

**HARVESTING SOCIAL KNOWLEDGE:  
SOCIAL NETWORKS AND KNOWLEDGE IN  
TECHNOLOGY-MEDIATED TEAMS**

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**NATIONAL UNIVERSITY OF SINGAPORE**

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# TABLE OF CONTENT

<b>ACKNOWLEDGEMENT</b> .....	<b>i</b>
<b>TABLE OF CONTENT</b> .....	<b>iii</b>
<b>LIST OF TABLES</b> .....	<b>vi</b>
<b>LIST OF FIGURES</b> .....	<b>vii</b>
<b>STUDY ONE</b> .....	<b>viii</b>
1. Introduction.....	1
1.1. Motivation for Study.....	1
1.2. Research Questions.....	4
1.3. Theoretical and Practical Contributions.....	5
2. Theoretical Foundations.....	6
2.1. Sources of Creativity.....	6
2.2. Social Ties and Expertise.....	8
2.3. Moderating Role of Multiple Media.....	10
3. Hypotheses Development.....	13
3.1. The Effects of State-type Ties on Expertise Responsiveness.....	13
3.2. The Effects of Event-type Ties on Expertise Diversity.....	14
3.3. The Moderating Effects of Media Multiplexity.....	15
3.4. The Effects of Expertise Diversity/Responsiveness on Creativity.....	17
4. Methodology.....	19
4.1. Research Context.....	19
4.2. Measurements.....	20
4.3. Data Analysis.....	23
5. Discussion.....	37
5.1. Tie Types and Creativity.....	37
5.2. Expertise Diversity/Responsiveness and Creativity.....	39
5.3. Media Multiplexity.....	40
6. Theoretical and Practical Implications.....	43
6.1. Theoretical Implications.....	43
6.2. Practical Implications.....	43
7. Conclusion.....	45
7.1. Limitations.....	45
7.2. Future Research.....	46

7.3. Concluding Remarks.....	47
<b>REFERENCE.....</b>	<b>48</b>
<b>STUDY TWO.....</b>	<b>52</b>
1. Introduction.....	53
2. Literature Review.....	56
2.1. Relational Capital.....	56
2.2. Leadership and Relational Capital.....	57
2.3. Relational Capital and OCBs.....	58
2.4. Technology Support for Contextualization.....	59
3. Research Model and Hypotheses.....	60
3.1. Effects of Inspirational Leadership on Relational Capital.....	60
3.2. The Moderating Role of Technology Support for Cognitive Contextualization.....	61
3.3. The Moderating Role of Technology Support for Affective Contextualization.....	62
3.4. Effects of Relational Capital on OCBs.....	63
4. Methodology.....	64
4.1. Data Collection.....	65
4.2. Measures.....	65
4.3. Measurement Model.....	68
4.4. Structural Model.....	72
5. Discussion.....	73
6. Theoretical and Practical Implications.....	78
6.1. Implications for Practice.....	78
6.2. Implications for Theory.....	79
7. Limitation and Future Research.....	80
7.1. Limitations.....	80
7.2. Suggestions for Future Research.....	80
8. Conclusion.....	81
<b>REFERENCE.....</b>	<b>82</b>
<b>APPENDIX I.....</b>	<b>86</b>
1. Introduction.....	88
2. Theoretical Background.....	91
2.1. Contextual Attributes in the Knowledge Creation Process.....	91
2.2. Knowledge Attributes in a Heterogeneous Network.....	93
3. Hypotheses Development.....	96

4. Methodology .....	98
4.1. Research Context .....	98
4.2. Measurements .....	99
4.3. Analysis Strategy .....	101
4.4. Results.....	102
5. Discussion .....	104
6. Theoretical and Practical Implications.....	107
6.1. Theoretical Implications .....	107
6.2. Practical Implications.....	108
7. Limitations and Future Research .....	109
8. Conclusion .....	110
Reference .....	111
<b>APPENDIX II SURVEY QUESTIONS FOR STUDY ONE .....</b>	<b>114</b>
<b>APPENDIX III SURVEY ITEMS FOR STUDY ONE .....</b>	<b>124</b>
<b>APPENDIX IV SURVEY ITEMS FOR STUDY TWO .....</b>	<b>125</b>
<b>APPENDIX V INLLUSTRATION OF DYADS AND DATA ORGANIZATION. 126</b>	
1. Illustration of Dyads .....	126
2. Illustration of Data Organization .....	126

## **LIST OF TABLES**

Table 1.1. Types of Social Ties .....	8
Table 1.2. Demographic Information of Participants .....	21
Table 1.3. Descriptive Statistics.....	25
Table 1.4. Regression Results.....	28
Table 1.5. Summary of Hypotheses Testing.....	31
Table 1.6. Test of Multicollinearity .....	33
Table 2.1. Descriptive Statistics, Correlation of Constructs, and Square Root of AVE Values .....	70
Table 2.2. The Convergent Validity and Collinearity Diagnostics.....	71
Table 2.3. Summary of the Results of Path Coefficients .....	72
Table 2.4. Demographic Information of Respondents.....	74
Table 3.1. Means, Standard Deviations and Correlations.....	103
Table 3.2. Hypotheses Testing.....	104



## **LIST OF FIGURES**

Figure 1.1. Research Model.....	18
Figure 1.2. Interaction Effects on Expertise Responsiveness.....	29
Figure 1.3. Interaction Effects on Expertise Responsiveness.....	29
Figure 1.4. Interaction Effects on Expertise Diversity.....	30
Figure 1.5. Interaction Effects on Expertise Diversity.....	30
Figure 1.6. Results of Hypotheses Testing.....	32
Figure 2.1. Research Model.....	64
Figure 2.2. Path Estimates and R squares.....	73
Figure 3.1. Multiple Entities of Content in a Heterogeneous Network.....	90

## **STUDY ONE**

### **SOCIAL TIES AND EXPERTISE ON CREATIVITY IN TECHNOLOGY-MEDIATED TEAMS**

#### **ABSTRACT**

Acknowledging that cognitive limit may constrain creativity, researchers have begun identifying social networks as possible sources of diverse knowledge in technology-mediated teams. However, previous studies on network perspectives of creativity tend to focus on individual networks as conduits that transfer diverse information. Very few studies have considered the role of network ties in improving information quality that foster creativity between pairs of individuals. In this study we build on literature in social networks, psychology and team research to hypothesize that network ties will create opportunities for information diversity and quality, and extend this stream of research by investigating an untested relation between network ties, expertise and creativity.

We conducted a field study with 128 individuals in a research institution in the electronic technology industry. Based on the results of 382 pairs of dyads, we identify two types of network ties (i.e., state-type and event-type ties) that predict different sources of ideas generation (i.e., expertise diversity and responsiveness). The results also reveal the moderating effects of multiple media usage in dyadic communication. The findings provide theoretical and practical contributions to extant literature on social networks and the usage of multiple media in teams that engage in creative tasks.

## **1. Introduction**

### **1.1. Motivation for Study**

As work becomes increasingly dynamic, uncertain, and knowledge-based, organizations depend on creative ideas from employees who collaborate in technology-mediated teams (Sha and Chang 2012). *Creativity* is defined as the production of ideas that are both original and useful (Amabile 1996). There has been a burgeoning interest to understand the factors that facilitate or constrain creative contributions in technology-mediated work contexts. Considerable research efforts have described individual differences and psychological forces as important factors that motivate creative performance at work (e.g., Elsbach and Hargadon 2006; Grant and Berry 2011; Shalley et al. 2004). The majority of research has focused on identifying personality traits associated with creative outcomes (e.g., Bergami and Bagozzi 2000; Gong et al. 2009), structuring work contexts that support creative performance (e.g., Lam et al. 2007; Shalley 2008), and intrinsic motivation that enhances creative ideas generation (e.g., Grant and Berry 2011; Janssen and Van Yperen 2004). Recently, acknowledging that the generation of creative ideas involves synthesis and combination of different perspectives from one another in teams, researchers have started to examine social networks as possible sources of diverse knowledge (e.g., Perry-Smith and Shalley 2003; Perry-Smith 2006; Zhou et al. 2009).

However, social network research on creativity has mainly emphasized network ties as structural constraints that affect individuals' ability of accessing diverse ideas (Perry-Smith 2006; Zhou et al. 2009). There is limited research on social networks as forms of improving information quality that can enhance creative performance. Yet, network ties reflect individuals' motivation to expend efforts on their tasks, and foster their interests in providing new and high-quality ideas and solutions (Gagné and Deci 2005). In this study we build on literature in social networks, psychology and team research to hypothesize that network ties will create

opportunities for information diversity and quality, and extend this stream of research by investigating an untested relation between network ties, expertise and creativity.

Recent research has found that the generation of creative ideas is not only a simple combination of different perspectives, it also requires diverse and high-quality information in the process (Amabile et al. 1994; Tiwana 2008). Accordingly, we propose that the generation of creative ideas benefits from two sources: *information diversity* in the form of *expertise diversity*, and information quality in the form of *expertise responsiveness*. *Expertise diversity* helps establish novel linkages to different knowledge pools that are important for generating creative outcomes (Perry-Smith and Shalley 2003; Zhou et al. 2009). *Expertise responsiveness*, on the other hand, reflects individuals' motivation to expend efforts (Ryan and Deci 2000), and enhances creativity by enhancing psychological engagement, and willingness to respond with thought-through answers (Marsden and Campbell 1984). In a word, expertise responsiveness complements expertise diversity to explain that except for the diverse knowledge that have an impact on the generation of creative ideas, expertise responsiveness that indicates information quality has potential explanatory power of creative outcomes. Expertise diversity controls the amount of knowledge overlapping between the source and the recipient (Reagans 2005), while expertise responsiveness guarantees quality and depth of interaction.

Previous studies have found that different types of social network ties serve different purposes to predict expertise diversity and expertise responsiveness (Yuan et al. 2010). Network theorists tend to categorize network ties into two basic types: *states* and *events*. State-type ties are the intensity of one's feeling about relatively stable relationships, such as role-based relations (e.g., friend of, parents of), cognitive (e.g., recognizes; value the skills of) and affective relations (e.g., likes; hates) (Borgatti and Halgin 2011). In contrast, event-type ties are the frequency of events

happened between two individuals, such as email exchange, knowledge seeking and contributing. State-type ties build individuals' energy for sustaining effort and increase their willingness to expend time to reciprocate with thought-through answers, for the reason that state-type ties reflect a stable relationship and predictable behaviors. Accordingly, two kinds of network ties are identified under this category, which are *cognitive ties* and *affective ties*. *Cognitive ties* in dyads refer to the extent of which two individuals in the tie cognitively recognize each other's expertise and skills. *Affective ties* are defined as the ties that reflect positive bonds and enjoyment in the tasks that is being performed.

On the other hand, event-type ties emphasize the level of expertise diversity between dyads, under which two kinds of events that commonly happened in working places are examined, namely *knowledge seeking* and *knowledge contributing*. *Knowledge seeking* refers to the frequency to which one in a dyad seeks work-related information from the other (Borgatti and Cross 2003). *Knowledge contributing* is the frequency to which one in a dyad contributes his/her work-related information to the other (Wasko and Faraj 2005). High frequency of knowledge seeking and knowledge contributing is likely to share redundant information between dyads due to dyads' limited amount of knowledge, therefore decrease the level of expertise diversity. By adopting this categorization based on state-type ties and event-type ties, this study investigates the effects of these ties on expertise diversity and expertise responsiveness.

Scholars on communication studies have found that communication media have a great impact on the relationships between social relationships and the process of information exchanging (Burkhardt and Lubart 2010). Employees in modern organizations often use various communication media to collaborate with colleagues. The number of these technologies available to employees constantly increases. As a result, the use of multiple media in complex

work environments can have significant implications for communication outcomes. Findings from previous research show that, when individuals engage in information related activities, they can reap the benefits of multiple communication media in an integrated way to share knowledge in multiple formats. As a result, the level of expertise diversity may increase due to rich formats of information presented through multiple media ( Yuan et al. 2010). Multiple media ease the transfer of tacit and complex knowledge, reduce misunderstanding during communication, and facilitate developing interpersonal relationships. Consequently, multiple media also increase the chance of obtaining high-quality responses from others (Haythomthwaite and Wellman 1998). Therefore this study investigates the impact of *media multiplexity*, which refers to the extent to which individuals use multiple communication media to interact with the other on the relationship between network ties and expertise diversity/expertise responsiveness.

## **1.2. Research Questions**

All variables in this study are operationlized at dyadic level. Creativity has been examined intensively at both individual level and group level. However, as an output of combination and synthesis of knowledge exchanged between individuals, dyads constitute an ideal unit of analysis to reflect that the differences in dyadic network ties may result in different levels of creative performance. First, the day-to-day interactions in technology-mediated teams are typically dyadic although there are communication media that enable whole teams to interact at the same time. Much of the interaction in technology-mediated teams involves two team members at one time collaborating on the same tasks (e.g., Majchrzak, Malhotra, Stamps & Lipnack, 2004). Second, researchers suggest structuring teams that are engaging creative tasks into pairs of collaborators within teams is as productive as purely teams (Dew and Hearn 2009). Besides, dyadic exchange not only conduits knowledge but also transmits various level of social

support. As a result, dyadic analysis helps disentangle more precisely the effects of different types of network ties, and different levels of expertise diversity/expertise responsiveness within dyads on the generation of creative ideas. Disentangling these effects help us uncover what differences in dyadic network ties in terms of information diversity and quality that they conduit. would have an impact on the generation of creative ideas. Therefore, this study is going to investigate the following research questions:

- 1) What are the effects of state-type ties and event-type ties on expertise diversity and expertise responsiveness between dyads?
- 2) What are the effects of expertise diversity and expertise responsiveness on creativity between dyads?
- 3) How are the effects of state-type ties and event-type ties on expertise diversity and expertise responsiveness influenced by the level of media multiplexity between dyads?

### **1.3. Theoretical and Practical Contributions**

The present research makes three noteworthy theoretical contributions to the extant literature. It contributes to the network perspective of creativity by theoretically and empirically examining the relatively untested role of network ties in improving information quality. Emphasizing the importance of both information diversity and quality, this study provides a more comprehensive way to explain the process of generating creative ideas. Second, by examining creativity at a dyadic level, this study identifies different types of network ties existing in the same dyads (state-type ties and event-type ties) to investigate their impact on influencing information diversity and quality. Dyadic level analysis helps explain that why some dyads are more creative than other dyads from a network perspective. Third, by providing a theoretical support for

multiple media usage in communication, this study provides theoretical and empirical support to the moderating role of communication media on the relationship between network ties and dyadic communication process.

This study offers managerial insights for fostering team creative performance and adopting appropriate communication media. First, to facilitate the generation of creative ideas, this study suggests taking into consideration of both information diversity and quality in a dyadic communication. To be specific, it is important to recruit new members with diverse background to guarantee diverse information flow within the team. On the other hand, it cannot be ignored that fostering interpersonal relationship to improve information quality. Second, this study provides insight for selecting communication media for teams that perform creative tasks. As an increasing number of communication media is available to employees, adopting appropriate communication media under different context is beneficial to improve work performance.

## **2. Theoretical Foundations**

### **2.1. Sources of Creativity**

In a reflection of the insight that the generation of creative ideas is the result of novel combinations of different perspectives and approaches individuals are exposed to via social interactions (Allen 1977), recent scholars have identified social network parameters that shape creativity at work. Social network scholars mainly examine network ties as conduits of information flow, and emphasize that communicating diverse information with others is an important source of generating creative ideas. The notion of diversity information roots in the strength-of-weak-tie theory. Previous studies have suggested that weak ties favor creativity for the reason that infrequent interactions indicate low knowledge redundant, thus ease the access to diverse information (e.g., Perry-Smith and Shalley 2003; Perry-Smith 2006; Uzzi and Spiro 2005; Fleming and Mingo 2007). Diverse information indicates novel linkages to different



knowledge pools and stimulate autonomous thinking (Perry-Smith and Shalley 2003). It is particularly valuable to the production of creative ideas for it allows individuals to access and expose to information that is likely to be novel, thus have a greater potential for generating creative ideas.

The effect of information diversity is grounded in the role of cognitive variation in generation of creative ideas. Knowledge creators have large pool of potential novel and useful ideas to choose when the source has greater variance in their cognitive idea generation. In other word, the number of cognitive elements that are used for knowledge creation are essential to generate creative ideas, for the reason that they can be combined into new variations depending on the exiting knowledge elements in the mind of knowledge creators (Simonton 1999). Hence diverse knowledge is supposed to increase the cognitive variation of the creator and is more likely to facilitate the generation of creative ideas. In this study, we use *expertise diversity* to describe the extent to which content in the dyadic communication includes distinct domains and non-redundant knowledge (Perry-Smith and Shalley 2003; Zhou et al. 2009).

On the other hand, to produce creative ideas, researchers have believed that except for exposure to diverse information, individuals need to exchange high-quality information to make fruitful discussion (Elsbach and Hargadon 2006). Previous studies found that the partner's level of responsiveness determines the quality of creative communication (Fliaster and Schloderer 2010). To generate creative ideas, it is not enough for the dyads to rely on different pieces of knowledge but engage in repeated searching and interactive discussions (Csikszentmihalyi and Sawyer 1995), especially when they exchange complex technological know-how (Cross and Sproull 2004). Generating creative ideas not only includes combination and synthesis of new information, but also high-quality knowledge that contains explicit and tacit components (Nonaka and Takeuchi 1995). Therefore creative interactions require more intellectual efforts as

well as stronger intrinsic motivation (Reagans and McEvily 2003). Identified from previous study, we define *expertise responsiveness* as the extent that the source in the dyads provides timely and thoughtful feedbacks to the recipient, and examine its effects on creativity (Fliaster and Schloderer 2010).

## 2.2. Social Ties and Expertise

It is common that multiple relationships existing in the same dyadic ties. Different dyadic ties that serve for multiple purposes may predict expertise diversity and expertise responsiveness. Researchers have adopted several ways to categorize kinds of ties (e.g., Ho and Levesque 2005; Haythornthwaite 2002). Recently, Borgatti and Halgin (2011) summarize types of ties and categorize the kinds of ties into two basic types: states and event (see Table 1.1). State-type ties are characterized by a relatively stable relationship such as cognitive/affective relations. Event-type ties are created by recurred communication event, such as knowledge seeking and knowledge contributing. These two categories of tie types are not mutually exclusive and may occur at the same time.

Table 1.1. Types of Social Ties (Adapted from Borgatti and Halgin 2011)	
State-type ties	Event-type ties
<ul style="list-style-type: none"> <li>• Cognitive ties (e.g., knows)</li> <li>• Affective ties (e.g., likes or dislikes)</li> </ul>	<ul style="list-style-type: none"> <li>• In-degree interactions (e.g., knowledge seeking ties)</li> <li>• Out-degree interactions (e.g., knowledge contributing ties)</li> </ul>

In this study we adopt this categorization of tie types to investigate how they influence expertise diversity and responsiveness.. As motivated information processing theory suggests, when employees share stable relationships, they are likely to have predictable behaviours and positive affect toward each other. Thus they are relational motivated to respond with thought-through answers and high-quality expertise (Amabile et al.1994; Ryan and Deci 2000). Accordingly, we

propose that state-type ties that indicate stable relationships may have an impact on expertise responsiveness. Specifically, under the categorization of state-type ties, we examine two of the most common state ties, which are *cognitive ties* and *affective ties*. Cognitive ties explains how individuals in a group with their own skills and expertise, develop communication networks that help them identify the skills and expertise of others in the group (Katz et al. 2004). Cognitive ties facilitate flows of knowledge between two individuals, and increase the access of diverse skills or expertise available elsewhere within other individuals. We define *cognitive ties* in dyads as the degree of that two individuals feel they recognize each other's expertise and skills. Affective ties describe the personal emotion toward each other in a dyad, such as liking or disliking each other, whether enjoying involving in the relationship, etc. Affective ties can be reflected in terms of identity (Bergami and Bagozzi 2000), commitment (Sha and Chang 2012; Kanter 1968), reciprocity (Gouldner 1960) and homophily (McPherson et al. 2001). Affective ties indicate a positive attitude in the relationship that would ease the transfer of tacit and complex knowledge, increase the mutual understanding, and provide intrinsic motivation and social support. We define *affective ties* in dyads as the degree of that two individuals share positive bonds and enjoyment in the tasks that are being performed.

On the other hand, event-type ties are supposed to have an impact on expertise diversity for the reason that their frequency determines the level of information redundancy in communication. Under the categorization of event-type ties, we examine two activities commonly happened in knowledge-intensive professional organizations, which are *knowledge seeking* and *knowledge contributing*. Frequency of knowledge seeking and contributing within a constrained network may lead to exchange redundant information and increase the possibility of similar perspectives. Low frequency of event-type ties is more likely to connect different actors and to access and expose to non-redundant perspectives and approaches. First, low frequency of event-type ties

indicates one's weak connection to a particular social circle. As a result, weaker connections may be less likely to be repetitive and associated with non-redundant information. Another reason that weak connections facilitate creativity is that they are more likely to provide access to diverse perspectives. Individual with whom a focal individual has weak contacts are likely to be different not only from the focal individual, but also from one another. Hence, low frequency of event-type ties provides access to diverse perspectives (Perry-Smith and Shalley 2003).

### **2.3. Moderating Role of Multiple Media**

As employees work in complex environment, they share membership of multiple teams, access to an increasing number of communication media and follow norms of communication media usage to perform communication-based tasks. As individuals are likely to maintain various ties in communication, they use multiple communication media to enhance dual usefulness of network ties. Theories on communication media explain the role of communication media in influencing the relationships between frequency of network ties and information content. For instance, in the seminal paper of media multiplexity theory written by Haythornthwaite and Wellman (1998), the findings suggested that dyads that are engaged in the intensive work relationships and close friendships intend to use several kinds of media to communicate and exchange information in multiple formats (Haythornthwaite and Wellman 1998). At the meantime, the usage of multiple media may also have the potential to have an impact on the relationship between intensity of network ties and relationship development. For example, some case studies have investigated that how multiple media can be used in combination to support communication, and how social relationships correlated with media usage (e.g., Watson-Manheim and Bédanger 2007). Findings show that multiple media usage may have positive impact on relationship development and interpersonal trust.

There are some theoretical arguments that can be used to support the role of multiple media in the tasks of generating creative ideas. First, multiple media provides individuals with multiple technological accessibilities. Communicating with multiple media enables employees to switch from one medium to another when they do not receive a response to a medium in a timely fashion. For instance, e-mail is sometimes not perceived as reliable medium for interaction because it doesn't provide employees with confidence to get response from others. While some instant communication media may overcome the limitation of e-mail to allow employees to access and get response quickly, thus increase the responsiveness of interaction.

