaches to team research have gained particular popularity (Balkundi & Harrison, 2006; Tjosvold, Poon, & Yu, 2005). Researchers have articulated that social ties have the potential to facilitate the flow of all kinds of resources within teams, which correspondingly determines the success of teams (Balkundi & Harrison, 2006). However, little effort has been made in previous research to pinpoint the mechanisms through which social relationships have impacted team outcomes (Balkundi & Harrison, 2006). Knowledge is indispensable to contemporary organizations, and the importance of knowledge is particularly noticeable for teams given their need to create, share and apply knowledge (Choi, Lee, & Yoo, 2010). Accordingly, knowledge management (KM) has become an important issue in organizations since only when knowledge is managed effectively can organizations increase their innovativeness and responsiveness to competitive threats (Alavi & Leidner, 2005). In particular, knowledge sharing and application are widely recognized as the key determinants of team performance (Choi et al., 2010; Janhonen & Johanson, 2011). Previous researchers have argued that social relationships might have an impact on KM outcomes and so called for further research into the effect of relationships in KM (Argote, McEvily, & Reagans, 2003). In this study, applying the input-process-output model, we concentrate on the impact of social ties on team outcomes through the perspective of knowledge coordination processes within teams.

Two basic forms of interpersonal relationships, involving instrumental and expressive ties, have been distinguished by social network researchers (Balkundi & Harrison, 2006). These two types of ties remain theoretically distinct, as the former is work related, while the latter is more associated with socio-emotional attachment. Previous scholars have explicitly called for new research to pay attention to the expressive dimensions of relationships in networks and suggest that appropriate expressive ties for instrumental purposes might have unintended consequences on performance related outcomes (Cross & Cummings, 2004).

As knowledge is a critical asset for teams and is often distributed across team members, ensuring that the right knowledge is available to the right person at the right time is vital if teams are to be successful (Kwan & Balasubramanian, 2003). In order to address the

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issue of knowledge coordination and utilization within teams, the transactive memory system (TMS) (Wegner, 1987) has been proposed as an effective knowledge processing technique. A TMS refers to a specialized division of cognitive labor that develops within a team regarding team members' encoding, storing and retrieving of information (Wegner, 1987). Many studies have confirmed that a well-developed TMS can indeed improve team outcomes (Kanawattanachai & Yoo, 2007; Lewis, 2004; Zhang et al., 2007). TMS is considered to have three aspects: specialization, credibility and coordination (Akgun, Byrne, Keskin, Lynn, & Imamoglu, 2005; Kanawattanachai & Yoo, 2007; Lewis, 2003; Moreland & Myaskovsky, 2000; Zhang et al., 2007). These researchers argue that TMS has the potential to allow team members to develop and be aware of each other's specialized expertise (specialization), confide in each other's competence and reliability (credibility), and integrate each other's knowledge together in a coordinated manner (coordination). Most previous research simply bundled these three aspects together, which may have caused difficulties in interpreting the real meaning and effect of TMS on team outcomes. Recent studies have tried to separate these three dimensions since specialization and credibility are cognitive processes, while coordination is a behavioural process; the three aspects are thus theoretically distinct (Kanawattanachai & Yoo, 2007). In order to better understand the antecedents and outcomes of TMS, we also study these three dimensions separately.

Based on the input-process-output model of teamwork, recent studies have turned attention to another kind of intermediate mechanism – the emergent state – that underpins the impact of team input on outcomes (Ilgen, Hollenbeck, Johnson, & Jundt, 2005; Marks, Mathieu, & Zaccaro, 2001; Srivastava, Bartol, & Locke, 2006). Team emergent state is different from team processes; team processes are the means by which members work interdependently to utilize various resources through cognitive, verbal and behavioural activities, while emergent state describes "cognitive, motivational, and affective states of teams, as opposed to their member interaction" (Marks et al., 2001, p. 357). Srivastava et al. (2006) have explicitly articulated the importance of incorporating both team process and emergent state in a single model and called for future research to do so. With respect to the relationship of team processes and emergent state, researchers have argued that a team's emergent state can be influenced by team cognitive processes (Marks et al., 2001). One emergent state – team efficacy – has drawn much attention, and two recent meta-analyses (Gully et al., 2002; Stajkovic, Lee, & Nyberg, 2009) provide compelling evidence that team efficacy is significantly related to team performance. Previous research has also indicated that TMS may contribute to team efficacy (Gibson & Earley, 2007; Mannix, Griffith, & Neale, 2002), which indicate that TMS not only has a direct effect on team performance, but the effect may be also partially mediated by promoting the team efficacy. Nevertheless, little research has empirically investigated the relationship between TMS and team efficacy. However, such an investigation may help us better understand the effect of TMS on team performance and so provide more insights into how team performance can be improved. All of these factors stimulate our interest in research on the mediating effect of team efficacy on the relationship between three dimensions of TMS and team performance.

In general, in this study, we aim to answer the following research questions: (1) How do instrumental ties and expressive ties influence team outcomes through TMS and team efficacy? (2) How may TMS contribute to team outcomes through the mediating role of team efficacy? We use team efficiency and team effectiveness to evaluate team outcomes in this study. In answering these questions, this paper contributes to the previous literature in several ways. Firstly, we add to the social network literature by examining the team processes through which social networks exert their influence on team outcomes. Secondly, we investigate the mediating role of team efficacy among TMS and team performance. Thus, the relationship between team processes, team emergent state and teamwork outcomes are much clearer. Thirdly, we separate the three dimensions of TMS so as to enrich our understanding of the development and outcomes of TMS.

Following this introduction, we review the relevant literature and justify the above arguments in a theoretical development where we construct the research model and develop the hypotheses. The empirical test of the research model will also be described. The results will then be presented, followed by the discussion of the theoretical and managerial implications, and future research directions.

2. Theoretical background

Several areas of literature underpin the research described in this paper: instrumental ties and expressive ties, transactive memory system and team efficacy.

