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Effects of Social Capital and Knowledge Integration on Innovation Performance: An Example of Virtual Teams

Jieyi LI¹, Xiaoxiao WAN², Xia WANG³

Abstract

With the rapid development of economic globalization and information technology, virtual teams has become widely accepted. Aiming at virtual teams in the Yangtze River Delta, total 429 copies of questionnaire are distributed for this study and total 367 valid copies are retrieved, with the retrieval rate 85.5%. The relationships among social capital (structural dimension, relational dimension and cognitive dimension), integration of knowledge, information technology and innovation performance are verified with the data collected. The results reveal significant positive effects of social capital on knowledge integration of virtual team and social capital on innovation performance of virtual team, and knowledge integration partially mediates the effects of social capital on innovation performance of virtual team. The application of information technology weakens the effects of social capital on innovation performance and knowledge integration. Therefore, in face of a variety of information technologies, managers should select the suitable one for the team, and pay attention to establish a harmonious social relations network as well as coordinate the conflict and cooperation behavior among virtual team members, for promotion of the knowledge integration and innovation performance.

Keywords: virtual teams, social capital, innovation performance, knowledge integration, information technology, social network.

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Introduction

Industrial competition has become fierce because of global regional economic integration, the trade barriers in various countries have been collapsing since various globally international organizations are established, and the rapid development of information technology and grid technology have shortened the geographic distance (Koskinen & Vanharanta, 2002). Information technology has become the primary productivity and penetrated in business management so that it develops critical functions in the promotion of corporation innovation performance. The rapid development of information technology, especially the emergence of Internet, cloud computing and big data, has resulted in the qualitative changes of business management model and employee communication. Virtual teams have gradually become the trend of organizational change and the important organizational form under knowledge-based economy and started to replace traditional teams in certain organizational tasks. The emergence of virtual teams has actually changed organizational structure and operation forms, overcome organization limits, integrated internal and external resources of organizations, and adjusted to environmental changes with the rapidest speed.

China plays a significant role in global economy and presents critical effects on the economic operation of other countries. Particularly, western management thoughts have penetrated in Chinese enterprises and caused certain catalysis in the development and growth. Nevertheless, different from western culture, Chinese society presents the cultural characteristics of relation orientation, harmony orientation and high context communication based on Confucianism, which enhance the complexity of teams. Current research on virtual teams mainly focuses on western society and explore issues related to virtual teams under western context. However, it is still short of a comprehensive theory framework to studies on virtual teams under both Chinese cultural context and modern information technology context. Besides, the relevant theory and practice research is considered weak, and there is still a gap between research results and policy demands. Under the context of conflict between Confucianism and information technology, the management strategies in virtual teams could assist Chinese enterprise managers in implementing the relative strategy and measure so as to promote the development of Chinese enterprises. Based on both Chinese cultural context and modern information technology context, this study stresses on the effects of social capital on innovation performance of virtual teams, and extends the research focus to the relationship between knowledge integration and innovation performance upon discussing the dimensions and structure of social capital of virtual teams from the viewpoint of social network, then proposes management strategies accordingly for promoting innovation performance of virtual teams.

Literature review

Virtual team (VT)

Townsend, DeMarie, and Hendrickson (1998) indicated that a virtual team was composed of cross-region and cross-organization members who were associated through communication and information technologies and attempted to complete organizational common tasks. A virtual team could be the combination of (1) modern communication technology, (2) effective trust and team education, and (3) employing the most suitable people for cooperation, where personnel were the key factor. Zigurs (2003) gave a more satisfactory explanation to virtual team that a virtual team was the group formed by individuals, who were dispersed in different dimensions of area, structure, time, and cultural background and mainly connected through information and communication technology to achieve the organizational goal. Compared to traditional teams, Castellani, Jimenez, and Zanfei (2013) considered that virtual teams could not exchange face to face all the time but could integrate the specialties of members for the maximum benefits.

Social capital

Frick, Eriksson, and Hallen (2011) regarded social capital as the acquisition of implicit and explicit resources through relation network. Burt, Jannotta, and Mahoney (1998) considered social capital as a structure hole which was the opportunity to acquire critical knowledge. According to relevant research, social capital of virtual teams under Chinese cultural context is defined as a resource exchange ability in a information-technology-based internal networking among virtual team members, embedded in the factors of Chinese typical nepotist society. Nahapiet and Ghoshal (1998) proposed relational dimension, structural dimension, and cognitive dimension for social capital. Structural dimension and relational dimension proposed from the structural perspective and relational embeddedness proposed by Grant (1996). Tsai and Ghoshal (1998) specifically set three dimensions as social function connect, trust and reliability, and common vision. Merlo, Bell, and Whitwell (2006) divided it into three dimensions: open exchange, culture of trust, and shared vision. Summing up above literatures, (1) structural dimension, (2) relational dimension, and (3) cognitive dimension proposed by Nahapiet and Ghoshal (1998) are used as the direction for the questionnaire design in this study.