Second, multiple media expand the communication channels for employees to access diverse knowledge. To access diverse knowledge, multiple media first provides various choices for employees to select the media to access the specific expert they need to interact. Multiple media also offers employees with benefits of each communication media in an integrated way to obtain different types of expertise from different people to accomplish a task (Yuan et al. 2010). Multiple media transmits multiple cues and a variety of symbols in terms of different information formats are likely to enrich the diversity of content in the communication tie. As a result, multiple media increase and deepen the mutual understanding of information exchanged between dyads. Some information may be easier to convey in one format rather than another. For instance, senders may include information beyond the words when the message is transmitted, such as including verbal and nonverbal symbols. Multiple media complements with each other to provide rich cues to ease the sharing of tacit knowledge especially when the expertise providers encounter the difficulties of knowledge codification and verbalization (Hansen 1999; Yuan et al. 2010).

In addition, multiple media enable relationship development between employees. For instance, findings from previous case studies show that using e-mail is not sufficient for relationship development, but combined with either meetings or phone conversations it provides enough for a personal touch to overcome the limitation of emails (Watson-Manheim and Bédanger 2007). Multiple media is also associated with the feelings of “presence” with others, it is likely to trigger positive attitude between communicators and facilitate them to develop intrinsic motivation to be in the relationship. In a word, the usage of multiple media improve both accuracy and efficiency in knowledge sharing, deepens the understanding of problems, and cultivates positive affect for generating thought-through interactions and solutions.

### **3. Hypotheses Development**

#### **3.1. The Effects of State-type Ties on Expertise Responsiveness**

The dyads with cognitive ties have an implicit structure of the other's informational responsibility based on their shared conception of one another's expertise. The dyads are assigned with responsibility for providing information they are specialized in. As a result, when individuals become aware of expertise of one another, the more expert member in the dyads is assigned with responsibility for information related to expertise the other one need (Anand et al. 1998). Therefore the dyads are more effective in obtaining the information they want because knowledge comes more specialized as a result of the delegation of knowledge responsibilities to dyads. Thus we propose:

*H1: Intensity of cognitive ties will be positively associated with expertise responsiveness between dyads.*

Affective ties link dyads that are intrinsically willing to work together. Strong affective ties reflect whether two individuals in the dyads enjoy working together and are willing to provide social support to each other. Affective ties are likely to have intrinsic motivations that provide support for generation of creative ideas (Ryan and Deci 2000). Strong affective connections build up relational capital between the dyads, which cultivate the feelings of identification, commitment toward each other, and develop the norms of reciprocating. The behaviors of the dyads with strong affective ties are predictable (Sha and Chang 2012), and increases the chance of obtaining thought-through response from the other as expectation. Thus we predict:

*H2: Intensity of affective ties will be positively associated with expertise responsiveness between dyads.*

### **3.2. The Effects of Event-type Ties on Expertise Diversity**

Knowledge seeking and knowledge contributing are two activities that commonly happen in working places. As indicated in previous studies, the generation of creative ideas sources from the combination of different perspectives (Hansen 1999; Reagans and McEvily 2003). However, Researchers have identified that the more frequent interaction the dyads have, the more likely they share redundant information (Perry-Smith 2006). Knowledge seeking happens when dyads hope obtain work-related advice and eager to refresh themselves with new perspectives from the other. At the first stage of knowledge seeking, the seeker in the dyads may feel information from the other new and diverse from their own. However, as the frequency of seeking knowledge increase, the amount of diverse information from the other may decrease due to source's limited knowledge amount.

*H3: Frequency of knowledge seeking ties will be negatively associated with expertise diversity between dyads.*

As knowledge contributors have limited knowledge base, infrequent communication may make their recipients feel that the contributors' knowledge pool is distinct from theirs. However, as the communication frequency increase, the updating speed of contributors' knowledge pool may not match the seekers' information request. Knowledge contributors maybe more likely to share redundant information and decrease the diversity of information during dyadic communication. Therefore the high frequency of knowledge contributing will reduce the level of diverse information in the interaction. Thus we predict:

*H4: Frequency of knowledge contributing ties will be negatively associated with expertise diversity between dyads.*



### **3.3. The Moderating Effects of Media Multiplexity**

Media multiplexity describes the phenomenon that individuals use multiple media to communicate with others. The usage of multiple media benefits dyads meeting different communication needs, depending on the strengths and types of ties. For example, Instant messaging tools are very helpful to build immediate connections with a high possibility of responsiveness, thus influence the strength of dyadic ties. Emails may improve both accuracy and efficiency when the knowledge is tacit and hard to articulate (Hansen 1999), and are used in most of the formal situations to exchange text-based information that can be codified and recorded. Therefore media multiplexity facilitates greater flexibility in fulfilling communication needs.

According to media usage research in organizations, managers prefer to use limited number of communication media (Watson-Manheim and Belanger 2007). As a result, except for the usage of group-wide communication media, dyads may have limit access to each other. The usage of multiple media in dyadic communication offers multiple choices for the dyads to get access to each other, especially when dyads are linked by cognitive ties. Dyads with recognition of each other' expertise are more effective in getting thought-through responses from others, for they have better knowledge of what expertise the other has. As result, they are more likely to choose appropriate media from multiple media to access the other and obtain the information they want.

Thus we predict:

*H5a: The relationship between cognitive ties and expertise responsiveness will be strengthened by media multiplexity.*

For the dyads connected by affective ties, media multiplexity plays a role in enhancing their relationship. Affectively tied dyads share positive attitude toward each other, and they are

intrinsically motivated to seek more than one kind of media to engage in the communication (Yuan et al. 2010). Multiple media has varied abilities to transmit information with contextual cues, and serve for different communication needs, such as for networking, collaborating, transferring, etc. Multiple media is associated with the feelings of “presence” with others, it is likely to trigger positive attitude between communicators and facilitate them to develop intrinsic motivation to be in the relationship. Thus we predict:

*H5b: The relationship between affective ties and expertise responsiveness will be strengthened by media multiplexity.*

As mentioned before, multiple media have different advantages in representing information based on its abilities of transmitting rich formant of cues and synchronizing the communication. Using multiple media is effective to enrich the content of professional communication, improve the accuracy and effectiveness of interaction especially when knowledge is complex technological know-how. For knowledge seekers, they have more choices to present their information request with the help of multiple media. For instance, compared to emails, wikis and blogs are more suitable to present complex knowledge with format of non-verbal cues, such as images and videos. Therefore knowledge seekers’ information request includes diverse information cues and contributes to the completion of the information in terms of various formats. Correspondingly, knowledge seekers are more likely to obtain diverse expertise that is responded in different formats via different communication channel. Thus seekers may perceive more diverse information from the contributors. Thus we predict:

*H6a: The relationship between knowledge seeking ties and expertise diversity will be strengthened by media multiplexity.*

Similarly, multiple media help knowledge contributors present their sharing in multiple formats by making use of the advantages of each media. For instance, contributors may use E-mail to elaborate their basic ideas for a new product, with a video to give a demonstration virtually. Therefore, it is more likely for the recipients to feel that they obtain diverse responses with rich information from the contributors in different formats. Thus we predict:

*H6b: The relationship between knowledge contributing ties and expertise diversity will be strengthened by media multiplexity.*

### **3.4. The Effects of Expertise Diversity/Responsiveness on Creativity**

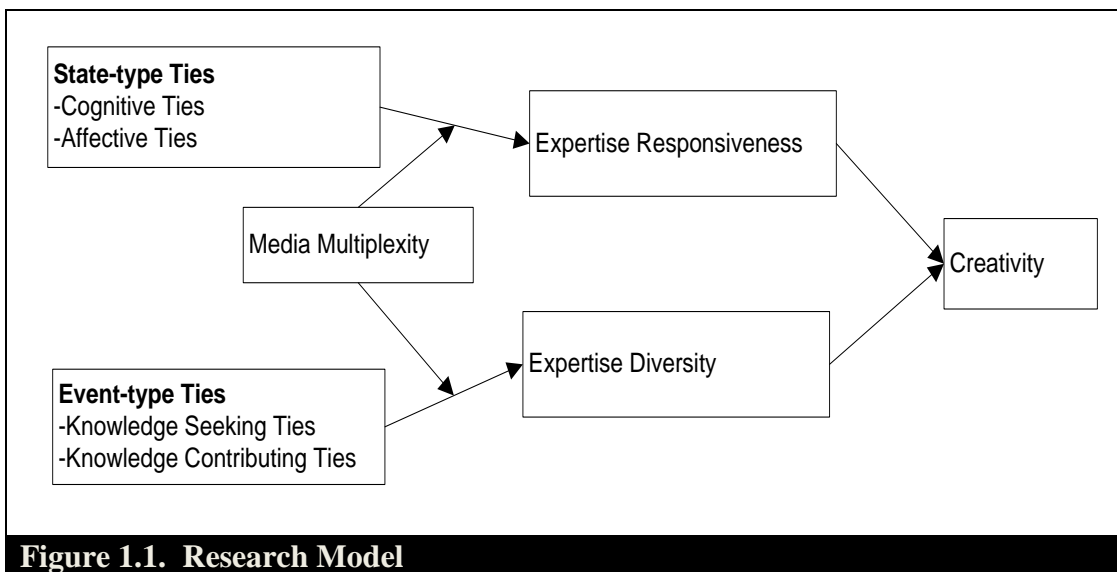
The findings in previous research on creativity have suggested that accessing diverse knowledge and developing skills to establish novel linkages to different knowledge pools are important for generating creative outcomes (Cattani and Ferriani 2008; Sosa 2011). The dyads with diverse knowledge are able to greatly reduce redundant information and refresh their mind by new ideas, thus are more adept at generating creative ideas. Hence individuals in dyadic interactions that conduits distinct knowledge domain is more likely to generate creative ideas. Thus we propose:

*H7: Expertise diversity will be positively associated with creativity.*

Creativity requires fruitful discussion between the dyads and requires intensive and immediate feedbacks (Cross and Sproull 2004). Previous studies found that the partner's level of responsiveness determines the outcome of creative ideas (Fliaster and Schloderer 2010). First, generation of creative ideas depends on how available and accessible the source is to the recipient, and whether the responses from the source are thought-provoking and inspiring. A formal reply from the source will not benefit creative discussion but a waste of time for recipient to process. Second, generating creative ideas is time-consuming and requires much

efforts and motivation. A high level of mutual responsiveness within the dyads would maintain the motivation of interacting for creative ideas and reduce the waiting time during interactions (Reagans and McEvily 2003). It also cultivates positive communication norms that dyads in the interaction feel identified, committed and responsibility to trust and reciprocate to each other. Therefore we predict:

*H8: Expertise responsiveness will be positively associated with creativity.*



## **4. Methodology**

### **4.1. Research Context**

The setting for our empirical analysis was a large research institution in the electronics technology industry in Asia. We first understood the research setting, the value that the institution placed on creativity, the level of interaction among the employees and the communication media they use to interact. We excluded both administrative staff and temporary personnel such as interns.

The primary function of the research institution was to promote technology innovation and provide technical solutions for electronics devices, with a focus on addressing technological difficult problems. Generating creative ideas was critical for the overall success that improved work efficiency and provided solutions to customers. Employees in the research institution shared dynamic membership, with an updated new membership when they were enrolled in a new research project. Although employees are required to form teams with several others, they usually communicate frequently with a fixed other peer from the same institute for the tasks they were currently engaging. The tasks for the research institution required the ability of exchanging information across products, research ideas, geographies, and required the ability of building and maintaining coordinated and shared understanding of information and group activities. Employees also had access to a variety of communication media, including emails, telephone, instant messaging, collaborative tools and other social media tools based on their communication needs.

Following the convention of social network studies (Scott 2000; Wasserman and Faust 1994), we collected data for most of the variables using onsite survey using a method of name generation. All employees in the division were invited to participate in the study. All employees

were asked to complete the survey during their working days to obtain highest possible response rate. The survey took an average of 40 minutes to complete and was filled out by 128 of 147 employees in the research institution (87.1% response rate), which included 382 pairs of dyads. Each participant was provided with a fixed roster of employees and was asked to list the name of employees who they know in the research institution. After participants identified their contacts, they were asked to answer the questions about the relationships with each of their contacts. On average, participants listed 4 contacts they knew in the research institution. In addition, demographic data was obtained from company records (shown in Table 1.2).

Collecting complete social network data involves asking a respondent to answer the same question over and over again about each of his or her contacts. As the intensive work involved in this process, most social network scholars rely on single-item measurement to measure relationships due to the concern for participants' level of fatigue (Borgatti and Cross 2003; Labianca et al. 1998). Consistent with social network research, and to ensure a high and reliable response rate, each variable was measured by a single network question (Carrington et al. 2005; Marsden 1990).

#### **4.2. Measurements**

*Creativity* The primary dependent variable, *creativity*, was measured by one item, adapting from previous studies (George and Zhou 2001). On a five-point scale ranging from 1 (strongly disagree) to 5 (strongly agree), respondents were required to rate the extent to which they agree or disagree with the statement related to creative performance. This type of measure had been widely used in creativity research (Oldham and Cummings 1996; Shalley and Perry-Smith 2001; Tierney et al. 1999) and provided a broad assessment of creative contributions. The item

was “I often develop new ideas with this person when solving the problems in project tasks”. A one-mode matrix was constructed to map the mutual evaluation of creative performance.

<b>Table 1.2. Demographic Information of Participants</b>			
Variables	Category	Frequency	Percentage
Gender	Male	88	68.8%
	Female	40	31.2%
Age	22-30	28	21.9%
	30-35	55	43.0%
	35-40	20	15.7%
	40-45	12	9.3%
	>45	13	10.1%
Tenure	< 5 year	29	22.7%
	5 to 10 years	52	40.7%
	10 to 20 years	23	18.0%
	>20 years	24	18.6%
Discipline Background	Computer Science	87	68.0%
	Management	20	15.6%
	Electronic Engineering	21	16.4%
Highest Degree Attained	Poly	17	13.3%
	Bachelor	64	50.0%
	Master	47	36.7%

*Tie Types* Suggested by Borgatti and Haigin (2011), depending on the characteristics of different ties, state-types ties can be measured by intensity and event-type ties can be measured in terms of frequency of occurrence. For *cognitive ties*, respondents were asked to indicate the degree of that they feel they recognize each contact’s expertise. For *affective ties*, respondents were asked to rate the degree of that they enjoy working with the identified contact. The scale was from 1 (strongly disagree) to 5 (strongly agree). *Knowledge seeking* measured the frequency of one’s knowledge seeking from identified contact on project-related issues during the past three month (Borgatti and Cross 2003). *Knowledge contributing* measured the frequency of one’s knowledge contributing to the identified contact on project-related issues

during the past three month (Wasko and Faraj 2005). The scale was 1=never, 2= less than once a week, 3= once a week, 4=several times a week, 5=at least once a day.

*Expertise diversity* Expertise diversity measured the extent to the recipient feel information acquired from the source was different from his/her own knowledge domains. A self-report item “knowledge receive from this person is new to me” was used to measure dyadic expertise diversity. The scale was from 1 (strongly disagree) to 5 (strongly agree). A higher number indicated a high level of expertise diversity.

*Expertise responsiveness* Expertise responsiveness measured the extent to which dyads provide each other with thought-through responses, by using the single item “when asking work-related questions, this person responds with thought-through answer and not just a formal reply” (Fliaster and Schloderer 2010). A five-point scale from 1 (strongly disagree) to 5 (strongly agree) was used to measure the variable. A higher number indicated a higher level of expertise responsiveness.

*Media multiplexity* The measure for media multiplexity was derived from media-usage matrices. It was measured by asking respondents to indicate the frequency (1= never, 2= less than once a week, 3= once a week, 4= several times a week, 5= at least once a day) of each media they use to communicate with each of the identified person. The listed communication media included face-to-face meeting, ad-hoc meeting, E-mail, phone, instant messaging, social media and collaborative tools. Following previous studies (Sykes et al. 2009), media multiplexity captured the number of tools used at least once a week in the dyads. The responses were put into matrices such that a cell value of 1 in each matrix indicated that a participant (in the column) had used that media to communicate with a specific contact (in the row) at least weekly, otherwise 0. Following Haythornthwaite and Wellman (1998)’s study, media multiplexity was measured by



summing these matrices to create a single matrix with cell values ranging from 0 (no media used per week) to 6 (all medium used per week).

In addition to the primary variables, several control variables were included in the analysis. *Background heterogeneity* was the heterogeneity of functional background (Williams and O'Reilly 1998), which were obtained from participants' resumes. Functional background was each person's highest academic degree. We calculated background proximity to assess the extent to which a participant's background is similar to each other, and reversed it as the measure of background heterogeneity. Background heterogeneity was included for it may influence the diversity of information transferred between the dyads (Perry-Smith 2006). *Prior working ties* measured whether respondents had shared working experience on research projects before. Respondents were asked to indicate how many projects they had worked on in the past year, using one question "How many common projects have you worked with this person previously". *Work duration* was the number of years the dyad knows each other. Prior working ties and work duration were included for its high correlation with the mediating variables (Perry-Smith 2006; Sosa 2011). We controlled *knowledge seeking cost* and *knowledge contributing cost* for they may have an impact on expertise diversity and expertise responsiveness (Borgatti and Cross 2003). In addition, we also controlled *task type* for it may influence the diversity of information exchanged between dyads.

### **4.3. Data Analysis**

To test the model statistically, network correlation and regression were performed. The observations of network data are not independent and do not satisfy assumptions of statistical inference in classical regression. Consequently, special procedures known as quadratic assignment procedure (QAP) and multiple regression quadratic assignment procedure

(MRQAP) (Krackhardt 1988) was used to run the correlations and multiple regressions respectively. QAP and MRQAP were identical to their non-network counterparts with respect to parameter estimates, but used a randomization permutation technique (Edgington 1969) to construct significance tests. Significance levels for correlations and regressions were based on distributions generated from 10,000 random permutations. In the first step of MRQAP, Pearson correlations between the dependent and the independent network matrices were calculated. In the second step, the significances of the association between the matrices were determined by using a random permutation method (e.g., Labianca et al. 1998). To test our hypotheses, we used MRQAP that was implemented in the software package UCINET (Borgatti et al. 1999).

We first calculated the Pearson correlations between variables. Means, standard deviations and correlation coefficient for all measures are in Table 1.3. As expected, background heterogeneity was positively correlated with creativity. Prior working ties were significantly associated with all the independent variables and dependent variables. Among the independent variables, cognitive ties and affective ties were positively associated with expertise responsiveness and creativity. Knowledge seeking and contributing ties were negatively with expertise diversity. Expertise diversity and responsiveness were positively correlated to creativity.

**Table 1.3. Descriptive Statistics**

Variables	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. BH	2.659	0.934	-													
2. PT	3.381	1.377	-0.040	-												
3. WD	4.676	0.861	-0.067	0.233*												
4. TT	2.136	0.816	0.024	0.125	0.003											
5. CC	2.080	0.808	-0.062	0.228*	0.217*	0.062										
6. SC	2.256	0.672	-0.033	0.165	0.173	-0.038	0.480**									
7. CT	3.972	0.432	-0.094	-0.020	-0.040	0.111	-0.075	-0.073								
8. AT	3.966	0.761	-0.120	0.246*	-0.069	0.178	-0.153	-0.216*	0.118							
9. KS	3.182	1.061	0.028	0.221*	-0.172	0.163	-0.063	-0.065	0.210*	0.472**						
10. KC	3.188	0.932	-0.077	0.210*	-0.115	0.129	-0.033	-0.022	0.112	0.378**	0.401**					
11. MM	2.019	1.357	0.073	0.195	-0.013	0.165	-0.008	-0.017	0.185	0.259**	0.384**	0.264**				
12. ED	3.318	0.860	0.021	-0.107	-0.001	0.101	-0.012	-0.154	0.116	0.095	-0.063	-0.046	0.009			
13. ER	4.222	0.576	0.014	0.058	0.087	0.197*	-0.136	-0.118	0.071	0.290**	0.306**	0.208*	0.018	0.213*		
14. DC	3.778	0.854	0.216*	-0.039	0.126	0.153	-0.164	-0.119	0.245*	0.137	0.063	0.031	0.144	0.383**	0.331**	

\*  $p < .05$ , \*\*  $p < .01$

(BH= Background heterogeneity; PT= Prior working tie; WD= Work duration; TT= Task type; CC= Contribute cost; SC= Seek cost; CT= Cognitive ties; AT= Affective ties; KS= Knowledge seeking; KC=Knowledge contributing; MM= Media multiplexity; ER=Expertise responsiveness; ED=Expertise diversity; DC=Dyadic creativity)

Note: N=382 dyads

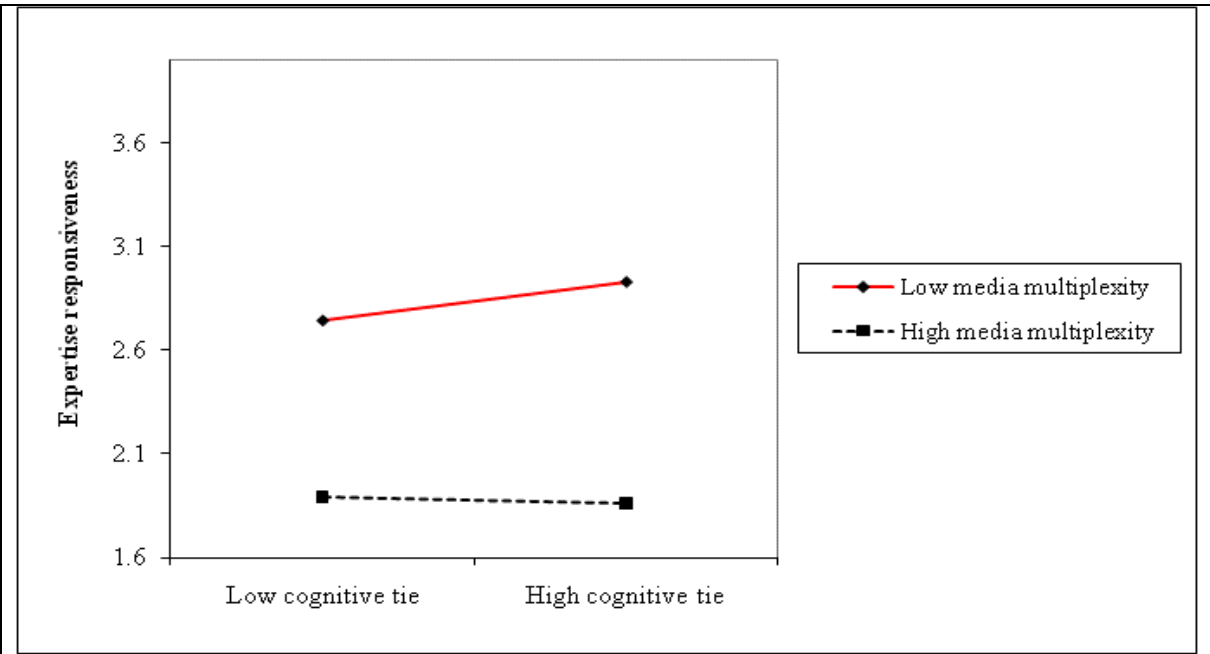
To test the hypotheses, we conducted a three-step regression using MRQAP. First, we regressed expertise diversity on control variables, independent variables and moderating variables. Second, we regressed expertise responsiveness on control variables, independent variables and moderating variables. Third, we regressed creativity on all the variables included in the model. To minimize any potential problems of multicollinearity and to better interpret the results, we centred the predictor variables before calculating the cross-product terms and examining the interaction effects before doing regression analysis (Aiken et al. 1991; Enders and Tofighi 2007). The results of the three regression models are shown in Table 1.4.