2.1. Instrumental ties and expressive ties

The social network perspective has been increasingly adopted in recent studies of teamwork. Previous studies distinguished two different types of social ties based on the tie content, expressive ties and instrumental ties (e.g., Zhou, Siu, & Wang, 2010; Lin, 2007). Instrumental ties typically arise in the workplace and emerge based on formal work relationships. Instrumental ties are recognized as pathways of work-related advice and are typically used to facilitate the transfer of physical, informational or financial resources within units (Ibarra, 1993; Umphress, Brass, & Scholten, 2003). Team members are usually involved in instrumental ties when they gather information, advice, and expertise from other team members in order to accomplish a task. This kind of ties is utilitarian-oriented; thus they are unstable and temporary (Lee, Pae, & Wong, 2001). The main purpose of instrumental ties is work or career related. Instrumental ties are weak, which link people who differ in personal characteristics and in their expertise in vertical and horizontal division of labor in access to differentiated resources (Ibarra & Andrews, 1993). On the other hand, expressive ties involve people who exchange feelings and satisfy their need for care, social support and a sense of belonging (Berman, West, & Richter, 2002; Manev & Stevenson, 2001; Umphress et al., 2003). They are distinguished by attributes like emotional intimacy, perceived social similarity and expectations of mutual altruistic behaviour (Gibbons, 2004). Owing to these traits, expressive ties have been demonstrated to be more associated with commitment, emotional attachment and shared understanding, clear communication and acceptance of partners' suggestions (Morrison, 2002; Sias & Cahill, 1998). Expressive ties are quite useful in the workplace as they can provide psychological support for the individual such as encouragement in trying times, comfort when encountering difficulties and give advice about balancing work and life pressures. In general, instrumental ties are information and cognition based, while expressive ties are affect based. These two types of ties developed within teams are both very important for work completion and team viability.

Research about social network ties showed that both instrumental ties and expressive ties could largely facilitate knowledge sharing directly (Lin, 2006) or through the mediating role of trust (Lin, 2007; Zhou et al., 2010). Ou, Davison, Zhong, and Liang (2010) empirically validated the direct influence of social network ties on team performance and the mediating role of knowledge sharing. In two case studies on globally distributed projects, Kotlarsky and Oshri (2005) suggested that establishing social network ties can

facilitate knowledge map formation within project teams and act as enablers for coordination between coworkers. Moreover, Chen and Peng (2008) suggested that close social network ties between coworkers might smooth the process of coordination and cooperation for task completion. This is likely to enhance outcomes for the employee as well as for the organization.

2.2. Transactive memory system (TMS)

Wegner (1987) introduced the concept of a TMS as an approach to understand how couples coordinate their interactions as they solve information memory problems. Wegner defined the TMS as a combination of knowledge possessed by each individual and a collective awareness of who knows what. He argued that this system provides individuals with access to a vast amount of knowledge that no one individual could possess.

Since Wegner's (1987) original study, researchers have paid considerable attention to TMS. In general, TMS is considered to have three aspects: specialization, credibility and coordination (Moreland & Myaskovsky, 2000). Specialization refers to the differentiated structure of expertise among team members and collective awareness of each other's knowledge. Specialization can reduce the cognitive load of team members since team members only need to concentrate on their own area of expertise, yet can simultaneously leverage other team members' knowledge in jointly performing a given task. Credibility is defined as the confidence in other team members' competence and reliability. When team members trust others' knowledge, they can save much time as they do not need to make explicit claims to justify their own knowledge (Kanawattanachai & Yoo, 2007). Coordination means the effective and coordinative knowledge processing. It includes a set of concerted actions of the task decomposition and effective subtask distribution and integration (Lewis, 2003). Most previous research bundled these three dimensions together as a single construct. However, this may create difficulties when interpreting the impact of TMS on team outcomes, since it is difficult to judge which dimension is contributing to that outcome. More recently, Kanawattanachai and Yoo (2007) asserted that not all dimensions have a direct impact on team performance, empirically demonstrating that specialization and credibility lead to better coordination, which, correspondingly, contributes to better team performance.

2.3. Team efficacy

Derived from social cognitive theory (Bandura, 1997), team efficacy is an extension of self-efficacy from the individual level to the collective level. Team efficacy refers to a team's "shared belief in its conjoint capabilities to organize and execute courses of action required to produce given levels of attainment" (Bandura, 1997, p. 477). Team efficacy is different from TMS, as TMS is a team cognitive process (Kozlowski & Ilgen, 2006), while team efficacy represents a team's "emergent state" (Marks et al., 2001). Researchers have advocated incorporating both team processes and team emergent state into team research (Srivastava et al., 2006). Team efficacy has been studied as an important team emergent state (Ilgen et al., 2005; Shin & Zhou, 2007; Srivastava et al., 2006).

Many factors have been suggested to contribute to the formation of team efficacy. Team members' personal efficacy is related to team efficacy (Fernández-Ballesteros, Diez-Nicolàs, Caprara, Barbaranelli, & Bandura, 2002). This relationship was confirmed by Tasa, Taggar, and Seijts (2007) who conducted a multilevel, longitudinal study and found that members' self-efficacy developed into team efficacy over time. Lee, Tinsley, and Bobko (2002) provided empirical evidence that team cohesion and the strength of a group's norms are positively related to general team-level efficacy beliefs. In a study of university student groups in the USA and Hong Kong, Gibson (2003) found that self-efficacy, group affect and collectivism were the determinants of team efficacy. Gibson and Earley (2007) suggested that intragroup cooperation, awareness of group member task-related abilities is positively related to group efficacy. Team efficacy can also be built through behavioural activities, like exchanging, evaluating and integrating (Alavi & McCormick, 2008).

2.4. Team performance

Team performance is a complex, multidimensional construct that is not consistently defined in the literature (Delarue, Van Hootegem, Procter, & Burridge, 2008). In this paper, since most of our theoretical constructs relate to work contexts, we operationalise team performance with respect to the efficiency and effectiveness with which work is undertaken. This conceptual approach has been widely used in previous team level research (e.g., Faraj & Sproull, 2000; Hoegl & Gemuenden, 2001; Jung & Sosik, 2002). Effectiveness refers to the degree to which team members meet the requirements and expectations of work quality as well as team collective goals. Efficiency refers to the team's ability to adhere to budgets and schedules. Thus, being effective means doing the right thing and it can be assessed on the basis of whether worthwhile targets have been achieved. Being efficient means producing satisfactory results with minimum inputs. It is the ability to carry out actions and complete tasks quickly. It is equally important for teams to be both effective and efficient if they are to achieve good team performance.