Innovation performance

Ahuja and Curba (2001) explained innovation performance, in a narrow sense, it refers to the evaluation mechanism of introduction of invention and creation into the market. In a broad sense, it refers to the achievements of invention, technology and innovation in the whole process from concept generation to introduction of

invention and creation into the market. Belderbos, Carree, and Lokshin (2004) measured innovation performance from the aspects of process innovation and product innovation. Dautel (1999) regarded innovation performance as the performance promotion of an enterprise acquired through product or process innovation. Jantunen (2005) considered that corporate innovation performance was originated from performance promotion induced in product innovation or process innovation. From the perspective of innovation subject, Daft (1978) classified innovation into technology innovation and management innovation. Prajogo and Ahmed (2006) further divided technology innovation into product and service innovation and production process innovation. Management innovation was also divided into organizational structure innovation, organizational climate innovation, and marketing innovation. Dautel (1999) mentioned that innovation performance did not simply contain product innovation, but covered process and efficiency innovation and proposed product innovation effectiveness, innovation project efficiency, and process innovation effectiveness as the dimensions of innovation performance.

Knowledge integration

Zack (1999) regarded knowledge integration as an organization organizing, sharing, and spreading knowledge to various departments to enhance the convenience of use and effectively utilize knowledge so as to achieve favorable performance. Zollo and Winter (2002) held that constant experience accumulation, knowledge association, and knowledge systemization are dynamic abilities, achieving knowledge integration. Henderson and Clark (1990) proposed knowledge integration is the knowledge structure of an organization from the perspective of structure innovation, driven by external market demands, passing certain solution to generate new knowledge. Huang and Newell (2003) regarded knowledge integration as a common belief to form, state, and redefine through the interaction among team members in an uninterrupted process. Learning experiences and knowledge from others to change personal work steps was not simply to search and copy. In the research model of Bresman (2013), such a process contained identification, translation, adoption, and continuity.

Correlations among social capital, knowledge integration, innovation performance of virtual teams, and information technology

Grant (1996) pointed out the irreplaceable function of social capital for knowledge integration and the apparent effects of social capital on knowledge integration of virtual teams. First, the internal social capital and information technology platform of a virtual team offered the route for the team members acquiring knowledge internally. Second, the higher trust could more possibly result in knowledge integration. Okhuysen and Eisenhardt (2002) also concluded

that knowledge integration could be understood after the tiny social interaction between individuals was realized. In other words, the networking established by individuals in an organization would support individual and organizational knowledge integration. De Long and Fahey (2000) also revealed the effects of trust on knowledge transfer intention and quota of employees. The dimensions for social capital of a virtual team affect the knowledge integration of team members in layers. Structural dimension demonstrates the higher structure standard, the richer knowledge integration channels; relational dimension explains that higher trust could deepen knowledge share; and cognitive dimension reveals that similar value and common languages allow knowledge integration being easily implemented. Accordingly, the following hypotheses are proposed.

H1: Social capital presents positive correlations with knowledge integration of virtual teams.

Koch (2011) mentioned that knowledge integration could promote team performance through technology innovation and management innovation. Accordingly, knowledge integration presents important function on organizational decision-making and organizational performance. Ritala, Olander, Michailova, and Husted (2012) revealed that knowledge integration could help an organization acquire favorable innovation performance. Apparently, knowledge integration could reinforce innovation performance of a virtual team through information technology. The promotion of innovation performance through social capital was also supported in literatures. According to the data collected from 210 enterprises, Maurer, Bartsch, and Ebers (2011) verified the effects of social capital on technology innovation performance through capital resources, information resources, and knowledge acquisition. Ahn and Kim (2017) proposed that social capital could offer an enterprise with access to external resources and opportunities to expand markets so as to help the enterprise enhance innovation capability and further promote innovation performance. According to above literatures, the following hypotheses are proposed.

Hypothesis 2: Knowledge integration capability appears positive correlations with innovation performance of virtual teams.

Hypothesis 3: Social capital presents positive correlations with innovation performance of virtual teams.

Hypothesis 4: Knowledge integration reveals mediation effects on the positive relations between social capital and innovation performance of virtual teams.