Model 1 in Table 1.4 shows the regression results of expertise responsiveness on control variables, independent variables and moderating variables. Background heterogeneity ( $\beta=0.032$ ,  $p < .01$ ) and work duration ( $\beta=0.087$ ,  $p < .01$ ) were positively related to expertise responsiveness. Contribute cost ( $\beta=-0.152$ ,  $p < .01$ ), seek cost ( $\beta=-0.279$ ,  $p < .01$ ) and task type ( $\beta=-0.039$ ,  $p < .05$ ) were negatively associated with expertise responsiveness. As predicted, H1 that states cognitive ties are positively related to expertise responsiveness was supported ( $\beta=0.267$ ,  $p < .01$ ). H2 was supported too ( $\beta=0.145$ ,  $p < .05$ ), indicating affective ties are positively associated with expertise responsiveness. H5a stated that the relationship between cognitive ties and expertise responsiveness would be strengthened by media multiplexity. H5a was not supported ( $\beta=-0.088$ ,  $p < .01$ ). H5b positing that the relationship between affective ties and expertise responsiveness would be strengthened by media multiplexity was supported ( $\beta=0.079$ ,  $p < .01$ ). The moderating effects of media multiplexity on state-type ties and expertise responsiveness are plotted in Figure 1.2 and 1.3.

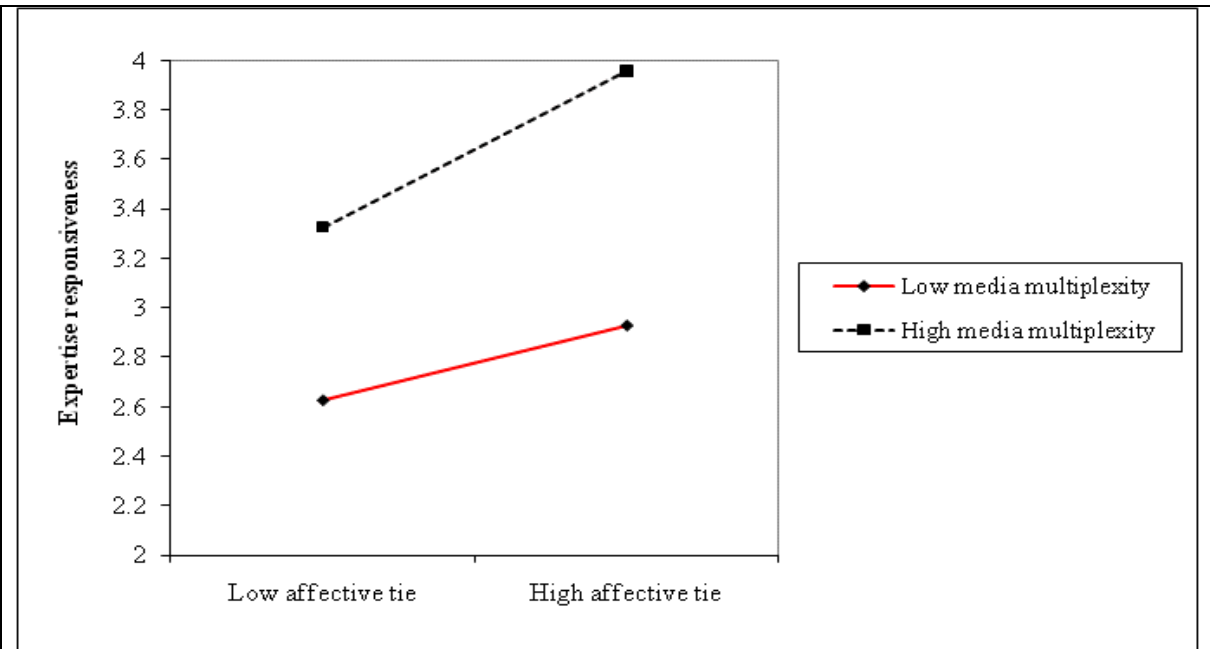
Model 2 in Table 1.4 shows the regression results of expertise diversity on control variables, independent variables and moderating variables. Background heterogeneity ( $\beta=0.042, p < .05$ ) and work duration ( $\beta=0.044, p < .05$ ) were positively related to expertise diversity. Prior working ties ( $\beta=-0.086, p < .01$ ), contributing cost ( $\beta=-0.109, p < .01$ ) and seeking cost ( $\beta=-0.241, p < .05$ ) were negatively related to expertise diversity. As predicted in H3 and H4, knowledge seeking ties ( $\beta=-0.082, p < .01$ ) and knowledge contributing ties ( $\beta=-0.047, p < .01$ ) were negatively associated with expertise diversity. Both hypotheses were fully supported. They suggest that dyads are less likely to generate creative outcomes when they have high frequency of knowledge seeking and contributing activities. H6a was supported ( $\beta=0.146, p < .01$ ), which indicates that when the dyads use multiple media to communicate, the negative relationships between knowledge seeking ties and expertise diversity would be reduced. H6b was not supported ( $\beta=-0.158, p < .01$ ), with the path coefficient of the opposite direction significant, indicating that as the events of knowledge contributing happen increasingly between the dyads, using multiple media to communicate may reduce the level of expertise diversity. The moderating effects of media multiplexity on event-type ties and expertise diversity are plotted in Figure 1.4 and 1.5.

**Table 1.4. Regression Results**

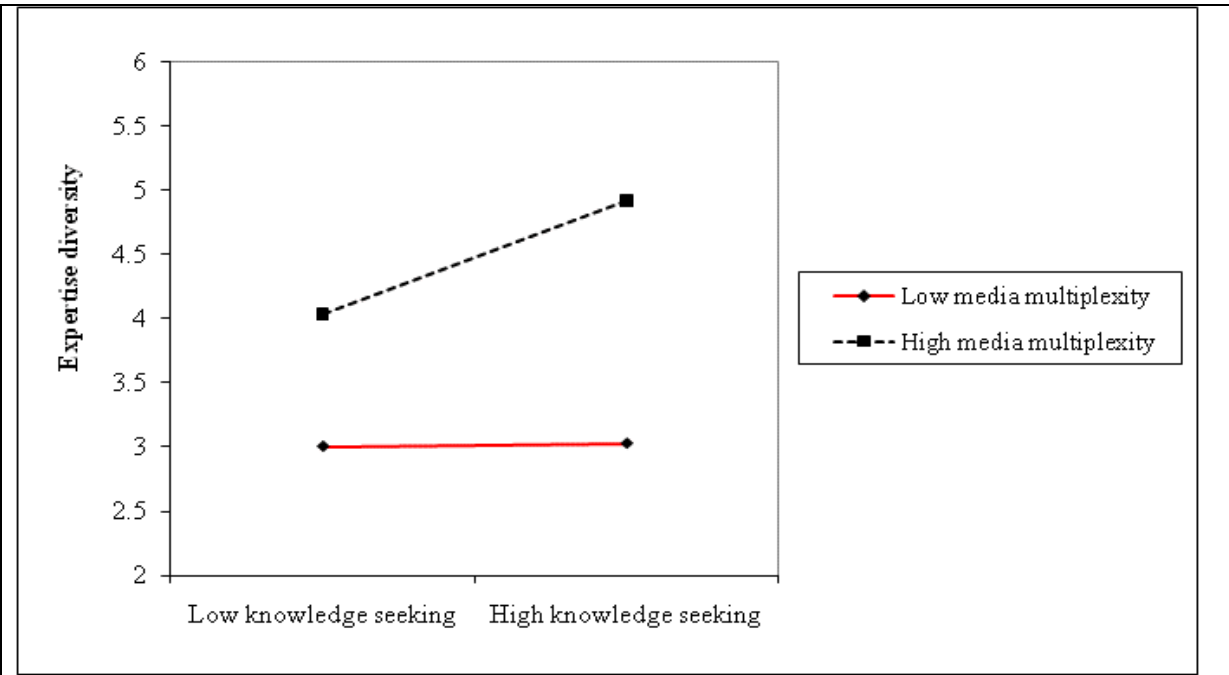
	Model 1 (DV: Expertise Responsiveness)			Model 2 (DV: Expertise Diversity)			Model 3 (DV: Creativity)			
	Model 1a	Model 1b	Model 1c	Model 2a	Model 2b	Model 2c	Model 3a	Model 3b	Model 3c	Model 3d
Background heterogeneity	0.002	0.042**	0.032**	0.021	0.023	0.042	-0.183**	-0.194**	-0.198**	-0.202**
Prior working ties	0.006	-0.013*	-0.017	-0.094*	-0.081	-0.086**	-0.071	-0.018	-0.059	-0.013
Working duration	0.102	0.097**	0.087**	0.044	0.041	0.044*	0.165*	0.162**	0.121*	0.134*
Contribute cost	-0.174**	-0.185**	-0.152**	-0.079**	-0.076**	-0.109**	-0.361**	-0.304*	-0.283**	-0.257*
Seek cost	-0.167**	-0.296**	-0.279**	-0.245**	-0.242**	-0.241**	-0.431*	-0.241*	-0.324*	-0.181*
Task type	-0.057	-0.033*	-0.039*	-0.048**	-0.051**	-0.053	-0.033	-0.015	-0.019	-0.007
Knowledge seeking ties					-0.005*	-0.082**	0.009	-0.560	-0.038	0.047
Knowledge contributing ties					-0.032	-0.047**	-0.066	-0.066	-0.084	-0.077
Media multiplexity		-0.042*	0.001		0.029**	0.065**	0.085	0.081	0.113*	0.099*
Knowledge seeking* Media multiplexity						0.146**				
Knowledge contributing* Media multiplexity						-0.158**				
Cognitive ties		0.212**	0.267**				0.369**	0.238*	0.359*	0.238*
Affective ties		0.269**	0.145*				0.141	0.004	0.073	0.033
Cognitive ties* Media multiplexity			-0.088**							
Affective ties* Media multiplexity			0.079**							
Expertise diversity								0.534**		0.499**
Expertise responsiveness									0.474**	0.237*
Intercept	3.818	1.659	1.999	3.262	3.418	2.937	1.561	0.806	0.694	0.292
Adjusted R-squared	0.102	0.204	0.242	0.063	0.067	0.103	0.207	0.466	0.253	0.483



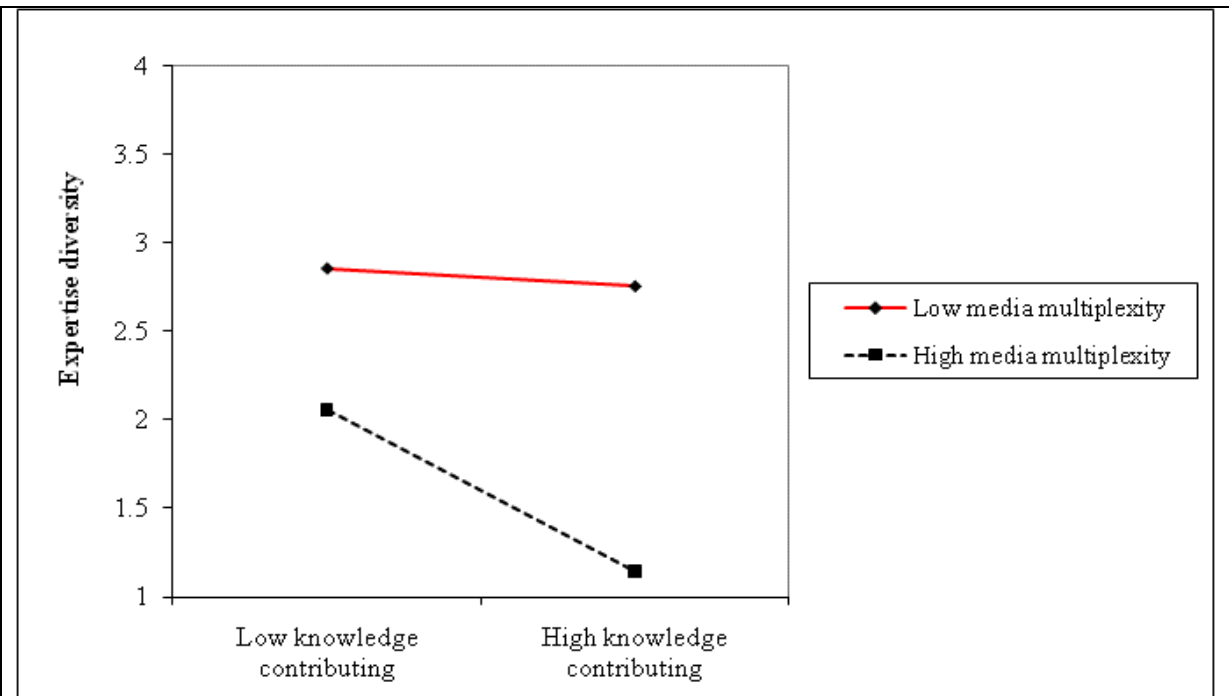
**Figure 1.2. Interaction Effects on Expertise Responsiveness**



**Figure 1.3. Interaction Effects on Expertise Responsiveness**



**Figure 1.4. Interaction Effects on Expertise Diversity**

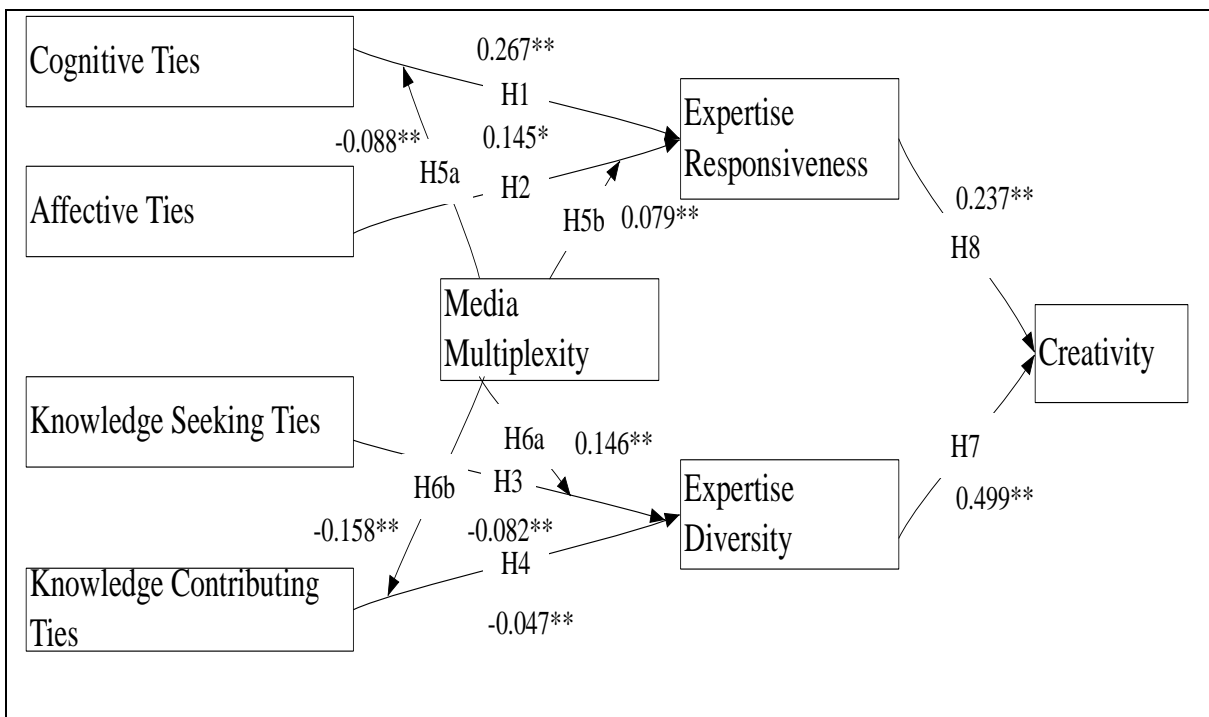


**Figure 1.5. Interaction Effects on Expertise Diversity**



Model 3 in Table 1.4 shows the regression results of creativity on all the variables. Background heterogeneity ( $\beta=-0.202, p <.01$ ), contribute cost ( $\beta=-0.257, p <.05$ ) and seek cost ( $\beta=-0.181, p <.05$ ) was negatively related to creativity. Work duration was positively associated with creativity ( $\beta=0.134, p <.05$ ). Expertise diversity had a significant positive effect on creativity ( $\beta=0.499, p <.01$ ), which indicates H7 was supported. H8 was supported too, indicated by the significant positive relationship between expertise responsiveness and creativity ( $\beta=0.237, p <.05$ ). The summary of hypotheses testing is shown in Table 1.5.

<b>Table 1.5. Summary of Hypotheses Testing</b>	
Hypotheses	Supported?
H1: Intensity of cognitive ties will be positively associated with expertise responsiveness between dyads.	Yes
H2: Intensity of affective ties will be positively associated with expertise responsiveness between dyads.	Yes
H3: Frequency of knowledge seeking ties will be negatively associated with expertise diversity between dyads.	Yes
H4: Frequency of knowledge contributing ties will be negatively associated with expertise diversity between dyads.	Yes
H5a: The relationship between cognitive ties and expertise responsiveness will be strengthened by media multiplexity.	No
H5b: The relationship between affective ties and expertise responsiveness will be strengthened by media multiplexity.	Yes
H6a: The relationship between knowledge seeking ties and expertise diversity will be strengthened by media multiplexity.	Yes
H6b: The relationship between knowledge contributing ties and expertise diversity will be strengthened by media multiplexity.	No
H7: Expertise diversity will be positively associated with creativity.	Yes
H8: Expertise responsiveness will be positively associated with creativity.	Yes



**Figure 1.6. Results of Hypotheses Testing**

### **Test of Multicollinearity**

Multicollinearity could distort the statistical results because the unique contribution of each independent variable cannot be determined due to the largely overlapping information between the (Hair et al. 1995). As a result, the variance of regression is inflated leading to rejection of the hypotheses. We calculated the value of variance inflation factor (VIF) to measure multicollinearity. A common cut-off threshold is the VIF value of 2. As reported in Table 1.6, the VIF values were all below the thresholds, indicating no evidences were found for the existence of multicollinearity.

<b>Table 1.6. Test of Multicollinearity</b>		
Variables	Tolerance	VIF
Cognitive ties	0.798	1.253
Affective ties	0.525	1.905
Knowledge seeking ties	0.720	1.389
Knowledge contributing ties	0.565	1.769
Media multiplexity	0.808	1.237
Expertise diversity	0.711	1.406
Expertise responsiveness	0.593	1.686

### **Test of Reverse Causality**

Causality is another important and theoretical issue in our setting. Due to the interdependent nature of constructs associated with creativity (Amabile et al. 2005; Fleming et al. 2007), it is unclear that whether the strength of network ties lead to creative outcomes, or do creative outcomes strengthen the strength of network ties. Hence our study is susceptible to arguments that could favour reverse causality. In the absence of longitudinal data and unavailability of appropriate instrumental variables at the dyadic level, we approximately checked for whether reverse causality was significant by estimating the interaction effects of tie duration with the key predictor variables, such as state-type ties and event-type ties, which might be suspected of

reverse causality. If reverse causality is significant, the relationships between predictor variables and dyadic creativity would be greater for older ties (Repenning 2002). We estimated alternative regression models similar to those shown in Table 1.4 but including interaction effects between work duration and the key predictor variables, and such interaction effects were found not to be significant.

### **Test of Common Method Bias**

An important limitation of organizational studies investigating relationship outcomes is the lack of independent sources to measure the dependent relational variable. This may make results artificially inflated due to common method bias (Podsakoff and Organ 1986). We conducted the Harmon one-factor test to mitigate the threat of common methods bias. Harmon's one-factor test was conducted by entering all independent variables and dependent variables in an exploratory factor analysis. The data would have a common methods bias problem if a single factor emerged that accounted for a large percentage of the variance in the resulting factors. We first averaged the dyadic measures into measurements at individual level of measurements. After that, we constrained the number of factors extracted in the EFA to be just one (rather than extracting via eigenvalues). Then we examined the un-rotated solution. However, a single factor did not emerge in our analyses. This provides assurance that our results are not due to common methods variance.

## Post-hoc Analyses

We did a post-hoc analysis to further examine the frequency and type of media usage in influencing the relationships between social ties and sources of creativity. Media multiplexity actually measured the number of media used in dyadic communication. In post-hoc analyses, we are interested in examining whether frequency of using communication media and types of communication media matters.

To measure frequency of media usage between dyads, we summed frequency of each media that one use to communicate with the identified contact and divided it by the number of media to measure the frequency of media usage. To examine the interaction effects of frequency of media usage, we centered the predictor variables and calculated the cross-product terms between predictor variables and frequency of media usage to examine the interaction effects. We found significant results showing that as frequency of media usage increase, the relationship between frequency of knowledge contributing ( $\beta=-0.101, p < .05$ ) and level of expertise diversity, intensity of cognitive ties ( $\beta=-0.131, p < .05$ ) and level of expertise responsiveness is strengthened between dyads. These findings shows that high frequency of media used in dyadic communication decrease the level of expertise diversity when dyads engage in high frequency of knowledge contributing activities. High frequency of media used in dyadic communication either decreases the level of expertise responsiveness when dyads highly cognitively recognize each other's expertise. The results provide alternative explanations for the insignificant effects of media multiplexity on the relationship between knowledge contributing and expertise diversity, cognitive ties and expertise responsiveness.

We further tested the type of media usage and its effects on the relationship between social ties and sources of creativity. First, based on media synchronicity theory, we rated each communication media in terms of their media capabilities, including transmission velocity,

parallelism, symbol sets, rehearsability and reprocessability (Dennis et al. 2008). The rating was from 1 (low) to 3 (high). Similar to measure frequency of media usage, we summed scores of each media that one use to communicate with the identified contact and divided it by the number of media to measure each capability of media that was used between dyads. The results show that the relationship between knowledge seeking ties and expertise diversity was significantly influenced by the capability of symbol sets ( $\beta=0.131, p < .01$ ), indicating that the ability of multiple media in transferring a number of ways in which a medium allows information to be encoded for communication.

## **5. Discussion**

This research was an effort to understand the generation of creative ideas by examining network ties of employees in a large research institution in electronics technology industry at a dyadic level. An important advantage of examining creativity at a dyadic level is that it assumes that dyadic relationships are not equally good catalyst in the generation of creative ideas. Dyadic level of analysis is helpful to investigate that regarding a specific dyadic exchange, what differences in terms of expertise diversity and quality, as well as communication media used by the dyads affect the generation of the creative ideas.