In previous research, both TMS and team efficacy have been demonstrated to be powerful antecedents of team performance in different kinds of teams. Akgun, Byrne, Keskin, and Lynn (2006) and Akgun et al. (2005) found that TMS can greatly improve new product success by enhancing speed-to-market and facilitating team learning. In a study of top management teams, Rau (2005) found that expertise location positively influenced performance for teams with low levels of relationship conflicts. Drawing on data from 104 teams from multi-organizational samples, Zhang et al. (2007) confirmed the positive influence of TMS on team outcomes, like efficiency, quality, technical innovation, adherence to schedules, adherence to budgets, and work excellence. There is also growing evidence that team efficacy is positively related to team outcomes. Jung and Sosik (2002) found that team efficacy is positively related with perceived group effectiveness based on data analysis of forty-seven groups from four Korean firms. Fuller, Hardin, and Davison (2007) found that team efficacy can boost group outcomes perceptions and also actual performance in computer-mediated teams. In a study of 62 sales teams in China, Lin and Peng (2010) empirically confirmed the positive influence of team efficacy on team performance. Furthermore, two meta-analytic reviews (Gully et al., 2002; Stajkovic et al., 2009) drew similar conclusions regarding the predicting role of team efficacy on team performance.

3. Research framework and hypotheses development

Based on the literature review, we developed a structural model and associated hypotheses (see Fig. 1). We propose that TMS serves as underlying mechanism through which two types of social network ties exert an impact on team outcomes. The model also considers the mediating role of team efficacy between the three dimensions of TMS and team performance.

Specialization refers to the differentiated structure of expertise among team members and the collective awareness of each other's knowledge. Originally derived from social network theory, social network ties are regarded as convenient conduits that facilitate exchange of information and mutual support. People will both be more aware of and value to a greater extent the expertise and

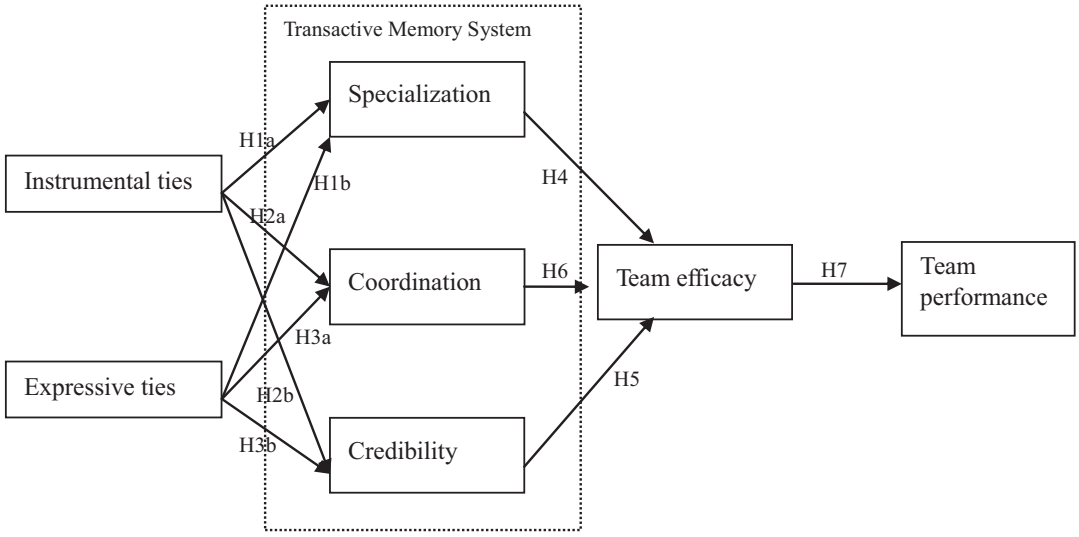

Fig. 1. Proposed research model.

specialized knowledge of their egocentric networks than people with whom they are less familiar (Borgatti & Cross, 2003). Previous researchers have demonstrated that both instrumental ties and expressive ties can facilitate knowledge sharing directly (Lin, 2006) or through the mediating role of trust (Lin, 2007; Zhou et al., 2010). Instrumental ties involve information and knowledge exchange and are conceived as conduits of work advice (Umphress et al., 2003). The expressive ties among team members can also release work-related information, with expressive ties characterized as more interactive and therefore as constituting a more effective approach for the transfer of tacit knowledge (Fang, 2006). The knowledge sharing and interaction activities help members learn more about the content and depth of one another's knowledge and help to elaborate, refine and clarify members' perceptions of member-expertise associations (Lewis, 2004). Besides the knowledge map formation, close instrumental and expressive ties can also facilitate team members to know what kind of information and knowledge other team members need; which may also promote the specialization about knowledge allocation and processing. After the formation of such knowledge maps, team members may then concentrate on and bear the obligation of developing their own expertise in order to refine their own job performance and enhance their personal specialization. This leads to our first two hypotheses:

H1a. Instrumental ties within teams are positively related to specialization in teams.

H1b. Expressive ties within teams are positively related to specialization in teams.