Information technology application has changed the traditional face-to-face collaborative practice (Majchrzak, Malhotra, & John, 2005). With the application of electronic information technology, virtual teams can overcome the barriers of time, region or organizational boundaries. But boundary-blurring, electronic communication and cultural internationalization lead virtual teams to information

distortion, poor communication and low efficiency of knowledge operation. Moreover, information routing from multiple channels can cause a very serious threat of data separation and business intelligence gap. It is very effective for the automatic use of conventional explicit knowledge by electronic information technology, but it has a very limited effects on the acquisition and integration of tacit knowledge (Griffith & Sawyer, 2003). Information technology application has greatly supported virtual teams to the information communication, but it also brings about some negative effects, such as information virus, information penetration, and increasing dependence on information. Information technology application may lead to suspicion and mistrust among members, thus affecting the quality of team interaction and team consensus formation. It is difficult for virtual teams to communicate information related to emotional themes and work performance used information technology. Information technology is not used properly or is over relied on, thus may bring many problems which may hinder the effective operation of teams and have a negative impact on innovation performance. Accordingly, the following hypotheses are proposed.

Hypothesis 5: Information technology has a negative moderation effect on the relationship between social capital and knowledge integration of virtual teams.

Hypothesis 6: Information technology has a negative moderation effect on the relationship between social capital and innovation performance of virtual teams.

Methodology

Measurement of research variable

Social capital. Based on Likert's 7-point scale, three dimensions for social capital proposed by Nahapiet and Ghoshal (1998) are applied to the questionnaire. (1) Structural dimension contains 4 questions, with the Cronbach's α reliability coefficient 0.662, (2) relational dimension includes 4 questions, with the Cronbach's α reliability coefficient 0.818, and (3) cognitive dimension covers 4 questions, with the Cronbach's α reliability coefficient 0.830.

Innovation performance. Referring to Leiponon's (2000) points of view, innovation performance is measured with market performance of product innovation, number of new product developed, novelty of new product, new product in the market for the first time. The Cronbach's α reliability coefficient appears 0.854.

Knowledge integration. Referring to Grant (1996), the implicit effects of knowledge integration include the efficacy, scale, and flexibility of knowledge integration. The mediator is measured from the aspects of knowledge contribution and knowledge composition in this study. Total 4 questions are covered, and the Cronbach's α reliability coefficient is 0.720.

Information technology. Referring to Majchrzak *et al.* (2005), information technology is measured with information communication tool, convenience of electronic media, influence of the information technology on the work efficiency and ability. The Cronbach's α reliability coefficient appears 0.827.

Research sample

In consideration of the regional fuzziness of virtual team members, the questionnaires are distributed in Jinhua, Shanghai and Jiangsu in China. The questionnaires are distributed (1) to the enterprises in Jinhua with the assistance of the research team, (2) through the Internet survey by indirect transmission via personal connection, and (3) through information technology, like E-mail. Total 429 copies of questionnaire are distributed, and 389 copies are collected, including 367 valid ones. The effective retrieval is 85.5%. The data are proceeded Regression Analysis with SPSS24.0.

Results and Discussion

The Regression Analysis results are shown in *Table 1* and *Table 2*. Social capital is regarded as the independent variable, innovation performance is the dependent variable, and knowledge integration is the mediator variable, Information technology is the moderator variable. The discussion is divided into six cases.

Case 1 presents the regression of social capital to knowledge integration(M1-M3). From *Table 1*, social capital (structural dimension $\beta = 0.510$, $P < 0.001$, relational dimension $\beta = 0.572$, $P < 0.001$, cognitive dimension $\beta = 0.576$, $P < 0.001$) reveals significantly positive relations with knowledge integration that H1 are supported.

Case 2 presents the regression of knowledge integration to innovation performance (M4). From *Table 1*, knowledge integration ($\beta = 0.878$, $P < 0.001$) shows remarkably positive relations with innovation performance that H2 are supported.

Case 3 presents the regression of social capital to innovation performance (M5-M7). From *Table 1*, social capital (structural dimension $\beta = 0.640$, $P < 0.001$, relational dimension $\beta = 0.680$, $P < 0.001$, cognitive dimension $\beta = 0.686$, $P < 0.001$) reveals significantly positive relations with innovation performance that H3 are supported.

Case 4 (M8-M10) presents the regression of social capital to knowledge integration and innovation performance, and knowledge integration is added as the mediator in Case 4. From *Table 1*, contrast cases 1 to cases 4, the β of structural dimension remarkably dropped from 0.640($P < 0.001$) to 0.277($P < 0.001$), and relational dimension notably dropped from 0.680($P < 0.001$) to 0.399($P < 0.001$), and cognitive dimension notably dropped from 0.686($P < 0.001$) to 0.394($P < 0.001$).