### **5.1. Tie Types and Creativity**

A network tie is always characterized by social relationships that serves more than one purpose or entails more than one type of social activity. Previous literature has identified that individuals benefit from maintaining various social relationships with the same person for different resources and support (e.g, Sosa 2011; Borgatti and Cross 2003). Our study suggests that different exchange between dyads may transfer different source that influence the generation of creative ideas depending on the purposes of the tie reflects. Different tie types maintained between the dyads, which are state-type ties and event-type ties, may benefit the generation of creative ideas in different ways.

Results of this study show that event-type ties (i.e., knowledge seeking,  $p < .01$ ; knowledge contributing,  $p < .01$ ) have significant negative effects on expertise diversity, and state-type ties (i.e., cognitive ties,  $p < .01$ ; affective ties,  $p < .01$ ) have significant positive effects on expertise responsiveness. The purpose of differentiating tie types due to the consideration of two aspects that facilitate the generation of creative ideas: information diversity and quality. Generally speaking, state-type ties have an impact on information quality through influencing individuals'

relational motivation in the communication process, whereas event-type ties influence diversity of knowledge exchange. Previous studies suggest that state-type ties have a positive effect on communication and encourage individuals to expend efforts in tasks and provide thought-through answers with each other (Madjar 2008). Dyads with strong state-type ties spend amount of time and intellectual effort in the process of interaction to develop creative solutions based on mutual understanding and trust on each other's expertise. State-type ties provide a foundation for the dyads to listen to each other, express concerns, and provide nurturing as well as encouragement for creativity. It maintains activities include self-discipline, sharing activities, positive interactions and mutual supportiveness. Besides, the behaviours of individuals who are linked by state-type ties are predictable. State-type ties indicate relational capital within the dyads that influences one's participation in the network (Wasko and Faraj 2005). As a resource of social interaction, strong state-type ties reflect positive characteristics of relationship in terms of mutual trust, shared norms, obligations and identifications (Nahapiet and Ghoshal 1998). Therefore state-type ties represent nature of the ties that provides a positive context of creative interaction. Individuals are expected to provide insightful response to each other and enhance the effectiveness of creative interaction.

Consistent with the findings of previous studies, our study support the point that weak event-type ties favours creativity by connecting different social circles to be the source of non-redundant information. Furthermore, this study extends the network perspective of creativity by distinguishing the different event-tie types in dyadic communication. Our results suggest that high frequency of knowledge seeking and contributing within dyads have negative impacts on the transfer of diverse information. It indicates that the more seeking and contributing behaviors between dyads, the higher possibility of exchanging redundant information. Frequent knowledge exchange increases the homophily between source's and recipient's perspectives.



Although homophily increases interpersonal interaction, it leads to more similarity such as similar perspective and opinions.

## **5.2. Expertise Diversity/Responsiveness and Creativity**

Findings of this study show that the process of generating creative ideas requires network ties not act as solely conduits of exchanging diverse knowledge, but carry some positive attributes that facilitate transferring and absorbing of the flow in the conduit. As conduits of information flow, previous studies repeatedly emphasize that it is crucial for a dyad to exchange diverse knowledge to trigger creative interactions (e.g., Granovetter 1983; Perry-Smith and Shalley 2003; Zhou et al. 2009). The results acknowledge that expertise diversity indeed helps generate creative ideas. Findings from previous research suggest the generation of creative ideas also depends on the degree to which people engage in deep exploration of their knowledge (Rietzschel et al. 2007). This study shows the evidence to support that the process of generating creative ideas requires individuals devote amount of time to involve in the fruitful discussion based on a certain level of mutual understanding.

Expertise responsiveness reflects a reciprocal nature of a dyadic relationship and indicates a feel of strong commitment and responsibility in providing responses (Kurtzberg and Amabile 2001). The generation of creative ideas needs to explore each other's expertise deeply. It is far from enough to trigger creative thoughts only relying on one single piece of advice but on iterative search and interactive discussions. Different from expertise accessibility, responsiveness emphasis on bio-directions of knowledge exchange between source and recipient in the dyadic interaction, and put more emphasize on the aspect of the response quality from the source. Communication literature have identified that interactive discussion in dyadic relationship

depends on both source and recipient, whereas the depth of interaction mainly relies on feedback from the knowledge source (Zeithaml et al. 1988).

According to previous studies (Fliaster and Schloderer 2010), expertise responsiveness first depends on how available and accessible the source is to the recipient. Second, responsiveness also rely on the transferred knowledge is directed at solving current problems and on a current task or project of the receiver (Cross and Sproull 2004). Expertise responsiveness requires the source to externalize and socialize their knowledge in terms of certain language that can be understood by the recipient easily. Responsiveness also needs the source's commitment of time as well as strong motivation (Reagans and McEvily 2003). Expertise responsiveness reflects several fundamental norms involved in positive social behaviors, including norms of reciprocity (Gouldner 1960) and commitment (Kanter 1968). The norms of reciprocity assume that individuals who receive favor have to repay in the future. Therefore people tend to be responsive to those who are responsive to them to reward others for collaborative behaviors. A sense of commitment reflects individuals' social responsibility that they should be responsive to others who are in the same tasks or projects. It indicates individuals' attitude toward the tasks they are engaging, and have an impact on the extent to which they are engaged in the creative interaction. Both the norms of reciprocity and the sense of commitment will positively affect mutual responsiveness and contribute to the creative performance of the dyads.

### **5.3. Media Multiplexity**

In today's complex working environment that is facilitated by various communication media, employees may feel confused to choose appropriate media to fit their tasks. Results of this study provide insights of the context to adopt different communication media. First, the results of this study support the positive relationships between network ties and media multiplexity proposed

in previous studies to some extent (Haythomthwaite and Wellman 1998; Miczo et al. 2011). For the moderating effects of media multiplexity, our study shows that the usage of multiple communication media may mitigate the negative relationships between knowledge seeking ties and expertise diversity. It indicates that as knowledge seekers, it is beneficial for them to use multiple media to present their information request in a clear way and access to the information source to satisfy their seeking needs. As creative interactions include exchange of both tacit and explicit knowledge, the ability of media to support transferring rich information cues is extremely important to make sure knowledge seekers get the responses they want. As multiple media has their strength of presenting information cues, for example, instant messaging improve the synchronicity of communication, video conferencing enhances richness of information cues, individuals may benefit from multiple media by enriched information cues that make information complete, and diverse presentation of information that enhance the understanding. The significant moderating effects of symbol sets shown in our post-hoc analysis provide statistical support for the advantage of presenting information by media multiplexity.

Our results also support that multiple media have an impact on relationship development, which is indicated by the significance of moderating effect of media multiplexity on the relationship between affective ties and expertise responsiveness. Our results show that when two individuals are delight to work with each other, the usage of multiple media would increase the level of responsiveness between them. The role of multiple media on relationship development is consistent with previous studies (e.g., Watson-Manheim and Belanger 2007). The usage of multiple media provides multiple accesses to the other, thus reduce the uncertainty and increase mutual trust during communication process. Informal relationships and communication are important in transmitting organizational support and knowledge across different functional and

hierarchical levels. With the combination of advanced communication media, employees may make advantage of various communication media to overcome the limitation of single media.

However, our findings also show that the disadvantages of using multiple media. Our results indicate that when individuals engage in high frequency of knowledge contributing, the usage of multiple media may cause the reduction of diverse information transmitted between dyads. In addition, when the dyads use multiple media, the positive relationships between cognitive ties and expertise responsiveness would be less obvious. It may due to two possible explanations. First, knowledge contributors have limited knowledge base. As the frequency of knowledge contributing activities increase between the contributor and the seeker, it is more likely to exchange redundant information. The usage of multiple media may make this situation even worse because knowledge contributors are highly likely to share the same knowledge across different media. Therefore it may burden the recipients with much more redundant information. Second, for the dyads that have good knowledge of each other's expertise, the usage of multiple media would definitely take extra amount of time to maintain across multiple communication media, making them feel high cost in communication process, and reduce the intrinsic motivation of providing good responses. The results of post-hoc analyses support our explanation of the insignificant results. Post-hoc analyses show that the number of multiple media offer advantages of presenting information in multiple formats that increase the level of expertise diversity. However, the frequency of multiple media usage may make knowledge contributors more likely to share redundant information, and make dyads cognitively recognize each other's expertise feel cost to maintain dyadic communication.

## **6. Theoretical and Practical Implications**

### **6.1. Theoretical Implications**

Results of this study refine and extend network perspective of creativity by investigating two different sources of creativity: information diversity and quality. Building on theories of social networks, this study tests how expertise diversity and expertise responsiveness influence creativity jointly. The results significantly support and emphasize the importance of both information diversity and quality.

Second, this study identifies different network ties that predict information diversity and quality. By significantly supporting that event-type ties have a negative relationship with information diversity, whereas state-type ties have a positive relationship with information quality, this study proposes that dyads linked by different tie types provide each other with different source and support that are beneficial for the generation of creative ideas.

Third, this study also augments media multiplexity theory by differentiating its effects depending on different social network ties. Specifically, consistent with previous research, our study supports that multiple media helps knowledge seeking ties in presenting information in various formats, and facilitate affective ties to develop positive interpersonal relationships. However, the results of our study also suggest the negative aspect of multiple media usage, which is the maintain cost and the possibility of causing redundant information. Our study contributes the literature on communication media usage by differentiating the context that media multiplexity can play a positive role in communication process.

### **6.2. Practical Implications**

Our study provides managerial insights for fostering team creative performance. On the one hand, heterogeneous expertise creates the potential for novel recombination of knowledge and

skills. On the other hand, relational motivation that cultivates trust, reciprocity, responsibilities and guarantees positive affect in interactions must be nurtured. In other words, managers who are interested in fuelling creativity may introduce structural opportunities for employees to interact with diverse others, at the meantime, cultivating the relational capital between employees that increase their intrinsic motivation to respond with thought-through answers with each other.

Second, this study provides suggestions for selecting team members for creative tasks. This process may involve implementing organizational design to stimulate individuals interact with others who they have knowledge of their expertise and who they have positive attitude to. At the same time, to foster the exchange of diverse knowledge within the teams, individuals who are selected to finish creative tasks should have mutual understanding of each other's expertise. Furthermore, besides making diverse knowledge available, it is important to realize the role of relational motivation that influences individuals' affective attitude toward each other. With strong motivation within the dyadic ties, it is more likely to get thoughtful responses and enhancing individuals' level of engaging in the interaction.

Furthermore, managers may also consider implement multiple media to facilitate the creative interaction. The overall result of this study suggests that making usage of multiple media is not beneficial for the generation of creative ideas except that it is used when the dyads need to seek knowledge from others, for it enriches the formats of information presentation. Thus when external information is needed to be processed, implementing media that have different abilities of presenting rich information would make the presentation of problems more complete and accurate, especially for tacit and complex knowledge.

## **7. Conclusion**

### **7.1. Limitations**

Although this sociometric study provides important empirical evidence supporting the hypothesized effects outlined in the theoretical framework, a limitation stems from our inability to validate the existence of the reported relationships. However, previous research suggests that although people may not be able to recall certain interactions in a limited period of time, they are able to accurately report typical social relationships (Hansen 1999; Marsden 1990). Hence, threats to reliability of the name generator method validity may not be of great concern in this study. Furthermore, the dyadic unit of analysis causes the limitations when generalize the findings.

Second, our reliance upon survey results and the self-assessment of creative performance may introduce bias when evaluating dyadic creative performance. The success of past interaction with certain colleagues may overvalue the contribution of these dyadic relationships. Although we controlled shared working experience in the past (e.g., prior working ties), it may not eliminate the concern of evaluation bias.

Third, our hypotheses testing relied upon cross-sectional data, reducing our ability to make causal statements. For example, the strength of ties may change as the communication frequency increase. The difficulty of collecting longitudinal data has long been a concern in network research. We conducted a test of reverse causality, which however does not remove entirely the possibility that reverse causality is present in our study.

## **7.2. Future Research**

First, given that the bias that may be introduced by self-assessment of creativity, we suggest objective measures of creativity in the future research. Most studies of creativity, either at individual level or team level, measure creativity by asking supervisors to evaluate each person/team's performance. Constrained by the survey methodology adopted in this study, we only can use subjective measures for creativity. Future studies may conduct dyadic analysis of creativity with objective measures. For instance, for software development teams, the dyadic creativity can be measured by the numbers of bugs they debugged together, or the solutions they provided for customers.

Second, to make causal statements, longitudinal data is suggested to test the model in the future. In the absence of appropriate instrumental variables at the dyadic level, future studies may consider develop suitable instrumental variables at dyadic level, and conduct a longitudinal study to investigate causal relationships between the attributes of relationship and creative outcomes.

Third, this study examines the role multiple media in communication at a general level. Future research is recommended to identify and examine specific features of multiple media, and make recommendation to managers for adopting communication media for different purpose.



### **7.3. Concluding Remarks**

The present study aims to explain the factors that facilitate the generation of creative ideas from a network perspective. Our study tries to provide better explanation of the process of generating creative ideas by suggesting expertise diversity and responsiveness as two important sources that have impact on creativity. Expertise diversity emphasizes that knowledge actually conveyed in the ties should be diverse. Expertise responsiveness indicating individuals' relational motivation is positively associated with creativity that guarantees mutual response and fruitful discussion. In addition, this study identifies differentiate two types of network ties (i.e., state-type ties and event-type ties), to predict expertise diversity and responsiveness. The findings of our study suggest that event-type ties negatively influence creativity because they reduce the level of expertise diversity. However, state-type ties have positive effects on creativity due to it represents relational motivation in the relationships. Furthermore, it is suggested that the usage of multiple media could facilitate the exchange of diverse information when dyads seek knowledge from each other. The usage of multiple media is also identified to help develop positive interpersonal relationships. However, multiple media may also cause the problems of maintaining cost, burdening dyads with redundant information for knowledge contributors and the dyads that have good knowledge of each other's expertise. The findings of this study contribute to the extant literature on network perspective of creativity, and communication media usage in organizations. It also offers practical implications for managers to foster the employees' creative performance, and adopt appropriate communication media.

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## **STUDY TWO**

### **THE ROLE OF LEADERSHIP AND CONTEXTUALIZATION ON CITIZENSHIP BEHAVIORS IN DISTRIBUTED TEAMS: A RELATIONAL CAPITAL PERSPECTIVE**

#### **ABSTRACT**

This study investigates how inspirational leadership and technology support for contextualization cultivate relational capital in distributed teams, and motivate members' engagement in organizational citizenship behaviors. Drawing on the inter-relationship between social capital and leadership theories, we highlight the importance of inspirational leaders who are effective in cultivating two kinds of relational capital, namely commitment and reciprocity. We also explore the differential values of contextual information from the cognitive and affective dimensions. A key result is that the effect of inspirational leadership on reciprocity is strengthened when there is technology support for cognitive contextualization. On the other hand, we find that technology support for affective contextualization has a direct impact on commitment. These findings provide empirical support for affective and cognitive contextualization in distributed organizational communication, and suggest a way for distinguishing reciprocity and commitment. Our research concludes by illustrating the positive effects of commitment on citizenship behaviors such as knowledge sharing and interpersonal helping. It provides interesting implications for theory and practice in distributed teams.

## **1. Introduction**

As the global economy compels organizations to coordinate inter- and intra- organization linkages to achieve business goals, individuals are increasingly working in geographically distributed environments and relying on technology-mediated communication. Previous studies have indicated that geographically distributed teams experience conflicts as a result of being distantly located, and their reliance on technology to communicate and work with one another. Researchers have attempted to solve the conflicts from various perspectives, including that of social capital, which has been well recognized for its role in the effective functioning of distributed teams (Zornoza et al. 2009). Social capital is typically defined as “resources embedded in a social structure that are accessed and/or mobilized in purposive action” (Lin 2001). It is embedded in relationships between individuals and their connections with teams (Putnam 1995). While social capital is a multi-dimensional concept including structural, cognitive and relational components, relational capital has been studied repeatedly for its effectiveness in solving problems of coordination, reducing transaction costs, stabilizing organizational memberships, and facilitating exchange of knowledge among individuals in organizations (e.g.,Lazega and Pattison 2001; Nahapiet and Ghoshal 1998c). As a resource of social interaction, relational capital reflects the strong and positive characteristics of relationships that influences one’s participation in a network (Burt 1992). However, some researchers have suggested that it is difficult for relational capital to be developed in a distributed team because of its lack of shared history and face-to-face interactions (Nahapiet and Ghoshal 1998b). Hence, this paper focuses on the relational component of social capital and attempts to address the question of how distributed teams build relational capital through the lens of leadership.

The role of leaders has been extensively examined for its capability of shaping follower motivation in the workplace (e.g., Bass 1985; Judge and Piccolo 2004; Klein 1989). As relationship building increasingly becomes a key component of leadership research (Uhl-Bien 2006), researchers suggest that attention should be directed to studying the importance of specific types of leadership that cultivate relational capital. However, geographical distribution reduces the frequency of interaction between traditional leaders and team members, which weakens the leaders' ability to create shared contexts (Kiesler and Cummings 2002). Consequently, the role of the traditional leader may be ambiguous due to members' weak links with their leaders and the lack of common ground (Cramton 2001; Hinds and Bailey 2003). *Inspirational leadership* (involves communicating a compelling vision, expressing confidence, and energizing team members) is increasingly effective in motivating high-quality relationships in distributed settings (Bass 1985). Therefore, this paper aims at examining how inspirational leaders can cultivate high-quality relationships among members in distributed working environments.

Inspirational leaders in distributed teams can build relational capital through both social and technological axes (Ye 2006). The social axis emphasizes the development of leader-member dyads (Grane and Uhl-Bien 1995) and the cultivation of strong relationships between members (Kozlowski and Ilgen 2006). The technological axis complements the social axis by supporting the communication process through providing contextual cues to help members frame decisions, engage in sense making, and structure messages for better understanding and easy absorption (Majchrzak et al. 2005; Te' eni 2001). The technological axis consists of a broad range of communication tools and information systems, including knowledge management systems (KMS), wikis, social networking sites and micro-blogs. It can be differentiated, at the theoretical level, by the extent to which it supports different kinds of contextual information.



Specifically, based on the cognitive-affective model of communication (Te'eni 2001) and related studies (Cramton 2001; Sproull and Kiesler 1986; Te'eni 2001), the capabilities of these technologies in sharing cognitive and affective contextual cues can potentially overcome insufficient face-to-face interactions. Cognitive contextual cues allow for explanations of task-related issues to ensure effective communication by reducing misunderstandings among members. *Technology support for cognitive contextualization* (the ability of information technologies to share task-related cognitive contextual cues) allows for explicit interpretation of task information that facilitates the development of shared languages (Cramton 2001). Affective contextual cues, on the other hand, include relational components that describe emotions and moods (Schwarz 1990). *Technology support for affective contextualization* (the ability of information technologies to share affective contextual cues such as personal background, interests and current activities) helps members in developing personal relationships with one another, which may improve relational capital.

Organizational citizenship behaviors (OCBs) are fundamental outcomes of relational capital (Bolino et al. 2002). OCBs are “affective driven behaviors” [23] that individuals who know, identify with, and understand each other are more likely to support team activities by engaging in OCBs. To examine OCBs in distributed teams, we focus on two kinds of OCBs: *interpersonal helping* (a good quality of relationship among team members) and *knowledge sharing* (the voluntary sharing of task-relevant knowledge among members). Prior research has identified that knowledge in distributed teams can be either abstracted or explicitly represented (Faraj and Sproull 2000). In this study, we refer to knowledge sharing as the exchange of both tacit and explicit knowledge among geographically distributed team members.

Therefore, in this study we explore the role of inspirational leadership in cultivating relational capital, and the effects of relational capital on members' OCBs. We also investigate how

technology support for contextualization interacts with inspirational leadership to play a role in building relational capital. The rest of the paper is structured as follows. The section of literature review provides a theoretical background of this study and proposes the hypotheses. We describe the data collection, key measurements, and the results of data analyses in the section of methodology. The following section of results discusses our empirical findings and provides possible explanations. The final section concludes by considering theoretical and practical implications of these results and, based on the limitations of the current study, makes recommendations for future research directions.

## **2. Literature Review**

### **2.1. Relational Capital**

Relational capital is reflected by the existence of close interpersonal relationships, in terms of mutual trust, shared norms, obligations and expectations, and identifications (Nahapiet and Ghoshal 1998c). Previous research indicates that when there is a high level of relational capital in which people know, trust and identify with each other, working together can be more effective. In this study we focus on relational capital because of the emphasis on leader behaviors that generate close and collaborative relationships within distributed teams.

As indicated by prior research, two dimensions that are linked to leaders' behaviors which can reflect relational capital are reciprocity and commitment (Nahapiet and Ghoshal 1998c). Reciprocity refers to individuals' beliefs regarding being indebted in future to provide assistance to others from whom they have received benefits (Chang 2005; Onyx and Bullen 2000). It is positively related to the benefits given by others (Croson 2007). The more they receive from others, the stronger the sense of reciprocating. When there is a norm of reciprocity, members are more willing to make an effort because they believe their contribution will be reciprocated.

Commitment can be another indicator of relational capital. It is an obligation to engage in a future action (Coleman 1988). Commitment conveys an individual's obligation to engage in future activities on the basis of shared membership. It is an individual's independent sense of obligation which does not change as the contributions of others change (Croson 2007). By developing a strong sense of commitment, individuals feel obligated to share knowledge (Chang 2008) and help other members (Podsakoff et al. 2000). Therefore, both reciprocity and commitment reflect high levels of relational capital that explain why members who receive organizational support are likely to engage in organizational outcomes (Robinson and Morrison 1995)

## **2.2. Leadership and Relational Capital**

Previous studies have recognized the role of leadership in building up relational capital among team members (e.g.,Joshi et al. 2009). Drawing on the social identity theory, previous studies suggest that relational capital exists when members collectively have a strong identification (Lewicki and Bunker 1996). In other words, leaders can build relational capital by building identity among team members.

It has been recently suggested that leaders are able to build up relational capital among team members by enhancing members' self-esteem and reducing members' uncertainty (Hogg 2001). The self-enhancement hypothesis posits that it is possible to motivate relational capital and group behaviors by satisfying the basic human need of members for positive self-esteem (Hogg and Abrams 1988). The behaviors of inspirational leaders that inspire confidence in team members serve to enhance members' self-esteem and further instill a sense of social identity. The sense of identity invokes team members' awareness of group membership and their perception of group success and failure as personal success and failure (Hogg and Abrams 1988). With enhanced self-esteem, team members become more committed to the team and

team tasks. On the other hand, the uncertainty reduction hypothesis suggests that reducing subjective uncertainty can promote relational capital. As an important way to reduce uncertainty, articulation of a compelling vision by inspirational leaders is effective to shift members' focus from self-interest to collective interests (De Cremer and Van Knippenberg 2002; Shamir et al. 1993). Thus, leaders contribute to building relational capital by both expressing confidence in members and emphasizing team vision, which further contribute to build relational capital within the entire team.