Coordination is the achievement of concerted action and social mechanism is an important facilitator of effective coordination (Kotlarsky, Van Fenema, & Willcocks, 2008). A dense network of ties within the team may lead to the achievement of better team coordination due to fewer conflicts and collective action (Reagans & Zuckerman, 2001). Close social relationships among team members may lubricate processes of coordination and cooperation for task accomplishment (Chen & Peng, 2008). In particular, coordination encompasses the exchange of all sorts of resources between team members through formal and informal transactions in order to integrate their respective contributions (Rico, Sanchez-Manzanares, Gil, & Gibson, 2008). People who have instrumental ties tend to be involved in resource exchange and advice seeking, which provide the conduits for effective coordination. The frequent work related communication and interaction can facilitate the comprehension of each other's knowledge and so reduce misunderstandings. Accordingly, the coordination can be improved. Instrumental ties, which involve significant work related interaction, may enhance the accuracy of expectations about other team members' thoughts, activities and anticipation, which promotes coordination and communication efficiency (Kotlarsky et al., 2008). Strong expressive ties are typically developed through prior social interaction and are usually characterized at a high level of familiarity. People who have many shared experiences could develop implicit coordination (Hollingshead, 1998a,b), since they can use nonverbal cues to understand each other and may anticipate the actions and needs of each other and dynamically adjust their own behaviour accordingly. Moreover, expressive ties may lubricate the coordination processes, since parties with dense expressive ties always involve open communication, emotional attachment and intimacy (Gibbons, 2004) and are more motivated to provide assistance to or support each other. The harmonious atmosphere associated with a dense network of expressive ties may enable team members to experience stronger positive moods during work. Accordingly, we propose:

H2a. Instrumental ties within teams are positively related to coordination in teams.

H2b. Expressive ties within teams are positively related to coordination in teams.

As Kanawattanachai and Yoo (2007) suggest, the credibility dimension of TMS bears considerable resemblance to cognition-based trust. Previous research has empirically tested the effect of instrumental and expressive ties on trust in coworkers (Lin, 2007; Zhou et al., 2010). When people are instrumentally associated with each other, they may be more inclined to have regular communication concerning their approaches to tasks and problems, as well as job-related information, which have been demonstrated to lead to the formation of cognition-based trust (Butler & Cantrell, 1994; Kanawattanachai & Yoo, 2007). As credibility is built on team members' prior work performance (McAllister, 1995), the instrumental link may provide team members more evidence of each other's reliability and qualification. Moreover, people are more likely to confide in others who have similar missions, attributes and values to themselves (Marsden, 1988). As for the expressive ties, the intimacy and expectations of partners' altruistic behaviours embedded in the expressive ties can create shared understanding, clear communication and acceptance of partners' viewpoints

(Gibbons, 2004). In addition, teams that have developed dense expressive ties can enjoy a trusting environment where ideas that would otherwise make one vulnerable to retaliation can be shared safely. Team members may then be more inclined to express their opinions and convey their expertise. Since team members with expressive ties usually behave altruistically towards each other, faith in others' good intentions probably increases the tendency and willingness to consider and trust their suggestions and performance. If the expressive ties are weak or no such expressive link exists among team members, they are unlikely to be sought out for task-related interaction no matter whether they are competent or not (Casciaro & Lobo, 2008). Taking all these arguments together, we suggest:

H3a. Instrumental ties among team members are positively related to credibility in teams.

H3b. Expressive ties within teams are positively related to credibility in teams.

Previous research suggests that, in a team, collective awareness of team members' specialized knowledge likely contributes to team efficacy (Gibson & Earley, 2007). They articulate that "as team members develop a fine-tuned set of skills applicable to a key task objective and are aware of the abilities each will contribute, the group will develop a correspondingly higher degree of certainty that they can achieve a task objective" (ibid., p. 443). Specialization makes it possible for individual team members to construct a profound level of knowledge in their own area of responsibility, since every team member may bear the obligation to develop and refine their expertise. Accordingly, members may have more self-efficacy to do their own job well, which greatly contributes to the development of team efficacy (Fernández-Ballesteros et al., 2002). Furthermore, if team members have specialized knowledge that others lack, the division of the whole task will be more efficient and effective and role ambiguity will be greatly reduced. When team members are more aware of their teammates' expertise and skills, they can allocate work more sensibly and can anticipate each other's behaviours, rather just react passively to each other (Cruz, Perez, & Ramos, 2007). When members encounter work-related problems, it will be much easier for them to find the right person when they seek help or advice if they know who is responsible for or competent in that area of knowledge. These differentiated aspects of knowledge and clear role divisions provide a group with the ability to cope with new tasks more implicitly and promote their confidence in dealing with any task related problems effectively. These arguments lead to the following hypothesis:

H4. Specialization in teams will positively influence team efficacy.

Previous research has demonstrated that interpersonal trust is linked to a number of interactive behaviours, including organizational citizenship behaviours, a desire for future interaction and knowledge sharing within teams (Naquin & Paulson, 2003; Pillai, Schriesheim, & Williams, 1999; Staples & Webster, 2008). Such collective cognitive processes are a source of team efficacy (Gibson & Earley, 2007). If they do not have much credibility towards others' competence, even if they have the individual efficacy to do their own job well, their confidence that the whole team can do the whole task well may be greatly reduced. Durham, Knight, and Locke (1997) also provided indirect evidence of the importance of credibility for team efficacy: in an experimental study of task performance in student groups, they found that perceived leader ability and member ability influenced team performance indirectly through their effects on team efficacy. When people trust others' knowledge, they may be more inclined to offer and accept others' suggestions and have the confidence to rely on each other's performance (Abrams, Cross, Lesser, & Levin, 2003). Thus, we argue that if an individual has the perception that everyone else in the team can do their own job well, then one's confidence that the whole team can perform well would be high. Here, we hypothesize that:

H5. Credibility in the team will positively influence team efficacy.

The importance of coordination for team efficacy has been recognized. "Groups composed of self-efficacious members may not necessarily develop high team efficacy if there is unsatisfactory interaction and coordination" (Alavi & McCormick, 2008). Collective collaboration and coordination in the early stage of the team influence the later team efficacy formation (Gibson & Earley, 2007; Lester, Meglino, & Korsgaard, 2002). Teams that achieve high levels of coordination may also encourage team members to work together closely and develop shared expectations and norms for appropriate behaviour and reduce social loafing (Stewart, 2006). On the other hand, when the coordinative collaboration among team members is absent, even if each team member does his/her own subtasks well, the integrated quality will still not be satisfactory; the team members may then become frustrated and team efficacy may be reduced. Team efficacy is not merely an aggregation of personal judgments concerning capabilities, but an emergent team level state that results from interpersonal interaction and coordination (Lin & Peng, 2010). If all members of a team work together in a well-coordinated fashion, the high efficiency of mobilizing resources and expertise also promotes their confidence in their collective capacity. Team members who work in a coordinative manner are more likely to work towards a common goal and share common beliefs of their capability (Lester et al., 2002). Thus, we propose:

H6. Coordination in teams will positively influence team efficacy.