It reveals the mediation effects of knowledge integration on the relations between social capital and innovation performance that H4 are supported.

Table 1. The results of regression models for testing four cases of mediation

	Case 1			Case 2	Case 4
Dependent / Independent	Knowledge integration			Innovation performance	
Social capital	M1	M2	M3	M4	M8
Structural dimension	0.510***				0.277***
Relational dimension		0.572***			
Cognitive dimension			0.576***		
Knowledge integration				0.878***	0.711***
R ²	0.307	0.476	0.542	0.577	0.624
	Case 3			Case 4	
Dependent / Independent	Innovation performance			Innovation performance	
Social capital	M5	M6	M7	M9	M10
Structural dimension	0.640***				
Relational dimension		0.680***		0.399***	
Cognitive dimension			0.686***		0.394***
Knowledge integration				0.596***	0.508***
R ²	0.361	0.503	0.575	0.642	0.588

Note: N=367; * stands for p<0.05, ** for p<0.01, *** for p<0.001.

Case 5(M11- M16) presents the regression of information technology to social capital and knowledge integration, and information technology is added as the moderator in Case 5. From Table 2, social capital * information technology (M14, $\beta = -0.068$, $P < 0.05$; M15, $\beta = -0.015$, $P < 0.05$; M16, $\beta = -0.004$, $P < 0.05$) reveals significantly negative relations with knowledge integration. And that the β of structural dimension remarkably dropped from 0.149($P < 0.01$) to 0.116($P < 0.01$), and relational dimension notably dropped from 0.348($P < 0.001$) to 0.343($P < 0.001$), and cognitive dimension notably dropped from 0.447($P < 0.001$) to 0.444($P < 0.001$). It reveals the negative moderation effects of information technology on the relations between social capital and knowledge integration that H5 are supported.

Case 6 (M17-M22) presents the regression of information technology to social capital and innovation performance, and information technology is added as the moderator in Case 6. From *Table 2*, social capital * information technology (M120, $\beta = -0.151$, $P < 0.001$; M21, $\beta = -0.119$, $P < 0.001$; M22, $\beta = -0.091$, $P < 0.001$) reveals significantly negative relations with innovation performance. And that the β of structural dimension remarkably dropped from 0.212 ($P < 0.001$) to 0.136 ($P < 0.001$), and relational dimension notably dropped from 0.363 ($P < 0.001$) to 0.320 ($P < 0.001$), and cognitive dimension notably dropped from 0.502 ($P < 0.001$) to 0.431 ($P < 0.001$). It reveals the negative moderation effects of information technology on the relations between social capital and innovation performance that H6 are supported.

Table 2. The results of regression models fortesting two cases of moderator

		Case 5					
Dependent / Independent	Knowledge integration						
Social capital	M11	M12	M13	M14	M15	M16	
Structural dimension	0.149 ***			0.116 ***			
Relational dimension		0.348 ***			0.343 ***		
Cognitive dimension			0.447 ***			0.444 ***	
Information technology	0.498 ***	0.312 ***	0.269 ***	0.462 ***	0.301 ***	0.268 ***	
Structural * Information				-0.068*			
Relational * Information					-0.015*		
Cognitive * Information						-0.004 *	
R ²	0.482	0.517	0.585	0.489	0.517	0.585	
		Case 6					
Dependent / Independent	Innovation performance						
Social capital	M17	M18	M19	M20	M21	M22	
Structural dimension	0.212 ***			.136 ***			
Relational dimension		0.363 ***			0.320 ***		

Cognitive dimension			0.502 ***			0.431 ***
Information technology	0.589 ***	0.433 ***	0.362 ***	0.508 ***	0.347 ***	0.327 ***
Structural * Information				-0.151 ***		
Relational * Information					-0.119 ***	
Cognitive * Information						-0.091**
R ²	0.544	0.562	0.633	0.573	0.581	0.644

Note: N=367; * stands for $p < 0.05$, ** for $p < 0.01$, *** for $p < 0.001$.

Conclusion

Based on thoroughly theoretical exploration, virtual teams of enterprises and organizations in Jiangsu-Zhejiang-Shanghai area are investigated in this study. Besides, the dimensions in social capital of virtual teams are measured in consideration of the cultural background and the characteristics of virtual teams. The major research conclusions are summarized as below.