### **2.3. Relational Capital and OCBs**

In this study we examine two forms of OCBs: knowledge sharing and interpersonal helping. Knowledge sharing refers to the voluntary sharing of task-relevant knowledge among members. This is critical for distributed teams because such teams rely on combining individuals' expertise to complete tasks. But it becomes more complicated than face-to-face teams since team members may choose to hoard their own expertise due to the lack of trust in other "unknown" members. Interpersonal helping refers to the general behaviors that physically and emotionally support team members. It suggests that high relational capital should be developed to improve the interpersonal relationships that motivate interpersonal helping (Nahapiet and Ghoshal 1998c; Striukova and Rayna 2008). Overall, according to Nahapiet and Ghoshal (1998c), the relational dimension of social capital can be reflected by high levels of trust, shared norms and perceived obligations, and a sense of mutual identification. It focuses on the extent of high-quality interpersonal relationships among team members that enhances mutual trust and collaboration, which leads in turn to knowledge sharing and helping behaviors (McCallum and Connell 2009).

## **2.4. Technology Support for Contextualization**

Distributed teams link specialists in different fields together to collaborate on a shared task. Different perspectives ensure a variety of views and capabilities that are important in collaborative work, but increase misunderstanding between communicators at the same time (Clark and Marshall 1981; Katz and Te'eni 2007; Sperber 1986). Te'eni (2001)'s cognitive-affective model indicates that one strategy to improve organizational communication is technology-supported contextualization. Contextualization, the explicit presentation of contextual information (Majchrzak et al. 2005; Te'eni 2001), can be used to help reduce communication problems (Dougherty 1992; Hinds and Mortensen 2005; Te'eni 2001). According to the cognitive-affective model, technology can be designed to satisfy both cognitive and affective requirements of the contextualization strategy. To be specific, cognitive contextualization is supported by technologies that can highlight other members' annotations of the documents, and link summary and detailed documents to explain the issues and their associated details. It also allows members to contribute informal documents and comments on other members' contributions, and to create evolving keywords to make retrieval easier (Boland et al. 1994). Majchrzak et al. (2005) in their study empirically test the five aspects of Boland et al. (1994) on technology-supported contextualization strategy to elaborate how IT can be designed to support contextual communication to develop collaborative know-how. Technologies such as knowledge management systems and collaborative document editors can be applied to manage distributed knowledge (Majchrzak et al. 2005). These are team-based knowledge repositories that are developed to "support and enhance the processes of information creation, storage/ retrieval, transfer, and application" (Alavi and Leidner 2001, p114).

In addition, Te'eni (2001)'s cognitive-affective model suggests affectivity as another effective type of contextualization that influences organizational communication. Affectivity refers to the

inclusion of affective components in a message that indicate emotions and moods (Schwarz 1990). It can be facilitated by technologies that support the exchange of relational contextual information such as team members' personal information and current activities. Affective contextualization has most likely been difficult to achieve in the past because affective communication in organizational life was traditionally regarded as “non-verbal, instinctive and intentionally non-documented” (Te' eni 2001, p 297). Currently, social networking technologies such as social networking sites and blogs play a pivotal role in bridging online social networks and offline relationships. Social networking technologies allow the individual to construct a public profile that can be shared through a updated connection with other team members (Boyd and Ellison 2007). Thus, even if they are located in different places, members are able to have close relationships with peers they have never met by sharing current activities in their daily lives and interacting through posting and replying.

### **3. Research Model and Hypotheses**

#### **3.1. Effects of Inspirational Leadership on Relational Capital**

Dating back to the 1960s, the reciprocity theory (Gouldner 1960) suggests that people are socially and psychologically under pressure to give as much as they have received. Previous studies have identified that some types of leadership will influence three kinds of perceptions and attitudes of followers, one of which is the intended response of reciprocity behaviors (Choi and Mai-Dalton 1999). According to the self-esteem hypothesis, inspirational leaders will pressurize individuals emotionally and cognitively to feel the obligation to reciprocate either toward leaders or team members when their sense of self-enhancement is satisfied. Therefore we propose:

*H1. Inspirational leadership will be positively related to reciprocity.*

Leadership style has been studied as one important antecedent of commitment (e.g. Avolio et al. 2004; Mowday et al. 1982). For example, Shamir et al. (1993) suggest that transformational leaders are able to influence followers' organizational commitment by emphasizing the linkages between the efforts and goal achievements of individuals. In dispersed settings where face-to-face communication seldom happens, inspirational leaders build enduring linkages between an individual's self-concept and a social group (Ellemers et al. 2004; Joshi et al. 2009). By articulating of a compelling vision, leaders help shift members' self interests to collective interests and reduce the sense of uncertainty (Shamir et al. 1993). This contributes to members' identification by using socialization procedures that emphasize the team's vision and reputation. Therefore it motivates members to be committed to team vision and organizational goals. Thus we propose:

*H2. Inspirational leadership will be positively related to obligations of commitment.*

### **3.2. The Moderating Role of Technology Support for Cognitive Contextualization**

Members have intensive interactions through posting and replying on task-related issues using technologies that facilitate the exchange of cognitive contextual cues. Therefore members can better understand the specific terms used in the posted message and the reason for other members having different perspectives regarding the same task issues. When their own posts are replied to and explained by others, they feel more obligated to reciprocate to solve other members' problems. Therefore we propose:

*H3a. The positive relationship between inspirational leadership and reciprocity will be strengthened by technology support for cognitive contextualization.*

Compelling vision that is articulated in detail is facilitated by technology that supports cognitive contextualization. It enhances the reduction of the uncertainty of members and shifts their focus from self-interest to collective interests (Shamir et al. 1993). The exchange of cognitive contextual cues also provides team members with a chance to understand team accomplishments and other team members' contributions and consequently show information related to collective skills, expertise, achievement, and contributions of team members. Collective messages enhance the individual member's sense of socialized identification towards the whole team as well as the obligation to engage in future team activities. Thus we propose:

*H3b. The positive relationship between inspirational leadership and commitment will be strengthened by technology support for cognitive contextualization.*

### **3.3. The Moderating Role of Technology Support for Affective Contextualization**

Technology support for affective contextualization creates a network of connecting members together outside the workplace through online interactions. In fact, it provides members with opportunities to personally become acquainted with other members and develop close relationships with them. Hence, it results in personalized identification with particular individuals. Furthermore, technology support indicates the willingness to remain in the team and creates the conditions for the formation of socialized identification. There is also a stronger sense of commitment towards the team since members are committed to some particular members in the team. Therefore we propose:

*H4a. The positive relationship between inspirational leadership and commitment will be strengthened by technology support for affective contextualization.*

Technology support for affective contextualization helps build common ground and mutual understanding when members are distributed. It shortens the psychological distance among



members that is caused by geographical distance. Thus, members can have close relationships with others through exchanging information about themselves in real life. When members are familiar with each other, they have greater intention to trust each other and are also more willing to reciprocate when others are in need. Therefore we propose:

*H4b. The positive relationship between inspirational leadership and reciprocity will be strengthened by technology support for affective contextualization.*

### **3.4. Effects of Relational Capital on OCBs**

A team with a high level of relational capital is characterized by a strong sense of commitment and reciprocity among members. Members who are committed to the team have a strong sense of socialized identity. They are more concerned about accomplishing shared team goals rather than pursuing their own targets (Ashforth and Mael 1989). Therefore they share their knowledge in the hope of improving team performance. In addition, members also take knowledge sharing as one way to reciprocate what they have received from others in the past. Thus we propose:

*H5. Reciprocity will be positively related to knowledge sharing.*

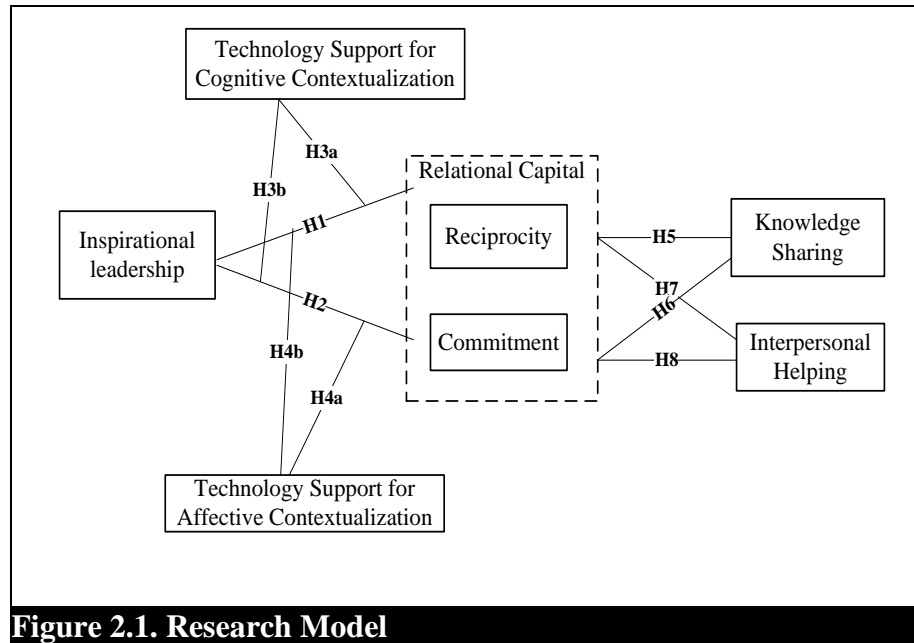
*H6. Commitment will be positively related to knowledge sharing.*

Prior research suggests that individuals who have a strong sense of reciprocating and being committed to their teams are likely to perform citizenship behaviors such as helping behaviors (Bolino et al. 2002). Commitment and reciprocity indicate a good quality of interpersonal relationships among team members that stimulates helping behaviors within the team. Therefore, we propose:

*H7. Reciprocity will be positively related to interpersonal helping.*

*H8. Commitment will be positively related to interpersonal helping.*

Figure 3.1 shows our research model.



#### 4. Methodology

This section provides the details of how we empirically test the hypotheses. We first describe the research setting of this study and how we recruit respondents to collect survey data. After which, we describe the measures for each of the variables, and test the validity and reliability of the measures in measurement model. Subsequently, we test the hypotheses using PLS in the subsection of structural model.

We chose survey as our research methodology as it is an efficient way of collecting information from a large number of respondents, and can represent the population adequately when proper method is employed. In psychometric analysis, the sample size should be large enough to

provide sufficient statistical power to identify significant results (Hair et al. 1995a). In addition, the sample size should be able to satisfy the assumptions of the statistical technology that is used by the researchers. In our study, we have opted for the use of partial least squares (PLS), which required the sample size to be ten times the number of items in the largest construct. Therefore, a sample size with a minimum of 60 responses would be needed for our study based on the largest construct with six items.

#### **4.1. Data Collection**

The survey was conducted in a major university in Asia with 165 target subjects. The subjects were part-time graduate students who were pursuing their master's degree. They were selected because the majority of them are knowledge professionals with working experience in distributed teams. We sent out invitation letters to all classes for part-time graduate students in order to gain access to the target subjects. We obtained access to eight classes majoring in Computing Science and MBA. A paper-based questionnaire along with a cover letter explaining the study's objectives was distributed to the students from the eight classes. The subjects were asked to indicate the number of countries or regions within one country that their teams were located in and their role in the teams. Responses indicating teams that were situated in only one location and their role as team leaders were removed from the analyses. Participation was completely voluntary. In all, we got 141 responses with a response rate of 85.5%.

#### **4.2. Measures**

We adapted most of the survey items from pre-existing scales in the literature. All responses were measured on a 7-point scale (1 = strongly disagree; 7 = strongly agree).

Inspirational leadership measures the extent to which a leader communicates a compelling vision to the team, expresses confidence in team members, and energizes the team (Bass 1985).

We used the six-item version of Bass's (1985) inspirational leadership questionnaire adapted by Spreitzer et al. (1999) to measure individual perceptions of inspirational leadership (see "inspirational leadership" in Appendix IV). An example of included items is "My leader encourages me to express my ideas and opinions. The items showed adequate internal consistency (Cronbach's Alpha= 0.92) and the construct explained 72% of the item variance (AVE= 0.72).

Technology support for cognitive contextualization is operationalized as the degree of support that technologies can provide in sharing contextual information relevant to tasks and processes. Respondents were asked to indicate whether three elements of contextualization strategy, i.e., ownership, easy travel and multiple perspective, could be supported by the technologies they used (Boland et al. 1994; Majchrzak et al. 2005). Six items adapted from previous studies were used to measure this variable (see "technology support for cognitive contextualization" in Appendix IV). For example, we asked the respondents "To what degree do the technologies that you used in your team (e.g., Lotus Notes) enable you to easily find out who contributed a piece of knowledge". The Cronbach's Alpha was larger than the accepted threshold (Cronbach's Alpha = 0.84) with sufficient explained variance (AVE = 0.55).

Technology support for affective contextualization is operationalized as the degree of support that technologies can provide in sharing affective information helpful for developing relationships with other members. Respondents were asked to indicate whether the technologies used enabled them to share personal information with each other. Five items were adapted from existing literature (Ma and Agarwal 2007; Schau and Gilly 2003) (see "technology support for affective contextualization" in Appendix IV). For example, we asked the respondents "To what degree do the technologies that you used in your team (e.g., Facebook, Myspace) enable you to

share your photos or personal information with other members”. The Cronbach’s Alpha (0.83) and AVE (0.58) were above the accepted threshold.

Relational capital describes the quality of personal relationships team members have developed with each other. Based on the prior conceptualization, we measured relational capital using two variables: reciprocity and commitment. We combined three items, adapted from previous studies (Eisenberger et al. 1987; Tetrick et al. 2004; Wasko and Faraj 2000) to measure reciprocity (see “reciprocity” in Appendix IV), for example: “If my team members do me a favor, I am responsible to do something in return.” The items showed adequate internal consistency and reliability (Cronbach’s Alpha = 0.71, AVE = 0.53). Commitment was measured by three items adapted from Meyer et al. (1993)’s study (see “commitment” in Appendix IV”). One item is: “I feel a strong sense of belonging to my team.” (Cronbach’s Alpha = 0.81, AVE = 0.73)

Knowledge sharing (Cronbach’s Alpha = 0.92, AVE=0.86) refers to the behaviors of sharing task-relevant information among team members. It was measured using three items such as “I share my expertise to help my team members solve their task problems” (Koh and Kim 2003; Wasko and Faraj 2005) (see “knowledge sharing” in Appendix IV).

Interpersonal helping (Cronbach’s Alpha = 0.80, AVE=0.55) refers to the behaviors that socially help and provide physical and emotional support to members. It was measured using three items that were used in existing literature (Skarlicki and Latham 1995) (see “interpersonal helping” in Appendix IV), for example: “I go out of the way to help new members in my team.”

Employees’ organizational tenure and team tenure were controlled since they were likely to influence an individual’s overall attitudes toward the team and its organization. Team size was controlled because it could influence the individual’s attachment to the team. The extent of

geographical distribution was controlled and measured by the number of geographical regions in which the team was located. We also examined the level of face-to-face interactions in the team as this might have a significant effect on performance and identification (Kirkman et al. 2004; Mortensen and Hinds. 2001). Responses were obtained on a 7-point scale (1 = less than once a year, 7 = more than once a month). Table 3.1 shows the correlation between the key variables.

We chose partial least squares (PLS) to test our hypotheses. Partial Least Squares (PLS) is one of the most widely known implementations of structural equation modeling, used for assessing the reliability and validity of a research model and estimating the relationships among included constructs (Word 1982). PLS was preferred as it has fewer restrictive assumptions and its ability for analyzing measurement and structural models including direct, indirect and interaction effects (Chin and Todd 1995). PLS involves two stages of analysis: the assessment of the measurement model, and the assessment of the structural model.

### **4.3. Measurement Model**

The measurement model shows the relationship between latent variables and their indicators. The validity of a measurement model provides an indication of instrument quality to test the research model. Assessing the measurement model involves the internal consistency reliability of the scales, the convergent and the discriminant validity of the measurements. Reliability was assessed using Cronbach's Alpha (Cronbach 1951). A value of 0.7 or one that was larger than Cronbach's Alpha indicated adequate internal consistency (Nunally 1978). For our study, all measures exhibited scores of Cronbach's Alpha well above the acceptable threshold (see Table 3.2). Convergent validity was assessed by examining composite reliability, item loadings and average variance extracted (AVE) from the measure (Hair et al. 1995a). As shown in Table 3.2, the composite reliability values ranged from 0.82 to 0.94, which were higher than the recommended value of 0.7 (Hair et al. 1995a). AVE values ranged from 0.53 to 0.73, which

were above the acceptable value of 0.5 (Hair et al. 1995). All items loaded higher on their intended constructs with a minimum loading of 0.59, which was greater than the commonly accepted threshold of 0.5 (Hair et al. 1995a). Discriminant validity was verified by examining the square root of the AVE as recommended by Fornell and Larcker (1981). The square root of the AVE between a construct and its measures was larger than the correlations between the construct and any other constructs in the model (See Table 3.1.). Thus, all items satisfied the criteria for reliability and validity tests.

**Table 2.1. Descriptive Statistics, Correlation of Constructs, and Square Root of AVE Values**

	Mean	SD	N	1	2	3	4	5	6	7	8	9	10	11	12
1.OT	1.69	1.24	141	-											
2.TT	2.54	1.93	141	0.46**	-										
3.LN	1.72	1.19	141	0.07	0.12	-									
4.TS	10.03	9.24	141	-0.03	0.01	0.16	-								
5.FF	2.45	1.58	141	-0.09	-0.11	-0.07	0.09	-							
6.IL	4.94	1.13	141	0.01	0.02	0.13	0.08	-0.14	<b>0.85</b>						
7.TC	4.65	0.79	141	-0.08	0.01	0.06	0.09	-0.05	0.33**	<b>0.74</b>					
8.TA	5.29	0.90	141	-0.05	0.05	0.10	0.03	-0.07	0.15	0.23*	<b>0.76</b>				
9.RP	5.53	0.84	141	0.09	0.01	0.10	0.02	-0.07	0.17	0.13	0.07	<b>0.73</b>			
10.CM	3.71	0.85	141	0.21*	0.12	-0.11	0.13	0.12	0.32**	0.10	0.08	0.03	<b>0.85</b>		
11.HP	5.33	0.77	141	0.06	0.12	0.24**	0.17	-0.05	0.30**	0.13	0.41**	0.13	0.15	<b>0.74</b>	
12.KS	5.81	0.89	141	0.09	0.08	0.13	0.19*	0.18*	0.54*	0.16	0.33*	0.22*	0.24*	0.51*	<b>0.93</b>

Notes: Variables 1-5 are control variables. The bold numbers forming the diagonal row are the square root of the average variance extracted for each constructs. Other entries represent the correlations between two constructs.

\* $p < 0.05$ ; \*\* $p < 0.01$

OT=Organizational Tenure, TT=Team Tenure, LN=Location Number, TS=Team Size, FF=Face-to-face Interaction, IL=Inspirational Leadership, TC=Technology Support for Cognitive Contextualization, TA=Technology Support for Affective Contextualization, RP=Reciprocity, CM=Commitment, HP=Interpersonal Helping, KS=Knowledge Sharing.



<b>Table 2.2. The Convergent Validity and Collinearity Diagnostics</b>							
Construct	Item	Std. Loading	AVE	CR	Cronbach's Alpha	VIF	CI
Inspirational leadership	IL1	0.81	0.72	0.94	0.92	1.21	9.58
	IL2	0.87					
	IL3	0.88					
	IL4	0.87					
	IL5	0.80					
	IL6	0.84					
Technology support for cognitive contextualization	TC1	0.79	0.55	0.88	0.84	1.19	18.35
	TC2	0.84					
	TC3	0.76					
	TC4	0.77					
	TC5	0.66					
	TC6	0.59					
Technology support for affective contextualization	TA1	0.60	0.58	0.87	0.83	1.06	27.56
	TA2	0.76					
	TA3	0.69					
	TA4	0.87					
	TA5	0.84					
	TA6	0.84					
Reciprocity	RP1	0.69	0.53	0.82	0.71	1.04	16.34
	RP2	0.76					
	RP3	0.65					
	RP4	0.79					
	RP5	0.79					
Commitment	CM1	0.77	0.73	0.89	0.81	1.11	14.64
	CM2	0.90					
	CM3	0.88					
Interpersonal helping	HP1	0.73	0.55	0.86	0.80		
	HP2	0.72					
	HP3	0.79					
Knowledge sharing	KS1	0.93	0.86	0.95	0.92		
	KS2	0.92					
	KS3	0.94					

Multicollinearity could distort the statistical results because the unique contribution of each independent variable cannot be determined due to the largely overlapping information between them (Hair et al. 1995a). As a result, the variance of regression is inflated leading to rejection of the hypotheses. Two measures commonly used for measuring multicollinearity are the variance inflation factor (VIF) and condition index (CI) (Hair et al. 1995a). A common cut-off threshold is the VIF value of 2, and the CI value of 30. As reported in Table 3.2, the VIF/CI values were all below their respective thresholds, indicating no evidence was found for the existence of multicollinearity.