The direct effects of team efficacy on performance outcomes have frequently been studied. Teams with high levels of team efficacy are more likely to strive to accomplish their assigned tasks and fulfill their obligations (Bandura, 1986). When encountering failure, highly efficacious teams demonstrate more "staying power" to overcome difficulties (Bandura, 2000) rather than exhibiting withdrawn behaviours. In addition, members who have little confidence in their team's ability to effectively confront challenges may perceive opportunities as debilitating rather than salutary (Lam, Chen, & Schaubroeck, 2002); the negative attitude may also influence their following efforts, which is important for effective performance. These arguments were further justified by Stajkovic et al. (2009) who summarized that team efficacy can influence "a group to initiate action, how much effort the group will exert, and how long the group's effort will be sustained". These propositions have also been justified empirically. Gibson, Randel, and Earley (2000) found a positive relationship between team efficacy and team outcomes such as time to completion, team agreement, process effectiveness, and perceived effectiveness of the group's solution; this relationship is further confirmed by Fuller et al. (2007) who suggested that team efficacy could influence group performance through the mediating effect of effort and team member communication. In a meta-analysis of the team efficacy research, Stajkovic et al. (2009) further verified the positive relationship between team efficacy and team outcomes. Thus, in this paper, we make the same hypothesis:

H7. Team efficacy is positively related to team performance.

4. Methodology

4.1. Measurement and data collection

In order to test our model, a survey was conducted. We use the survey method because it allows for quantitative hypothesis

testing, permits the gathering of real field information and then enhances the generalizability of the research findings. We developed our questionnaire primarily from previously validated measures. 7-point Likert scales ranging from "strongly agree" to "strongly disagree" were used to measure all items. The independent variables – instrumental ties and expressive ties – are measured with items adapted from Manev and Stevenson (2001). The questions about the two dimensions of transactive memory system – specialization and credibility – are based on the work of Lewis (2003). The coordination items are taken directly from the study of Kanawattanachai and Yoo (2007) on task knowledge coordination. The measures of team efficacy are derived from Salanova, Llorens, Cifre, Martinez, and Schaufeli (2003) work on team efficacy. Team performance was measured by two dimensions: team effectiveness and team efficiency. The items of team effectiveness are drawn from previous research on group effectiveness (Jung & Sosik, 2002). The measures of team efficiency are adapted from Hoegl and Gemuenden (2001). The control variable – task interdependence refers to the extent to which team members need information, materials, and support from other team members in order to complete their tasks (Zhang et al., 2007). The measurement of task interdependence was drawn from prior research (Zhang et al., 2007). All construct items were originally developed in English, so we translated the instrument into Chinese and then performed a back translation to ensure equivalence of meaning between the English and Chinese versions.

We first identified organizations that are engaged in knowledge work and where teams are employed in normal business processes. We chose knowledge intensive teams since the effects of TMS should be especially pronounced in teams whose outputs and performance rest on members' knowledge and expertise (Lewis, 2004). We deliberately sought to identify organizations located across China – including those in both large and smaller cities. We contacted a total of 43 companies of which 36 agreed to participate in the research. We explained the purpose of the research to the potential respondents and assured them that all the data collected would be kept confidential, with no data about any individual employee to be reported. In total, 309 responses were received from employees working in 72 teams. After deleting teams where less than 3 completed questionnaires were received or where questionnaires were incompletely answered, our final data set consisted of 284 individuals from 66 teams in 34 companies. This method of obtaining responses from some team members and then aggregating the responses to represent team level data is consistent with previous research on teams (e.g., Srivastava et al., 2006; Zhang et al., 2007). The number of respondents from a team ranges from 3 to 16. The demographic characteristics of these 284 respondents are presented in Table 1.

4.2. Measure validity and reliability

We use partial least squares (PLS) for structural equation analysis to test the hypotheses. PLS is a structural equation modeling technique that can assess both the reliability and the validity of the measures of constructs and estimates the relationships among the constructs (Wold, 1982). PLS supports both confirmatory and exploratory research (Gefen, Straub, & Boudreau, 2000). Five PhD students who majored in Information Systems were invited to review the measurement items so as to ensure content validity. We at first tested the convergent validity based on the individual data. Confirmatory factor analysis of constructs shows the loadings of one item for specialization and two items for credibility are lower than the acceptability level. Thus, we dropped these three items for further analysis.

4.2.1. Aggregation

Since the unit of analysis in this study was the team, individual responses were aggregated to create a team level score. After the adaptation of the instrument, we then calculated inter-team-member agreement (r_{wg}) for the variables to ensure that individual level data was appropriately aggregated into the group level based on the suggestion of James, Demaree, and Wolf (1984). Generally, aggregation is considered appropriate when the median r_{wg} of the scale is greater than 0.7 (George, 1990). Calculation results show that r_{wg} medians of instrumental ties (0.857), expressive ties (0.798), specialization (0.802), credibility (0.848), coordination (0.802), team efficacy (0.823), teamwork efficiency (0.912), teamwork effectiveness (0.827) and task interdependence (0.782) were all greater than 0.7, which warrants our aggregation approach. Thus, we averaged each individual's variable scores in the same team for the team level score.

4.2.2. Measurement model

After aggregation of individual level data into the team level, we examined composite reliability and the average variance extracted (AVE) to assess convergent validity of the team level data. Table 2 below shows our composite reliability values, ranging from 0.818 to 0.957, Cronbach's alpha scores ranging from 0.706 to 0.932 and AVE scores ranging from 0.532 to 0.881; all scores are above the acceptability level. In addition, all the weights and loadings of the measures are also above the acceptable level. Finally, we measured the square root of the AVE for each construct to assess discriminant validity (see Table 3). These square roots were larger than the correlations between constructs, which confirms discriminant validity.