1. *Knowledge integration* of a virtual team could help the formation of innovation performance of the virtual team. The empirical analyses show that knowledge integration positively promotes innovation performance of a virtual team. Knowledge integration is the communication, sharing, and integration of information and knowledge among team members to generate new knowledge or promote team performance with the application of knowledge innovation. For a virtual team, knowledge contribution and integration are also the knowledge integration process which could assist teams in solving problems and promoting team innovation performance.

2. *Social capital* could help knowledge integration of a virtual team. The empirical analyses prove the three demensions of social capital have significantly positive effects on knowledge integration. That is, social capital, under Chinese cultural context, could enhance the heterogenous knowledge integration of a virtual team. As a consequence, the development of social capital of a virtual team can reduce costs for knowledge integration and reduce barriers in the knowledge integration process to further enhance the completion of team tasks and promote team innovation performance.

3. *Knowledge integration* presents mediation effects on the promotion of innovation performance with social capital. Above research findings show the mediation effects of knowledge integration on the formation of innovation performance of a virtual team, i.e. the mediator between social capital and innovation performance. The knowledge integration standard of a virtual team is enhanced because of promoted social capital, and knowledge integration presents remarkably positive effects on the formation of innovation performance. In this case, an enterprise should pay attention to the promotion of team knowledge integration, strengthening and reinforcing the social capital, so as to better implement teamwork and promote innovation performance.

4. *Information technology* weakens the effects of social capital on innovation performance and knowledge integration. For virtual teams, information technology application can weaken the positive influence relationship between social capital and knowledge integration; it can also weaken the positive influence between social capital and innovation performance. In other words, information technology application has changed the development track of team social capital. This paper explores the mixed effects of the formation mechanism of virtual teams' innovation performance, and confirms that the application of information technology has a negative regulatory effect on the relationship between social capital and knowledge integration, as well as the relationship between social capital and innovation performance.

Suggestions

According to above analyses, suggestions for management practice are proposed as following.

– Due to the obviously positive effects of social capital on knowledge intergration and innovation performance, some measures reinforcing social capital should be taken: (1) Establishment and cultivation of trust among members is of great significance. In order to complete virtual team tasks, an enterprises should build favorable trust among members to enhance individual exchange, share, and mutual assistance among members and further cultivate harmonious team climate to reinforce the belongingness and security of team members in order to smoothly complete team tasks. (2) Promoting the consistency of team goals plays an important role. An enterprise should define a clear task goal to team members at the establishment of the team for the consensus. Based on it, a common language should be cultivated for the team to reduce unnecessary conflict in the process and smoothly achieve the final goal through effective communication. (3) Helping employees establish good interpersonal relationship is of necessary. Under the special Chinese culture background, virtual team members should help employees establish good interpersonal relationship, build “interpersonal circle” and “relationships network” among team members to enhance the emotion and deepen the trust. For this reason, face-to-face internal communication in a

certain time could be applied in a virtual team to share interests and preference for common topics beyond tasks to cultivate the members to build specific interpersonal relationship.

– Social capital of a virtual team and the heterogeneity enhance innovation performance, which lies in the mediation effects of knowledge integration. In this case, knowledge integration of a virtual team could be promoted from three dimensions. (1) Promoting knowledge share among team members. The formation of a knowledge exchange circle based on good private relationships could be encourage within a team. The Internet exchange tools, such as QQ, could be used for establishing exchange groups or exchange teams, regularly reporting results, and timely proceeding task communication. Matching with certain system regulations, the team members are encouraged to consult each other so as the form the knowledge supply in the team. (2) Promoting knowledge learning. Knowledge can be transformed into new knowledge merely by learning and exchange. A virtual team therefore has to cultivate the organizational culture of active learning and being good at learning. Third, encouraging members to proceed knowledge innovation and apply innovation. Employees at the post could combine acquired or learned knowledge with personal work property for regeneration or innovation application in order to break through the responsible tasks and further promote the innovation performance of the virtual team.

– Apply Information technology media rationally. In the era of information explosion, the opportunities of face-to-face communication among virtual team members are relatively lacking. A virtual team, with information technology as the communication base, could apply rich and multiple information technology media, such as establishing various exchange platforms, to attract the exchange and interaction among members, promote the interaction quality among team members, enhance interaction frequency, and encourage communication and exchange among members through various forms so that virtual team members could conveniently and smoothly exchange information. However, the role of information technology application is to support the operation of virtual teams, not to replace the management content of virtual teams. If virtual team members rely too much on information technology for communication, it may easily lead to information distortion. To promote the knowledge integration of virtual teams more conveniently and smoothly, to improve its innovation performance, the managers of virtual teams must consider the impact of communication mode on the communication quality of virtual teams, and grasp the applicability and applicability of information technology in the virtual teams.

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