#### 4.4. Structural Model

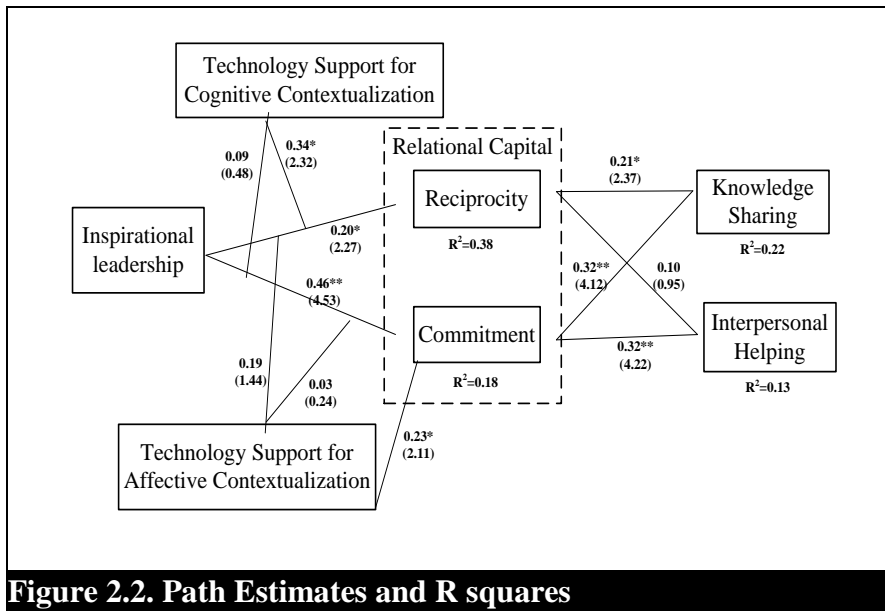
With adequate psychometric properties in the measurement model, we examined the statistical model for hypotheses testing. Path coefficients and the R squares for each dependent variable are shown in Figure 3.2. A summary of hypotheses testing is presented in Table 3.3. The impact of inspirational leadership on reciprocity is significant ( $t=2.27$ ,  $p<0.05$ ), thus H1 was supported. The impact of inspirational leadership on commitment is significant ( $t=4.53$ ,  $p<0.01$ ), thus H2 was supported. H3 and H4 hypothesized the moderating effect of technology support for contextualization. H3a was supported ( $t=2.32$ ,  $p<0.05$ ), indicating that the effect of inspirational leadership on reciprocity could be strengthened under the condition of cognitive contextualization. The moderating effects of technology support for contextualization on commitment were not significant, i.e. H3b ( $t=0.48$ ,  $p>0.05$ ) and H4a ( $t=0.24$ ,  $p>0.05$ ) were not supported. H4b was not supported ( $t=1.44$ ,  $p>0.05$ ), thus suggesting that the effect of inspirational leadership on reciprocity was not strengthened under the condition of affective contextualization. Two hypotheses about the effects of reciprocity (H5,  $t=2.37$ ,  $p<0.01$ ) and commitment (H6,  $t=4.12$ ,  $p<0.01$ ) on knowledge sharing were supported. H7 proposes the positive relationship between reciprocity and interpersonal helping, but the results showed that this hypothesis was not supported ( $t=0.95$ ,  $p>0.05$ ). However, H8 was supported, as results indicate that commitment is significantly related to interpersonal helping ( $t=4.22$ ,  $p<0.01$ ). The results of the structural model analyses are summarized in Table 3.3.

**Table 2.3. Summary of the Results of Path Coefficients**

Path Analysis	Path Coefficient	t-value	Path significantly different than zero?
<b>Main Effects</b>			
H1: Leadership-> Reciprocity	0.20	2.27*	Yes
H2: Leadership-> Commitment	0.46	4.53**	Yes
H5: Reciprocity -> Knowledge Sharing	0.21	2.37**	Yes
H6: Commitment -> Knowledge Sharing	0.32	4.12**	Yes
H7: Reciprocity -> Helping	0.10	0.95	No
H8: Commitment -> Helping	0.32	4.22**	Yes

Cognitive Contextualization-> Reciprocity	0.03	0.34	No
Cognitive Contextualization-> Commitment	0.13	1.25	No
Affective Contextualization-> Reciprocity	0.04	0.47	No
Cognitive Contextualization-> Commitment	0.23	2.11*	Yes
<b>Moderating Effects on Reciprocity</b>			
H3a: Leadership * Cognitive Contextualization->Reciprocity	0.34	2.32*	Yes
H4b: Leadership * Affective Contextualization ->Reciprocity	0.19	1.44	No
<b>Moderating Effects on Commitment</b>			
H3b: Leadership * Cognitive Contextualization->Commitment	0.09	0.48	No
H4a: Leadership * Affective Contextualization > Commitment	0.03	0.24	No

Notes: \*p < 0.05, \*\*p < 0.01



**Figure 2.2. Path Estimates and R squares**

## 5. Discussion

In this section, we discuss the results of hypotheses testing, link the results to the theoretical background of this study, and provide alternative explanations for unsupported hypotheses.

Out of the 165 subjects approached, we recruited 141 respondents for this study. Our respondents had diversified working background in their teams, with almost half of the respondents come from computer industry. 82% of respondents had less than 2 years working experience in their teams. Nearly 76% of respondents reported their team size of less than ten

team members. Our study shows that team tenure and team size is positively correlated with commitment and knowledge sharing at a significant level, which indicates that both team tenure and team size should be considered as control variables. In addition, although 62% of respondents indicated their team located within one country, they confirmed that their teams were located in different areas in the same country. Table 3.4 represents the demographic information of the respondents.

<b>Table 2.4. Demographic Information of Respondents</b>					
<b>Characteristic</b>	<b>Frequency</b>	<b>Percentage</b>	<b>Characteristic</b>	<b>Frequency</b>	<b>Percentage</b>
<b>Role</b>			<b>Tenure</b>		
Analyst	29	20.57%	< 1 year	85	60.28%
Consultant	13	9.22%	1 to <2 years	32	22.70%
Engineer	46	32.62%	2 to <3 years	14	9.93%
Manager	17	12.06%	3 to <4 years	7	4.96%
Sales	3	2.13%	>=5	3	2.13%
Others	33	23.40%			
<b>Geographic</b>			<b>Industry</b>		
1 country	88	62.41%	Computer industry	58	41.13%
2 countries	24	17.02%	Construction	3	2.13%
3 countries	15	10.64%	Education	19	13.48%
>= 4	14	9.93%	Finance	12	8.51%
<b>Team Size</b>			Manufacturing	10	7.09%
< 5	35	24.82%	Medical and legal	4	2.84%
6 to 10	72	51.06%	Travel	3	2.13%
11 to 20	21	14.89%	Others	31	21.99%
>= 21	12	8.51%	Unspecified	1	0.71%
Unspecified	1	0.71%			
<b>Nationality</b>					
Chinese	31	30.0%	Indonesian	11	0.08%
Indian	15	10.6%	Singaporean	47	33.3%
Vietnamese	8	0.07%	Others	23	16.3%

H1 and H2 that proposed inspirational leadership has a positive effect on commitment and reciprocity is fully supported at a significant level, which indicates that inspirational leadership

is a crucial factor that facilitates the cultivation of relational capital. As two main components of relational capital, reciprocity and commitment reflect the affective nature of the relationship within a team that benefits both the team and the members (Nahapiet and Ghoshal 1998c). According to Henry et al. (Henry et al. 1999)'s multi-dimensional model of identity that distinguishes the concept of identity into cognitive, affective and behavioral identity, inspirational leaders are capable to influence all the dimensions of identity. By communicating a compelling vision, leaders help members cognitively categorize themselves with their team members and make them aware of the behavioral identity that their tasks are interdependent and outcomes are shared. This creates members' sense to coordinate actions by reciprocating and committing to each other in pursuit of team objectives. By expressing confidence and energizing team members, leaders encourage and convince members about their abilities of helping others, which relates to the affective aspect of the relationships between members (Henry et al. 1999). As indicated in other studies (Joshi et al. 2009), inspirational leaders can act as representatives in dispersed settings lacking in shared contexts and spontaneous communications. They have the potential to "replace the physical, social and psychological markers of team membership and shape attitudes directed at the team" (Joshi et al. 2009, p 241). Leaders are able to foster team members' attitudes directed at the collective team entity by delivering collective messages and emphasizing the goals of the team. At the same time they indirectly cultivate positive relationships between members by aligning members' individual goals with the team tasks. As such, inspirational leaders reduce the potential conflicts that may exist among individuals and thus build a strong sense of socialized identification among them.

Our study follows recommendations by Majchrzak et al. (2005) to explore differential values of contextual information and thus suggests two kinds of contextualization strategies: cognitive contextualization and affective contextualization. H3a that proposed the positive relationship

between inspirational leadership and reciprocity would be strengthened by technology support for cognitive contextualization is significantly supported. Technology support for cognitive contextualization helps leaders emphasize the collective messaging and build good relationships among members by reducing the misunderstanding during communication process. Facilitated by technologies that support cognitive contextualization, members are aware of the identities of those responding to their posts and answering their questions. It increases the possibility of accepting alternative perspectives on an issue, and motivates members to experience a stronger sense of reciprocation as a reward of other members' efforts. It is effective in creating the team's shared mental model and eases the mutual understanding even there is no face-to-face communication. In addition, technology support for cognitive contextualization creates a condition that generates shared languages and codes, which is beneficial for developing the cognitive dimension of social capital. Shared languages and codes reduce the communication costs when members are within the team's communication network, and make members feel that they "belong" to their teams. This point is consistent with seminal work on social capital positing that the dimensions of social capital are not independent, but have an impact on each other (Nahapiet and Ghoshal 1998).

However, members will not become more committed with cognitive contextual cues, which are indicated by the insignificant result of H3b that posits the positive relationship between inspirational leadership and commitment would be strengthened by technology support for cognitive contextualization. One plausible explanation is that commitment is individual's independent belief that will not change no matter what others have done for them. It represents a sense of responsibility to engage in future action and the independent feelings towards the team. Cognitive contextual cues, as explanations that target at increasing mutual understanding about

task-related issues, may not be strong enough to be the influential external factors that change members' beliefs.

H4a and H4b were not significantly supported, indicating that the sharing of relational information about individuals has no significant effect on helping inspirational leaders in building relational capital. One possible explanation is that relational information is not easily developed when shared history and co-presence are lacking, and there exist potential problems caused by cultural and organizational differences, even if there are opportunities for members to become familiar with each other. Unexpectedly, we find significant main effects between technology support for affective contextualization and commitment ( $t=2.11$ ,  $p<0.05$ ). These interesting effects lend support to the affective perspective of contextualization showing that when members are familiar with each other, they may be committed to collectivity because they have a good relationship with a particular person and thus would behave in a desirable manner (Anderson and Weitz 1989). From this perspective, it is indicated that even when members are physically distributed, the more they would get to know each other individually, and the more committed they would intend to be. This provides practical implications for managers to consider implementing social networking technologies for distributed team members so that it is easier for members to familiarize with each other at the set-up stage of distributed teams, and for maintaining good work relationships afterward.

As in previous studies, citizenship behaviors can be an outcome of strong interpersonal connections (Bolino et al. 2002). Thus our study empirically verifies that relational capital can motivate knowledge sharing behaviors and interpersonal helping. However, one unexpected finding is that commitment predicts both knowledge sharing and helping behaviors while reciprocity is only significantly related to knowledge sharing. This finding distinguishes between commitment and reciprocity in distributed teams. This means that when a task plays the

most important role of bonding people from different locations to work together, members' intrinsic and independent obligations have much stronger effects on shaping their behaviors, regardless of what they have received from others. Hence, reciprocity does have an impact on knowledge sharing because it is task-relevant and directly influences team performance. However, one must note that members are generally willing to help others only after others have previously helped them.

## **6. Theoretical and Practical Implications**

### **6.1. Implications for Practice**

Our findings provide strong implications for practice. First, though the importance of self-management in teams is often emphasized, the result of this study implies that certain aspects of leadership may have a pivotal role in influencing important outcomes in dispersed settings. We point out that inspirational leadership is effective in influencing relational capital by improving team members' interpersonal relationships, as well as their decisions to engage in desirable behaviors. For professional communication practitioners, they can emphasize on leadership with inspirational attributes to get their team members to perform beyond standard requirements when they are physically dispersed. In addition, this study provides leaders and organizations with an opportunity to reflect on the appropriate technology that can be adopted to compensate for insufficient communication. Depending on the kinds of work outcome they want to achieve, they can either use technologies that support contextual cues for members to review and revise different perspectives at anytime and anywhere, or adopt technologies that support affective cues for members to increase personal communication that shortens the emotional distance caused by physical distance.



## **6.2. Implications for Theory**

A key contribution of our current study to the literature is the attempt to direct attention to relationships building among team members as an important form of leadership. In spite of being identified as an important resource for organizations, we know little about how relational capital can be built in distributed teams. Research on the relationship between leadership and relational capital is also relatively scarce. Our study contributes to this line of research by demonstrating how inspirational leadership builds relational capital by emphasizing socialized identification. This study adds to previous research by showing that inspirational leaders facilitate positive relationships among team members and cultivate relational capital within their teams.

This study is one of the first studies that examine technology support for contextualization from two perspectives: cognitive and affective contextualization. This paper follows on previous researchers' suggestions to look at affective aspects of contextualization that are able to improve individual relationships. Our results empirically verify that organizational communication can be strengthened when there is proper technology support. Replacing the media richness theory, this study adds some fresh insights into how newly emergent technologies such as social networking technologies and user-generated content can be applied to the workplace. This study also highlights the importance of technology in not only improving work performance, but also improving working relationships. Our study provides a new perspective of looking at the concept of contextualization, and redirects attention from task-related to affective contextualization.

## **7. Limitation and Future Research**

### **7.1. Limitations**

First, the respondents in this study were part-time graduate students who were knowledge professionals with experience in distributed teams. Each respondent might represent his/her working team and introduce bias to the results. Second, although the survey represented the most effective method for data collection across multiple locations, it meant that we had to rely on self-reported measures for all the variables. As our variables were measured in a single survey, the common method bias might have exaggerated the observed relationships among these variables.

### **7.2. Suggestions for Future Research**

First, future research might consider including the addition of objective measures to reduce the possibility of common method bias. For example, knowledge sharing can be measured by counting the number of posts that are recorded in knowledge repositories. Second, recent findings suggest that time was an important factor in the development of positive attitudes and collaboration in distributed teams (Wilson et al. 2006). We suggest a longitudinal research of a more extensive time span to investigate how work behaviors change over time. Third, while the respondents came from distributed teams within one country and across multiple countries, we did not find significant differences between the one-country group and the multiple-country group. Given that globally distributed teams might face conflicts such as cultural and linguistic issues, it will be interesting for future research to investigate the differences between distributed teams from one country (in different locations) and from multiple countries.

## **8. Conclusion**

This study highlights the significance of inspirational leaders in cultivating positive relational interactions and increasing the relational capital that motivates members' citizenship behaviors. In addition, this study empirically supports two levels of technology support for contextualization in improving organizational communication: cognitive and affective contextualization. It redirects attention from the sharing of the cognitive context that can reduce task-relevant misunderstandings to an affective context that is beneficial to interpersonal relationships. In this section, we discuss the implications for practice and theory, the limitations of this study, and provide suggestions for future research.

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## **APPENDIX I**

### **SUMMARY**

A followed-up study was conducted based on the two previous studies. Appendix I (Title: Knowledge Popularity in KMSs: Exploiting the Contextual Effects of Knowledge in a Heterogeneous Network) contains this study, which we investigate popularity of employees' knowledge after they were contributed to knowledge management systems (KMSs). In this study we optimize the dissemination of knowledge by identifying the factors that influence knowledge popularity. From a network perspective, this study proposes a model to evaluate knowledge popularity by investigating multiple attributes of contextual information (i.e., authors and tags) that are embedded in a heterogeneous network of the knowledge, and how they interact to have an impact on knowledge popularity. Objective data obtained through the interaction history of a knowledge management system in a global telecommunication company was applied to test the hypotheses.



# **KNOWLEDGE POPULARITY IN KMSs: EXPLOITING THE CONTEXTUAL EFFECTS OF KNOWLEDGE IN A HETEROGENOUS NETWORK**

(Accepted by Journal of the American Society for Information Science and Technology)

## **ABSTRACT**

Generally, in organizations, the amount of attention that user-generated knowledge receives in knowledge management systems (KMSs) may not imply its potential for benefiting organizational activities in terms of accelerating innovation and product development. To optimize the utilization of knowledge in organizations, it is crucial to identify the factors that influence knowledge popularity. From a network perspective, this study proposes a model to evaluate knowledge popularity by investigating two attributes of contextual information (i.e., authors and tags) that are embedded in a heterogeneous network of the knowledge, and how they interact to impact knowledge popularity. Objective data obtained through the interaction history of a knowledge management system in a global telecommunication company was applied to test the hypotheses. This paper contributes to the extant literature on knowledge popularity by identifying contextual attributions of knowledge, and empirically tests the impact of their interactions on knowledge popularity.

## **1. Introduction**

Recognizing the importance of knowledge management strategies in improving operational efficiencies, in intensifying innovation, and speeding up response to the market, an increasing number of organizations are building up internal knowledge management systems (KMSs) to encourage user-generated knowledge and facilitate knowledge sharing. The massive quantity of user-generated knowledge being generated on KMSs has engendered a consequent issue on the amount of attention it would ultimately receive. Knowledge receiving the most attention may not benefit organizations in terms of accelerating innovation and product development. Knowledge that receives only very few views but is imbued with content related to technical specialties would definitely provide better benefits (Lin, Seidel, Howell, & Walker, 2010). In this study, we use the amount of attention that a specific knowledge receives after it is published in KMSs to describe its popularity, which is known in knowledge management literature as knowledge popularity. Accordingly, to fully utilize knowledge in organizational KMSs that has great potential to be beneficial to organizational activities, it is crucial to identify the factors that impact knowledge popularity.

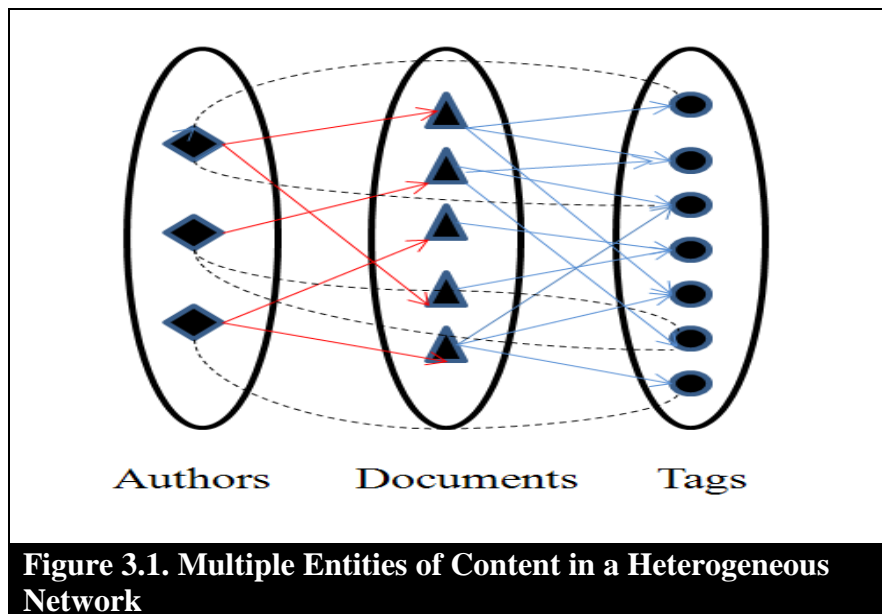
Recently, a number of social media technologies have emerged to encapsulate contextual information of knowledge, and these technologies have been widely adopted in optimizing the evaluation of knowledge popularity in previous studies (e.g., Gou, Zhang, Chen, Kim, & Giles, 2010; Zanardi & Capra, 2008). According to the knowledge creation theory, knowledge is intended to be attributed by contextual information during the process of knowledge creation (Nonaka, 1994). As one dimension of the knowledge creation process indicates, organizational knowledge creation could be understood in terms of “ a process that amplifies the knowledge created by individuals”, for individuals are the fundamental elements of knowledge creation (Alavi & Leidner, 2001). To some extent, individuals can represent certain contextual properties

of knowledge that are not explicitly stated in the content. For instance, knowledge that is created by a well-recognized technical expertise might indicate its focus and quality on technology know-how. To highlight the role of individuals in the knowledge creation process, identification mechanisms are developed to distinguish ownership of user-generated knowledge by allocating each user with a unique user ID in KMSs. In this study, we refer to the ownership of knowledge as the *authors* of knowledge, which is defined as a group of people who publish knowledge in KMSs. As one of the crucial indicators of the quality and popularity of knowledge, author reputation and the popularity of the knowledge an author generates have been found to be frequently tied together in a mutually reinforcing relationship (Bian, Liu, Zhou, Agichtein, & Zha, 2009).

The other dimension of the knowledge creation process emphasizes the articulation of a tacit perspective to explicit knowledge. *Tags*, which are user-generated textual keywords that describe a resource from individual perspectives (Bender et al., 2008; Boeije, Kolfshoten, de Vries, & Veen, 2009), have been identified to facilitate the transfer of tacit knowledge to explicit knowledge (Boeije et al., 2009). Although tags are mainly related to explicit knowledge, they lend a tacit dimension by means of context and experience, thus transmitting contextual information of the knowledge. For example, in social tagging systems, tag cloud, that is a visual representation for text data, groups digital resources on the basis of a shared tag. This grouping provides the context of a resource since related information and people are shown in their relations. In summary, based on the two dimensions of the knowledge creation theory, this study utilizes two categories of contextual information of knowledge, i.e., authors and tags, to evaluate knowledge popularity.

We evaluate knowledge from the perspective of a heterogeneous network, comprising multiple layers of a network. In KMSs, author, knowledge and tags are the three different networks that

impact each other mutually. Specifically, the heterogeneous network of knowledge comprises an author network connected by mutual downloading of authors' knowledge, a tag network connected by knowledge (documents) annotated with the same tags, and a knowledge (document) network connected by both tags and authors (see Figure 1). The popularity of knowledge is therefore a co-occurrent outcome of its contextual information, i.e. author, and tag, embedded in such a heterogeneous network. We assume that there are mutually reinforcing relationships between authors, tags and knowledge that could be reflected in knowledge popularity. For instance, a more influential author would have a greater likelihood of his knowledge being well accepted, and the more likely would the tags of the knowledge be popular. It thereby ensues that the authors of well-known knowledge are accorded greater acknowledgement than the authors of less popular knowledge. This paper therefore proposes a framework to evaluate knowledge popularity by investigating mutual relationships among authors, tags and knowledge in a heterogeneous network.



Generally, this paper focuses on three main aspects. First, this study highlights the role of KMSs in organizational knowledge management. KMSs gather individual knowledge that is scattered within organizations, thus minimizing the effort of requiring employees to build their professional profiles. Investigating knowledge shared on KMSs benefits organizations in terms of identifying and utilizing experts to assist in improvement of work performance. Second, this study sheds fresh light on the role of contextual information (i.e., authors and tags) in the evaluation of knowledge popularity. This study empirically tests how contextual information, deemed an important asset for exploring social interests in fast-growing communities, impacts knowledge popularity. Third, this study empirically evaluates knowledge popularity by investigating the relationships between multiple contextual information of knowledge from the perspective of a heterogeneous network. We construct a weighted network of tags and authors where link strengths are based on the frequencies of mutual downloads and annotations. The network perspective of knowledge popularity emphasizes the co-occurrence of multiple attributes embedded in different networks, but which collectively wield sufficient influence over each other to yield collective outcomes.

## **2. Theoretical Background**

### **2.1. Contextual Attributes in the Knowledge Creation Process**

In his seminal paper on the knowledge creation theory, Nonaka identified two dimensions of knowledge creation: epistemological dimension and ontological dimension (Nonaka, 1994). The epistemological dimension embraces a continual dialogue between explicit and tacit knowledge which drives the creation of new ideas and concepts. The ontological dimension emphasizes the linkages between knowledge creation and social interactions among individuals. Since KMSs have become popular platforms in organizations for individuals to create and share knowledge, social media technologies are adopted and embedded in KMSs to support the two dimensions of

knowledge creation, and endue knowledge with attributes that transmit contextual information of knowledge.