As the three dimensions of TMS are highly correlated to one another, to further ensure discriminant validity, we compared four different measurement models using a hierarchical model comparison strategy (Kanawattanachai & Yoo, 2007). We compared the following four models: (1) a null model (M0); (2) a single-factor model (M1) having all 11 items loaded on a single factor; (3) a three-factor model with correlation among factors fixed to one (M2); and (4) a three-factor model with factors being freely correlated (M3). The differences of chi-square statistics were used to test the superiority of the models. The results are shown in Table 4. The comparisons showed that the correlations among the three factors are statistically low and the three underlying factors were indeed distinct from one another.

Further, as several inter-construct correlations were higher than 0.60, we then analyzed the Variance Inflation Factors (VIFs) and the tolerance values to test for potential multicollinearity. The results showed that the highest VIF was 4.245, well below the 10.0 threshold, and the lowest tolerance value was 0.236, well above the benchmark value of 0.10. Thus, multicollinearity was not a significant problem in this research.

In addition, we tested for common method bias with Harman's single factor method (Carr, 2007). The results show that five constructs had eigenvalues greater than 1.0, accounting for 75.33% of the variance. Meanwhile, the first construct explained 19.39% of the variance. It indicates that common method bias does not seriously affect the results of this study.

4.2.3. Structural model

After examining the measurement model, we tested the hypotheses proposed before with PLS. The results are shown in Fig. 2. With respect to the antecedents of specialization, both instrumental ties and expressive ties are significantly related to specialization. This indicates that both H1a and H1b are supported. However, the instrumental ties are much more important than expressive ties when considering their impact on specialization. As for credibility, H2a and H2b are both supported, suggesting that

Table 1
Demographic information.

Measures	Items	Frequency	Percent	Measures	Items	Frequency	Percent
Gender	Male	180	63.4	Age range	18–25	131	46.1
	Female	104	36.6		26–35	123	43.3
					36–45	25	8.8
					46 and above	5	1.8
Education level	Primary/secondary school	4	1.4	Position	Non-management Employee	232	81.7
	College	56	19.7		Manager		
	Undergraduate	194	68.3		Senior or Executive Manager	46	16.2
	Master or above	30	10.6			6	2.1
Industry type	Manufacturing	11	16.7	Team location	Zhengzhou (N)§	8	12.1
	IT industry	28	42.4		Shenzhen (S)	6	9.1
	Education	4	6.1		Fuzhou (E)	8	12.1
	Construction	9	13.6		Haikou (S)	4	6.1
	Finance and banking	7	10.6		Beijing (N)	7	10.1
	Logistics and transportation	5	7.6		Shanghai (E)	10	15.1
	Others	2	3.0		Qingdao (E)	9	13.6
					Chengdu (W)	9	13.6
					Wuhan (C)	5	7.6
Number of employees	50 or below	13	4.6	Team size	5 or below	7	10.6
	51–100	90	31.7		6–10	18	27.3
	101–500	63	22.2		11–20	30	45.5
	501–1000	53	18.7		21–30	9	13.6
	1001 or above	65	22.8		31or above	2	3.0

Note: N, north; S, south; E, east; W, west; C, central.

Table 2
Results of confirmatory factor analysis.

Measures	No. of items	Cronbach's alpha	Composite reliability	Average variance extracted
Instrumental ties (IT)	4	0.917	0.943	0.806
Expressive ties (ET)	4	0.909	0.936	0.786
Specialization (SPE)	4	0.706	0.818	0.532
Credibility (CRE)	3	0.908	0.943	0.846
Coordination (COO)	4	0.894	0.928	0.764
Team efficacy (TE)	3	0.932	0.957	0.881
Team performance (TP)	6	0.844	0.893	0.809
Task interdependence (TI)	4	0.879	0.875	0.639

Table 3
Correlations of latent variables.

	IT	ET	SPE	CRE	COO	TE	TP	TI
IT	0.898							
ET	0.403	0.887						
SPE	0.619	0.519	0.729					
CRE	0.560	0.588	0.581	0.919				
COO	0.668	0.537	0.600	0.649	0.874			
TE	0.729	0.484	0.659	0.709	0.715	0.939		
TP	0.653	0.463	0.653	0.683	0.618	0.714	0.899	
TI	0.599	0.514	0.635	0.712	0.627	0.587	0.645	0.799

Note. The numbers in the diagonal row are square roots of the average variance extracted.

Table 4
Hierarchical comparisons of measurement models.

Model	χ^2	*df*
M0: null model	855.38	55
M1: one-factor model	190.49	44
M2: three-factor model (factor correlations fixed to 1)	176.56	44
M3: three-factor model (factors are freely correlated)	129.03	41

Model comparisons	χ^2	*df*	*p*
Testing for the presence of trait factors			
M0–M1: test for the fit of one-factor model over null model	664.89	11	<0.01
M0–M3: test for the fit of the three-factor model over null model	726.35	14	<0.01
M1–M3: test for the fit of the three-factor model	61.46	3	<0.01
M2–M3: test for the discriminant validity of the three factors	47.53	3	<0.01

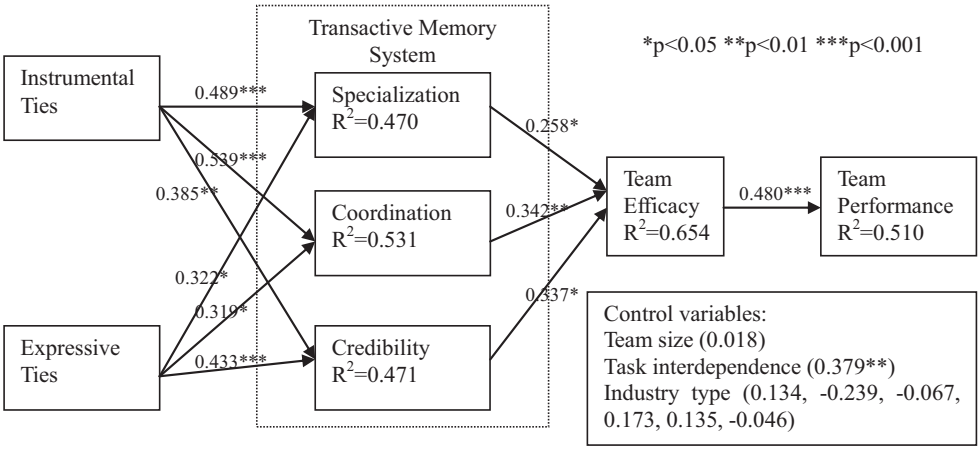

Fig. 2. Results of PLS analysis.

instrumental ties and expressive ties are both important predictors of credibility. Comparing the path coefficients, we found that the relationship between expressive ties and credibility is more significant than the relationship between instrumental ties and credibility. For coordination, both instrumental ties and expressive ties are significantly related to it. Thus, H3a and H3b are both supported. However, the instrumental ties play a more important role than expressive ties for smooth coordination.

When considering the influence of the three dimensions of TMS on team efficacy, all relevant hypotheses – H4–H6 – are supported, which demonstrates that specialized expertise among team members, trusting beliefs of other members' dependability and coordinative work style are significant precursors of team efficacy. Finally, team efficacy and team performance are significantly related, which accords with prior research. For the control variables, task interdependence is significantly related to team performance. Team size and six dummy variables for industry type are found to be insignificantly related to team performance.

We also tested the mediation effect of team efficacy between the three aspects of TMS and team performance. The three-step method was used following the suggestion of Baron and Kenny (1986). In step 1, we treated specialization as the dependent variable, and found a significant relationship between them. In step 2, we built a model that has team efficacy as the independent variable and team performance as the dependent variable. We found a significant effect. In step 3, we built another model to test the impact of the two independent variables – specialization and team efficacy – on the dependent variable – team performance. Both the effects of specialization and team efficacy on team performance were significant; thus, team efficacy partially mediated the impact of specialization and team performance.

We likewise tested whether team efficacy mediated other two dimensions of TMS and team performance using a similar test (see Table 5). The results showed that the TMS partially mediated the impact of all three aspects of TMS on team performance.

5. Discussion, implications and limitations

5.1. The effects of social ties on specialization

The effects of two kinds of social network ties on three aspects of TMS were investigated. Instrumental ties and expressive ties are both significantly related to all three aspects of TMS. This suggests that both types of ties may facilitate the development of a knowledge map of who knows what. Further, both types of ties can promote specialized expertise formation within in teams. The significantly positive impact of expressive ties on specialization is contrary to the suggestions of Kanawattanachai and Yoo (2007) that expressive ties among team members may cause members to focus primarily on the surface-level diversity, potentially hindering their ability to take advantage of each other's deep work related expertise and knowledge. Expressive ties have a stronger effect on specialization than do instrumental ties because expressive ties are more focused on the transfer of tacit knowledge (Zhou et al., 2010). However, we found that instrumental ties exert more influence on specialization than expressive ties. This can be understood easily, since instrumental ties are work-related and can release more expertise information.

5.2. The effects of social ties on coordination

We also found that both types of social ties can lubricate and promote coordination process. However, instrumental ties are more important than expressive ties. One reason for this may relate to the fact that expressive ties may lead to similar perspectives towards work (Gibbons, 2004) and so knowledge redundancy (Reagans & Zuckerman, 2001). Thus, for team coordination which requires

Table 5
Results of mediating effect tests.

IV	M	DV	Coefficient in regressions				Mediating
			IV → DV	IV → M	IV + M → DV		
					IV	M	
SPE	TE	TP	0.662***	0.661***	0.344***	0.491***	Partial
COO	TE	TP	0.648***	0.717***	0.260	0.526***	Full
CRE	TE	TP	0.684***	0.710***	0.358**	0.461***	Partial

Note.
*** Significant at the 0.001 level.
** Significant at the 0.01 level.

diverse knowledge from different team members, instrumental ties can provide more diverse task based knowledge, which is more important than the benefits of mutual social support derived from expressive ties.

5.3. The effects of social ties on credibility

The significant impacts of instrumental and expressive ties on credibility are also confirmed, which is congruent with previous research (Zhou et al., 2010). The results also indicate that expressive ties are more important for the formation of credibility. We argue that though credibility is formed based on the competence of other members, it is still an affect-laden construct. Besides, as we mentioned before, expressive ties often link individuals who may perceive social similarity with each other (Gibbons, 2004), since based on self-categorization theory, individuals are more likely to aggregate themselves with others in the light of objective attributes (Turner, Hogg, Oakes, Reicher, & Wetherell, 1987). Cultural-ethnic similarity is recognized as an important antecedent of cognition-based trust as persons will be more ready to trust a person in the same cultural group rather than a person in a different cultural group (McAllister, 1995).

5.4. The effects of TMS on team efficacy

The significant impacts of the three dimensions of TMS on team efficacy are confirmed. Among the three dimensions, coordination plays the most important role for team efficacy; the significance of credibility is slightly lower than coordination and specialization contributes the least influence. The results support the notion that coordination is the pivotal dimension of TMS (Kanawattanachai & Yoo, 2007) and imply that not only can the formation of TMS give inspiration to team construction and teamwork processes, but it can also promote a team's motivational state. It is clear that team efficacy has a significant relationship with team performance.

5.5. The mediation effect of team efficacy between TMS and team performance

Interestingly, we found that team efficacy fully mediated the relationship between coordination and team performance, but only partially mediated the impacts of specialization and credibility on team performance. Part of the reason for the mediating role of team efficacy may be that even if TMS is well developed in teams, if the team members do not have high certainty that they can achieve the collective goal, they may not want to exert much effort to take advantage of others' expertise. The amount of effort is an important precursor to team performance (Bandura, 1997).