Contextual information of knowledge describes the information on a particular knowledge that is not clearly stated in the content, but rather through the attributes to which it is attached. Specifically, to support social interactions between individuals, social media technologies allocate each individual with a unique ID to distinguish between ownership of user-generated knowledge. Such an identification mechanism in KMSs promotes the formation of new knowledge by empowering individuals with autonomy and enhancing their sense of self-efficacy, especially in virtual environments (Nonaka, 1994). We use the term *author* of knowledge as an identification mechanism of user-generated knowledge, which is defined as a group of people who produce knowledge in KMSs. The entity author, as one of the crucial indicators of the quality and popularity of knowledge, has been well recognized as an important attribute of knowledge. For example, in the bibliometrics field, authors whose publications have been intensively cited usually create a higher academic impact on their respective disciplines (e.g., Mutschke, 2003; Yan & Ding, 2009). Articles written by prestigious authors effortlessly attract a wide readership (Ding, 2011).

In addition to authors, *tags*, which are keywords or phrases attached to knowledge disseminated by authors, are classified under another unique emergent attribute of knowledge, in keeping pace with advances in social media technologies. Individuals annotate knowledge with tags that explicitly represent their structured knowledge and indicate how elements within a domain are inter-correlated (Diekhoff & Diekhoff, 1982). Thus, although tags are mainly concerned with explicit knowledge, they transmit contextual information for knowledge by adding a tacit dimension in terms of context and experience. This simple process whereby individuals add keywords to knowledge, codifies relationships among knowledge and concepts represented by

the tags, thus benefiting the organization of an individual's structured knowledge and transforming it into intelligence (Wu, Gordon, & Fan, 2010). The sharing of tags does not only facilitate the navigation of knowledge, but also strengthens social interactions among users (Capocci, Baldassarri, Servedio, & Loreto, 2010). Users are more likely to socially interact with peers who use similar tags that are indicative of shared interests and experiences (Steels & Tisselli, 2008). As individuals with similar interests tend to have a shared vocabulary, users may benefit by searching among related tags to find persons with shared interests and knowledge. Tags also tend to be charted in the "long tail" of the knowledge curve that users searching for knowledge using a variety of low-frequency keywords would have serendipitously discovered, and thus increased their chances of exposure to "niche" knowledge. Tags offer navigational cues to assist users to obtain more information about a particular knowledge and other relevant knowledge, and contain potential indicators of knowledge popularity.

## **2.2. Knowledge Attributes in a Heterogeneous Network**

Investigating contextual information within a heterogeneous network in the evaluation of knowledge has attracted increasing attention from various research fields, such as marketing (e.g., Ansari, Koenigsberg, & Stahl, 2011) and information science (e.g., Yan & Ding, 2010). Knowledge, should not, however, be viewed in isolation as a unit in a well functioning knowledge repository. Instead, knowledge is embedded in multiple relationships of its attributes. Therefore, investigating a single attribute in a homogenous network fails to account for the multiple factors that constitute knowledge communication. Recently, scholars have begun including multiple attributes in a heterogeneous network to investigate how they interact with each other to influence knowledge popularity. For example, Nie et al.(2005) developed a new ranking method, known as PopRank to evaluate the relative importance of articles, and this includes articles, authors, and conferences as multiple attributes. Zhou et el. (2007) proposed a

co-ranking model that includes two networks, a co-authorship network and a paper citation network, and connected the two networks using a paper-author matrix. More recently, Guan et al. (2010) developed a document recommendation system based on an analysis of data containing users, tags and documents. Yan and Ding (2010) proposed a new informatics indicator known as “P-Rank” to measure author prestige in heterogeneous scholarly networks containing articles, authors, and journals. A heterogeneous network perspective provides rich clues about the context of a particular knowledge and enables the network to perform better when evaluating knowledge popularity (Liu, Bollen, Nelson, & Van de Sompel, 2005; Sidiropoulos & Manolopoulos, 2005).

In this study, we construct a heterogeneous network consisting of authors, tags and knowledge. The knowledge creation theory indicates that knowledge is generated by social interactions among individuals. Authors are connected to others by mutual interactions, which constitute an author network. Thus, network positions of authors may influence the popularity of their knowledge. Centrality, which is defined by Wasserman and Faust (1994) as the measure of network node importance, captures the prominence of an author and represents his or her power in the network. Different measures of centrality indicate authors’ varying degrees of power in influencing their networks. For instance, an author’s degree centrality can be simply defined as the number of users to which that author is directly connected. Therefore an author with a high degree of centrality has the power of communicating with many direct contacts in the network through the downloading of his or her knowledge by others (Wasserman, 1994). We define an author’s degree centrality as *an author’s power of communication*, which represents a central position of an author and indicates that others download that author’s knowledge frequently. Betweenness centrality is another measure of network node importance, indicating how important an author is in terms of connecting other users. It indicates the potential power of an



author for controlling communication and connection with others. Authors with high betweenness centrality are more frequently the objects of communication than the sources of communication because they broker contacts among other users (Knoke & Burt, 1983). Therefore we define authors' betweenness centrality as *authors' power of connection*, describing an author's network position on the shortest path between other pairs of authors.

Constructing a network of tags is not a novel approach for scholars. E-commerce researchers are known to have built product-to-product networks via tags, revealing the relationships between products in the web space (Hsieh, Chen, Lin, & Sun, 2008). From a network perspective, two tags, i.e.,  $i$  and  $j$  are linked if they are annotated to the same knowledge. A link weight for two tags, i.e.,  $i$  and  $j$  can be introduced and defined as the number of joint appearances of the same piece of knowledge. A popular tag is defined as one that is frequently used in appearance with other tags within the same knowledge. Accordingly, *tag popularity* describes the tags that have the most number of links with other tags. It indicates the number of times people have used and is representative of popular and widely recognized topics across the community. Knowledge with popular tags may thus receive the greatest amount of attention for it reflects social interests (Wu & Zhou, 2009). On the other hand, knowledge of diverse categories can share a common tag and are thus correlated so that users can find other related knowledge that interests them. In this way, tags assist users in browsing and exploring others' structured knowledge. Therefore *tag connectedness* facilitates the finding of relevant knowledge for users and for knowledge to be associated with users by annotating knowledge within the same tag. The role of tags that link people and knowledge is widely recognized by researchers. It is via this link that they discover shared user interests and develop personal recommendation systems (e.g., Li, Guo, & Zhao, 2008). In summary, tags enable individuals to organize their own structured knowledge, and explore knowledge of interest to them but which belongs to others. Investigating tag networks

enables the revelation of user properties and knowledge attributes, as well as the exploration of their connections to perceive how they interact to influence knowledge popularity.

### **3. Hypotheses Development**

*Authors' power of communication* refers to the extent to which an author's knowledge is downloaded by others. It can be measured through the in-degree centrality of authors that is arrived at by counting the number of downloads. Authors' power of communication indicates author's dominant position that is based on the analysis of the history of his or her knowledge being downloaded or rated. Several studies have found with regard to author's network positions, that a position with high degree centrality, does positively impact article citation. For example, Yan and Ding (2009) found a significant correlation between author degree centrality and citation counts. Vidgen et al. (2007) applied degree centrality to rank a European research community on information systems. Thus we posit:

*H1: Authors' power of communication is positively associated with knowledge popularity.*

*Authors' power of connection* refers to the extent to which an author is influential in connecting other authors' knowledge in a network. We use betweenness centrality, which is defined as the extent to which an author benefits from being on the shortest path between other authors (Freeman 1977), to measure authors' power of connection. Betweenness centrality can indicate which authors are viewed most often as dominant authors that control the flow of information and thus may be able to take on the role of gatekeeper or broker (Freeman et al. 1980, p 128). Betweenness centrality thus describes an author's capability to control the path of knowledge dissemination and the access of each other's knowledge, which may increase the chance of their own knowledge downloaded by others. Betweenness centrality has been studied frequently for its significant role in article citation. For instance, Liu et al. (2005) found author betweenness

centrality performs best among three centrality measures in the co-authorship of in a digital library research community. In addition, Yan and Ding (2009), found that author betweenness centrality correlates with article citation with a much higher score than other types of centrality.

Thus we posit:

*H2: Authors' power of connection is positively associated with knowledge popularity.*

**Tag connectedness** refers to the extent to which tags are connected with other related tags, authors, or knowledge. For example, a Flickr photo of *La Sagrada Familia*, which is a massive Roman Catholic basilica under construction in Barcelona, is described by its owner using the tags *Sagrada Familia*, and *Barcelona*. Using the collective knowledge that resides in the Flickr community on this particular topic, one can extend the description of the photo with other relevant tags such as *Gaudi*, *Spain*, *architecture*. The tag *Barcelona* may lead users to other related famous places in Barcelona such as its *seafood market*, *Ramblas walk*, etc. We use closeness centrality of tags to measure tag connectedness. Tag connectedness indicates the distance between tags that reflects whether tags provide an effective way to explore and discover knowledge (Li et al. 2007). With tags that have short paths to others, users can conveniently navigate between knowledge through the paths of related tags. The steps needed to navigate between knowledge are relatively few via connections between these tags. The short path length between tags optimizes the results of knowledge searching and directs the searcher to related knowledge, which may increase the popularity of other knowledge, and reinforce its own popularity in turn. Thus we posit:

*H3a: The positive relationship between authors' power of communication and knowledge popularity will be strengthened when the knowledge is annotated with connected tags.*

*H3b: The positive relationship between authors' power of connection and knowledge popularity will be strengthened when the knowledge is annotated with connected tags.*

**Tag popularity** describes the frequency of tag usage. The appearance of a popular tag is always coupled with other tags within the same knowledge. Previous studies have found that the tags with the most links to others can represent the popular content on the Internet (Wu and Zhou 2009). First, tags with many outgoing links that are heavily and commonly used by users can best describe the target resources. Second, popular tags occupy prominent positions that are easily found by users and hence there is a greater possibility for them to be suggested by the tag recommendation system and chosen by users to describe newly added knowledge. Therefore, knowledge with popular tags contains more popular information that in turn receives more attention. *Thus we posit:*

*H4a: The positive relationship between authors' power of communication and knowledge popularity will be strengthened when the knowledge is annotated with popular tags.*

*H4b: The positive relationship between authors' power of connection and knowledge popularity will be strengthened when the knowledge is annotated with popular tags.*

## **4. Methodology**

### **4.1. Research Context**

The setting for our empirical analysis is a *Fortune 500* company in the telecommunication industry, with approximately 130 operating companies worldwide. The company operates across a broad spectrum of business activities in this industry, including innovative research, telecommunication equipment development, local solutions, marketing and sales. The marketing and sales function within the Chinese division is the focus of this study. For the purpose of

adopting a better strategy for surviving in an intensively competitive industry, an internal knowledge management system was set up for rapid exchange of market intelligence about the organization's products, competitors and customers. Employees in the marketing and sales divisions contribute the bulk of knowledge, storing in document format. After uploading documents, employees are encouraged to adding tags to annotate represented knowledge in the document. The tags are added freely and manually based on the employees' own understanding. To encourage voluntary contribution, the system administrator sets up incentive mechanisms to rank top active users by aggregating their activities of browsing, uploading, downloading and rating. Documents that are mostly downloaded by users is listed at the login interface by monthly downloading counts. In our study, we exported the log data from the company database for calculating the variables we used in the model.

We follow a co-citation approach (Chen 2006; Small 1973) to construct the tag network. Tags are nodes of the network. Two tags are linked if they are annotated to a same document. A link weight for any two tags is calculated as the number of documents in which the tags appear together. In simple, the tag network is constructed by linking tags on same documents.

## **4.2. Measurements**

*Authors' power of communication* measured the author's in-degree connections with other users. It was measured by constructing a matrix to map the number of times the author's documents were downloaded by individual users. The more frequently the author's documents were downloaded by the same user, the stronger was the relationship both have with each other. Here authors' power of communication indicated the number of ties that an author had with other users. The equation is as follows, where  $A_D(a_i)$  is the in-degree centrality of author  $a_i$ :

$$A_D(a_i) = d(a_i)$$

*Authors' power of connection* was measured by authors' betweenness centrality. It indicates the authors' capability to obtain information and connect through benefitting from being on the shortest path between other authors. In this study, it was measured based on the history of an author's interaction with other authors by mutual downloading. Similarly, a one-mode matrix was constructed to map the relationship between each pair of authors. Authors' power of connection was measured by the following equation based on the above matrix, where  $A_B(a_i)$  is the betweenness degree of author  $a_i$ ,  $g_{jik}$  represents all geodetics linking author  $j$  and author  $k$  that pass through author  $i$ ;  $g_{jk}$  is the geodetic distance between the author of  $j$  and  $k$ :

$$A_B(a_i) = \sum_{j,k \neq i} \frac{g_{jik}}{g_{jk}}$$

*Tag popularity* was measured by degree centrality representing the extent to which the tag is connected with other tags. For example, when Tag  $A$  always appears together with Tag  $B$ , this means that the "relationship" between Tag  $A$  and Tag  $B$  is strong. When Tag  $A$  has connections with most of other tags, this is an indication that Tag  $A$  represents popular knowledge in the KMS. Therefore, tag popularity was measured by the construction of a matrix to show the relationship between pairs of tags. This is a weighted network where each tag is a node and links are drawn between a pair of tags whenever the two tags co-occur in the same document. The number of different document in which each pair of tags appears is an indication of the weight of the relationship. We averaged the sum of the tag popularity of individual document to measure the extent to which documents are rated as popular. Tag popularity can be calculated by the following equation, where  $T_D(t_i)$  is the degree centrality of an individual tag  $t_i$ :

$$T_D(t_i) = d(t_i)$$

*Tag connectedness* was measured by the closeness centrality of the tag network. Closeness

centrality measures the path length from one tag to another and indicates the extent to which tags provide an effective way to explore and discover knowledge. The distance between two tags can be calculated based on the same matrix constructed for measuring tag popularity by the following formula, where  $T_C(t_i)$  is the closeness centrality of tag  $i$  and  $d(t_i, t_j)$  is the distance between two tags in the network. We averaged the sum of the individual measures of tag connectedness to measure the ability to support knowledge connectivity and navigation based on user-defined knowledge tags. This measure was calculated by dividing the sum of the individual records of tag closeness centrality by the number of the tags attached to each of the document:

$$T_C(t_i) = \frac{\sum_1^N 1}{d(t_i, t_j)}$$

*Knowledge popularity* is measured by the download count of a document, and this measure was obtained from the system logs.

*Knowledge age* was selected as one of the control variables owing to its high correlation with download counts. Knowledge that has been posted for longer period is likely to be downloaded less frequently since there is likelihood for it to be overwhelmed by newly added knowledge. *Information richness* of knowledge, was measured by calculating the word count of document content, is another control variable that could impact knowledge popularity because knowledge with little information is likely to be less popular.

### **4.3. Analysis Strategy**

Multiple Regression Analysis (MRA) is deemed the appropriate method of analysis when the research question involves a single dependent variable (in our case knowledge popularity) presumed to be related to two or more independent variables (Hair et al. 1998). MRA is targeted to predict the changes in the dependent variable (DV) in response to changes in the independent

variables (IV). This objective is most often achieved through the statistical rule of least squares. Moderated Multiple Regression (MMR) (Sharma et al. 1981) is an extension of MRA used to test the effects of multiplicative terms or interactions of factors. This technique applies MMR to detect the significance of moderator variables over and above direct variable effects. Therefore, the use of these techniques enabled us to test both the direct and moderating hypotheses of our models.

#### **4.4. Results**

Table 2.1 lists the means, standard deviations, and a correlation matrix for the variables. It shows that correlations among the independent variables had a low value of .007 and a maximum value of .86. It is also shown in Table 2.1 that knowledge age is negatively correlated with knowledge popularity ( $r = -.013, p > .05$ ). Furthermore, it can be seen that information richness in knowledge is positively correlated with knowledge popularity ( $r = .048^*, p < .05$ ), which indicates that rich information included in the knowledge may increase the level of knowledge popularity. From Table 2.1, it can also be perceived that both authors' power of communication ( $r = .201^{**}, p < .01$ ) and authors' power of connection ( $r = .094^{**}, p < .01$ ) are positively correlated with knowledge popularity. The correlation between authors' power of communication and connection is high ( $r = 0.86^*, p < .05$ ), with a variance inflation factor (VIF) of 4.329. Hence, multicollinearity did not pose a severe problem that would preclude interpretation of the regression analyses (Neter et al. 1983).

Table 2.2 presents the results of the regression analysis for the independent variables and the moderating effects. The table lists full-equation standardized regression coefficients for the independent variables which were entered simultaneously. In addition, a series of hierarchical multiple regression analyses was conducted to determine the unique variance, measured as the increment in  $R^2$ , of each independent variable that contributed to the dependent variables.



Hypothesis 1 predicts that authors' power of communication would be significantly related to knowledge popularity. The results of our investigation of this hypothesis reveal a significantly positive relationship between authors' power of communication and knowledge popularity ( $t = 8.248, p < .01$ ). Hypothesis 2 proposed that authors' power of connection was positively associated with knowledge popularity and this hypothesis was supported at a significance level ( $t = 4.306, p < .01$ ) too. For moderating effects, Hypotheses 3a ( $t = 2.927, p < .05$ ) and 3b were supported at a significant level ( $t = 2.881, p < .05$ ), which indicates that the effects of authors' power of communication and connection on knowledge popularity can be strengthened when the tags are connected and enhance the navigation of related knowledge, authors, and tags.

### Robustness Test

To rule out the alternative factors other than the independent variables that explain knowledge popularity, we were enabled to utilize our large sample size to leverage stronger results by conducting a robustness check. This robustness check was conducted by randomly selecting half of the cases in the original sample. The final randomly selected sample ( $n=657$ ) was used to repeat the same test that we conducted with the original sample. The results show no significant difference between the randomly selected and the original samples.

**Table 3.1. Means, Standard Deviations and Correlations**

	Mean	Std. Deviation	1	2	3	4	5	6	7
1. Knowledge age	525.28	298.295	-						
2. Information richness	11.408	16.605	.024	-					
3. Author popularity	1.179	0.813	-.367**	-.269**	-				
4. Author prestige	3.796	6.602	-.301**	-.236**	.860*	-			
5. Tag popularity	4.312	3.177	-.022	.054*	-.068*	-.027	-		
6. Tag connectedness	1.811	19.941	-.157**	.171**	-.015	.054*	.211**	-	
7. Knowledge popularity	6.00	3.462	-.013	.048*	.201**	.094**	.034	.007	-

\* $p < .05$ , \*\* $p < .01$

**Table 3.2. Hypotheses Testing**

Variables	Model 1			Model 2			Model 3		
	Beta	t	Sig.	Beta	t	Sig.	Beta	t	Sig.
Knowledge age	-.014	-.431	.667	.088	2.625	.009	.101	2.941	.003
Information richness	.048	1.513	.131	.114	3.514	.000	.109	3.357	.001
Author popularity				.527	8.381	.000	.523	8.248	.000
Author prestige				.307	5.062	.000	.273	4.306	.000
Tag popularity				-.013	-.412	.680	-.010	-.317	.752
Tag connectedness				.015	.452	.652	-.004	-.134	.893
Author popularity* Tag popularity							.011	.224	.823
Author popularity* Tag connectedness							.189	2.927	.004
Author prestige * Tag popularity							-.056	-1.109	.268
Author prestige * Tag connectedness							.199	2.881	.004
R Square	0.013			0.154			0.160		
R Square change	0.015**			0.144**			0.009*		

Beta is the standardized regression coefficient. R square change is derived from hierarchical regression analysis.

\*  $p < .05$ , \*\* $p < .01$

## 5. Discussion

As organizations increasingly realize the value of the “wisdom of crowds”, they have turned to managing internal knowledge through an approach incorporating employees at all levels. Typically, most organizations adopt Knowledge Management Systems (KMSs) for their employees to externalize and share their explicit and tacit knowledge with other colleagues, who in turn find their individual value growing as more users contribute knowledge. Indeed, KMSs have emerged, fundamentally changing organizational knowledge management by strategically aggregating individual unstructured knowledge. KMSs provide an effective way of gathering diversified unstructured knowledge from individuals, and also perform the function of

facilitating the creation of collective intelligence. In KMSs, unstructured knowledge is formatted as answers to a posted question, user-generated tags, a piece of collaborative editing, etc., thereby reflecting each individual's expertise and interests. Analyzing the contextual attributes of unstructured knowledge dispenses with the efforts required to build individual profiles, and offers an alternative approach to exploring and identifying valuable knowledge and expertise within organizations.

Our study suggests that aside from the widely adopted measure of popularity, organizations benefit from identifying the contextual factors that influence the popularity of knowledge. Authors' power of communication and connection are two descriptions of author importance in their network that appear similar, but differ in their role in influencing knowledge popularity, especially in organizations. As knowledge is classified into different categories, such as general knowledge and domain obscure knowledge, it is thus that in the managing of organizational knowledge, managers may encounter the problem that useful knowledge may be overwhelmed due to its restricted readership, and the massive amount of user-generated knowledge. It follows that authors who generate the most popular knowledge may not necessarily be the ones with the requisite expertise in a domain. Thus, as one of the contextual attributes, an author's network positions assist KMS users to evaluate the popularity of knowledge and assist managers in identifying individuals with valuable expertise. Authors with power of communication might be actively sharing general knowledge, such as the latest industry news, the most insightful reviews, etc. They attract widespread KMS users through directing interaction with others who are accessing their knowledge. On the other hand, authors with power of connection attract attention by connecting KMS users who are not directly connected. They occupy important network positions that indicate the attachment of new nodes and links. During network evolution, authors who have a stronger power of controlling the communication and information flow (i.e., higher

betweenness centrality) attract more attention from their networks (Abbasi, Hossain, & Leydesdorff, 2012).

Tags represent a form of individually-constructed structured knowledge (Wu et al., 2010). Tags connect knowledge elements that are effective in exploring knowledge via linked tags and relevant tags. Popular tags connecting most of the users and knowledge indicate community-shared interests, which should attract widespread attention. However, our results failed to support Hypothesis 4a and Hypothesis 4b, both of which posited that popular tags facilitate author networks by increasing knowledge popularity. The insignificant results may be due to the negative aspects of tag popularity in reality. Researchers have demonstrated that tags show stabilized properties of which tag distribution reaches stability as numerous users make annotations (Hsu & Chen, 2011). Specifically, during the stabilizing process, important tags would be assigned by more users, and provided higher tagging frequency. The frequency of a tag will be nearly fixed proportion to the total frequency of all tags, as the number of tags increases (Golder & Huberman, 2006). Consequently, popular tags link larger amount of knowledge that is annotated with the same popular tags than less popular tags. It is more likely for knowledge that is annotated with popular tags to encounter the risk of obtaining low popularity, because the large amount of knowledge that is under the same tag is powerful to share the attention from readers. Therefore, knowledge annotated with popular tags may be overwhelmed in the mass of knowledge items that are annotated with the same popular tags, even if their authors have power of communication and connection. On the other hand, tag connectedness has a significantly positive effect on the relationship between authors' power of communication/connection and knowledge popularity. It indicates the abilities of tags to support navigating related knowledge and increasing neighbor connectivity. Tag connectedness indicates the average length of the shortest path between two tags. With the help of tags that

have short paths to others, users can conveniently navigate between relevant knowledge through closely related tags. The short path length between tags directs the searcher to related knowledge through a few clicks. It helps authors and their knowledge obtain attention from the connected tags that are on the shortest path of linking other tags. The popularity of knowledge may increase due to the diverse incoming linkages from connected tags. Users may experience serendipitous searching of knowledge, moving from one tag to other diversified linked knowledge. In this way, tags improve the efficiency of exploring relevant knowledge and the associated authors.

## **6. Theoretical and Practical Implications**

### **6.1. Theoretical Implications**

This study introduces contextual information (i.e., authors and tags) into the factors that influence knowledge popularity. Authors and tags are popular design features based on user-generated content in KMSs. Featured authors and knowledge tags have significant effects on the browsing and searching behaviors of users that influence the popularity of knowledge. Complementary to popularity measures that are indicated only by downloading, contextual information captures attribute-based descriptions of knowledge. Differentiation between authors' power of communication and connection assist organizations in identifying influential individuals that have the potential to obtain preferential attention but who might be otherwise overwhelmed by large amounts of user-generated knowledge. Tags represent individuals' structured awareness that connected tags ease the exchange and exploration of individual knowledge.

We constructed weighted separate networks for authors, tags and knowledge, and explored how they interconnect to impact each other. Despite the inclusion of multiple attributes in evaluating knowledge popularity, an approach recently adopted by an increasing number of studies in

*Information Science* and *Computer Science* for developing their algorithms for content ranking, there is still a dearth of significant empirical findings on the evaluation of knowledge popularity. The construction of different networks with multiple attributes of knowledge emphasizes the co-occurrence of multiple attributes that are embedded in different networks but influence each other into generating collective outcomes. The network perspective addresses the question of how the massive amounts of user-generated knowledge can be organized to facilitate navigation and search. Connecting knowledge through multiple attributes is demonstrated to be an effective design for facilitating the acquisition of more knowledge, as ease in accessing the related knowledge increases the “exposure” of underutilized knowledge.

## **6.2. Practical Implications**

In terms of organizational knowledge management, this study suggests that incorporating the features of social media technologies in KMSs can facilitate the management of individual knowledge in organizations. Indeed, social media technologies offer technology drivers that render organizational knowledge management effective. First, knowledge creation becomes more available with the increasing adoption of KMSs in organizations. Second, KMSs allow for more formats of individually structured knowledge and this consequently reduces the costs of voluntary contributions. Furthermore, the KMS features facilitate the searching by users for locations containing knowledge that interests them, thus offering related knowledge, and facilitating navigational “serendipity”.

Our study also suggests to KMS designers, that exploring the networks among multiple attributes of knowledge is crucial. Enabling linkages between items of knowledge so as to construct a well-connected knowledge network is of prime importance. KMSs consequently encourage the flow of novel and informative knowledge to tags containing underutilized technical knowledge within a network and hence induce serendipitous discoveries. This implies

that active and influential individuals within knowledge networks may facilitate the exposure and recognition of various intersecting types of knowledge in the system because of their mutual embeddedness. Hence, KMS designers are advised to be aware of the power of multiple attributes of knowledge and deepen their understanding on how the attributes complement each other to utilize the full potential of knowledge.

This study, for KMS managers, highlights the role of contextual information that has the potential to identify community-shared interests. This is especially useful for business analysts in the marketing and sales divisions of organizations. In order to capture their consumers' attention and recommend feasible products, employees in the marketing and sales divisions need to be attuned to the focused interests of their communities and perceive what their consumers really find interesting. An influential consumer who gains prominence by writing reviews or sharing experiences of his or her products, plays a crucial role in the promoting of a product. Indeed, it is by analyzing the product tags from consumers' reviews, that organizations are enabled to recommend suitable products to the right individuals.

## **7. Limitations and Future Research**

First, given the dynamic nature of tag network and author network, an optimal approach for predicting knowledge popularity is the inclusion of a time issue. However, due to constrained accessing of the organizational data, we failed to obtain a longitudinal dataset. We suggest that researchers in future conduct a longitudinal study on a dataset from online social media platforms. For instance, by comparing the changes of tag network and author network between different time slots, we are able to observe the causal relationship between authors, tags, and knowledge popularity. At the meantime, with a longitudinal study, we are also able to

investigate how tag network and author network change over time is related to the popularity of knowledge.

Second, we were unable to control the topical variance of the knowledge as this factor was missing in the database. We would have needed to split the dataset into two sets to prove that the dataset was lacking in the variety of topics. Future research endeavors may consider the calculation of the popularity of a topic and factor it as one of the control variables.

## **8. Conclusion**

This study examines how multiple attributes of knowledge that are embedded in a heterogeneous network mutually interact with each other to influence knowledge popularity. We constructed different networks for multiple contextual information of knowledge and investigated their network relations to explore how they mutually reinforce each other to impact knowledge popularity. Our results indicate that knowledge generated by authors with power of communication and connection receives greater attention. This trend becomes obvious when authors' knowledge is annotated with tags that are connected by relevant tags. Our study highlights the role of contextual information with regard to knowledge. It complements previous studies by empirically investigating knowledge popularity using objective data from KMSs in organizations, while offering practical implications for KMS managers, designers, and business analysts in the marketing and sales divisions of organizations.



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## APPENDIX II SURVEY QUESTIONS FOR STUDY ONE

问卷号: \_\_\_\_\_

### 团队创新能力与知识共享的社会网络分析问卷调查

感谢您参加本次调查问卷。本次调查问卷是新加坡国立大学信息系统系的研究课题，目的是通过研究成员之间的社会网络关系来探寻影响企业团队合作创新表现以及知识管理效率的因素。本次问卷的数据仅将用于学术研究分析，作为保密数据处理，绝不公开泄露。

该问卷分为三部分。第一部分是关于您的个人基本信息，第二部分是关于您与同事之间社会网络关系以及交流模式的问题，第三部分是一些感知性问题。您的答案无所谓对或错，只要是您的真实体验和想法即可。

为了感谢您对本次调查研究的参与与支持，在问卷完成后，我们将赠送价值 50 元的手机充值卡。

如有任何问题或需要查看研究成果，请联系课题研究组成员沙溪清 (Email: [xiqing@nus.edu.sg](mailto:xiqing@nus.edu.sg); Tel: 86-13916948059).

新加坡国立大学信息系统系

2012 年 4 月



第一部分：基本信息

1-1.您的性别：1) 男 2) 女

1-2.您的年龄：1) 22-30岁 2) 30到35岁 3) 35到40岁 4) 40到45岁 5) 45岁以上

1-3.您的受教育程度：1) 高中及以下 2) 专科 3) 本科 4) 硕士及以上

1-4.您的教育专业背景：1) 科学工程（理学、工学、农学、医学） 2) 经济管理 3) 文学艺术（哲学、文学、历史学） 4) 法律 5) 其他（教育学、军事学等其他）

1-5.您的工作年限：\_\_\_\_\_年

1-6.您工作的职位：1) 高层管理人员 2) 中层管理人员 3) 基层管理人员 4) 普通职员

1-7. 贵企业主要业务所属的行业：1) 高科技 2) 传统制造 3) 建筑/房产 4) 商贸/服务 5) 其他行业（请指明：\_\_\_\_\_）

注：高科技是指计算机/软件/网络/电信/通讯/电子/生物制药/高分子/化工等科技含量高的产业；

传统制造是指机械/设备/仪表/纺织/建材等产业；

商贸/服务是指运输/仓储/金融/保险/创意/娱乐/会务/会展/旅游/餐饮/教育等。

1-8. 平均来讲，当您完成一项项目时，每周花多少时间和项目成员一起工作？\_\_\_\_\_小时每周

1-9. 您对社交传媒（比如新浪微博，开心网，人人网，QQ等）的熟悉程度：1) 非常不熟悉 2) 比较不熟悉 3) 一般 4) 比较熟悉 5) 非常熟悉

1-10. 您在您所处的部门的工作角色是：1) 设计产品 2) 开发产品 3) 产品测试 4) 协调与协助 5) 管理领导 6) 维护与支持

第二部分： 社会网络关系及交流模式

首先，请列出您在工作上交流最多的同事的名字（不超过 6 个）

A \_\_\_\_\_

B \_\_\_\_\_

C \_\_\_\_\_

D \_\_\_\_\_

E \_\_\_\_\_

F \_\_\_\_\_

B \_\_\_\_\_ 韩梅梅 \_\_\_\_\_

C \_\_\_\_\_ 林涛 \_\_\_\_\_

D \_\_\_\_\_ 吴小明 \_\_\_\_\_

E \_\_\_\_\_ 李华 \_\_\_\_\_

F \_\_\_\_\_ 王莉莉 \_\_\_\_\_

比如：

A \_\_\_\_\_ 李雷 \_\_\_\_\_

接下来，请就您在上页所列的每个人，回答表格 1 和 2 中的问题,并在数字上圈出您的答案。您的答案无所谓对或错，只要是您的真实体验和想法即可。

比如：

您所列的人名	A 李雷	B 韩梅梅	C 林涛	D 吴小明	E 李华	F 王莉莉
2-1.您认识这个人多久了？	① 少于半年 2. 半年到 1 年 3. 1 年到 2 年 4. 2 年到 3 年 5. 3 年以上	1. 少于半年 2. 半年到 1 年 ③ 1 年到 2 年 4. 2 年到 3 年 5. 3 年以上	1. 少于半年 2. 半年到 1 年 3. 1 年到 2 年 ④ 2 年到 3 年 5. 3 年以上	1. 少于半年 2. 半年到 1 年 3. 1 年到 2 年 4. 2 年到 3 年 ⑤ 3 年以上	1. 少于半年 2. 半年到 1 年 3. 1 年到 2 年 ④ 2 年到 3 年 5. 3 年以上	1. 少于半年 ② 半年到 1 年 3. 1 年到 2 年 4. 2 年到 3 年 5. 3 年以上

表格 1. 您和以上所列人员的关系

您所列的人名	A	B	C	D	E	F
2-1. 您和这个人在同一个部门吗？	1. 是 2. 否	1. 是 2. 否	1. 是 2. 否	1. 是 2. 否	1. 是 2. 否	1. 是 2. 否
2-2.您认识这个人多久了？	1. 少于半年 2. 半年到 1 年 3. 1 年到 2 年 4. 2 年到 3 年 5. 3 年以上	1. 少于半年 2. 半年到 1 年 3. 1 年到 2 年 4. 2 年到 3 年 5. 3 年以上	1. 少于半年 2. 半年到 1 年 3. 1 年到 2 年 4. 2 年到 3 年 5. 3 年以上	1. 少于半年 2. 半年到 1 年 3. 1 年到 2 年 4. 2 年到 3 年 5. 3 年以上	1. 少于半年 2. 半年到 1 年 3. 1 年到 2 年 4. 2 年到 3 年 5. 3 年以上	1. 少于半年 2. 半年到 1 年 3. 1 年到 2 年 4. 2 年到 3 年 5. 3 年以上
2-3. 您和这个人在过去合作过多少个项目？	1. 从来没有 2. 1 3. 2 4. 3 5. 多于 3 个	1. 从来没有 2. 1 3. 2 4. 3 5. 多于 3 个	1. 从来没有 2. 1 3. 2 4. 3 5. 多于 3 个	1. 从来没有 2. 1 3. 2 4. 3 5. 多于 3 个	1. 从来没有 2. 1 3. 2 4. 3 5. 多于 3 个	1. 从来没有 2. 1 3. 2 4. 3 5. 多于 3 个
2-4. 您和这个人工作上的合作关系有多近？	1. 非常近 2. 比较近	1. 非常近 2. 比较近	1. 非常近 2. 比较近	1. 非常近 2. 比较近	1. 非常近 2. 比较近	1. 非常近 2. 比较近

	3. 一般近 4. 比较远 5. 非常远	3. 一般近 4. 比较远 5. 非常远	3. 一般近 4. 比较远 5. 非常远	3. 一般近 4. 比较远 5. 非常远	3. 一般近 4. 比较远 5. 非常远	3. 一般近 4. 比较远 5. 非常远
2-5. 您从这个人那里获取项目相关知识的频率是?	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次
2-6. 当这个人向我求助项目相关问题时, 我觉得有责任帮助她/他。	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意
2-7. 当我向这个人咨询项目相关问题时, 她/他总是能向我提供经过深思熟虑的回答, 而不是简单敷衍。	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意

2-8. 您向这个人分享项目相关知识的频率是?	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次
2-9. 我和这个人之间会有一些工作以外非正式的活动, 比如周末一起出去玩, 一起看电影等。	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意



2-10. 我很享受和这个人一起工作。	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意
2-11. 这个人的专业知识和我差别很大。	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意
2-12. 这个人的专业知识对我的工作很有价值。	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意

2-13. 当我需要项目上的帮助时，这个人总是能提供足够的时间来帮我解决问题。	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意
2-14. 从这个人那里获取的知识大多数是一些经验之谈，不太容易用文档记录下来。	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意
2-15. 多大程度上您认为从这个人那里获取的知识对您来说是新的？	1. 一点也不新 2. 有点新 3. 中立	1. 一点也不新 2. 有点新 3. 中立	1. 一点也不新 2. 有点新 3. 中立	1. 一点也不新 2. 有点新 3. 中立	1. 一点也不新 2. 有点新 3. 中立	1. 一点也不新 2. 有点新 3. 中立

	4. 比较新 5. 非常新	4. 比较新 5. 非常新	4. 比较新 5. 非常新	4. 比较新 5. 非常新	4. 比较新 5. 非常新	4. 比较新 5. 非常新
2-16. 我觉得向这个人分享我的知识和信息耗费个人时间和精力。	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意
2-17. 相比于其他同事, 您觉得这个人在项目工作中贡献新的知识方面的表现怎样?	1. 远低于平均水平 2. 稍低于平均水平 3. 平均水平 4. 稍高于平均水平 5. 远高于平均水平	1. 远低于平均水平 2. 稍低于平均水平 3. 平均水平 4. 稍高于平均水平 5. 远高于平均水平	1. 远低于平均水平 2. 稍低于平均水平 3. 平均水平 4. 稍高于平均水平 5. 远高于平均水平	1. 远低于平均水平 2. 稍低于平均水平 3. 平均水平 4. 稍高于平均水平 5. 远高于平均水平	1. 远低于平均水平 2. 稍低于平均水平 3. 平均水平 4. 稍高于平均水平 5. 远高于平均水平	1. 远低于平均水平 2. 稍低于平均水平 3. 平均水平 4. 稍高于平均水平 5. 远高于平均水平
2-18. 我经常和这个人一起为项目想出创新性的解决方案。	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意
2-19. 我了解这个人有什么样的专业知识。	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意
2-20. 我觉得从这个人那里获取知识耗费时间和精力。	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意
2-21. 你和这个人除工作之外的朋友关系有多近?	1. 很远的朋友 2. 不太熟的朋友 3. 一般朋友	1. 很远的朋友 2. 不太熟的朋友 3. 一般朋友	1. 很远的朋友 2. 不太熟的朋友 3. 一般朋友	1. 很远的朋友 2. 不太熟的朋友 3. 一般朋友	1. 很远的朋友 2. 不太熟的朋友 3. 一般朋友	1. 很远的朋友 2. 不太熟的朋友 3. 一般朋友

	4. 比较近的朋友 5. 非常近的朋友	4. 比较近的朋友 5. 非常近的朋友	4. 比较近的朋友 5. 非常近的朋友	4. 比较近的朋友 5. 非常近的朋友	4. 比较近的朋友 5. 非常近的朋友	4. 比较近的朋友 5. 非常近的朋友
2-22.我宁愿选择不和这个人在一个团队。	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意

2-23.我需要和这个人合作来完成项目。	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意
2-24. 我感觉自己和这个人很相似。	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意	1. 强烈不同意 2. 不同意 3. 中立 4. 同意 5. 强烈同意

Qn2-25. 在过去半年内，您和您所列出的同事用以下交流模式交流的频率是多少？请在数字上圈出您的答案。您的答案无所谓对或错，只要是您的真实体验和想法即可。

表 2.您和以上所列人员交流使用的传媒工具

交流模式	A	B	C	D	E	F
事前约好的面对面会议	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次
临时安排的面对面会议	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次
电子邮件	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次
电话	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次
即时聊天工具（比如 QQ, MSN 等）	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次

社交媒体（比如微博，开心网，人人网等）	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次
其他，请指明- _____	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次	1. 从不 2. 少于1周1次 3. 一周1次 4. 少于每天一次 5. 每天至少一次

### APPENDIX III SURVEY ITEMS FOR STUDY ONE

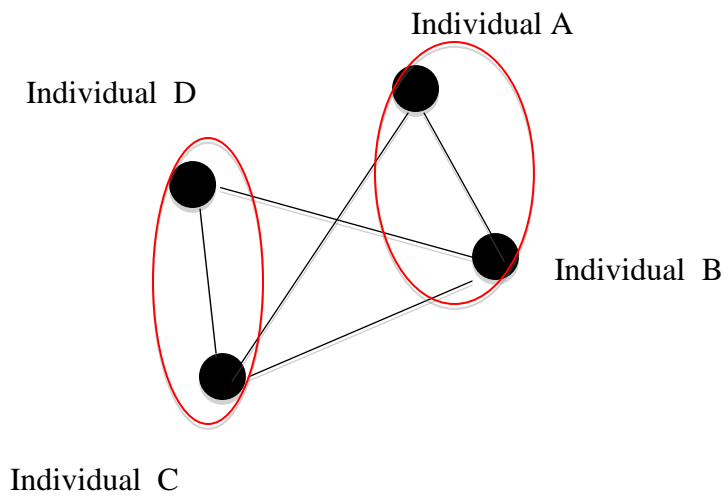
Measurements		
Construct	Items	Citations
Prior working ties	How many common projects have you worked with this person previously?	Sosa 2011
Work duration	How long have you known this person ?	Zhou et al. 2009
Seek cost	In the light of such interpersonal risks and obligations, please indicate the extent to which you feel that seeking information/advice from this person is costly.	Borgatti and Cross, 2003
Contribute cost	In the light of such interpersonal risks and obligations, please indicate the extent to which you feel that contributing information/advice from this person is costly.	Borgatti and Cross, 2003
Cognitive ties	I know what skills and expertise this person has.	Borgatti and Halgin, 2011
Affective ties	I enjoy working with this person.	Amabile et al. 2005
Knowledge seeking ties	How often do you seek project-related information from this person?	Borgatti and Cross, 2003
Knowledge contributing ties	How often do you contribute project-related information from this person?	Wasko and Faraj, 2005
Media multiplexity	How often do you use each of the following media to communicate with each of the identified person?	Haythornthwaite and Wellman, 1998
Expertise diversity	To what extent do you think the knowledge receive from this person is new to you?	Sosa, 2011
Expertise responsiveness	When asking project-related questions, to what extent does this person respond with thought-through answer and not just a formal reply?	Fliaster and Schloderer, 2010
Creativity	I often develop new ideas with this person when solve the problems in the project tasks.	George and Zhou, 2001

## APPENDIX IV SURVEY ITEMS FOR STUDY TWO

Measurements		
Construct	Items	Citations
Inspirational Leadership	<ol style="list-style-type: none"> <li>1. My leader makes everyone in the team enthusiastic about the team's assignments.</li> <li>2. My leader encourages me to express my ideas and opinions.</li> <li>3. My leader has a sense of mission that he/she transmits to me.</li> <li>4. My leader is an inspiration to me.</li> <li>5. My leader excites us with his/her visions of what we may accomplish if we work together as a team.</li> <li>6. My leader makes us believe we can overcome anything if we work together as a team.</li> </ol>	Bass 1985, Spreitzer et al 1999
Reciprocity	<ol style="list-style-type: none"> <li>1. When I receive help, I feel it is only right to give back and help others.</li> <li>2. Members should return favors when other members are in need.</li> <li>3. If my team member does me a favor, I am responsible to do something in return.</li> </ol>	Wasko and Faraj, 2000; Tetrick et al. 2004; Eisenberger, et al. 1987
Commitment	<ol style="list-style-type: none"> <li>1. I feel a strong sense of belonging to my team.</li> <li>2. It wouldn't be too costly for me to leave my team now (reverse).</li> <li>3. I really feel as if this team's problems are my own.</li> </ol>	Meyer, Allen, and Smith 1993
Technology support for contextualization	<p><b>Technology support for cognitive contextualization</b> To what degree do the technologies that you used in you team (e.g. wikis, knowledge management systems, Lotus Notes) enabled you to:</p> <ol style="list-style-type: none"> <li>1. Easily know who contributed a piece of knowledge.</li> <li>2. Easily find specific entries that have been contributed by specific team members.</li> <li>3. Easily view annotations and comments on knowledge made by other members.</li> <li>4. Easily allow team members to find summaries as well as details.</li> <li>5. Easily label any entry with multiple key words it pertains to.</li> <li>6. Easily view annotations and comments on knowledge in team's repository made by other team members.</li> </ol>	Majchrzak et al. 2005; Boland et al. 1994
	<p><b>Technology support for affective contextualization</b> To what degree do the technologies that you used in you team (e.g., Facebook, Twitter, Myspace) enable you to:</p> <ol style="list-style-type: none"> <li>1. Share your photos or personal information with other members.</li> <li>2. Tell my past stories to other members.</li> <li>3. Express my opinions in my posts.</li> <li>4. Present information about myself in my profile.</li> <li>5. Let other team members visit my personal web pages.</li> </ol>	Ma and Agarwal 2007; Schau and Gilly 2003
OCB	<p><b>Knowledge Sharing</b></p> <ol style="list-style-type: none"> <li>1. I shared my expertise to help my team members solve their task problems.</li> <li>2. I enjoy sharing my working experience to provide solutions to other team members.</li> <li>3. I share my knowledge when other members need.</li> </ol>	Wasko and Faraj 2005; Koh and Kim 2003
	<p><b>Interpersonal Helping</b></p> <ol style="list-style-type: none"> <li>1. I generally help others who have heavy workloads.</li> <li>2. I go out of the way to help new members in my team.</li> <li>3. I take a personal interest in the well-being of other team members.</li> </ol>	Skarlicki and Latham 1995

# APPENDIX V INLLUSTRATION OF DYADS AND DATA ORGANIZATION

## 1. Illustration of Dyads



Note: red circles represent a dyad. Similarly, individual A/B, A/C, B/C,B/D, and C/D are all dyads.

## 2. Illustration of Data Organization

Illustration of Data Organization				
	A	B	C	D
A	-	2	2	-
B	3	-	1	1
C	4	5	-	3
D	-	1	5	-

Note: Data was organized as matrix shown above.