5.6. The effects of task interdependence on team performance

In this study, we also found that the control variable – task interdependence – has a significant effect on team performance. A possible explanation of this effect may be that task interdependence is the glue that holds different team members together; when team members are highly interdependent with each other, team members will be more motivated to put their efforts together to perform well (Janz, Colquitt, & Noe, 1997). Correspondingly, the team performance will be high. Moreover, at a lower level of task interdependence, team members may focus more on individual accomplishment rather than on team accomplishment (Aubé & Rousseau, 2005). Thus, when task interdependence is high, all team members may strive to the same direction in order to better accomplish the team collective goal.

6. Theoretical implications

This study makes several important contributions to the study of social networks and team information management. Firstly, unlike other previous research that typically bundled the three dimensions of TMS together, in this study we found that they are distinct from each other – and so should be treated separately. They are influenced differently by the two types of social network ties and each has a different impact on team outcomes. Secondly, previous research demonstrated that a knowledge management system (KMS) is an important mechanism for knowledge management; knowledge should be codified and gathered in a KMS. However, our study shows that the personalized approach is powerful, since people can develop a meta-knowledge of who knows what and pinpoint the right person for accessing their expertise. Thirdly, previous research just articulated the importance of social networks on teams; however, the underlying processes and mechanisms by which the social network ties exerted their influence on team outcomes were not very clear.

Our study demonstrates that the ties within teams can help team members understand others' knowledge and refine their own expertise, stimulating them to confide in others' expertise and ease the coordination process. Consequently, the team emergent state – team efficacy – may increase, and team performance tends to be enhanced. Furthermore, our study also responds to previous suggestions of incorporating constructs of team processes and also team emergent state into team level model. Thus, the picture of team level concept is clearer and more complete. We also found that the impact of TMS on team performance is mediated by team efficacy. This is an important finding because prior research argued that the relationship between TMS and team performance is direct (Akgun et al., 2006, 2005; Zhang et al., 2007). However, we found that the relationship between TMS and team performance is more complex and that part of its impact is manifested through team efficacy. The development of TMS can indeed improve team performance. Nevertheless, if team efficacy is low due to other reasons, the team performance may still suffer even if the TMS is well developed.

7. Managerial implications

Our research provides a number of implications for practice. Firstly, the significant effects of instrumental and expressive ties on TMS have been confirmed. This suggests that managers should not only concentrate on the development of KMS but should also put efforts into improving information management though a personalized approach, such as by providing more opportunities for team members to engage in instrumental and expressive interactions, thereby promoting their TMS development. It will be beneficial for organizations to have frequent formal meetings that give every member the opportunity to demonstrate their expertise and cultivate a mature climate of knowledge seeking and sharing. Managers should arrange some organizational off-work activities for employees, such as get-together dinners and sightseeing tours that promote the emotional attachment among coworkers.

Secondly, the direct impact of team efficacy and indirect influence of TMS on team performance has been demonstrated. Organizations, particularly those that take advantage of teams to accomplish tasks, should try to improve team efficacy and pay attention to the development of teams' TMS. More specifically, managers should consider developing and disseminating web-based directories of team members' respective knowledge, experience, skills and expertise. Tasks can then be assigned based on members' experience and expertise. A trusting atmosphere is

also critical for teamwork. To improve team efficacy, the development of a TMS is important.

8. Limitations and future research

This study suffers from several limitations. Firstly, we rely on perceptive data. These subjective measures may not fully indicate the actual objective reality. In addition, while we only collected cross-sectional data at one time, the development of TMS is likely to evolve over time (Kanawattanachai & Yoo, 2007). We recommend that in future research, a longitudinal study that investigates the impacts of different kinds of social network ties on the development of TMS should be undertaken. Moreover, the study was conducted in a specific context, Chinese teams. Thus, readers should be cautious when generalizing the results to a different cultural context. As China is noted for its high levels of in-group collectivism (Triandis, 1989), where collective interests are superior to individual interests, the two group level concepts – TMS and team efficacy – may exert more significant impacts on team outcomes than they would in other countries. In future, researchers may conduct similar studies in other countries. As mentioned above, TMS also involves several information processes, viz., encoding, storing, retrieving and integrating. Future research can investigate the influence of social network ties on different TMS processes.

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Appendix A.

Scale: strongly disagree (1)–strongly agree (7)

Instrumental ties

1. Members in my team are involved with each other for receiving or sending information for coordination, control, planning or evaluation.
2. Members in my team are involved with each other for receiving or sending technical assistance.
3. The contacts among members in my team are important for our work.
4. The members in my team are involved with each other for work related advice and suggestion.

Expressive ties

1. Members in my team are well acquainted personally with each other.
2. Members in my team talk with each other about things beyond work.
3. Members in my team consult each other for personal matters.
4. Members in my team build good friendship with each other.

Transactive memory system

Specialization

1. Each team member has specialized knowledge of some aspect of our projects;
2. Different team members are responsible for expertise in different areas;
3. The specialized knowledge of several different team members is needed to complete our project deliverables;
4. I know which team members have expertise in specific areas.

Credibility

1. I am comfortable accepting procedural suggestions from other team members;
2. I trust that other members' knowledge about our projects is credible;
3. I am confident relying on the information that other team members bring to the discussion;

Coordination

1. Our team members have a global perspective that includes each other's decisions and the relationship among them.
2. Our team members carefully interrelate action to each other to the teamwork done.
3. Our team members carefully make their decision to maximize an overall team performance.
4. Our team members have developed a clear understanding of how each business function should be coordinated.

Team efficacy

1. I feel confident about the capability of my group to perform the tasks very well.
2. My group is able to solve difficult tasks if we invest the necessary effort.
3. I feel confident that my group will be able to manage effectively unexpected troubles.

Team performance

Team efficiency

1. Overall, my team does our work in a cost-efficient way.
2. Overall, my team does our work in a time-efficient way.
3. Overall, my team does our work within schedule.
4. Overall, my team does our work within budget.

Team effectiveness

1. My team is effective in getting things done.
2. My team completes its task successfully.

All six dummy variables for industry type () are found to be insignificant.

Task interdependence

1. I work closely with others in doing my work.
2. I frequently must coordinate my efforts with others.
3. The way I perform my job has a significant impact on others.
4. My work requires me to consult with others fairly frequently.

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